Technical Report to IDRC

Building African Capacity in Science, Technology and Innovation Indicators

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Synthesis

This Project exemplified learning by doing, using and interacting. It was about case study teams responding to a Call for Proposals, issued by UNU-MERIT, doing research on the topics of their choice and producing reports accepted at international conferences and published on the UNU-MERIT website. At every stage an expert team of trainers and mentors supported the members of the case study teams. The knowledge gained from the Project contributed to the thinking that led to the new Inclusive Innovation for Development (IID) Programme of IDRC and the case study team members are participating in an emerging network of scholars in Africa that is considering the creation of Africalics, an African part of Globelics. Both case study team members, and members of the training team, are expected to contribute to IID projects in the future.

The IDRC supported UNU-MERIT Project, *Building African Capacity in Science, Technology and Innovation Indicators*. It started in July 2009 and was scheduled to end in July 2010 but was extended to December 31, 2011. During the two and a half years of the Project, the Project team of adjudicators and trainers issued a Call for Proposals to invite support for case study research into innovation activities in Mozambique, Rwanda and South Africa. Low response to the Call led to adjustments in the work plan of the project. These included the replacement of Rwanda by Senegal and a proactive search for teams that could satisfy the eligibility criteria of the Call. In the end, four case study teams were supported, one in Mozambique, one in Senegal and two in South Africa. Training planned originally for Mozambique and South Africa was consolidated into one event in South Africa in September 2010 and training for Senegal was integrated with a *Design and Evaluation of Innovation Policy in a Developing Countries* (DEIP) and an *Economics of Knowledge and Innovation* (EKI) workshop being offered by UNU-MERIT in Dakar, also in September 2010. Training included members of the four case study teams and eight graduate students supported by another IDRC grant.

With four case study teams, rather than the originally planned nine, resources were available to support a workshop in March 2011 to review the reports of the teams and to make recommendations for improvement and for dissemination of the reports. The team of trainers was re-engaged to support this improvement and to facilitate the submission of papers to appropriate conferences, especially the 2011 Globelics, and to work towards the reports appearing as UNU-MERIT Working Papers.

The fundamental purpose of the Project was capacity building in the teams of researchers and the raising awareness of the place of innovation indicators in public policy discussion. As the Project progressed, the sustainability of the capacity building became a priority and this has resulted in the strengthening of the networks of the researchers through conferences and access to further education. The reports, on innovation in the informal economy, in agriculture, in firms that are user innovators, and in the diffusion of telephone banking and related financial services in the Townships of South Africa have common elements of knowledge creation and different approaches to knowledge sharing that connect to global discussions. What makes the papers particularly relevant is their description of innovation activities at the grass roots level in a development context.

The Project built sustainable capacity and achieved its objective.

Contents

Research Problem

The objective, stated in the Project proposal, was capacity building, the training of approximately 35 researchers, practitioners and junior- to mid-level policy makers in the use and application of science, technology and innovation (STI) indicators. The question was whether this could be accomplished through a small grants competition and a related capacity building program.

The small grants competition was for support to research teams wishing to do case studies related to innovation and to comment on the potential for developing and using indicators of innovation activities coming out of their findings. The question was whether the case study teams could design a project, conduct interviews, and make a connection to possible indicators of innovation activity which could, were they produced, inform policy in developing countries.

The financial support for each case study was US$ 20,000, and, in the Call, three where allocated to each of the three target countries: Mozambique; Rwanda; and South Africa. In addition training workshops of three days duration were to take place in each of the three countries.

The training was expected to provide particiapants with the tools necessary to answer the following questions:

- what are STI indicators;
- why are STI indicators important to development;
- what kinds of indicators are relevant to developing countries;
- what are the strengths and weaknesses of indicators; and,
- how should STI indicators be used?

The combination of case studies and training was expected to promote understanding of indicator development and use in the target countries, to lead to teaching materials that were accessible in developing countries, and, to provide a record of the learning by all of the participants in the Project, the researchers, trainers and administrators.

Each of the case studies addressed a specific research problem. In generic form it was whether it was possible to identify and measure innovation activities in the domain of interest and to identify potential indicators which could be developed to inform public policy.

Research Findings

There are three levels of research findings in the Project: understanding the capacity of respondents to the Call (Appendix 1) to submit a proposal that met the eligibility criteria; understanding how to conduct a case study that had its own research objective but which had also to address the potential for the development of statistical indicators in the domain of study; and, the findings from the case studies themselves. All three levels of research findings relate to the principal objective of the Project, the building of (sustainable) capacity.

Responding to the Call

The running of the small grants competition, while not intended for the purpose, became research into the capacity of potential respondents to submit a credible proposal. The research was conducted by the team of adjudicators/trainers. The adjudication process was a collective act in determining what could work and what could not work.

The first finding was that there was reluctance on the part of researchers in the target countries to undertake empirical research. This was evident from the response to the Call for this Project and for the related Project (104655) which offered support to graduate students to do empirical work related to innovation as part of their doctoral studies. This may be due to a lack of capacity to formulate questions and gather information from firms or individuals, or it may reflect a view that 'real' research involves econometrics. These are anecdotal observations as the sample is small.

The second finding, not peculiar to this Project or to developing countries, was that few of the applicants read the Call and even fewer took the time to understand the eligibility criteria.

Indicators related to innovation

An objective of this Project was an increase of the number of researchers who were both able and willing to do empirical research in support of indicator development and who could seek support for such activities. The finding, based on the adjudication of the responses to the Call, was that this was possible but it required mentoring as well as training. As the Project was a learning activity, the response to the finding was to shift emphasis from training to mentoring as the Project moved to completion. Three of the four responses to the Call were revised as a result of comments from the team of adjudicators to ensure that basic standards were met.

Case study findings

There were four case studies in three countries and they were conducted in three languages, English, French and Portuguese. The case study descriptions and the full set of findings are in the reports which are submitted separately in the document: *Building African Capacity in Science, Technology and Innovation Indicators: Reports of Four Case Studies*.

The Mozambican case study of user innovation in firms with twenty-five or more employees in Maputo province was the closest to innovation studies in developed economies in that it was a firm based study, examining innovation activities in the firm and specifically process innovation done by the firm for its own benefit, which is an example of user innovation. As a result of such user innovation, knowledge is created and, in developed countries where this has been studied, Canada, the Netherlands and the U.S., there is a propensity to give the knowledge away, or to freely reveal it. There is also evidence of the protection of knowledge using the standard intellectual property instruments, but free revealing happened. By contrast, in the cases studied in Mozambique, this transfer of knowledge was almost non-existent. The firms in Mozambique were self contained. They financed their own user innovation within the firm or in collaboration with other units of the firm and they kept the knowledge in the firm. A parallel case is found in the newly industrialized country of Korea, where lack of sharing is attributed to the dominance of the chaebols, the competitive environment and lack of trust. The key finding in Mozambique, that firms do not share knowledge resulting from user innovation, calls for a follow up study to probe this important point. The case study suggested statistical indicators related to the propensity to engage in user innovation and to share knowledge that could form the basis for a better understanding of these activities in Mozambique, leading to more effective innovation policy.

Trust was a factor in the study of the informal economy in Senegal, in the operation of networks in the informal economy, which were frequently based on kinship or affinity to some religious or other social organization. It was also a factor in finding the units to be examined in the case study. Respondents recommended other respondents. Clearly this did not give rise to a statistical sample, but it did support a case study that shed light on innovation in the informal sector in Senegal, whether it was for subsistence, or entrepreneurial, or behaving in a way that was close to that of similar units in the formal sector. The classification of the kinds of informal innovation and the role of social networks in supporting the activity formed a basis for suggesting statistical indicators that could be developed to contribute to the policy debate on how to support desirable activities in the informal sector, perhaps with a view to encouraging migration of economic units to the formal sector.

Social innovation was prominent in the study in KwaZulu Natal of farmers that engaged in grass roots innovation. There were two examples, the planting of a cash crop and what was needed to have a sufficient scale of production, and a new way of planting and caring for a traditional crop, in this case potatoes, in order to meet social needs. In the first case, there had to be a change in relations between a large land holder and the subsistence farms that surrounded the large land holding and the stimulus for this was the possible returns on growing bell peppers and selling them. For this community, this was a new or significantly improved product, new to them, and it required organizational innovation, or social innovation in order for it to be successful. What was important in this example was the inclusiveness of the activity that originated with the farmers. The agricultural research system in South Africa was not excluded from the activity, but the initiative came from the farmers, not from government supported agricultural research. In the second case, there was a social need to move from the hard work of digging furrows and burying seed potatoes and then weeding the fields, to a growing process that was less physically demanding and less labour intensive. In this case the seed potatoes were put on the ground and were covered with mulch. While the yield was lower, the labour productivity was comparable and this mattered when the farmers were older women, a consequence of the younger men having died of HIV/AIDS.

The fourth case study brought together social innovation and trust in the provision of banking services in the townships of South Africa, in this case Soweto, using mobile phones as the platform. The study examined the growth in the use of mobile phones in the townships and then the growth of the use of telephone banking by people who were poor. This was also an aspect of inclusive innovation as telephone banking empowered women who could manage their own accounts through the mobile phones and accumulate resources to support other entrepreneurial activities, or additional education. As well, precious time did not have to be allocated to going to a traditional branch bank to engage in banking transactions and literacy appeared not to have been a barrier to use of telephone banking once the pattern of keys to be pushed was memorized. The study focused on people who used telephone banking and it raised questions about the role of the user in demanding new financial services, such as insurance for animals, and identified the factors that influenced the use of telephone banking, one of which was trust in the service provider which resulted in a lower perception of risk.

Fulfilment of Objectives

The Project had a general objective and there were six specific objectives. What makes this Project remarkable is that its management team was able to adjust to a number of changing circumstances and challenges and still meet all but one of the objectives. It will be argued that the one objective not achieved was inappropriate for a project of this kind.

The general objective of the Project was to train thirty-five researchers and/or junior to mid-level policymakers in the techniques, approaches and user of science, technology and innovation indicators. That assumed that there would be nine case study teams and three training sessions at which there would be three case study teams, two IDRC supported graduate students, and locally invited experts. In the end, there were four case study teams, two training workshops, and one review workshop. Direct training was received by sixteen people supported by the Project or otherwise by IDRC. However, there were deliberate outreach activities to bring the message to a wider community in South Africa, consisting of meetings between members of the training team and government officials, the giving of public lectures, and special seminars, and spending time with graduate students not supported by the Project. This was made possible by a willingness on the part of the team members to go beyond the job description.

In Dakar, the lectures intended for the IDRC supported case study team members and graduate students were given to all participants in the UNU-MERIT training courses being offered there and, as a result, had a broader reach. In Senegal and in South Africa more than thirty-five researchers and/or junior to mid-level policy makers were exposed to the training initiatives of the Project.

There are six more specific objectives of the Project all but one of which were met.

1. *To raise awareness, relevance and critical thinking of science, technology and innovation indicators and their application in the development field.*

This was achieved through the work of the case study teams, mentored by the trainers, using the training tools of the Project. More broadly it was achieved by public lectures, seminars and the contribution of three lectures to the UNU-MERIT training workshops in Dakar. The Project Director met with the Indicators Reference Group (IRG), a sub-committee of the South African National Advisory Council on Innovation (NACI), to contribute precisely to this objective.

2. *To identify case studies on innovation processes in Mozambique, Rwanda or South Africa*

The decision was made, with the support of IDRC, to substitute Senegal for Rwanda. Once that was done, case studies on innovation processes were identified (Appendix 2), along with the team members.

3. *To determine the status of indicator development (and use) in country-specific cases in Mozambique, Rwanda and South Africa*

At the start of the Project, this objective was seen as a way of providing context for the work of the case study teams. However, it became clear as the responses to the Call were reviewed and the case study teams began their work that they were much more focused on carrying out the case studies than on reviewing the indictor development and use in their countries. Team members had an understanding of some of the exisiting indicators and how their projects could contribute to indicator development, but to develop the 'big picture' would have required resources that were better spent on the case studies, the reports, and the building of capacity. As this was a 'learning project' at all levels, it was decided that the Project would be better served by setting aside this objective and concentraing on the building of capacity. However, the objective was not forgotton.

At the same time as the Project work was happening, the AU/NEPAD African Science, Technology and Innovation (ASTI) initiative was bringing data together from R&D and innovation surveys in nineteen African countries, including the three involved in the Project. The African Innovation Outlook 2010 that resulted was launched in Addis Ababa in May 2011 and it responded directly to this objective. While the AIO was outside of the Project, three of the training team and the head of one of the case study teams were actively involved in it, albeit in different capacities. The conclusion is that the objective was achieved but not by this Project.

4. *To strengthen and develop the critical mass of African researchers with a common understanding of science, technology and innovation policy, in particular on the importance of relevant indicators in the policy process.*

The critical mass of African researchers in innovation studies has a long way to go before it is achieved. What this Project did was to nurture the work of seven, originally eight but one had to drop out, researchers with emphasis on understanding science, technology and innovation policy and its relevance to their work and, in turn, the relevance of indicators that could arise from their work to evidence-based policy. As the Project moved from its original conception of nine case studies in three countries to four case studies, more resources were allocated to developing the people involved and connecting them to policy networks in each of the countries being studied and in the African Union. These people have emerged from the Project well connected, able to design and execute projects, or direct them, and they will have an informed and critical view of the policy process and the place of indicators in that process.

5. *To develop local context relevant teaching materials*

Two of the books used for the training, which were outputs of the Project, addressed Africa and contextual issues more generally. In Senegal there was more emphasis on the informal economy, and in Mozambique the need not just to have, but to have implemented, an innovation strategy was a timely consideration. In South Africa there was interest in the changing of emphasis in the Department of Science and Technology with the arrival of a new minister. All of these local contextual issues were woven into the discussions. While the objective was achieved it is not reproducible, as much of the knowledge required to lead the discussions with the members of the case study teams was tacit and depended upon the experience of the members of the training team and response to changing circumstances in each of the target countries.

6. *To document the learning process taken by all participants*

This report is the documentation of the learning process of the training team. The milestones for the case study teams were their responses to the Call, their presentations at the Training Workshop, leading to their developing guidelines for their reports (Appendix 2), the first drafts of their reports presented to the Review Workshop, and the final versions completed by the end of January 2012. The responses to the Call are in a separate document, *Building African Capacity in Science, Technology and Innovation Indicators: The Call for Proposals and the Successful Responses*. The final reports are also in a separate document, *Building African Capacity in Science, Technology and Innovation Indicators: Reports of Four Case Studies.* The version provided in the separate document is the working paper on the UNU-MERIT website. The working papers benefitted from the comments of the trainer/mentors, and from exposure at the 2011 Globelics conference in Buenos Aires. In the case of the paper from Mozambique, comments were received at the Open and User Innovation Conference in Vienna 2011.

Project Design and Implementation

The Project design included a Call for Proposals, expert adjudication, award of grants, the design and undertaking of the case studies described in the proposals by the case study teams, the provision of training for the teams and eight graduate students funded separately by IDRC to support empirical work done as part of their thesis research, and, finally, the dissemination of the results.

The implementation of the Project was managed by the Project Manager, advised by the four experts in the team of adjudicators/trainers, and by the administrative staff of UNU-MERIT.

The Project Manager moved to UNU-MERIT on July 20, 2009 and involved the team of adjudicators/trainers in a review of the Call that formed part of the Project proposal. This was anticipated in the original proposal, as the adjudicators needed to agree that the proposals submitted in response to the Call would be subjected to straightforward and defensible adjudication. It was also a team building exercise. A revised call was issued on September 7, 2009 with a closing date of October 30 and a reporting date of December 18. The call was widely disseminated in English, French and Portuguese and it appeared on the SciDEV website as well as on the UNU-MERIT site.

Response was low and the team, with the exception of Prof. Bell, met at the Globelics conference in Dakar, Senegal, on October 4, 2009 to review the situation. At this point there was nothing from Rwanda, and some response from South Africa and Mozambique. It was agreed to evaluate existing proposals in November 2009 and to extend the Call to December 11, 2009. The Globelics conference was also used to encourage researchers to submit proposals and help was sought from the Program Officer, Innocent Butare, and from Francois Gasengayire of IDRC in Africa. Both were well connected in Rwanda.

At the end of the first Call, two proposals from Nigeria and one from Egypt were rejected as they did not deal with the target countries. Clearly the Call had not been read. Three proposals, one each from Rwanda, Mozambique and South Africa, were rejected as they sought support to do science or engineering and not to study innovative activities, build capacity or to identify possible indicators. It was evident that the eligibility criteria in the Call was not understood. Consideration was given to spending time working with a researcher in Rwanda who wanted to do econometrics on existing databases, but not do case studies, but in the end the project was rejected as being out of scope. Similar consideration, with a similar outcome, was given to a project in Mozambique to promote independent journalism. That left two proposals in South Africa that met the eligibility criteria and one was approved and the other project team was invited to resubmit, taking account of the comments of the team.

From the extended Call no new proposals were received. The revised proposal from South Africa was accepted and the team decided to be more aggressive in seeking good projects. The Program Officer was informed and there were two lines of attack. The first was a renewed contact with institutions of higher education and think tanks in Rwanda and the second was through the work of the Office of Science and Technology of the New Partnership for Africa's Development (NEPAD) with which the Project Manager was associated. This latter approach yielded potential projects in Rwanda, Senegal and Mozambique. As the proposal in Rwanda was not strong, and it was not clear that it met the eligibility criteria, only the projects in Senegal and Mozambique were approved. This resulted in a total of four out of nine possible projects which are listed in Appendix 2 and required a rethinking of the work of the Project.

The first decision was to abandon Rwanda (A discussion of this is given in Appendix 3), which was done with reluctance, but the capacity to prepare a proposal was not there, and to substitute Senegal. To protect the resources of the Project, the members of the case study team, and the graduate students from the related Project 104655 were to be trained as part of UNU-MERIT courses to be given in Dakar, the week of September 27, 2010, with the Project Manager giving three lectures as part of the two courses to ensure that the needs of the case study team and the graduate students would be met. Meetings where also held with the members of the case study team and with the graduate students in the course of which they received all of the printed course materials.

The second decision was to consolidate the training. As there was only one case study team in Mozambique, and no graduate students, the team members were invited to participate in the training session being offered in South Africa at IERI. This was to ensure the training of the three case study teams and six of the eight IDRC supported graduate students. The training agenda is given in Appendix 4. Input to the agenda was sought from the project leaders of the two case studies in South Africa during a visit to South Africa by the Project Manager in May, 2010 and through correspondence with the project leader of the team in Mozambique.

Three other decisions were taken that related to training. The first was to cover the on-site expenses for the training at IERI, such as administration, catering, equipment rental, printing, and local transportation and the second was to cover the travel expenses of the case study team in KwaZulu Natal and the graduate student doing his research in Rwanda. The mechanism was to contract with IERI to manage all of this, following the procedures of the university. The justification for the second decision related to training was that the research grants were small and that the researchers should not be disadvantaged by attending the training required by the Project.

The third decision was to allocate US$ 10,000 to editing the OECD book, *Innovation and the Development Agenda*, which came out of an IDRC supported OECD-UNESCO Workshop (105572) and a subsequent OECD meeting of development experts. The contract included delivering camera-ready copy and it was necessary in order to have the book at the September training workshop. It was one of three books used as training tools. The other two were *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management* by Fred Gault and *Knowledge to Policy: Making the Most of Development Research*, by Fred Carden. All three were co-published by IDRC and were provided to all workshop participants. The first two were Project outcomes as the co-publication was part of the Project budget. The third replaced another book, *Global Innovation in Emerging Economies*, by Prasada Reddy, that could not be available on time.

The fourth decision was to facilitate high quality reports of the work of the four case study teams and to consider commissioning material in related subject matter areas in order to produce a book on innovation in sub-Saharan Africa. Such a book was planned to be a concrete outcome of the Project on which proposals for subsequent projects could build. In the end, this proposal was abandoned as the case study teams were reluctant to commit the additional time need to produce a book, but they were very willing to put time in to producing final reports of high quality.

While these changes were being made, the Program Officer suggested that the training team be used in Mozambique to provide training and analytical capacity in support of work of IDRC with the government of Mozambique to develop a proposal for support to implement the 2006 Mozambique Science and Technology Strategy (MOSTIS). While meetings were held with the IDRC supported consultant in September 2010, it was agreed that the time was not appropriate for such an intervention.

The key point being made here is the flexibility of the management of the implementation which required the support of the IDRC Program Officers involved, the adjustment of budgets and targets by the UNU-MERIT administrative team and the constant involvement of the team of trainers, not just as adjudicators and trainers, but as advisors on the management of the Project.

As the case study field work was completed in early 2011, it was decided to hold a workshop to review the reports and to develop strategies for their improvement, for their dissemination, and for exposing the work of the team members to constructive criticism that could be gained by presenting papers at conferences. By this point, it was recognized that capacity had been built, but the question was how to make that capacity sustainable so that the members of the case study teams could continue to contribute to the innovation debate after the end of the Project. This is developed further in the section on Capacity Building.

Project Outputs and Dissemination

The revised Call (Appendix 1) was the first output of the Project. However the first output resulting from the work of a case study team was a short presentation of emerging work at the 2010 Open and User Innovation (OUI) Workshop at MIT, August 3 and 4, 2010, *User Innovation in Manufacturing Firms in Mozambique*, prepared by the case study team, Júlia Zita and Avelino Lopes, and the Project Manager, Fred Gault, and presented by Fred Gault (at no cost to the Project). This made the OUI community aware of the work in Mozambique and its similarity to work in Korea also presented at that Workshop. This paved the way for the report, *User Innovation in the Business Sector of Maputo Province in Mozambique*, to be accepted as the basis for a short presentation to a plenary session and a longer presentation to a parallel session at the 2011 OUI Workshop in Vienna. A significant point was that there was an active user innovation group in Portugal which formed a link with the Mozambicans as part of sustaining their involvement in this kind of work. The two members of the case study team from Mozambique, supported by the Project, participated fully in the 2011 OUI Workshop and received comments on their paper.

The second set of outputs was linked to the training workshop in September, 2010, at the Institute for Economic Research on Innovation (IERI) at the Tshwane University of Technology (TUT). The workshop itself was a Project output which attracted much attention in South Africa. Two of the trainers gave public lectures to large audiences, *The Role of Design and Engineering in African Innovation System Building*, by Martin Bell, and *The OECD Innovation Strategy and its Relevance to Development*, by Fred Gault, who also gave a seminar to the policy community, organized by the National Advisory Council on Innovation (NACI) of the Government of the Republic of South Africa, on *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management*, the subject of a book published by Edward Elgar and IDRC and used as one of the course texts.

The Training Workshop included presentations from the three case study teams that participated and from six of the eight IDRC supported graduate students. This, and the workshop in Senegal, provided the training for the graduate students that was part of the IDRC programme that supported their empirical work. Delivering that training was a Project Output. The agenda and for the Training Workshop is given in Appendix 4 as information on the UNU-MERIT training programmes in Dakar, *the Economics of Knowledge and Innovation* (EKI) and the *Design and Evaluation of Innovation Policy in a Developing Context* (DEIP). Presentations of the trainers are provided separately in *Building African Capacity in Science, Technology and Innovation Indicators: Presentation by Members of the Training Team.*

The UNU-MERIT training workshop in Senegal was an opportunity to provide training to the case study team and to two of the IDRC supported graduate students, one of which was a member of the case study team. This was arranged at no cost to the Project and the agenda is provided in Appendix 4. The presentations of the Project Manager, which are Project outputs, are provided in *Building African Capacity in Science, Technology and Innovation Indicators: Presentations by Members of the Training Team.*

All IDRC supported participants in the training workshops were given print copies of the OECD/Eurostat Oslo Manual that deals with the concepts and definitions needed to measure the activity of innovation copies of two Project outputs, *Innovation and the Development Agenda*, edited by Erika Kraemer-Mbula and Watu Wamae, co-published by IDRC and OECD and *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management* by Fred Gault, co-published by IDRC and Edward Elgar. They were also given *Knowledge to Policy: Making the Most of Development Research*, by Fred Carden, co-published by IDRC with Sage. The two books that were Project outputs were launched at the Globelics Conference in Kuala Lumpur in November 2010 and have since been widely disseminated in the developing world as they can be downloaded from the IDRC website. They are being used as course books at TUT-IERI in South Africa and as resource material in the South African Human Sciences Research Council Centre for Science, Technology and Innovation Indicators (CeSTII).

In Canada, *Innovation Strategies for a Global Economy* is used in graduate courses at UQAM and the Univeristy of Calgary.

The Review Workshop was a Project output (Appendix 5). However, unlike the Training Workshop, it was a meeting of all the case study team members and the trainers, but closed to all others with the exception of the IDRC Program Officer responsible for the Project. The focus was on the review of the case study reports with a view to improving them. Trainers, now acting as mentors were assigned to each of the case study teams with a view to improving the reports.

As part of dissemination of the findings of the case study teams, the Project Manager made a presentation, *Grass Roots Innovation and How it Can Influence Official Statistics*, at a UNU-MERIT Conference on *Micro Evidence on Innovation in Developing Economies* (MEIDE) in San Jose, Costa Rica, June 27-28, 2011. As with the UNU MERIT training in Dakar, there was no cost to the Project for this opportunity to disseminate Project results.

An important part of the learning and dissemination process for the case study teams was the 2011 Globelics Conference in Buenos Aires, Argentina in November 15-17, 2011. After the Review Workshop, the four revised reports were submitted to Globelics and all four where accepted. This was a major achievement for the case study team members, supported by the training and mentoring of the Project. In the end, one team leader and a team member where unable to attend Globelics, but all of the rest of the team leaders and members where assured of support to attend Globelics and three presenters of papers received travel subsidies from Globelics. The opportunity to present papers at Globelics and to receive constructive feedback was valuable and led to the final product of the Project.

The final product of the Project was the posting of the four case study reports, revised after Globelics, on the UNU-MERIT website as UNU-MERIT Working Papers. The URLs for the working papers are given in Appendix 2 and the papers are reproduced in *Building African Capacity in Science, Technology and Innovation Indicators: Reports of Four Case Studies*. These papers include, where appropopriate, the survey instruments that were used to generate the data.

A special issue of the *African Journal of Science, Technology Innovation & Development* is yet another possibility but that will be considered and managed by UNU-MERIT as a post Project activity, with full credit given to IDRC for its support.

Capacity Building

The Project had some impact on capacity building in UNU-MERIT, more at IERI, and considerable impact upon the members of the case study teams, the majority of which were women.

UNU-MERIT has considerable experience of managing research projects for governments and for the European Commission, but it is still building its portfolio of development projects and revising its training programmes offered in developing countries. The presence of this project in UNU-MERIT has resulted in changes in the curriculum concerning indicators of science, technology and innovation for the Micro Evidence on Innovation in Developing Economies

(MEIDE) course and the Design and Evaluation of Innovation Policy in Developing Countries (DEIP) course. Results of the Project have been presented in one MEIDE course and Project materials have contributed to the indicators part of several DEIP courses. A greater awareness of the techniques of proposal writing and management related to work in the developing world have also evolved, but the principal outcome of the work of this Project has been an enhanced capacity to deliver training on the development and use of science, technology and innovation indicators in developing countries.

IERI hosted the Training Workshop and was given a contract to manage all of the infrastructure activity, including transportation and accommodation of all participants, excluding the training team which was managed by UNU-MERIT, the organization of what was required for the training sessions, and the organization and publicity for the well attended public lectures. While this was done in consultation with the Project Manager the work required considerable local initiative which was delivered. IERI has now demonstrated that it can support a training workshop and related high profile events. In the case of GIBS, the business school is in the business of running training workshops so the Review Workshop benefited from that but did not enhance the capacity. It was already well established.

This was a small grant activity so there was limited administration required on the part of the case study teams. However, they did have to schedule interviews, carry them out, prepare status reports, capture and analyse data and write a report of their findings. Many had case study experience but none had done case studies where they were not just identifying and recording a phenomenon, but were also looking for activities which could suggest indicators for development and possibly for use in policy. This added an element of complexity and built capacity to deal with that complexity. The case study teams also benefitted from having to present their work, twice in Project workshops, and to respond to questions and comments. This was in addition to dealing with the written comments of the training team members assigned to work with them.

Of the four case study teams, three where led by women. Of the case study team members, two, originally three, were women. While the Project did not do gender specific capacity building, the majority of the members of the case study teams who acquired increased capacities in areas related to the Project were women. This is demonstrated by the fact that one case study team leader has been accepted as a Ph.D. candidate at UNU-MERIT, based on the work that she had done for the Project and another has registered to do a Ph.D. at the University if KwaZulu-Natal, South Africa, again motivated by the capacity built as a result her work on the Project. A third team leader is seeking support so that she too can study for a Ph.D. Of the remaining four case study team members, the team leader from Senegal has a Ph.D. and has been invited to conferences in Canada and South Africa to present the work of the team on innovation in the informal economy. He has also been invited to join the Advisory Committee of the Center for Science, Technology and Innovation Indicatros (CeSTII) in South Africa. The team member from Senegal is completing her Ph.D. in sociology. The team member in Mozambique has found a better job and the team member in South Africa continues working in agriculture. All have gained, and are continuing to gain, capacity from this Project, supported by the network that it has built.

Project Management

This report is written by the Project Manager which may colour the assessment. However, from the beginning, this was a complex project with changing challenges and opportunities and it could only have been led by someone with considerable management experience involving institutions and people in the public sector, as all of the case study teams worked in the public sector.

Throughout, the sustaining themes were capacity building and excellence and everything else worked around these. This was reinforced by the other members of the training team who accepted these themes and were consistent in applying them in every judgement made. The emphasis on excellence did not mean that all responses to the Call had to be excellent, but they had to show the potential for excellence that could be nurtured by the members of the training team and, early on, boundaries were drawn which established at which point a proposal would be rejected because it would require too much involvement of the members of the team. This was a management decision and an important one. The decision to issue a final contract of $5,000 for team members to bring the reports presented to the Review Workshop to the standard of a UNU-MERIT Working Paper was a management decision which recognized the contribution of the team members and the importance of that contribution to the building of sustainable capacity.

While the Project Manager managed the Project in a manner consistent with the rules of UNU-MERIT, the Project could not have been managed without the high level of subject matter expertise held by the Project Manager and the team members. The Project had two components, the conduct of case studies of subjects chosen by the applicants, and the identification of indicators related to innovation in the work that the case study teams did. A case study is a relatively straight forward exercise, but keeping a focus on innovation and indicators was the role of the training team. It cannot be stated too strongly that the subject matter knowledge and the experience of applying that knowledge in a wide range of circumstances was a significant factor in what made this Project succeed.

The final point on management has been made elsewhere in this report, and that was the flexibility of the IDRC Program Officers that were responsible for the Project. They were very supportive of all of the changes that had to be made to deliver the final outcomes. Had they insisted on keeping the work of the Project to what was in the original proposal the Project would have failed.

Impact

This Project has had impact at the grass roots level as people in the informal economy in Senegal have been asked questions that have made them think about what they are doing and how it related to the work in the formal economy, people in townships in South Africa are seeing their impact on the financial services that they use through their mobile phones, firms in Mozambique have been introduced to the concept of user innovation and the fact that they gain intellectual property from doing it and farmers in KwaZulu Natal are sharing knowledge gained from their innovation activity with others through this Project. These impacts result from the action of the researcher as teacher. Once the question is asked, the thinking that results does not stop. While these impacts are impossible to quantify, they may be the most important outcome of this Project from a development perspective.

The Project has had impact on the members of the case study teams as they have learned, with the help of the training team, how to write a project proposal and to prepare a research report. Most understood how to do case studies, but some guidance was also given in the analysis of data and the presentation of the findings in an appropriate context. Each case study team member, at the end of the Project is in a better position to conceive of more ambitious projects and seek support to carry them out. They form a cadre of well connected analysts with a critical understanding or policy and its impacts in their area of expertise. From a development perspective they will have considerable impact on the thinking in their countries in the years to come.

The Project has created opportunities and changed expectations for the case study team members. Some examples are the acceptance into Ph.D. programmes, by Tashmia Ismail at UNU-MERIT and by Brigid Letty at the University of KwaZulu-Natal. Julia Zita is ready to do a Ph.D. but is seeking funding. Almamy Konte was invited to give seminars on the work of the Senegal team on the informal economy, one in Montreal by the UNESCO Institute of Statistics and one in Cape Town by the Human Sciences Research Council (HSRC). He has also become a member of the HSRC Advisory Steering Committee that provides guidance on the work of the Centre for Science, Technology and Innovation Indicators (CeSTII).

Institutionally, the Project Call for Proposals has influenced at least one call by the NEPAD Agency for research papers making use of the indicators in the African Innovation Outlook 2010. In South Africa, a Ministerial Committee was created in 2010 by the Minister of Science and Technology to review the characteristics of the national system of innovation. The work on grass roots innovation by Letty and Shezi was brought to the attention of the Committee by Michael Kahn, a member of the Project training team, and the Committee Chairperson, Prof. L. Nongxa, and the Project Manager travelled to Pietermaritzburg to interview Letty and Shezi. While the report is not yet released, this opportunity was taken to stress the importance of social innovation, the work of PROLNNOVA in supporting R&D in agriculture and the work of the Farmer Support Group which was able to balance innovation for the marginalised with innovation by the marginalised. The work of the Project influenced the deliberations of the Committee; the extent of the influence will be made clear when the report is released.

Much of the learning from the Project contributed to the development of the new IDRC programme of Inclusive Innovation for Development (IID) as the Project Manager was part of the consultation process. Members of the case study teams contributed to scoping discussions held after the Globelics meeting in Argentian in 2011 and it is anticipated that members of the training team will play a role in projects that will be undertaken as part of IID.

Overall Assessment

This Project has, in two years, taken four case study teams from the response to a Call for Proposals to the presentation of a final report of a high standard. Capacity to measure grass roots innovation and to identify potential indicators has been built. By connecting case study team members to international networks through Globelics, the training team and other means, the capacity built has been made sustainable. This is a significant achievement, consistent with the original goals of the Project.

In terms of value for money, there is no question as to the worth of this Project as the members of the case study teams put in far more work than a small grant of $20,000 would justify, and the members of the training team devoted time to revising the Call, to reviewing the applications, critically and sympathetically, and providing training and mentoring that was above and beyond what could be reasonably expected.

In summary, the Project did what it set out to do, not quite in the way originally proposed, and changed a lot of lives for the better in the process. It was a success.

Recommendations

The recommendations derive from lessons learned in managing the Project. An overarching lesson is that this Project could not be replicated by reading this report and related documents. It owes its success to the quality of the people on the expert team who made use of their deep and complex tacit knowledge to move the Project forward. That leads to the first two recommendations.

Project leadership

Ensure that the members of the expert team are of high quality, with a track record of delivering results, and experienced in working in developing countries. This was the case in this Project but it was clear that had it not been, the Project would have failed to meet its objectives. Put another way, build in excellence from the outset and do not deviate from that as a guiding principle.

While the Project Manager should have subject matter knowledge, as a member of the expert team, a fundamental additional requirement is considerable experience in public administration and a track record for delivering results in difficult circumstances.

Attracting applicants and allocating resources

Consider doing workshops in target countries, followed by a Call for Proposals. The purpose of the Call was to ensure that the work supported was demand driven, but the requirement to deal with innovation and indicators may have been a barrier to application, especially for a small grant. However, the use of a Call should not be rejected as revising the Call was the first activity of the expert team of adjudicators and trainers and ensured common understanding of the goals of the Project and how applications were to be assessed.

The budget for any repetition of this Project should be structured differently. The budget for the Project could not have sustained nine case study teams given the level of involvement required by the trainers and the Project Manager. Missing in the original budget was the cost of travel within the country for the participants in the Training Workshops, not all the participants were working in the city where the workshops were held. Also missing was support for the revision of the final reports so that they could meet a high standard and the support for case study team members to present their work at conferences. There are three clear stages in a Project like this: the adjudication of proposals, including guidance on resubmission, and the resulting identification of training required by the case study teams; preparation and delivery of the training; and, mentoring of the case study teams through the analysis and report preparation. Providing these services requires both a strong team of adjudicators/trainers/mentors and a greater financial commitment than that originally envisaged for this Project.

Training and knowledge transfer

While the adjudicators/trainers/mentors where carefully chosen for their knowledge and experience, the Project would have benefitted from bringing the team together early on in the Project to agree on training methods, use of materials and the content of lectures. This would have ensured the use of a common vocabulary, greater coherence of the training offered and an early opportunity for team building. This is not an essential recommendation so long as all of the team members are subject matter experts with extensive training experience.

Do not attempt to train Ph.D. students as part of a capacity building project directed at more experienced researchers. Many of the Ph.D. students in South Africa were not prepared enough to gain from the training that was provided as it was more advanced than the basic case study methods and techniques of data analysis and report writing that they needed. Most of the members of the case study teams already had these skills and the objective was to increase their capacity to use them and extend them.

Build on the resources in the managing institution. This Project was managed by UNU-MERIT Ideas were exchanged between the staff engaged in UNU-MERIT training courses given in developing countries and the Project Manager and it was possible to discuss subject matter issues and development issues with an informed, experienced and well connected staff. The administrative support was first class. Working from an UNU institution also ensured greater opportunities for members of the case study teams.

The role of IDRC and of the host institution

Do not forget the institutional history of IDRC. This project has benefited from clear conception and a link to lessons learned from earlier work on training in Africa supported by IDRC. The translation of the lessons learned from earlier work in to the structure of this Project was the contribution of Jean Woo, the original Program Officer who conceived this Project with Fred Gault and oversaw the first few months of the Project, including working with Rita Bowry of the Centre's Fellowships and Awards program to add in additional resources solely dedicated to graduate students.

Management flexibility is important. The two subsequent Program Officers responsible for the Project, Innocent Butare, and then Fernando Santiago, were open to changes in the details of the management of the Project as challenges were addressed. This has made the management of the Project much easier for the grant holder than it could have been.

The first class administrative support provided by the host institution, UNU-MERIT, has allowed the Project Manager to concentrate on content while leaving the business to Marc Vleugels and

Eric Engelen. If there are recommendations here, they are that flexibility at the Centre and strong administrative support make it much easier to run a complex Project.

The role of Globelics

Globelics played an important role for this Project as the case study team members gained considerable confidence when all four of their papers were accepted by Globelics and they had the opportunity to present their work and receive constructive criticism. While Globelics has a significant role to play, it is very important that the host country be accessible to people from developing countries. In the specific case of this Project, South Africans did not require a visa to go to Argentina. However, participants from Mozambique and Senegal had to travel to Argentine Consulates in other countries in order to be interviewed before a visa was granted. This took time and Project resources and it leads to a strong recommendation that a condition of IDRC funding for Globelics is that the host country be easily accessible to participants from developing countries.

Globelics continues to play a role in the capacity building of the case study team members as they were invited to participate in an emerging network of STI scholars meeting in Tanzania in March 2012 to discuss the creation of Africalics as part of Globelics. Some members of the trainng team were also involved and remain accessible to the case study team members even though the Project has ended.

Appendices

Appendix 1: Call for Proposals

Research and Training Support to Build
African Capacity in Science, Technology, and Innovation Indicators

A Call for Proposals by the
United Nations University – Maastricht Economic and social Research and training centre on Innovation and Technology (UNU-MERIT)

Deadline for Applications: 30 October 2009

Project Objectives

The **immediate objective** of this Call for Proposals is to support the development of case studies of innovation processes in Mozambique, Rwanda and South Africa. Project teams of successful applications, once they have made progress with their case studies, will engage in training to learn techniques, approaches, and uses of science, technology and innovation indicators as part of the policy process. This training will support the measurement and evaluation of domestic science, technology, and innovation capabilities in these countries, and more specifically build a critical mass of graduate students, researchers, and junior-to-mid-level policymakers with a strong understanding of the importance of linking various science and technology (S&T) capabilities in the country.

The **broader objective** of this competition is to train approximately thirty researchers and/or junior to mid-level policymakers in the techniques, approaches and uses of science, technology and innovation indicators. Some recent advances, current initiatives, and resources in indicator development and innovation studies on Africa are found in the African Statistical Journal, Volume 6, May 2008[1] and in the Discussion document: African Science, Technology and Innovation Indicators (ASTII) - Towards African Indicator Manuals[2] and should be consulted when developing proposals. Applicants are encouraged to think about innovation activities in their countries and to put forward case studies that will yield indicators that are not necessarily conventional, but which address local issues, including those arising in the informal economy, or those resulting from public sector activities or regulation.

Objectives and Research Themes:

This competition invites research proposals for specific case studies that address the following questions:

- How is the activity of innovation carried out in Mozambique, Rwanda or South Africa, with reference to specific examples from case studies?
- Do the findings from case studies of the activity of innovation in Mozambique, Rwanda or South Africa suggest indicators that could be used to support evidence-based policy?
- Based on the findings from case studies and related analysis, are there indicators of innovation that could be developed in future work and what are some possible implications for STI indicator activities in the country or region??

[1] http://www.afdb.org/en/knowledge/statistics/publications/african-statistical-journal/african-statistical-journal-vol-6/
[2] http://www.nepadst.org/doclibrary/2006.shtml

Process and Timetable

2009

- 07 September Launch of Competition
- 30 October Deadline for submission of proposals (16:30 hrs in Maastricht)
- 18 December Communication of final decisions

2010 Dates to be agreed with case study teams and trainers.

- Training workshop in Mozambique
- Training workshop in Rwanda
- Training workshop in South Africa
- December 31, completion of case studies

Duration and Grant Size

Nine awards up to US$20,000. These grants will have duration of up to15 months.

Training Activities Associated with the Competition

The research team of the winning proposals will participate in a 3-day training workshop designed to support the creation of domestic capabilities in the development of science, technology, and innovation indicators and their use for monitoring and evaluation. The workshop will use material collected by the research teams in the course of their case studies.

Eligibility of Applications

Please read the eligibility requirements carefully. Proposals that do not meet these criteria will not be considered. In all cases, the decisions of the Review Committee will be final.

- Applications will only be accepted from developing country institutions in the countries being studied.
- The recipient institution must be a recognized legal entity that is capable of entering into contractual arrangements and assuming legal and financial obligations.
- Research proposals must demonstrate relevance to the overall theme of the competition.
- The applicant(s) must demonstrate that they work in an environment that supports research through the administration of funds and the provision of space and equipment.
- Funds granted to winning proposals will be paid to the principal researcher's host institution. Final budgets awarded for each project will be determined by UNU MERIT based on the review process and, if necessary, negotiation with the applicant institution. Comprehensive project budgets must be submitted as part of the proposal and should be consistent with the rules of the institution of the applicant.
- Collaboration with relevant ministries (e.g. Ministry of S&T) is encouraged.
- Teams consisting of researchers that also involve policymakers and collaboration with relevant ministries are encouraged.

Grants Selection

- Project ideas that fail to meet the eligibility criteria will be rejected.

- Proposals will be reviewed and rated by a Review Committee established specifically to assess the research methods and provide feedback on the feasibility of the proposals.

Content of Proposals

There is no application form. The quality assessment of the proposals will include clarity and succinctness.

These proposals should:

- Outline the proposed project and indicate how it addresses the theme of the competition and the specific role of indicators;
- State the specific objectives of the proposed project;
- Indicate how this project will contribute to addressing national or regional priorities;
- Indicate how the results of this project could be used (potential impact);
- Present a timetable and indicative budget by major budget headings*;
- Provide a list of the researchers, supported by curricula vitae, and indicate their institutional affiliation.

* The timetable should not include the training workshop. The workshop will be arranged by UNU MERIT after some or all of the case study work has been done. The grant is expected to cover the cost of participation in the workshop which will take place in the country where the work is being done.

Review Criteria

Eligible proposals will be assessed on the basis of the following criteria:

- Quality and feasibility (weighting 30%);
- Potential for impact (weighting 20%); and,
- Suitability of research team (weighting 50%).

Application Procedures

Send the proposal (email or courier) by no later than 16:30 hrs, Maastricht time, on 30 October, 2009) to Marc Vleugels (vleugels@merit.unu.edu) or to:

Marc Vleugels
UNU MERIT
Keizer Karelplein 19
6211 TC Maastricht
The Netherlands

Appendix 2: Case Study Projects, Report Guideline, and Generic Contract

A. Case Study Projects

Mozambique

Title: *Innovation Survey in Mozambique: Case Study in the Business Enterprise Sector for Maputo Province*

Lead Researcher: Júlia Zita, Statistics Division, Ministry of Science and Technology, Maputo, Mozambique
Team Member: Avelino Lopes, EnerTerra, Maputo, Mozambique
Avelino Lucas, from the MST, was instrumental in the initiation of the project.

Final Report: Julia Eva Baltazar Zita and Avelino Hermineo Lopes, *User Innovation in the Business Enterprise Sector of Maputo Province in Mozambique*, UNU-MERIT Working Paper 2011-062, pp. 28, www.merit.unu.edu/publications/wppdf/2011/wp2011-062.pdf

Senegal

Title: *Informal Sector and Innovation Processes in Senegal*

Lead Researcher: Almamy Konté, Directeur de la Récherche Technologique Ministère de l'Enseignement Supérieur, des Université et Centres Universitaires Régionaux et de la Récherche Scientifique, Sénégal
Team Member : Mariama Ndong, Doctorante en sociologie à l'Univetsité Gaston Berger de Saint-Louis, Sénégal

Final Report : Almamy Konté and Mariama Ndong, *The Informal ICT Sector and Innovation Processes in Senegal*, UNU-MERIT Working Paper 2012-009, pp. 36, www.merit.unu.edu/publications/wppdf/2011/wp2012-009.pdf

South Africa

Title: *Innovation Activities in Farming Communities in South Africa*

Lead Researcher: Brigid Letty, Programme Leader, Sustainable Agriculture and Food Security Programme, Institute of Natural Resources (IRN), Scottsville, South Africa
Team Member: Zanele Shezi, Farmer Support Group, University of KwaZulu-Natal, Scottsville, South Africa
Maxwell Mudhara, from the Farmer Support Group, supported the project throughout.

Final Report: Brigid Letty, Zanele Shezi and Maxwell Mudhara, *Exploration of agricultural grassroots innovation in South Africa and implications for innovation indicator development*, UNU-

MERIT Working Paper 2012, 2012-00X, pp. 81, www.merit.unu.edu/publications/wppdf/2011/wp2012-023.pdf

Title: *Wizzit: A Case Study in Telephone Banking*

Lead Researcher: Tashmia Ismail, Project Co-ordinator, Gordon School of Business Science (GIBS), University of Pretoria, South Africa
Team Member: Radhika Perrot, Gordon School of Business Science (GIBS), University of Pretoria, South Africa
Professor Helena Barnard, from GIBS, supported the project throughout and MBA student Khumbula Masinge provided assistance. Radhika Perrot withdrew from the case study.

Final Report: Tashmia Ismail and Khumbula Masinge, *Mobile Banking: Innovation for the Poor*, UNU-Working Paper 2011-074, pp. 39, www.merit.unu.edu/publications/wppdf/2011/wp2011-074.pdf

B. Report Guideline

.
At the end of the Training Workshop in September 2010, the teams developed a guide for preparing their reports. The final version was produced by Brigid Letty and circulated to the teams. It is reproduced here.

Draft Outline for a case study report / chapter
The project of agrarian innovation is used as an example. Target is 5K -10K words, double spaced, Times New Roman, 12 pt.

1. Introduction
The background to the project to provide a context.
There will be some duplication but this will allow each case study to be a stand-alone document.

2. Background to the case (What is happening that is happening)
Prolinnova is a network…
FAIR is a programme…..
FAIR was selected as a case study, with a focus on the community of Potshini.

3. Literature review (What others have said about this activity and about innovation)
Cover key concepts that relate to the particular case. The report should stand alone. There will be duplication in the four reports but that can be addressed later if necessary.

4. Methodology
Describe how the case was investigated…

5. Description of the innovation case (Why what was observed was innovation)
Overall description…

Triggers

Discuss the factors response for triggering the process of innovation (For example, is the general shortage of labour in the area the trigger for the innovator investigating a planting practice that involves a lower labour requirement)

Indicators of innovation
Discuss indicators (in this case indicators of grassroots agrarian innovation) identified and measures/quantified – both for quantifying innovation as well as for quantifying impact

6. Implications for policy

7. Lessons learnt from the case study

8. Way forward
For example, that more research is needed to validate the findings and be able to make firm policy recommendations

9. Conclusion

Appendix
Survey instrument/Interview Guide where appropriate.

References
Please use E Elgar style for references. You have examples in *Innovation Strategies for a Global Economy*.

C. Generic Contract

One of the host institutions of the teams, if there were more than one, was selected to receive and to administer the contract. A generic version is reproduced here.

Research and Training Support to Build African Capacity in Science, Technology, and Innovation Indicators

Project managed by the [*Name of Institution, Country*]

Terms of Reference for the Project

1. A case study involving [*description of what is to be studied*] is to be conducted and a report produced before the end of the contract. An outline of the report should be provided for comment six months after the start of the Project.

2. The final report should show how innovation is being managed by the subject of the case study.

3. The findings of the final report should include suggestions for: statistical indicators that could be used for evidence-based policy; and, for indicators that could be developed in future work.

4. Participants in the Project are expected to participate in a three day training session to be scheduled once the Project work has been started.

5. The work of the Project is to be overseen and conducted by [*Name of case study leader and team members with institutional affiliation*].

6. For administrative purposes, the outline of the report, the final report, and any questions about the content of the Project should be sent to Fred Gault (gault@merit.unu.edu) and financial reports and any questions about the financial management of the Project should go to Marc Vleugels (veulgels@merit.unu.edu).

Appendix 3: Rwanda

UNU-MERIT issued a call in September 2009 for proposals for case studies dealing with innovation and with the possibility of suggesting statistical indicators that could be produced in subsequent work. These were small grant projects with a budget of US$20,000 each and three were available to Rwanda. The objective of the projects, in addition to producing results from the field work, was capacity building. Capacity building was to be supported by the provision of three days of training of the case study teams in Rwanda delivered by five international experts with experience of working in Africa.

In addition, a related programme supported by IDRC, and managed by the Tshwane University of Technology, offered to provide US$10,000 in support of empirical research that was part of the doctoral studies of two students in selected countries, including Rwanda. Successful students were also able to take advantage of the three days of training, along with the case study teams.

Both calls were widely disseminated using the UNU-MERIT website, SciDev and the Tshwane website. There were two applications for case studies from Rwanda that did not satisfy the eligibility criteria (capacity building and empirical work). No awards were made based on responses to the Call.

When no suitable proposals were presented, even after the Call was extended, an active search was conducted by the UNU-MERIT project manager. This search included emails to the Rectors of the Kigali Institute of Technology (KIST) and the National University of Rwanda (NUR), emails to the Ministry of Science and Technology, while noting that Minister Murenzi was in the United States, and emails to the Institute des Sciences Agronomiques du Rwanda (ISAR), and Umutara Polytechnic. There were negotiations with the Institute of Policy Analysis and Research (IPAR) which holds an IDRC Think Tank grant. IPAR lacked the capacity to make a proposal and emails were not returned from KIST, NUR, ISAR, Umutara Polytechnic or the government. There were also discussions with the Imbuto Foundation, but it too appeared to lack the capacity to prepare a proposal.

In each of the contacts the points were made that the proposer could choose their own topic, such as innovation in the informal economy, or in agriculture or any other area of local interest, and the case study could consist of a small number of interviews related to the topic, followed by analysis and the writing of a report, all with help of a team of experienced trainers.

The final attempt to stimulate a proposal was made with the help of NEPAD. The NEPAD Office of Science and Technology had been supporting surveys of R&D and innovation activity in 19 countries, but not Rwanda as it had not shown any interest. The NEPAD Secretariat did suggest a possible candidate who did produce a proposal, with some help, but it failed to meet the eligibility criteria and there were unresolved questions about how the grant money would be managed.

In the end no awards were made in Rwanda and Senegal was substituted as an alternative.

After the decision to replace Rwanda was made discussion continued with international organizations that had an interest in Rwanda to see if recommendations could be made that might be of use to projects in the future. These aid organizations included the World Bank and the

Institute for the Study of International Development at McGill University in Montreal, Canada. The recommendations which emerged were tied to two facts: innovation is a market phenomenon so contact with business organizations could be a start; and, case studies have to be led by competent and committed people.

The suggestions were to contact The Private Sector Federation of Rwanda (www.psf.org.rw), the ISOKO Institute of Entrepreneurship (www.bridge2rwanda.org/our-work/center-for-entrepreneurship/) or the OTF Group (www.otfgroup.com). For strong leadership the recommendation was to contact the Rwanda Association of University Women (RAUW@dgroups.org).

Appendix 4: Training in September 2010

Agenda of the Training Workshop

South Africa **September 7-9, 2010, Pretoria, South Africa**

Training for the three cases study teams from Mozambique and South Africa and six IDRC supported graduate students will be provided by the Training Workshop described below. In addition, there will be opportunities for informal interactions with the training team.

Workshop Title: Learning about Innovation and the Use of Indicators

Purpose: This workshop brings together groups doing case studies of innovation activities in South Africa and Mozambique, graduate students supported by IDRC to do empirical work related to innovation as part of their thesis research and a group of international lectures. The objective is to build capacity and a network related to empirical research on innovation in Africa. The activities consist of morning sessions for the case study teams, graduate students and lecturers, afternoons of pedagogical presentations by the Worship lecturers and discussions involving other researchers, policy analysts and administrators with an interest in the subject, and public lectures on the first and second day to raise public awareness of the subject.

Sponsors: This is a joint TUT-IERI and UNU-MERIT Workshop supported by Canada's International Development Research Centre (IDRC).

Programme

	06/09/10	**07/09/10**	**08/09/10**	**09/09/10**
	Monday	*Tuesday*	*Wednesday*	*Thursday*
08:00	Arrival in Tshwane and hotel check in Informal discussions		Convene, informal discussions and coffee	Convene, informal discussions and coffee
09:00		Registration		
09:30		Welcome, Introduction & Overview of Programme	Opening Session, Review of the Tuesday Issues and Objectives for Wednesday	Opening Session, Review of the Tuesday & Wednesday Issues and Objectives for Thursday
09:45		Case Study 1: Farmer Access to Innovation Resources	Case Study 2: Wizzit	Case Study 3: User innovation in manufacturing firms in Mozambique
10:15		Discussion	Discussion	Discussion
11:00		**Break**		

11:30		Student 1: Conceptualizing the Township System of Innovation Student 2: Science Teachers as Learners	Student 3: Assessment of the Innovation Indicators in Selected African Countries: Mozambique, Tanzania, Rwanda, Ethiopia and Tunisia Student 4: An Analysis of a Transformed Workers Mindset Through Science, Technology and Innovation (STI) within SMEs	Student 5: Will 'GEOS' be impacting on Sustainable Development as far as innovation is concerned? The Case of SADC Countries Student 6: Contribution of Renewable Energy towards Climate Change Mitigation and Energy Challenges in South Africa
12:00		Discussion	Discussion	Discussion
12:30		Lunch		

14:00		Review of Issues from the morning session and brief discussion of how to advance the work	Review of Issues from the morning session and brief discussion of how to advance the work	Review of Issues from the morning session and brief discussion of how to advance the work
14:30		Lecture 1: Mammo Muchie Making African Innovation Systems: Suggesting knowledge indicators for harmonizing the communities and the regions.	Lecture 3: Watu Wamae Innovation systems, their applications in developing country and related indicators	Lecture 5: Fred Gault What have we learned and what is our agenda?
15:30		**Break**		**Break and end of afternoon session of presentations**
16:00		Lecture 2: Michael Kahn Data gathering and developing and using innovation indicators.	Lecture 4: Martin Bell The Interaction between science, technology and innovation (STI) indicators and the STI policy agenda.	Trainers and Case Study Groups: Discussion of challenges and solutions.

17:15		Public Lecture 1: Martin Bell The role of design and engineering in African innovation systems building	Public Lecture 2: Fred Gault The OECD Innovation Strategy and its relevance to development	
18:15		Adjourn	Adjourn	Adjourn
1900	Dinner for trainers, case study groups, students and invited guests			

Detailed Programme

IERI, UNU-MERIT Research Training Workshop
Tshwane, South Africa
Tuesday, September 7, 2010

09:00 Registration and coffee
09:30 Opening Session, Welcome and Outline of the Workshop
09:45 Case Study 1: Farmer Access to Innovation Resources (FAIR) (Presentation and Questions 20-30 min, Discussion 30-40)
Institute of Natural Resources (INR) and the Farmer Support Group (FSG) of the University of KwaZulu-Natal (UKZN)
Presentation of the work programme and questions for resolution
Brigid Letty, INR and Zanele Shezi, FSG
11:00 Pause
11:30 Student 1: Conceptualizing the Township System of Innovation: eKasi and the Neighbourhood Development Partnership Grant
Geci Karuri-Sebina, IERI (15 minutes to present the key issues and to raise questions)
11:45 Student 2: Science Teachers as Learners
Casimir Mutabazi Karasira, UKZN
12:00 Discussion of issues raised by students
12:30 Lunch
14:00 Review of Issues from the morning session and brief discussion of how to advance the work
14:30 Lecture 1: Mammo Muchie
Making African Innovation Systems: Suggesting knowledge indicators for harmonizing the communities and the regions.

15:30 Pause
16:00 Lecture 2: Michael Kahn
Data gathering and developing and using innovation indicators.

17:00 Public Lecture 1

Introduction: The training workshop as the occasion, introduction of the speaker
Presentation Martin Bell
The role of design and engineering in African innovation systems building
Thanking the speaker and linking back to the key points of the day.
18:30 Adjourn
19:00 Dinner

Wednesday, September 8, 2010
08:00 Informal discussions and coffee
09:30 Opening Session, Review of the Tuesday issues and objectives for Wednesday
09:45 Case Study 2: A South African Case Study: Wizzit
Presentation of the work programme and questions for resolution
Tashmia Ismail and Radhika Perrot, Gordon School of Business Science, University of Pretoria
11:00 Pause
11:30 Student 3: Assessment of the Innovation Indicators in Selected African Countries: Mozambique, Tanzania, Rwanda, Ethiopia and Tunisia
Desiree Sephlapelo-Ibouanga, IERI (15 minutes to present the key issues and to raise questions)
11:45 Student 4: An Analysis of a Transformed Workers Mindset through Science, Technology and Innovation (STI) within SMEs: A Case Study Approach
Wilson Rendani Maladzhi, IERI
12:00 Discussion of issues raised by the students
12:30 Lunch
14:00 Review of Issues from the morning session and brief discussion of how to advance the work
14:30 Lecture 3: Watu Wamae
Innovation systems, their applications in developing country and related indicators
15:30 Pause
16:00 Lecture 4: Martin Bell
The Interaction between science, technology and innovation (STI) indicators and the STI policy agenda.
17:00 Public Lecture 2
Introduction: The training workshop as the occasion, introduction of the speaker
Presentation Fred Gault
The OECD Innovation Strategy and its relevance to development
Thanking the speaker and linking back to the key points of the day.
18:30 Adjourn
19:00 Dinner

Thursday, September 9, 2010
08:00 Informal discussions and coffee
09:30 Opening Session, Review of the Tuesday and Wednesday issues and objectives for Thursday
09:45 Case Study 3: User innovation in manufacturing firms in Mozambique

	Presentation of the work programme and questions for resolution Júlia Zita, Ministry of Science and Technology, Mozambique and Avelino Lopes, Mondlane University, Maputo
11:00	Pause
11:30	Student 5: Will 'GEOS' be impacting on Sustainable Development as far as innovation is concerned? The Case of SADC Countries Lukovi HM Seke, IERI (15 minutes to present the key issues and to raise questions)
11:45	Student 6: Contribution of Renewable Energy towards Climate Change Mitigation and Energy Challenges in South Africa Silas Mulaudzi, IERI
12:00	Discussion of issues raised by the students
12:30	Lunch
14:00	Lecture 5: Fred Gault What have we learned and what is our agenda?
15:00	Pause and close of the afternoon session of presentations
16:00	Final Session for Trainers and Case Study Groups
18:15	Adjourn

Note: Some of the presenters will available for discussions on the Monday or the Friday.
The Training Worship is supported by Canada's International Development Research Centre (IDRC)

Senegal **September 27 to October 1, Dakar, Senegal**

Training for the case study team and the two IDRC supported graduate students in Senegal was integrated into two UNU-MERIT courses which are described below. The Project Manager engaged team members and students to ensure that they had what they needed to do their research. Information on the two courses is available on the websites below.

Course 1	Economics of Knowledge and Innovation (EKI) http://www.merit.unu.edu/training/EKI_201009_en.php
Course 2	Design and Evaluation of Innovation Policy in a Developing Context (DEIP) http://www.merit.unu.edu/training/deip_201009_senegal_en.php

The case study team members participating where Almamy Konte and Mariama Ndong, a graduate student supported by IDRC for her empirical work. Mamadou Ly, an IDRC supported graduate student also participated.

Presentations by the training team members are in Supplementary Documents 2 and 3, *Building African Capacity in Science, Technology and Innovation Indicators: Presentations of the Training Team.*

Appendix 5: Review Workshop

UNU-MERIT Project on Research and Training Support to Build African Capacity in Science, Technology, and Innovation Indicators

Meeting of Case Study Teams and Trainers, February 28, 2011 and March 1, 2011 at the Gordon Institute of Business Science (GIBS)

Agenda

February 28, 2011

09:00 Opening and stage setting

09:30 Case Study 1, presentation of substance and outstanding problems in about 15 -20 minutes followed by discussion. The same format will be used by the other three presentations.

Mobile banking: a financial solution for the poor
Tashmia Ismail

11:00 Pause

11:30 Case Study 2

User innovation in Mozambicans Business Enterprise Sector for Maputo province: Presence of user innovation
Júlia Eva Baltazar Zita and Avelino Hermíneo Lopes

13:00 Lunch

14:00 Case Study 3

Assessing the impact of grassroots innovation in agriculture
Brigid Letty and Zanele Shezi

15:30 Pause

16:00 Case Study 4

Innovation in the Informal Sector in Senegal
Almamy Konte and Mariama Ndong

17:30 Review of the issues from the day.

18:00 Adjourn

March 1, 2011

09:00 Discussion of our next objectives
Based on yesterday's discussion we have four reports at different stages of development, all with something important to say about innovation and development. We discussed ways the reports could be revised, leading to a final report.
Discussion of how help will be provided to case study teams as they move to final reports.
We need a target for dissemination, such as a UNU-MERIT working paper or other such target. Other suggestions?
We need a date.

10:00 Going beyond the short term target?
If the papers are turned into working papers, do we add a paper on the discussion of common themes and distinct differences?
Literacy, problem solving, role of community, gender, inclusiveness, business conditions, Africa, development …
Does anyone want to do it?

11:00 Pause

11:30 Additional material and discussion of the project.
There will be a final report to IDRC from UNU-MERIT which will discuss how the project delivered upon its objectives. Ideally it would be a guide to others wanting to propose a similar project.
Brief discussion of what worked and what did not with this project. How could we have made it better?

12:30 Tasks for the group and comments by trainers and IDRC.

13:00 Lunch

14:00 Other business
Bilateral discussions, trainers and groups

15:00 Pause

15:30 Other business

We can use this hour to cover any lose ends.

16:30 Adjourn

Appendix 6: Additional Documents Related to this Technical Report

Suppementary Documents that form part of the Technical Report

1. Building African Capacity in Science, Technology and Innovation Indicators: Call for Proposals and Four Successful Responses

2. Building African Capacity in Science, Technology and Innovation Indicators: Presentations of the Training Team, IERI Workshop, Tshwane University of Technology, South Africa, September 7-9, 2010

3. Building African Capacity in Science, Technology and Innovation Indicators: Presentations of the Training Team, UNU-MERIT Workshops, Dakar, Senegal, September 27 – October 1, 2010

4. Building African Capacity in Science, Technology and Innovation Indicators: Reports of Four Case Studies.

Docmuments used in support of the training with URLs.

Carden, Fred (2009), Knowledge to Policy, Making the Most of Development Research, London: Sage and Ottawa: IDRC, (www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx?PublicationID=70).

Gault, Fred (2010), Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management, Cheltenham: Edward Elgar and Ottawa: IDRC, (www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx?PublicationID=45)*.

Kraemer-Mbula, Erika and Watu Wamae (2010), Innovation and the Development Agenda, Paris: OECD and Ottawa: IDRC, (www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx?PublicationID=63)*.

OECD/Eurostat (2005), Oslo Manual, Guidelines for Collecting and Interpreting Innovation Data, Paris: OECD (www.oecd.org/sti/oslomanual).

*Document produced as part of this project.

Building African Capacity in
Science, Technology and Innovation
Indicators

REPORT TO IDRC

Technical Report

Supplementary Documents that form part of the Technical Report

> **1. Call for Proposals and Four Successful Responses**
>
> **2. Presentations of the Training Team, IERI Workshop, Tshwane University of Technology, South Africa, September 7-9, 2010**
>
> **3. Presentations of the Training Team, UNU-MERIT Workshops, Dakar, Senegal, September 27 – October 1, 2010**
>
> **4. Reports of Four Case Studies.**

IDRC Grant Number: 104753
Period Covered: July 6, 2009 – December 31, 2011
Submitted: March 30, 2012
Submitted by: Fred Gault
Managing Institution
United Nations University – Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT), the Netherlands

Building African Capacity in Science, Technology and Innovation Indicators

Call for Proposals

and

Four Successful Responses

Technical Report to IDRC: Supplementary Document 1
Technical Report: Building African Capacity in Science, Technology and Innovation Indicators
IDRC Grant Number: 104753
March 30, 2012

Contents

Introduction

This document starts with the Call for Proposals to be used as a framework for reviewing the four successful submissions that follow.

The minimum of editing has been done for the submissions so those with Tables of Contents will not have the correct numbering.

To minimize the sensitive material in the document, the curricula vitae of the researchers are not reproduced.

The purpose of this document is to allow a programme officer or a principal investigator who is considering running such a project to examine the Call and the range of successful responses that were received by Project 104753.

Research and Training Support to Build
African Capacity in Science, Technology, and Innovation Indicators

A Call for Proposals by the
United Nations University – Maastricht Economic and social Research and training centre on Innovation and Technology (UNU-MERIT)

Deadline for Applications: 30 October 2009

Project Objectives

The **immediate objective** of this Call for Proposals is to support the development of case studies of innovation processes in Mozambique, Rwanda and South Africa. Project teams of successful applications, once they have made progress with their case studies, will engage in training to learn techniques, approaches, and uses of science, technology and innovation indicators as part of the policy process. This training will support the measurement and evaluation of domestic science, technology, and innovation capabilities in these countries, and more specifically build a critical mass of graduate students, researchers, and junior-to-mid-level policymakers with a strong understanding of the importance of linking various science and technology (S&T) capabilities in the country.

The **broader objective** of this competition is to train approximately thirty researchers and/or junior to mid-level policymakers in the techniques, approaches and uses of science, technology and innovation indicators. Some recent advances, current initiatives, and resources in indicator development and innovation studies on Africa are found in the African Statistical Journal, Volume 6, May 2008[1] and in the Discussion document: African Science, Technology and Innovation Indicators (ASTII) - Towards African Indicator Manuals[2] and should be consulted when developing proposals. Applicants are encouraged to think about innovation activities in their countries and to put forward case studies that will yield indicators that are not necessarily conventional, but which address local issues, including those arising in the informal economy, or those resulting from public sector activities or regulation.

Objectives and Research Themes:

This competition invites research proposals for specific case studies that address the following questions:

- How is the activity of innovation carried out in Mozambique, Rwanda or South Africa, with reference to specific examples from case studies?
- Do the findings from case studies of the activity of innovation in Mozambique, Rwanda or South Africa suggest indicators that could be used to support evidence-based policy?
- Based on the findings from case studies and related analysis, are there indicators of innovation that could be developed in future work and what are some possible implications for STI indicator activities in the country or region??

[1] http://www.afdb.org/en/knowledge/statistics/publications/african-statistical-journal/african-statistical-journal-vol-6/
[2] http://www.nepadst.org/doclibrary/2006.shtml

Process and Timetable

2009

- 07 September Launch of Competition
- 30 October Deadline for submission of proposals (16:30 hrs in Maastricht)
- 18 December Communication of final decisions

2010 Dates to be agreed with case study teams and trainers.

- Training workshop in Mozambique
- Training workshop in Rwanda
- Training workshop in South Africa
- December 31, completion of case studies

Duration and Grant Size

Nine awards up to US$20,000. These grants will have a duration of up to15 months.

Training Activities Associated with the Competition

The research team of the winning proposals will participate in a 3-day training workshop designed to support the creation of domestic capabilities in the development of science, technology, and innovation indicators and their use for monitoring and evaluation. The workshop will use material collected by the research teams in the course of their case studies.

Eligibility of Applications

Please read the eligibility requirements carefully. Proposals that do not meet these criteria will not be considered. In all cases, the decisions of the Review Committee will be final.

- Applications will only be accepted from developing country institutions in the countries being studied.
- The recipient institution must be a recognized legal entity that is capable of entering into contractual arrangements and assuming legal and financial obligations.
- Research proposals must demonstrate relevance to the overall theme of the competition.
- The applicant(s) must demonstrate that they work in an environment that supports research through the administration of funds and the provision of space and equipment.
- Funds granted to winning proposals will be paid to the principal researcher's host institution. Final budgets awarded for each project will be determined by UNU MERIT based on the review process and, if necessary, negotiation with the applicant institution. Comprehensive project budgets must be submitted as part of the proposal and should be consistent with the rules of the institution of the applicant.

- Collaboration with relevant ministries (e.g. Ministry of S&T) is encouraged.
- Teams consisting of researchers that also involve policymakers and collaboration with relevant ministries are encouraged.

Grants Selection

- Project ideas that fail to meet the eligibility criteria will be rejected.
- Proposals will be reviewed and rated by a Review Committee established specifically to assess the research methods and provide feedback on the feasibility of the proposals.

Content of Proposals
There is no application form. The quality assessment of the proposals will include clarity and succinctness.

These proposals should:
- Outline the proposed project and indicate how it addresses the theme of the competition and the specific role of indicators;
- State the specific objectives of the proposed project;
- Indicate how this project will contribute to addressing national or regional priorities;
- Indicate how the results of this project could be used (potential impact);
- Present a timetable and indicative budget by major budget headings*;
- Provide a list of the researchers, supported by curricula vitae, and indicate their institutional affiliation.

* The timetable should not include the training workshop. The workshop will be arranged by UNU MERIT after some or all of the case study work has been done. The grant is expected to cover the cost of participation in the workshop which will take place in the country where the work is being done.

Review Criteria
Eligible proposals will be assessed on the basis of the following criteria:
- Quality and feasibility (weighting 30%);
- Potential for impact (weighting 20%); and,
- Suitability of research team (weighting 50%).

Application Procedures
Send the proposal (email or courier) by no later than 16:30 hrs, Maastricht time, on 30 October, 2009) to Marc Vleugels (vleugels@merit.unu.edu) or to:

Marc Vleugels
UNU MERIT
Keizer Karelplein 19
6211 TC Maastricht
The Netherlands

Republic of Mozambique

Project Proposal for Innovation Survey in Mozambique: Case Study in Business Enterprise Sector for Maputo Province

Júlia Zita

Avelino Lopes

Maputo, May 2010

Basic information of the project

1. **Title:** Development of National Innovation Indicators System in Mozambique: Case Study in Business Enterprise Sector for Maputo Province

2. **Area:** The Project will be in Maputo Province, a case study.

3. **Duration**: The project duration is 15 months.

4. **PROJECT DESCRIPTION**

4.1 Introduction

The Mozambique Science, Technology and Innovation Strategy (MOSTIS) was approved in June 2006. It makes the case for the stimulation of innovation to promote economic development and poverty reduction. One of the points raised in the strategy is the importance of the process by which individuals and groups "devise new ways to solve immediate problems" (Ministry of Science and Technology 2006: 55). The case study in this proposal probes the solution of immediate problems in private sector firms, and the economic consequences. This activity is a form of user innovation (von Hippel 2005)

As this is a pilot study, the focus is on the problem solving that helps the firms to move goods and services to the market. Problem solving to improve the quality of life of consumers, leading to the production of better products by the firms that produce them, is not included in the pilot study as it would require a survey of the consumers in addition to the already existing survey material from the firms. However this is another form of user innovation which could be examined in future work.

User innovation in firms is important in all economies, but more so in developing economies where there is limited capacity to invest in new capital goods or software systems. An alternative to buying production technologies is to make existing technologies perform better or, in extreme cases, to develop the production technologies needed by the firm.

The purpose of this project is to establish the presence of user innovation in firms that have been identified by the Mozambican National Innovation survey 2009. If user innovation can be identified, two issues arise. The first is the type of innovation strategy that would support this activity. The second is the type of statistical indicators that could be developed to show the presence of user innovation in firms. Both of these issues would suggest a work programme which could be considered for support.

This case study project concentrates on the business enterprise sector in Maputo Province.

4.2 OBJECTIVES

4.2.1 General Objective:

To explore the presence of user innovation in the business enterprise sector.

4.2.2 Specific Objectives:

- To produce a report on innovation activities for the business enterprise sector in Maputo Province;
- To make a case for the publication of regular reports with innovation indicators and the results of case studies;
- To demonstrate the feasibility of the project with a view to attracting permanent funding.

5. Motivation

The Mozambican National Innovation Survey 2009 gives a wealth of data about innovative and non innovative firms but limited information about the presence of user innovation in the innovative firms. Probing for user innovation, by investigating a few firms in the Province of Maputo, could establish the presence of this activity, which would have implications for indicator development and for the development of evidence-based policy based on such indicators.

6. Why User Innovation

User innovation occurs in two forms.

There is consumer user innovation where the consumer changes the good or service that they receive from the producer to meet their needs. They can then share the resulting product with a peer group or, they can return to the producer and present a prototype. This is an important part of user innovation discussed by von Hippel (2005). However, it is beyond the capacity of this case study as information would have to be gathered from the consumers engaged in user innovation.

The case study may be able to identify consumer user innovation if there are firms that reported that their product innovation was done by others. This will be probed but there are unlikely to a large number of events.

The second case is user innovation by firms. This occurs when the firm modifies its production process to improve it. Firms that have said that they are engaged in process innovation and that they did it themselves, the majority of responses in the data, are likely candidates for user innovation. Firms that did it with another institution may be user innovators, or they may be working with the producer. This is to be determined.

There are several reasons why user innovation in firms is important to innovation policy. In firms that do not do R&D, the problem solving in the firm that creates value by improving the production process requires policies that are quite different from those that support R&D in the business sector. That is the first reason why it is important to establish this phenomenon in Mozambican firms.

There is a second reason. Work by Gault and von Hippel (2009) suggests that firms that are user innovators have a higher propensity to give away, or freely reveal, the intellectual property that results from the problem solving in the firm. This has implications for intellectual property policy.

Beyond the findings on user innovation in firms, there is another potential benefit of this case study project. In the data now available, it appears that the number of firms have their process innovation done by others is very small if not zero. This suggests that these firms are not buying capital equipment or software from outside the firm which could be 'new to the firm' innovation. Understanding this is a bonus.

7. Methodology

- Based on results of the Mozambican Innovation Survey 2009, about 20 firms carrying out innovation activities will be selected for Maputo province;
- A set of questions will be developed, based on the studies carried out in this field by other countries;
- A questionnaire fitting to the Mozambique situation will be prepared and pilot tested. Note will be taken of a 2007 questionnaire used by Statistics Canada (Statistics Canada 2008). A personal interview approach will be adopted to capture information;
- Information collected will be analyzed with respect to the different evaluation parameters and conclusions drawn;
- Based on the analysis a report will be prepared and published;
- In addition, this report will also provide the policy makers a useful tool for new policy measures for promotion of innovative activities in the country.

7.1 Limitation of the study

- Some enterprises may not share the required information for this project.
- Since the evaluation/assessment will be mostly qualitative, and recommendations based on the out come of the study may more indicative than exact in terms of the relevant parameters.

8. Analysis

An extensive analysis on various parameters will be made, such as where did the firms engaged in user innovation get their ideas. What did they do with the knowledge they generated. Whether the innovation activities are occasional or continuous, whether firms have separate R&D units, and how the firms benefited from their innovation. Also most importantly these findings will be linked to government policy measures/remedies to be adopted by the government to encourage innovation efforts in the country.

9. Timetable of Implementation

List of Activities	2010								2011						
	Mai	Jun	Jul	Ags	Set	Oct	Nov	Dez	Jan	Fev	Mar	Abr	Mai	Jun	Jul
1.1 Updated list of enterprises															
2.1 Acquire Software for Survey															
2.2 Contract 1 senior specialists in statistical systems															
2.3 Design of draft questionnaire and respondent guide															
2.4 Design and implementation of the survey database															
2.5 Pilot testing of questionnaire															
2.6 Engage province in the process: feedback on questionnaires and guide															
2.7 Prepare final questionnaire and reporting guide Design sample stratification, edits and imputation procedures and quality control															
2.8 Data collection/ personal interview Rent a car															
2.9 Supervision of data collection and follow up															
2.10 Contract for data capture technicians															
2.11 Data Capture Apply edit, imputation and quality control procedures, produce estimates															
2.12 Analysis															
2.13 Publication: Descriptive statistics															
2.14 Workshop with main users of the statistics to present results															
3. Publication: Analysis and more elaborate statistics															

10. Linkage to the Other Development Plans

Development and Implementation of the S&T Indicator System are integrated in the following national documents:

- The Economic and Social plan (PES 2006) where the Development and Implementation of S&T Indicators System is defined;
- Program of Government for Five Years stipulates development of the information system and production of S&T Indicators;
- Mozambique Strategic of Science and Technology (MOSTIS) define this issue in objective 4.1.

B. Total Budget[3]

List of Activities	Esteemed Costs (USD)	
	2010	2011
1. Survey Frame Development: Update List	250.00	
2.1 Acquire Software for Survey:	500.00	
2.2 Technical Assistance: Contract One Specialists in Statistics	1,000.00	
2.3 Design draft questionnaire and respondent guide	1,000.00	
2.4 Pilot testing of Questionnaire	2,500.00	
2.5 Engage province in the process: feedback on questionnaires and guide	1,000.00	
2.6 Prepare Final Questionnaire:	500.00	
2.7 Data Collection: Rent 1 Vehicles		2,000.00
2.8 Supervision of Data Collection and Follow-up		1,500.00
2.9 Contract for 2 Data Capture Technicians		1,000.00
2.10 Data Capture and quality verification		
		500.00
2.11 Analysis		3,300.00
2.12 Publication: Descriptive Statistics		500.00
2.13 Workshops with main users of the statistics to present results.		3,000.00
3.1 Publication: Analysis and Statistics		1,450.00
TOTAL REQUIRED		**20,000.00**

[3] See the Budget Notes for more information

1. Budget Notes

2.2 Technical Assistance: Contract One Specialist in Statistics

There is a need for advice through all stages of the project on the gathering and the use of the data for the statistics. As the 20 firms to be studied have already been identified as respondents to the Mozambican Innovation Survey 2009, there is no need for sample design, however there is a need for advice on quality control and data analysis. More importantly, a questionnaire has to be designed and tested and there is a need for expert advice on cognitive testing of questions and the design and testing of a questionnaire. If the case study is able to identify user innovation in the sample selected, there is a question of to what extent this information could be used to make a comment on the presence of user innovation in the population estimates to be produced as a result of the Mozambican Innovation Survey 2009.

2.7 Data Collection Rent 1 Vehicles

The vehicles are required for data collection, for supervision of data collection and data collection follow-up and the institutions are far.

The appropriate size of vehicle is a Pick Up 4x4 car because some institutions are outside the city.

The car rental firms were approached for estimates and the lowest, for the period required, is the following: $2,000.00 including insurance in 4 weeks.

It will be: 20 days per $100.00 day= $2,000.00

2.13 Workshops with main users of the statistics to present results

The costs of the workshops are broken out below and assume the participation of 20 users and 3 Project staff.

Transportation: $1,000.00

Prdm: 500.00

Room and Equipment rental (audio visual, computers): 1,500.00

C. Expected Results

The Project produces the following results:

- Organized Instrument for Data Collection;
- Collection methodology of innovation indicators case study developed according to Mozambique Context;
- Publication of user innovation activities for the business enterprise sector case study in Maputo Province.

D. Contacts

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Universidade Eduardo Mondlane

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Email: avelinohlopes@hotmail.com

E. References

Gault, Fred and Eric von Hippel (2009), *The Prevalence of User Innovation and Free Innovation Transfers: Implications for Statistical Indicators and Innovation Policy*, MIT Sloan School of Management Working Paper no. 4722-09, Cambridge, MA: MIT.

Ministry of Science and Technology (2006), *Mozambique Science, technology and Innovation Strategy (MOSTIS)*, Maputo: Ministry of Science and Technology.

Statistics Canada (2008), *Follow-up to the Survey of Advanced Technology 2007*, The Daily, October 27, 2008, Ottawa: Statistics Canada.

Von Hippel, Eric (2005), *Democratizing Innovation*, Cambridge, MA: MIT Press.

ANNEX

These question come from the survey released by Statistics Canada in 2008. They are a basis for discussion among members of the project team. The questions to be used in the case study will be designed for use in the Mozambican business environment.

User Innovation Survey Schedule

Q1. How frequently is the modification (development) of technologies carried out in your business unit?

Continuously
Occasionally

Q2. How is the modification (development) of technologies carried out in your business unit?

Formal Program
Informal Program

Q3. How is the modification (development) of technologies funded in your business unit?

Internally
By customers
From other funding sources
By suppliers

Q4. Which budgets are used for technology modification (development)in your business unit?

Part of the maintenance budget
Dedicated budget for each project
Part of the R&D budget
Other budget
Part of the innovation budget

Q5. Does your enterprise has separate R&D unit / R&D budget?

Yes
No

Q6. *Do you know of other firms that have carried out (developments) similar to yours?*

Yes
No

Q7. Does your business cooperate with other business units, firms or institutions to modify(develop) technologies?

Yes
No

Q8. Who did your business cooperate with for the modification (development) of technologies?

Suppliers
Other business units in firm
Consultants
Clients
Industrial associations
Universities
Commercial labs
Competitors
Federal government labs
Colleges

Provincial labs
Private non-profit
Other type

Q9. Does your business unit share the technologies that it has modified (developed) with other firms or institutions?

Yes
No

Q10. How does your business unit share the technologies it has modified (developed)?

At no charge
In exchange for something of value (i.e., free equipment)
Other method
For a fee

Q11. Why did your business unit choose to share the technologies that it modified (developed)?

To allow a supplier to build a more suitable final product
Gain feedback and expertise
Nothing to lose (no direct competition)
Enhance reputation
Other
Contractual obligation

Q12*. Does your business unit use any method to protect your process Intellectual Property (IP)?*

Yes
No

13. If yes, how do you protect your IP?

Confidentiality agreements
Patents
Secrecy
Trademarks
Copyrights
Other

Q14. To the best of your knowledge, have any of the technology modifications (developments) in your business unit been adopted by the following:

Supplier of the original technology
Other firms that use the original technology

Q15. i) The average cost of labor
(for the most recently modified or newly-developed technology)

ii) The median value of cost of labor
(for the most recently modified or newly-developed technology)

Q16. Ii) The average cost of machinery
(for the most recently modified or newly-developed technology)

ii) The median value for cost of machinery

Informal Sector
and
Innovation Processes
in
Senegal

Table of Contents

1. Background and rationale

The 1980s marked the beginning of the economic crisis in Africa. Since then, the continent has seen a litany of programmes and projects to escape from the crisis, under the leadership of the International Monetary Fund (IMF) and World Bank.

Implicit in the 1970s, the informal sector has grown to the point of competing with the modern sector today. This sector, defined as non-structured by the International Labour Organization (ILO), currently occupies a very large place in the Senegalese economy. Indeed, for over two decades, this sector's contribution to GDP has always been larger than that of the modern sector (See Table 1). Moreover, according to a recent study by the World Bank, the sector generates 97% of new jobs at a time when more than a quarter of the population is affected by unemployment and underemployment. This study shows that 95% of active employees work in this sector and that more than half of informal sector workers have never gone to school. The fact that these human resources are poorly educated is not an obstacle to the development of this sector, which is gaining more and more ground.

The informal sector in Senegal has developed so much over the past two decades that we are now witnessing the emergence of shopping centres whose services are still unstructured. Informal businesses are now coming into the spotlight on the international stage. Thus, today the Comptoir Commercial Bara Mboup works in partnership with the South Korean company Samsung, as well as with Chinese auto manufacturers such as Hover and Chery.

With this observation, it has become necessary to conduct a study on this sector's capacity for innovation and adaptation in Senegal.

2. Research questions

In Senegal, everyone stands in agreement recognising the important role the informal sector plays in the national economy, and especially in improving the living conditions of the population. It is characterised by great ingenuity and a highly developed entrepreneurial spirit. Thus, the questions we must pose are:

- What are the mechanisms for adaptation of the informal sector in Senegal?
- What are the innovations in this sector?
- What are the processes?
- And how can they (the innovations) fit into the Senegalese market?

These questions remain entirely legitimate in the sense that they allow us to invest in the innovation process in the informal sector in Senegal, and to understand the mechanisms and procedures for validation and inclusion in the Senegalese market.

3. Objectives of the study

a. Overall objective

Our research focuses on innovation processes in the informal sector in Senegal. The study should therefore allow the development of indicators for better understanding the innovation processes in the informal sector in Senegal.

b. Specific objectives

- Understand the adaptability of the informal sector in Senegal's economy.
- Examine innovation processes to know in greater detail what characteristics innovative companies share and the features that set innovators apart from other companies.
- Better understand innovation processes in the informal sector in Senegal.

4. Interest in the topic

The research theme about the informal sector and the innovation processes that we propose to study propels us to wonder about the mechanisms of innovation that drive them. This interest lies in the fact that the informal sector is seldom, if ever, examined from this angle. Generally, only those aspects directly related to production are investigated. It goes without saying that since this represents a major part in demonstrating entrepreneurship and innovation in these markets, the issues are very important to study and understand. To achieve this, we decided to focus on innovation processes that allow entrepreneurs to survive in the economic market and even to position themselves as leaders in certain areas. We will investigate the business sector and Information Technology and Communications (ITC), which in recent years has seen spectacular development in light of the important role it plays in the Senegalese economy.

5. Methodology

The first constraint to the proposed research is the lack of documentation. It is almost non-existent or unavailable, restricted to descriptive literature that merely gives a synopsis of the informal sector, which is the first hurdle that we will surmount to answer our central research question. Initially, there was no information on this sector and specifically, not on the target area. Thus, the study will build upon the following points:

- The identification of variables
- Interviews with company owners who have evolved in the sector
- A quantitative questionnaire individually adapted to the sector to understand innovation
- A qualitative questionnaire: open questions due to the incidence of low sampling, to be conducted with focus groups organised in the form of workshops

a. The targets

It will create reference groups in these categories:

- Transient merchants
- Merchants with canteens in markets

- Informal companies operating in the ITC sector
- Shopping centres
- Businessmen and women

b. *Research steps*

i. Exploratory study

This will be a decisive phase in the study, taking place at both at the level of informal companies as well as entrepreneurs and with the ministries concerned. During our investigation, we will make contact and try to establish a climate of trust in order to extract the most information possible from targeted individuals. We are convinced that in order to understand the informal sector in Senegal and understand the innovation processes, we not only must know how industry is organised, who are the organisers, but more importantly how the players perceive what they do.

ii. Detailed study

It will be based on the categories of players to be interviewed and their place in the sector. Thus, we essentially will use the interview guide, the questionnaire and informal discussions aimed at completing the information collected on the ground.

6. Expected results and potential impacts

In the usual sense, when one speaks of the informal sector, it automatically advances to theories characterised by little or no formal activities and reduced to their survival functions in response to the economic crisis. We will try to go beyond this reductive point of view by studying the innovation processes in this sector that operate today in an area supposed to be reserved for the modern sector. In this study, we intend to raise a debate on the relevance of the place given to the informal sector in the national economy. We believe this sector shows great potential that needs to be better known and understood.

The expected results of this study are as follows:

- A status report of the informal sector (specifically in the targeted area) in Senegal is carried out and an analysis of its role and its place in the national economy is outlined.
- Its mode of organisation is known.
- The informal sector is studied closely and light is shed on innovative activities, their implementation processes, the areas affected by these innovations and their degree of adaptation.
- The future of the informal sector and its innovation process is questioned and an attempt is made to provide answers.

These findings may be, starting from a better understanding of innovation processes in the Senegalese informal sector, a base document for institutional players whose mission is to make the sector more dynamic. The information this study will provide about innovation processes in the informal sector can serve to identify good practices in the sector, to promote and assist in finding the best solutions and the most effective solutions to the problems identified.

7. Beneficiaries of the study

- The political authorities and institutional players.
- The ministries concerned (Ministry of the Economy, Ministry of Research and Technological Innovation, etc.)
- Donors of funds
- The informal sector players
- Researchers and universities

Appendix 1: Table 1

In billions of CFA francs current	1990 def	1991 def	1992 def	1993 def	1994 def	1995 def	1996 def	1997 def	1998 def	1999 def	2000 def	2001 def	2002 def	2003 def	2004 def	2005 def	2006 def	2007 s.def	2008 prov
TOTAL VALUE ADDED	1 399	1 416	1 421	1 457	1 960	2 195	2 318	2 434	2 651	2 787	2 935	3 157	3 261	3 501	3 715	3 992	4 232	4 662	5 213
Primary Sector	294	302	280	315	395	485	490	509	544	571	599	625	551	650	627	715	685	696	874
Secondary Sector	295	299	329	328	447	499	536	543	598	613	644	734	786	807	876	900	959	1 085	1 180
Tertiary Sector	810	814	812	815	1 118	1 212	1 292	1 381	1 509	1 604	1 691	1 798	1 924	2 044	2 212	2 378	2 587	2 881	3 159
Modern Sector	620	624	692	667	909	946	1 016	1 083	1 169	1 210	1 242	1 351	1 485	1 578	1 729	1 842	1 947	2 178	2 433
Informal Sector	779	791	729	791	1 051	1 249	1 301	1 351	1 481	1 578	1 692	1 806	1 776	1 923	1 986	2 150	2 285	2 484	2 780
+ NET TAXES ON INCOME	158	169	169	151	193	240	274	293	317	380	397	419	457	486	528	601	662	743	731
GDP	1 556	1 585	1 589	1 608	2 153	2 435	2 591	2 727	2 968	3 167	3 332	3 575	3 718	3 987	4 243	4 593	4 894	5 405	5 944

Source: National Statistics and Demographics Agency

(http://www.ansd.sn/publications/annuelles/autres_donnees/Agregat_macro_2009.htm)

Appendix 2: Definition of concepts

1. **The three sectors of the economy**
   a. **Primary sector**

The primary sector includes raw materials: it consists of agriculture (and its offshoots), fisheries, forest products and mining products.

   b. **Secondary sector**

The secondary sector includes activities related to the transformation: it brings together industry, energy, electronics etc.

   c. **Tertiary sector**

The tertiary sector includes all activities related to services and distribution. It includes transport, tourism, telecommunications, etc.

2. **The informal sector**

All production units that do not have a NINEA Identification Number (National Identification Number for Companies and Associations) or taxpayer number in the case of employers and independent workers, who do not maintain official accounting records.

3. **The modern sector**

In contrast to the informal sector, the modern sector includes all production units that have obtained a regular NINEA number and a taxpayer number. They are also units, both on the side of employers and workers, that maintain official accounting records.

GORDON INSTITUTE OF BUSINESS SCIENCE
University of Pretoria

A call for Project Proposals by UNU-MERIT prepared by GIBS

South African Case Studies

Radhika Perrot, Tashmia Ismail and Helena Barnard

Submitted on 11th December 2009 to Prof. Fred Gault, UNU-MERIT, The Netherlands

CONTENTS

CASE STUDIES PROPOSAL FOR SOUTH AFRICA

INTRODUCTION

An examination of the South African policy environment would reveal a glut of policy documents which unfortunately tend to remain theoretical concepts. The development of Impact and Outcome indicators may be a way in which concrete, constructive action could be encouraged. The process of identifying activities which result in positive outcomes would benefit developing institutions and encourage the conversion of policies and concepts into positive action.

In their paper, Sutcliffe and Court (2005) suggest that that policy decisions be informed by available evidence and rational analysis. Further, they maintain that such policy is far more likely to have positive outcomes than those based on political ideologies, which is the dominant model in South Africa right now.

Case studies can therefore serve as a vehicle to demonstrate systematic evidence of real life situations from which indicators can be developed. In this way indicators are able to highlight both positive and negative outcomes informing future policy to be more relevant rather than theoretical.

To analyse the case studies we would use an innovation systems approach which stresses upon the flow of technology and information among people, firms and institutions key to an innovative process (Lundvall, 1985). It contains the interaction (and the content of the interaction) between actors who are needed in order to turn an idea into a process, product or service in the market. We believe that such a conceptual and methodological approach will guide our search for S&T indicators in developing countries, and its use has also been implied in Gault (2007). This is because developing countries do not have a conventional approach to innovation, and therefore standard S&T indicators like patents, R&D expenditure etc are not always useful in the given context. An understanding of a system of innovation, the relationship between the actors and institutions of the system, and how they function with each other, will help science policy gain microscopic insights that will improve economic efficiency and achieve desired national goals.

As we intend to look at the diffusion of a particular technology, product or a process in our case studies, we categorize the innovation system as a 'technological' one and use a technological innovation system (Carlsson and Stankiewicz, 1991; Breschi and Malerba, 2001; Suurs, 2009). The purpose of most such studies is to analyse and evaluate the development of a particular technological innovation in terms of the structures and processes that either support or hinder it (Suurs, 2009). A technological system is defined as "...network(s) of actors interacting in a specific technology area under a particular institutional infrastructure for the purpose of generating, diffusing, and utilizing technology..." (Carlsson and Stankiewicz, 1991, p. 21). Such a system is made up of three main elements (Jacobsson and Bergek, 2004):

Actors may be firms, e.g. users, suppliers or venture capitalists or other organisations. A particularly important actor is an actor (or set of actors) or 'prime-movers' which is technically, financially and/or politically so powerful that it can strongly influence the development and diffusion process.

Networks constitute important channels for the transfer of both tacit and explicit knowledge. These networks (of actors) may be built around markets that may lead to the identification of problems and the development of new technical solutions. They may also be non-market related and lead to a general diffusion of information or to an ability to influence the institutional set-up. Being strongly integrated into a network increases the resource base of individual actors, in terms of gaining access to the information and knowledge of other actors. Networks also influence the perception of what is desirable and possible, i.e. shape the actors' images of the future, which then guide the specific decisions of firms and other organisations.

Institutions stipulate the norms and rules regulating interactions between actors (Edquist and Johnson, 1997). The roles of institutions vary as some influence connectivity in the system whereas others influence the incentive structure or the structure of demand.

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1 We would determine actor-actor, actor-institution and actor-technology relationships. An actor-actor relationship is characterised by two-way interactions, whereas the actor-technology and actor-institution relationship is not truly interactive (Suurs, 2009)

We would first identify the actors, 'prime movers' and institutions in the network of the technological innovation system so considered. We would then identify the *functions* between the actors in the network and the institutions supporting or hampering the relationships[1] and functions between the actors. There are five basic functions between actors of a technological system of innovation (Jacobsson *et al.*, 2004) which are in fact S&T indicators between actors of a system:

- The creation and diffusion of tacit and explicit knowledge (which has also been indicated in (Gault, 2007))
- The supply of resources such as capital, funds, skills and technical competencies*
- The creation of positive external economies (direct and indirect), either market or non-market specific, and includes the number of jobs created, pollution-reduction etc.* These are indicators of impact
- The formation of markets* measured by revenues from sale of the product, market share etc. Since innovations rarely find ready-made markets, these may need to be stimulated or even created. This process may be affected by governmental actions to clear legislative obstacles and by various organisations' measures to legitimise the technology

In fact, all the above-mentioned indicated functions are measures of S&T indicators and * are outcome S&T indicators (Gault, 2007). These functions are not independent of one another, and changes in one function may lead to changes in others (Johnson and Jacobsson, 2001). For instance, the creation of an initial market may act as an inducement mechanism for new entrants that bring new resources to the technological system (Jacobsson and Bergek, 2004).

Determining the *factors* influencing a function will be also important, as for example, a feed-in tariff for renewable energy could have increased Eskom's supply of renewable energy in its total energy mix but without regulations mandating Eskom to source renewable energy, the implementation of feed-in-tariffs is a failure. These factors maybe institutional or organizational and not all factors are specific to any one technological system, and they maybe inducing or blocking mechanisms. The factors influencing a function also influences S&T indicators, and are therefore an important consideration in the case studies.

We have only briefly shown how we intend to create S&T indicators using the technological innovation system in our case studies, and detailing the constructs, the specific relationships and functions between actors of a technological innovation system. We have not identified nor specified all the relevant S&T indicators, as we think they will appear in the course of the development of the case studies, and is specific to each case study.

CASE PROPOSALS

The case study outline for Wizzit below is based on an interview conducted with the founder of Wizzit, Brian Richardson, press articles, academic publications and government issued literature. The case study proposal for Nestle is based on several meetings held at the Nestle office in Randburg with the relevant Nestle staff. The case study for Johanna Solar is based on a telephone interview with a Central Energy Fund (CEF) official, press articles, academic publications and government issued literature.

CASE I: WIZZIT

SOUTH AFRICAN CONTEXT AND RELEVANCE TO NATIONAL PRIORITY

South Africa has a large informal economy with only 5 million registered individual taxpayers out of a population of approximately 49 million. A national priority is the inclusion of larger numbers of people from the informal into the formal economy.

In an address to parliament , the then president of South Africa Thabo Mbeki, stated that a key challenge of the new government will be in reconciling the first world banking sector, characterized by a well established infrastructure and technology but limited participation, with an increasing demand for financial services. He outlined the three pillared approach to South Africa's dilemmas: encouraging the growth and development of the First Economy, increasing its possibility to create jobs; implementing programmes to address the challenges of the second economy; and building a social security net to meet the objectives of poverty alleviation.

The financial sector is recognized as an important tool in bridging the divide between the first and the second economy (Kirsten, 2006). Easy access to a basic bank account will help open the floodgates of a myriad of financial services, and which many people can have access to.

The key to drawing people into the formal economy is to give them an instrument or tool to save and transact money from. Approximately six million South Africans transfer money in the amount of R12-billion in cash annually, a large part of which are remittances to family members in rural areas. FinScope survey data (FinScope, 2005) suggests that 53% (16.4 million) of South Africa's adult population are excluded from formal financial services and do not have a bank account. These 16.4 million people are marginalized or formally excluded from credit (FinScope, 2005).

The Financial Sector Charter committed the financial sector, represented by banks, insurers, black business, fund managers and brokerage firms, to make banking more accessible to the nation and, specifically, to increase banking reach to all communities. (Finmark Trust, 2003)

One of the first products to come out of the charter agreement was the Mzansi account, a collaborative product of the four dominant SA banks. The idea was for the Mzansi account to be affordable, readily available and built to suit the specific needs of unbanked communities.

However, in creating this product the banks merely created a more affordable version of their traditional products. By the end of 2008 only 3.5 of the 8 million bank accounts opened under the Mzansi banner were active. Private Banks also generally report losing money on each account, even when considering only the direct costs. However, it is felt that a strong need for accessible transactional banking will be an important feature of the South African banking economy (Bankable Frontier Associates, 2009)

The Wizzit case study is important as it is a good example of a financial services solution with an innovative approach to banking, and which has moved away considerably from the traditional banking models typical in South Africa. Understanding the dynamics in the setting up and running of such a service offering have important learnings for the policy maker intent on raising access to financial products for the poor.

On the demand side, poverty and increasing unemployment influences the nature and characteristic of demand for financial services from low income and poor households. On the supply side, policy, legal and regulatory changes impact on the provision of services to low income and poor households. Deputy Minister of Finance, Nhlanhla M. Nene commented that a need exists to monitor developments in financial access indicators, not only to flag up key trends, but to understand financial behaviour in a way that helps in formulating appropriate policy responses (Address by Deputy Minister of Finance, 2009).

CHALLENGES IN CONVENTIONAL BANKING SYSTEM

Banks have a very simple paradigm in that bank have branches and adopt a bricks and mortar strategy. The question then is, can one bring affordable financial services to the lower-end of the market segment with a bricks-and-mortar attitude or will it be just too expensive?

It is necessary therefore to think differently, and which is very difficult for bureaucratic, traditional, conservative organizations like banks that have built their entire business model on a branch network.

Traditional and existing local banks have large footprints. Banks are highly regulated and process driven and is very difficult to bring change to these institutions. Amidst such process bottlenecks and regulations of banks, the challenge now is to serve an informal market that is by nature chaotic.

Conventional thinking is that people come to the branch, a branch with nice furniture, desks and photocopy machines. Making a copy of an ID document is easy. Under a rural tree there are no such photocopiers, and in fact you might not find electricity, and therefore getting an ID across to the bank's head office is a huge logistical problem.

Therefore, Exemption 17 relaxed certain regulations particularly around proof of residence and other paperwork that made it incredibly difficult to open a bank account. However, despite this, even for an Mzansi account, which is the entry level banking account, it takes up to an hour to open an account. The unbanked person has to get to a branch that is open between 9am to 5.30pm and is an added problem if one is working on an hourly wage and has to take time off work to open an account.

FICA requirements are a huge burden to low income consumers. Proof of residence is quite difficult in emerging markets and particularly for the unbanked. The regulation around exemption 17 stipulates that one has to identify and verify the accounts one opens.

The regulator maintains that the compliance officers in each bank will interpret and design processes according to their bank's policy that mitigates the risk. However these are low level bank accounts, for people earning between R800 and R2, 500. In terms of the importance of money laundering and the funding of terrorist activities, it may be more traceable to have people within the net than outside the net doing it with cash.

The number of cellphone bank users today outnumbers people using internet banking, mobile banking is therefore a technology of the future to be encouraged. Large banks have a stronghold on the payment space and new entrants in the same is space have an incredibly difficult time in launching new ideas.

WIZZIT ACTIVITY SUMMARY

- WIZZIT was the first cellphone-based banking facility introduced in South Africa and globally was one of the first entities to use mobile banking to bank the unbanked[2].
- Their target market is the estimated 16 million unbanked or underbanked South Africans - about 60 percent of the country's population.
- Unlike its competitors (FNB and MTN), WIZZIT does not require users to have a bank account and is compatible with early generation cell phones popular in low-income communities. The facility even works with customers who use pay-as-you-go cellphones - another distinction.
- In addition to being able to conduct cellphone-to-cellphone transactions, WIZZIT account holders are issued Maestro debit cards that can be used at any ATM or retailer.

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2 The unbanked are described by the Federal Deposit Insurance Corporation (FDIC) as those without an account at a bank or other f inancial institution and are considered to be outside the mainstream for one reason or another.

- WIZZIT charges per-transaction fees that range from 99c (USD 0.15) to R4.99 (USD 0.78) and does not charge a monthly fee nor require a minimum balance. There are no transaction limitations - the service is purely pay-as-you-go.
- WIZZIT employs over 800 "Wizz Kids". Wizzit's model is to employ unemployed people, called Wizzkids typically unemployed university graduates from low-income communities. Their role is to promote the product and help unbanked customers open accounts. Wizzit's model is to employ unemployed people, called Wizzkids, to go directly to unbanked potential customers and sign them up.
- Wizzkids are usually part of the community and provide ongoing support to customers, a strategy that underlies Wizzit's success. Although MTN Banking and Wizzit have a similar number of account holders, about 500 000, the number of active Wizzit accounts is more than 60% compared with MTN Banking's 20%.

CASE OUTLINE

Prominent South African politician, Cyril Ramaphosa, had a very frustrating day. He was trying to open a bank account for his son who was heading off to begin his studies in Cape Town. Later that day Cyril happened to express his frustration to friend Brian Richardson and remarked "Jeepers, if you think it is a problem for us at the top end of the pyramid, can you imagine how difficult it is for the people at the bottom".

Entrepreneurial Brian found himself reflecting on this simple statement which made him question about what was happening in the world of banking. This problem couldn't necessarily be unique to Cyril and was certainly not unique to SA.

This conversation was the seed of the creation of Wizzit, a cell phone banking solution bringing banking to the unbanked.

Brian's journey began by embarking on a global research project to uncover working models. The initial idea was for an electronic purse which would provide some type of banking solution. Eventually, after much time researching various models, the team realised that there were very few success stories. Rather the landscape was littered with failures and at the time only Octopus Card operating out of Hong Kong was having any form of commercial success.

Brian quickly realized that the only way that one could begin to look at banking the unbanked was through technology, and through the use of technology. In speaking to counterparts, colleagues and business people in the 'western paradigm' or the developed world, technology meant internet banking. In emerging markets, internet banking for the masses is not a viable solution. There are issues around electricity supply, the cost of PCs, PC literacy rates, connectivity issues, all of which are solved if you move to a cell phone application. Everybody has one and it is one of the fastest growing industries in Africa, and has in-built applications that enable far more than just making and receiving calls and sending SMS's. At this point the Wizzit team shifted their thinking from an e-purse to a cellphone application.

Entering the banking arena with a cell phone application posed fairly serious challenges. South African regulation dictates that a banking license is necessary to work in this space. Banking licenses however are difficult if not impossible to get and the cost of the banking license destroyed the entire revenue model necessary to cater for a low income client. This is when the decision was taken to align with the Bank of Athens in what is known as an Alliance Banking Relationship: Wizzit pays them a fee for the use of their license, and operates essentially as a division of the bank. Bank of Athens however has no investment or shareholding in Wizzit and all profits and losses are for Wizzit's own account. Regulatory and compliance communications with the Reserve Bank take place through The Bank of Athens.

THE TECHNOLOGY AND INNOVATION

The technology the Wizzit team envisaged had to meet three requirements which we were not negotiable as the unbanked do not have the time or resources to ensure a phase 2 compliant phone, a 32k SIM card and a single network provider, therefore:

1) It had to work on all handsets

2) It had to work on all SIM cards, and

3) It had to work across all of the networks.

The three factors listed above are major barriers and deterrents to banking the unbanked. The problem then surfaced that no existing technology company approached believed it be done.

The Wizzit team did not accept this but instead created their own tech company which they named R-Cubed. Next, Wizzit found South African Peter Kruger, a great technologist with good banking experience who was also planning to emigrate. Peter was convinced to stay and became the brainchild behind creating Wizzit's technology platform.

R-Cubed, has its own revenue model owns all the IP and is the technology provider to Wizzit and others. For mobile banking to really work, you needed mass adoption. The more people and entities you have utilizing payments and mobile banking, the better the system as a whole works. R-Cubed was free to provide the technology to anyone else who was willing to pay for it globally. These tie into indicators for:

1. Knowledge and technology transfer and

2. Diffusion and use of technologies

To date R-Cubed technology has been outsourced in Zambia, Rumania, Tanzania, in Europe, to the SA postal service and on the short list for a Standard Bank contract.

If we examine the Kenyan example of the M-Pesa mobile money system, the Kenyan government was able to understand the benefit of this new innovative way of allowing people to transact and transfer money. This resulted in a policy change which enabled the phenomenal growth of this financial service. In just over two and a half years over 7, 7 million Kenyans transact through the M-Pesa system. Therefore regulation and the interpretation of the regulations have the ability to strangle new innovations which can have profound effects on social development or has the capacity to enhance and lubricate the process of innovation in entrepreneurial new firms.

CASE II: NESTLE

SOUTH AFRICAN CONTEXT AND RELEVANCE TO NATIONAL PRIORITY

Agriculture contributes less than 4% to GDP but accounts for 10% of total reported employment. Agriculture is in SA is well-diversified with field crops, livestock and horticulture the main sectors (OECD, 2006).

According to SAHRC, 2008, the South African government is pursuing three parallel land reform policies:

1. Land Restitution is a legal process whereby people who can prove that they were dispossessed of their land after 1913 can regain their land or receive due financial compensation.

2. Land Tenure Reform aims to give all South Africans, particularly farm workers, labour tenants and those in the former homelands, the right to occupy and use land.

3. Land Redistribution aims to address the racial imbalances in the ownership of commercial agricultural land (a target of 30 percent of commercial agricultural land being owned by blacks has been set for 2014)

The land reform policy has however come under some criticism and is not having the impact on poverty and rural development which was anticipated (CDE, 2006). Ideally land reform should lead to the emergence of viable farms. However, without training and extension not only in farm technologies, but also in marketing and financial management some of the beneficiaries of land reform have suffered defaults, being inadequately prepared for commercial farming in a high risk environment, or unable to raise sufficient capital for commercial production (SAHRC, 2004). Appropriate support services need to be developed, including financial services, market information, input supply networks, transportation and storage infrastructure and extension (OECD 2006).

The main potential to reduce rural poverty and inequity lies in the development of overall frameworks that provide social security, education and training as well as health care, and in developing adequate infrastructures in rural areas.

CASE OUTLINE

Nestle is a large multinational with its headquarters located in Switzerland. Many subsidiaries of Nestle are located in developing economies and pursue localised context relevant strategies and innovations.

Nestle South Africa is currently in the process of piloting projects where emerging farmers will be groomed to become future suppliers of raw materials to Nestle.

The first project is the 'Maluti Window' project which transfers technology and knowhow to emerging dairy farmers. The goal is to help these farmers understand and become competent enough to produce high quality milk. The next phase would be to scale up successful farmers to a commercial level. Nestle would provide a ready market for the milk produced.

The second project involves the production of chicory. Nestle currently imports almost all the chicory it uses from India. Chicory is the primary ingredient in 'Ricoffy'. Through this project Nestle hopes to create a local supply of chicory in order to create local supply chains rather than importing the raw inputs. This project is presently being piloted on a group of 16 farmers on land which was completely unproductive. The company has employed a team of agronomists and farming experts who have identified micro climates ideal for chicory farming at a reasonable distance from the Ricoffy manufacturing plant and who coach the local farmers in farming techniques, land management, financial management and other skills necessary to farm successfully. The project has the potential to economically transform the impoverished area where little of the land is put to productive use.

A large part of ensuring the success of these projects lies in overcoming bureaucratic and regulatory hurdles. Nestle has engaged in dialogue with the Gordon Institute of Business Science (GIBS) in order to join in collaborative platforms for engagement and discussion with other stakeholders interested in the creation of innovative business models for engaging with low income communities and private public partnerships.

CASE III: JOHANNA SOLAR

SOUTH AFRICAN CONTEXT AND RELEVANCE TO NATIONAL PRIORITY

Over a decade ago, most countries joined an international treaty - the United Nations Framework Convention on Climate Change (UNFCCC) - to begin to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. Developed countries had a binding agreement to reduce emissions and developing countries were expected to contribute to the effort as well. According to the IPCC Fourth Assessment Report, avoiding dangerous climate change requires developed countries to reduce their emissions compared to 1990 levels by 80% to 95% by 2050, and by 25% to 40% by 2020. In developing countries, substantial deviations below business-as-usual baselines are required.

With its significant dependence on coal, South Africa's per capita green house gases (GHG) emissions is only slightly lower than developed countries, and well above the developing country average. This is mainly because 90% of South Africa's electricity comes from coal-fired power stations. A U.S-based Carbon Monitoring for Action (CARMA) estimates that of all firms globally, Eskom is second biggest emitter of CO_2 in the world.

So partly pressured by the agreements of the UNFCCC and partly by the energy crisis, the Cabinet government of South Africa endorsed a Long Term Mitigation Strategy (LTMS) in 2008. The LTMS laid down a strategic direction for climate action in South Africa. Other than achieving a balance in mitigation and adaption policies in response to climate change, the LTMS explicitly states that:

"Over the long term we will redefine our competitive advantage and structurally transform the economy by shifting from an energy-intensive to a climate-friendly path as part of a pro-growth, pro-development and pro-jobs strategy." (Marthinus Van Schalkwyk, 2008)

Furthermore, the Cabinet approves that regulatory mechanisms as set out in the LTMS will be combined with economic instruments such as taxes and incentives with a view to diversify the energy mix away from coal, laying the basis for a net zero-carbon electricity sector in the long term and setting ambitious and mandatory targets for energy efficiency and in other sub-national sectors.

To achieve the targets set out in the LTMS, South Africa will need to invest in an energy mix of technologies like wind, solar, geothermal and hydro, not only to mitigate climate change but to develop and grow sustainably in the long-term. Exploring the specific case of Johanna Solar will contribute to the efforts of the South African government in implementing the LTMS and will allow them to understand how-to achieve a climate-friendly energy path, grow sustainably and create local jobs.

CASE OUTLINE

In 2005, after 10 years of long research, the University of Johannesburg (UJ) developed a flexible, thin-film, metal alloy based on CIGS[3] that reduced the cost of solar PV production manifold. This invention claimed to reduce the costs of solar PV production in the world by half (Engineering News, 2008). The UJ formed Photovoltaic Technology Intellectual Property (PTIP) to commercialize its research breakthrough. The technology licensing rights was given to a German company called IFE Solar Systems that set-up Johanna Solar Technology GmbH in 2006 to begin production of the CIGS technology in Germany. License fees are being paid to PTIP in instalments according to agreements set out in the licensing agreement. In 2008, Johanna Solar granted a first license of the CIGS technology to Sunvim Solar Technology to begin production of CIGS solar PV cells in China.

The creation of PTIP to commercialize the breakthrough and source of knowledge, ideas, supply of skills and funds for the invention are S&T indicators.

In the absence of a favourable regulatory environment for a fledgling technology in South Africa, commercialization and production of the new technology did not materialize. There was an outward rather than inward transfer of technology. The UNFCC emphasizes the importance of technology transfer of low carbon technologies into developing countries to achieve international and national climate change policies. The absence of a business or entrepreneurial incubation model in the country eventually made buying solar PV products within the country expensive, delayed the implementation of solar PV products, benefits like cost-reductions rising from economies of scale and scope that came with learning and experience curves over time could not be attained.

Transfer of technology into a country, creation of new jobs, mitigation of GHG4, business or entrepreneurial incubation frameworks and/or the formation of new markets are S&T indicators. Creation of new jobs and the mitigation of GHG are outcome S&T indicators.

The country missed an adequate policy framework that would have otherwise led the nascent technology to the local market: through technology-support policies like feed-in tariffs and production/investment and tax incentives[5]. Feed-in tariffs for solar PV, concentrating solar, wind and biomass were announced in September of 2009, but there has been no complementary and mandatory requirement by Eskom to source a certain per cent of their total energy from renewable energy.

Types of policy mechanisms and instruments that encourages/discourages technology development are potential S&T indicators.

Fortunately however, according to the terms of the first licensing agreement with Johanna Solar, PTIP has the right to grant an independent technology license to a South African consortium to establish a manufacturing facility in Africa. The consortium (called Thin Film Solar Technologies Pty Ltd) consists of South Africa's state-owned Central Energy Fund (CEF), Sasol, the University of Johannesburg (UJ) and the National Empowerment Fund are pursuing the South African project jointly as a public-private partnership (PPP). In addition, the European Investment Bank has lent €40-million to the PPP to support the construction of the local PV production facility (Pouris, 2008). All actors in such a PPP will be considered into the analysis. Sasol has a 40% interest in the start-up PV company, and will be looked upon as a 'prime-mover' actor in the network of actors as it has vested interest in continuing with its highly subsidized coal energy production.

3 CIGS is made from Copper, Indium, Gallium and Selenium and does not use silicon as feedstock. So CIGS cells are claimed to be less expensive per watt installed, more efficient in low-angle and low-light conditions and consume less material in production. They also have the potential to be flexible in their configurations, making them attractive for building integrated PV (BIPV).

4 As per requirements of international framework conditions (IPCCC)

As an outcome of the PPP, co-financed initiatives, the creation of incentives to support investments and the development of a technical support package will be considered as S&T indicators.

The machinery required for the South African plant would be acquired from Johanna Solar GmbH and will be shipped to the production site in Paarl, Western Cape, South Africa.

The acquisition of machinery and components from Germany, to build manufacturing production capacity in South Africa will be S&T indicators. The exchange of knowledge and the type of knowledge flows between the South African consortium and German project management experts (IFE); solar module producer Aleo Solar; construction firm EPR; glass manufacturer Interpane; and 3EFinanz will be potential S&T indicators that will be explored in the case studies.

POTENTIAL INDICATORS FROM THE CASES PROPOSED

1. Organisational forms and innovative practice:
    - Nestle local subsidiary R&D new supply sources
    - Wizzit's independent body responsible for tech applications
    - Thin Film Solar Technologies Pty Ltd., as a consortium
2. Number of R&D employees
3. Impact of cell phone technology i.e. the number of people that did not bank and is currently banking. Impact of solar PV use i.e. the amount of clean energy generated in MW from the solar PV panels produced and used
4. Impact of the technology on the economic development and activity of the user (e.g. savings, use of other financial products such as insurance, resistance against economic shocks etc.).
5. Comparison of economic impacts on suppliers :
    a. Nestle or Wizzit
    b. Wizzkids as suppliers
    c. Emerging dairy or chicory farmers as suppliers
    d. Production value chain of solar PV

5 The one significant difference between the German and SA operations is that in Germany, government subsidies cover 15%-20% of clean energy investment (Anastassios Pouris, University of Pretoria, 2008).European taxpayers and consumers have borne much of the pain of driving down the costs of wind power to a point at which it can begin to compete with power generated from natural gas and to an extent from coal

6. Amount of unused land sustainably converted to productive land by low income or emerging farmers. Contribution of solar PV energy in the total energy mix of South Africa

7. Economic impacts on emerging farmers and the communities in which they transact e.g. employment opportunities for community. Economic impact of solar PV to the country (GHG reduction) and to other actors in the consortium. The economic impacts on Wizzkids e.g. income

8. Regulatory and economic instruments impact (challenges, barriers) on network of actors (e.g. entrepreneurs, SME's, multinationals and small scale businesses) involved in the innovative or entrepreneurial activity.

9. An important linkage measure mentioned in the literature is that of commercialization. This involves the creation of market value from knowledge. An example of this is the spinning off of a new firm to bring new knowledge to market such as the R-cubed technology company created by Wizzit or the creation of Johanna Solar.

In summary, the potential indicators we propose fall into two main groups:

1. The first group of indicators are *function indicators* and also include impact/outcome indicators. It involves tracking the outcome of money/fund flows, value chains, and commercial transactions

stemming from the innovations of Wizzit, Nestle and Johanna Solar such as increased revenue, market share, or employment. Examples of function indicators are government funding of R&D for the potential benefits from science and technology to development including economic and social benefits among others, and the provision of capital, skills and technical competencies

3. The second group of indicators are *factor indicators* that influence the function of actors. Government bureaucracy, regulations and government policies and other market interventions that may hinder or encourage innovation and thus development are examples of factor indicators.

Dr Helena Barnard: Helena is a senior lecturer at the Gordon Institute of Business Science. She teaches in the areas of innovation, strategy and international business. She completed her PhD at Rutgers University in New Jersey in the USA in 2006 with a dissertation on how firms from developing countries use investment in the developed world as a strategy to increase their competitiveness. She has published academic research in Advances in Qualitative Research, the Journal of Management and Governance, and the International Journal of Technology Management. She has presented her work at numerous competitive conferences, e.g. the Academy of Management, the Academy of International Business, European Academy of International Business and Globelics (Global network for the Economics of Learning, Innovation, and Competence-building Systems, www.globelics.org). Helena sits on the executive committee of the INGINEUS project (Impact of Networks, Globalisation, and their Interaction with EU Strategies).

Dr. Tashmia Ismail: Tashmia Ismail is employed jointly by the European Union and the Gordon Institute of Business Science as a coordinator and researcher on a three year project involving eleven countries. The ultimate aim of this project is to inform EU policy on the creation of synergistic relationships with emerging economies and to manage the globalisation of innovation and knowledge creation. In this role Tashmia works closely with partners at institutes in Norway, Sweden, Copenhagen, Italy, Germany, Estonia, UK, China, India, Brazil and South Africa. She recently presented a paper at the International Globelics conference. Tashmia has been appointed as director/co-ordinator of a Base of Pyramid Hub (BOP) at GIBS. BOP addresses corporate involvement and innovation in low income markets in order to increase the economic and social wealth of both. The purpose of this hub will be to aggregate, codify and disseminate academic and business knowledge in the BOP space in order to promote the concept of inclusive markets. In 2006, Tashmia won a full scholarship to study for a two year MBA at GIBS, where she was placed on the Dean's list of top ten students and earned her degree in 2008.

Radhika Perrot is a PhD candidate at the UNU-MERIT, the Netherlands. Her PhD thesis looks at firm innovation strategies in three renewable energy technologies - wind, solar and hydrogen fuel cells. She is expected to complete her PhD in early 2010. Radhika worked with Lynn Mytelka, former Director of Investment at UNCTAD and UNU, on a hydrogen fuel cell monitor that disseminates information and research activities on fuel cells. The monitor was eventually handed over to the green transportation arm of South African National Energy Research Institute (SANERI). Radhika also worked for a think-tank in Brussels, researching and promoting feed-in-tariffs for renewable energy technologies in the EU. In South Africa, she assisted a research and consulting firm on a project developing future energy scenarios for the Gauteng provincial government. Previous to her study in the Netherlands, she was a correspondent and analyst for a premier IT media in India. She has presented her work at various conferences and academies around the world including Globelics, International Conference on Innovation and Management (ICIM) and at the ETH-Zurich, Switzerland.

BUDGET

Budget Outline

	Total Hours	Rate per hour/per researcher in Rand	Rate /hour in Euros	Total in Rand	Total in Euro
Researcher Cost	240	805	70	193,200	16,800
Overhead				20,000	1739
Travel/ Lodging				21,600	1878
TOTAL				**234,800**	**20,417**

All calculation based on two full-time researchers that will be involved in the project

We are assuming a researcher rate per hour that is close to the international estimates i.e. 805 Rand/hour or a rate of 70 Euros/hour. We are assuming a 6 hours of researcher time per week for 40 weeks. The travel and lodging is for two travels to Nestle, Cape Town, and over-night stay for the 2 researchers. We are however open to discuss the details of the budget further with you upon consideration. The Rand and Euro conversion rate is taken at 11.5 Rand/euro.

TIMELINE

March 2010	Desktop Research to be completed/contact key industry actors
April-July 2010	Primary Data Collection/Interviews and sit-visits
Aug-Oct 2010	Write Up the Cases
November 2010	Speak to experts in the GIBS Institute/UNU-MERIT, receive critiques/comments/finalize first draft

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PROPOSAL

RESEARCH AND TRAINING SUPPORT TO BUILD AFRICAN CAPACITY IN SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS

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11 December 2009

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PROPOSAL:
RESEARCH AND TRAINING SUPPORT TO BUILD AFRICAN CAPACITY IN SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS

1 BACKGROUND

The International Development Research centre (IDRC) has made funds available to UNU MERIT for an initiative that aims to build capacity in South Africa, Rwanda and Mozambique in the selection and use of indicators related to science, technology and innovation.

Science, technology and innovation is recognised as key to achieving economic and social change and sustainable development[1]. It is however also clear that one needs to have indicators of science, technology and innovation to be able to monitor and benchmark the state of the innovation system. The indicators allow one to evaluate projects against goals as well as against global indicators and provide evidence that can be used to inform policy.

Given the specific context of innovation systems in Africa, systems for determining indicators need to acknowledge a number of factors including the informal economy and key assets such as the existence of indigenous knowledge and biodiversity as well as people's inherent ability to innovate and adapt, which have the capacity to improve the livelihoods of African people. Building people's capacity to innovate is also important in the context of climate change where adaptation to climate variability will become increasingly important.

One can identify indicators that illustrate the science, technology & innovation activities in a region (e.g. the number of innovation processes being supported), linkages (e.g. the flow of knowledge or funding between different actors), outcomes of processes (e.g. improved livelihoods, publications, extent of uptake by others, etc) as well as the longer-term impacts of these activities.

The focus in terms of innovation is often on high tech activities being undertaken by formal institutions or businesses and there is often very little attention given to innovation happening on the ground. When formal R&D surveys are done they generally do not capture innovation that is taking place informally.

South Africa already has policies and strategies in place to support science, technology and innovation - for example, the White Paper on Science and Technology prepared by Department of Science and Technology in 1996. In addition a National Innovation Fund has been established, but it is necessary to broaden the formal understanding of innovation to include both community innovation (local innovation) as well as less technical forms of innovation that have the potential to improve livelihoods. Non-technical forms of innovation can involve the development of systems or social arrangements that strengthen people's

[1] NEPAD Science and Technology (2005) African Science, Technology and Innovation Indicators: Towards African Indicator Manuals, A Discussion Document.

ability to access resources, markets, etc. One needs to develop indicators that allow one to track such forms of innovation as well as providing a measure of the outcomes and impacts thereof in order to influence policy. Policy changes that might be encouraged if evidence of impacts is shown include the allocation of funds to support such innovation processes as well as the institutionalisation of funding arrangements that give smallholder farmers greater capacity not only to influence the research agenda but also to actively participate in the research process.

Another aspect that needs to be given attention is that of commercialisation of innovations. Commercialisation can be seen as the creation of market value from knowledge and involves the sale of intellectual property. It is thus an important linkage to be tracked when considering the concept of innovation[2]. The provision of support to individual innovators that are not part of formal institutions needs to be a policy decision that protects their rights and allows them to benefit through the upscaling of their innovations.

2 INTRODUCTION TO PROLINNOVA

In South Africa, the case study selected for this project will be an initiative in KwaZulu-Natal known as FAIR (Farmer Access to Innovation Resources), which is a sub-programme of the PROLINNOVA Network.

PROLINNOVA (**PRO**moting **L**ocal **INNOVA**tion in ecologically oriented agriculture and natural resource management) is an international NGO-led network of organisations that promotes participatory approaches to research and development and gives particular recognition to the concept of local innovation and the support thereof. PROLINNOVA is active in some 20 countries currently, including both South Africa and Mozambique, but also a number of African countries including Tanzania, Uganda and Kenya. It should be noted that active sharing between countries as well as institutionalisation of approaches within formal research and development institutions are key goals of PROLINNOVA.

PROLINNOVA supports an approach called participatory innovation development (PID) which is a development approach that is based on farmers' motivations and ideas about how to solve a local challenge or capture an opportunity to improve livelihoods (i.e. local innovation).

Through the FAIR initiative, the innovative efforts of smallholder farmers have been supported with technical input and access to other resources by NGOs and government departments working in the pilot area. Another key concept of FAIR is that of making funds available locally to support farmer innovation. Making such funds available has meant capacitating local structures to manage and distribute funds as well as receiving and screening requests from farmer innovators for support. A range of activities have been supported through FAIR, from farmer experimentation through to cross visits to stimulate the innovative capacity of local communities. This process of strengthening local institutions,

[2] Gault, F (2008) Science, Technology and Innovation Indicators: Opportunities for Africa. The African Statistical Journal, Vol 6, May 2008, Pg 141.

supporting local innovation as well as the specific cases of innovation, will serve as the case study for the current initiative.

The organisations involved in the initiative will consist of the organisation coordinating FAIR South Africa, namely the Institute of Natural Resources (INR) and the institution implementing the FAIR programme, namely Farmer Support Group (FSG), which is an outreach arm of the University of KwaZulu-Natal (UKZN).

PROLINNOVA-South Africa has a National Steering Committee that has representatives from different government organisations, educational institutions and NGOs. The network has also engaged actively with the Department of Science and Technology as well as the National Advisory Council on Innovation (NACI) and will continue the discussion on STIIs within this context.

3 OBJECTIVES OF THE INITIATIVE

The key objective of the call is to support the development of case studies of innovation processes that will allow project teams to engage in a process of training in techniques, approaches and use of STIIs in the policy development / influencing process.

The training process will support the measurement of science, technology and innovation capabilities of the participating countries and will also serve to build a critical mass of different actors with a strong understanding of the importance of linking S&T capabilities.

4 SPECIFIC PROJECT OBJECTIVE

The specific objective of this project is to explore the nature of the indicators that could be used to track community-level innovation (both social and technical innovation) as well as joint innovation processes (and the outcomes and impacts of these processes).

Joint innovation involves processes where different actors come together and develop new technologies or improved ways of doing things. In the case of PROLINNOVA, these are processes are based largely on existing motivations and ideas of smallholder farmers or community members.

Recognition needs to be given to the importance of this form of innovation and the impact that it can have on livelihoods of people, especially the poor. Support of local innovation allows for the development of technologies and systems that are suited to local needs and resources.

The identification of suitable indicators as well as the engagement of key policy makers will be an effort to ensure that the importance of supporting of local innovation processes is recognised.

5 RELEVANCE TO THEME OF THE INITIATIVE

The use of the FAIR programme as a basis for the case study will not only be an effective way of identifying indicators related to a different form or level of innovation, but will also be an effective way of initiating discussion with different actors, given the networking function of PROLINNOVA.

The analysis of the FAIR programme will yield indicators that address local issues as well as the informal economy. The FAIR programme already involves a number of different NGO and government players who will be able to participate in the process of identifying relevant indicators.

The analysis of the selected case study will illustrate:

- How joint innovation processes involving local innovators and support agents are currently being undertaken in South Africa (The case will also tease out ways that these processes could be strengthened and policy changes that are needed in order to achieve this).
- The sort of indicators of innovation that could be used to support evidence-based policy
- Whether there are indicators that could be developed in further work and which could be included in STI indicator activities in South Africa.

6 CONTRIBUTION TO ACHIEVING NATIONAL PRIORITIES

Local innovation and joint innovation processes based on smallholder farmers' motivations are seen as having the potential to contribute meaningfully to a number of the Millennium Development Goals (MDGs), especially the first one which is to 'Eradicate extreme poverty and hunger'. Supporting local innovation puts people in a better position to develop technologies and systems that allow them to use available resources to produce food or generate an income.

Food security is officially one of the constitutional rights in South Africa. On these rights, the Constitution states that every citizen has the right to have access to sufficient food and water, and that "the state must by legislation and other measures, within its available resources, avail to progressive realisation of the right to sufficient food. The vision of the Integrated Food Security Strategy is to attain universal physical, social and economic access to sufficient, safe and nutritious food by all South African at all times to meet their dietary and food preferences for an active and healthy life[3]. Support of local innovation is one way of strengthening people's capacity to be food secure.

In terms of relevant national policies and plans, the White Paper on Science and Technology, developed by the Department of Science and Technology in 1996, refers to a view of the future where all South Africans will (1) enjoy an improved and sustainable quality of life, (2) participate in a competitive economy by means of satisfying employment and (3) share in a democratic culture.

[3] Dept. of Agriculture, Forestry and Fisheries - Integrated Food Security Strategy-South Africa (2002)

The White Paper recognises that in order to attain this vision it is necessary to establish an efficient, well coordinated and integrated system of technological and social innovation within which stakeholders can forge collaborative partnerships and interact creatively in order to benefit themselves and the nation at large. It also recognises that resources from engineering, the natural sciences, the health sciences, the environmental sciences and the human and social sciences are utilised for problem-solving in a multidisciplinary manner.

The approach of joint innovation that draws on the knowledge and abilities of different groups of actors to jointly develop new technologies or systems is directly supportive of this concept.

7 METHODOLOGY

The FAIR programme, which involves both social and technical elements of innovation, will be used as the case study for the project.

An analysis of the various cases of experimentation or innovation will be undertaken to understand the background, the purpose, the type of support that has been provided and the expected outcome. The potential impact that each case could have on the individual household, broader community and even the province could be ascertained. Issues related to the need to protect intellectual property rights will also be investigated to understand how this could best be addressed.

Discussions with local innovators as well as other key support actors (Farmer Support Group, Provincial Department of Agriculture and another NGO also providing support, SaveAct) will be undertaken to understand how best such innovation processes could be tracked.

This initiative will strengthen the outcomes and impacts of the FAIR programme by adding another element to the learning process.

Since the innovation process is already ongoing and funded from elsewhere (Ford Foundation, Rockefeller), the project will mainly involve the documentation and analysis of the processes involved.

Specific project activities together with anticipated time frames are listed in Table 1 below.

8 POTENTIAL IMPACT

Considering the immediate FAIR project, the current project could play a key role in identifying indicators that could be used to show the outcomes and impact of the FAIR project. This would provide evidence that could be used in discussion with policy makers at Provincial Department of Agriculture regarding the possibility of piloting such local innovation support funds (LISFs) within other districts.

If one considers the broader policy environment, then the involvement of PROLINNOVA members in the training programmes would allow for the introduction of some new views regarding the importance of local innovation processes and the contribution that such processes could make to livelihoods and the local economy.

9 PROJECT TIME-FRAME AND BUDGET

The project will be undertaken over a 12 month period as depicted below and the total cost of the project is 19,985.71 US Dollars.

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Table 1: Time-frames for project activities

MAIN ACTIVITIES	Q1	Q2	Q3	Q4
Literature review				
Inception meeting with stakeholders				
Discussions with innovators and support agents				
Analysis and documentation of findings				
Sharing of outcomes				
Engagement with policy makers				

Table 2: Budget summary for proposed activities

MAIN ACTIVITIES	
Literature review	2,057.14
Inception meeting with stakeholders	2,014.29
Discussions with innovators and support agents	4,885.71
Analysis and documentation of findings	3,814.29
Sharing of outcomes	1,371.43
Engagement with policy makers	1,371.43
Sub-total (Human resource costs)	15,514.29
DISBURSEMENTS	
Vehicle use	1,600.00
Flights	1,085.71
Accommodation & Disbursements	928.57
Admin	857.14
Sub-total (Disbursements)	4,471.43
TOTAL COST	19,985.71

Note: The budget also covers the participation of the key team members in the training workshop to be arranged by UNU MERIT.

10 PROJECT TEAM

The lead applicant for this proposal is the Institute of Natural Resources (INR). The INR is a Public Benefit Non-Profit Company that is an associate institute of the University of KwaZulu-Natal.

The service and work of the INR aims to make a substantial contribution to the wise use of natural resources, sustainable livelihoods and poverty alleviation. Our services are based on participative, multi-disciplinary and integrated approaches to projects. We aim to bridge the gap between science and application, with emphasis on practical management systems. Our solutions aim for innovation in integrating the needs of People, Environment and Development.

The INR is the coordinating organisation for PROLINNOVA-South Africa, which is funded through ETC EcoCulture, which is based in the Netherlands.

INR will be collaborating with Farmer Support Group (FSG), which is an outreach arm of the University of KwaZulu-Natal and the implementing agent of the FAIR Programme which will serve as the case study for the current project.

The primary project team members are Brigid Letty from INR and Maxwell Mudhara, Director of FSG. On the ground support will be provided by project facilitators from FSG who are already involved with the FAIR project.

Table 3: Summary of key team members

Individual	Institutional affiliation
Brigid Letty	Programme Leader Sustainable Agriculture and Food Security Programme **Institute of Natural Resources**
Maxwell Mudhara	Director Farmer Support Group **University of KwaZulu-Natal**

See attached curricula vitae and Company Profile for the INR.

Building African Capacity in Science, Technology and Innovation Indicators

Presentations of the Training Team

IERI Workshop

Tshwane University of Technology

South Africa

September 7-9, 2010

Technical Report to IDRC: Supplementary Document 2
Technical Report: Building African Capacity in Science, Technology and Innovation Indicators
IDRC Grant Number: 104753
March 30, 2012

Contents

Introduction

This document provides the four lectures delivered by the training team as part of the Training Workshop held at IERI in Pretoria South Africa, September 7-9, 2010 as well as two public lectures presented at the end of each of the first two days of the Training Workshop. In addition, there is a lecture invited by the National Advisory Committee on Innovation (NACI) and delivered at the Department of Science and Technology.

The training and public lectures were attended by the case study team members engaged in the Project from Mozambique and South Africa and as well as by graduate students in South Africa holding IDRC grants to support empirical work as part of their doctoral research. The NACI lecture was attended by members of NACI and government officials from the Department of Science and Technology.

The case study team, and IDRC supported graduate students in Senegal, attended a separate course in Dakar and the lectures are provided in a separate document.

As the PowerPoint slides are printed two to a page, not all are readable. However, more than enough is readable to show how the training or lecture materials were presented. Copies of the presentations have been provided to IDRC for the archive should the reader require more detail.

Challenges of Building Africa's Innovation Systems

IERI/UNU-MERIT-Research Training Workshop
Pretoria, South Africa
September 7-9, 2010

By Mammo Muchie, SARCHi, IERI, TUT, South Africa and Aalborg University, Denmark, Senior Research Associate, SLPTM< Oxford University,UK

10-02-2012

Overview

- Inspiration
- Reality Check on Africa!
- Clarity on innovation?
- Making Systems of Innovation?
- Problems of Building Innovation Systems
- System of Innovation Actors
- National System of Innovation Problems in Making African innovation Systems
- CIS-Community System of Innovation
- Knowldge Indicators & Concluding Remark

10-02-2012

Inspiration!

- "There is no presumption that the system (of innovation-MM) was, in some sense, consciously designed, or even that the set of institutions involved work together smoothly and coherently." (Nelson & Rosenberg, in National Innovation System : A Comparative Analyis, Oxford University Press, Oxford 1993:4)

10-02-2012

Inspiration!

- "At present nations seem to be conscious as never before of their 'innovation systems' and how they differ from those of their peers… it is leading to attempts on the part of nations to adopt aspects of other systems that they see as lending strength." (Nelson, ibid. 520)

10-02-2012

Reality check on Africa?

- **About 70% of the African population lives on less than US$ 2 a day**
- **35 of the world's 50 least developed countries are reported to be on the African continent**
- **Population without access to electricity:**
- **Sub-Saharan Africa: ca. 75%**
- **China: ca. 1.5%**
- **About 40% of the African population has no access to safe and clean drinking water**
- **About 50% of the African population lives in poor sanitation conditions**

10-02-2012

Clarity on what Innovation is?

- Innovation comes in a variety of forms
- It seems to be used often by different people to mean different things
- Making sense of its use is necessary to know how we go about using it with a shared sense-making of its salient meaning.

10-02-2012

Clarification

- Two senses of its use are relevant... use and application as product, process and service
- And degree of novelty associated with innovation:
- incremental ..Immprovements not changes
- radical...Changes calling for a whole new architecture, not a modification of it
- Modular.. Using an existing system of a product while employing new or different components
- Architectural. A reconfiguration of an established system to link together existing components in a new way

10-02-2012

Clarification

- Innovations are not homegenous
- Innovations vary
- Finding out what precisely is being innovated is important
- Need to be critical of what we mean by innovative
- Responses to different types of innovation by those in competition will differ
- Creative destruction will affect the destroyed but will be good news to the new entrants ready to capitalise on the created.

10-02-2012

Not made in a vacuum

- Innovation does not occur in a vacuum
- Concept/definition/framing matters
- Theory Matters
- History matters
- Path dependency matters
- Context matters
- Institution matters
- Environment matters
- Culture matters

10-02-2012

Making Innovation systems

- All innovation systems have elements, components, parts
- All innovation systems have activities and perform functions with varying degrees of effectiveness
- All innovation systems have linkages, interconnections and interactions
- All innovation systems have boundaries (spatial, sectoral, technological, etc)

10-02-2012

Key System of innovation elements?

- Conceptual frame and ideas of governing
- Policy setting
- Actors
- Specific unit for system generation (e.g., national, sectoral, regional, community and so on)
- Activities
- Institutions
- Knowledge
- Incentives

10-02-2012

System of innovation building

- Are the included or selected elements specifically related to innovation creation, absorption, transfer and adaptation or not?
- Does the interaction facilitate certain outcomes and hinder others?
- Does the interaction lock in the system of innovation to certain paths of development?
- How and who facilitates system openess?
- How can the system building prevent locking out potential paths of development that may come from outside the system?
- For example, the opportunity to harness broad-based innovation by lock out!

10-02-2012

Analytically selecting a System boundary?

- Boundaries range spatially from local to city, community, region, national and global- where to draw the boundary? Who to include and who to exclude?
- Boundaries if related to production: (e.g., industry, firms, sectors, global firms)
- Boundaries if related to technology: high tech, low tech and intermediate
- Boundaries within a country or nation: urban and rural, industrial and agricultural, high- tech, medium-tech, low-tech, technology absorbing or technology generating and so on
- Boundaries can be narrow to exclude or broader to include!
- Boundaries are not necessarily fixed, they can be flexible and amenable to intelligent adjustment!

10-02-2012

Emergent Systems of Innovation

- If the interaction within the given boundary becomes strong and sustainable, a functioning system is said to emerge
- If the interaction is weak, a non-functioning system of innovation can occur
- If the interaction is neither strong or nor weak, a relatively functioning system may emerge

10-02-2012

Explaining Variation in Systems of Innovation

- The degree of functioning of a system of innovation is not only dependent on the quality and strength of interactions
- It also dependes on the quality of the actors interaction
- The politics of the actors , and the politics governing the nature of their interaction
- The expected outcome can be any goal set such as economic development, growth, social cohesion, knowledge production
- But the way the politics of system building plays out heavily influences the output and outcome

10-02-2012

System of Innovation Actors

- The system of innovation key actors differ in their capabilities, efficiences, commitment and policy creation and execution
- Universities differ
- Industries differ
- Governments differ
- They differ in the quality of what they produce and their interaction
- Some interactions produce results and outputs
- Others interact but produce little or no output.

10-02-2012

Evaluating System of Innovation Actors

- Key actor interaction:
- On the input side: are the actors well organised, do they have visions and missions to assist the vision and mission of the nation
- Do they have resources
- Do they have human capital and concentration of talent
- Do they have trust and dilaogue capital

10-02-2012

On the Output Side

- Does the interaction of actors enhance:
- more and the build up of capacity, capability, competence
- Does the interaction permit science , technology and innovation to enhance wealth creation
- Is the interaction productive or destructive?
- Is the output effective or ineffective?
- Is the output sustainable or one or short term?

10-02-2012

Variation in input and output

- Developing countries have problems in assembling the input side
- Hence problems in generating predicatable developmental output
- Poorer countries depend very much on outside input
- This distorts their policy vision and a well-functioning system generating potential
- Often distorts that vision
- Leading to states of entangled complexity

10-02-2012

Transition Countries

- The transion countries have features of system of innovation actor interactions that has a bifurcated developing and developed country features
- The challenge is to shed the developing country feature to make it a developed
- All the more to get their systems of innovation to evolve and develop.

10-02-2012

Developed countries

- They have established systems of innovations
- They have universities
- They have industries
- They have goverments (national and local)
- The se system of innovation actors , however the variations within, span a broadly well functioning system of innovation

10-02-2012

National Innovation System

- An ability by a nation to mobilise and use resources, deploy institutions, put in place incentives and regulations, carry out favourite experiments
- Why some countries are better at innovation than others?
- National culture that foster innovation matters
- Relevant to and affects attitude to work, time
- Use of authority
- Styles of decision-making
- Balancing contradictory claims
- Equality, legitmacy issues can influence innovative behaviour

10-02-2012

National Innovation System Vary

- in Africa, they have to be made; a need to launch an African innovation movement
- The unit for making them is a matter of debate: cities and wealth creation; linking rural with city economy; the region, continent and so on
- Where a national system exists like South Africa, it is radically bifurcated: need to combine its link with the challenge of linking ZA's NSI with the rest of Africa
- See our conceptualisation in our book: Bridging Digitial Divide: Innovation Systems for ICT

10-02-2012

The Making of African Innovation Systems

- Stimulate and understand inter economic and non-economic actor interactions and dynamics,
- Co-evoution of economic and non-economic governing institutions, practices and understanding (Richard Nelson)
- The interaction of policies, knowledge, incentives, instuitions, practices and the understanding involved in the process
- System building, to identify significant interactions and interfacing of parts,
- Bridge the gap between theory and reality,
- The sources and organisation for stimulating innovation, imagination and creativity, learning and comptence building
- To understand how routines are formed and novelties emerge and prepare and design policy frames!

10-02-2012

Making African NSI

- Integrating Africa or making the Africa nation itself is a problem of dynamic innovation systems, of creative destruction,requiring systemic approaches to understanding and creating knowledge in interaction with policies, instituitions, system of innovation actors, incentives
- Innovation systems are useful to assist in stimulating how an African unity can be forged!
- Africa's Greatest Day Is its unity: Will building Innovation System help?

10-02-2012

Why an African NSI?

- A national system of innovation to promote a national system of production
- To enable a system creation to produce what Africa consumes, and to consume what Africa produces
- To create Africa...wide producers and users interactions (Lundvall:85)
- To embed knowledge creation,innovation, learning in Africa's institutions,societies
- To inject a total learning and innovation culture in Africa
- To retain African resources to stimulate African development

10-02-2012

The options

- To try to build the NSI of existing states as they are–
- Use regional integration..
- AU/NEPAD processes
- Role of Pivotal States like South Africa
- Top-Up: Africa wide project
- Bottom up: Community System of Innovation

10-02-2012

The Neglected: Community and African Unity

- The Community level activities are ignored, unknown or neglected
- The Africa-wide level project is often misused, misconstrued and even abused
- Explore what the community level knowledge building may take place
- From exploration, process, exploitation and impact
- To build ' Africa's smart growth 'by linking bottom up with the broader African unification project
- Next I will only deal with the Community System of innovation

10-02-2012

Community System of Innovation

- To date the most popularised system of innnovation is the National Level, for Africa it means the existing states as they are!
- The issues for policy have been framed with technology or innovation catch up and development
- The relevant instituitions are those that create knowlege , R & D, absorb knowledge etc..
- The main actors often selected are: industry-university-Government interactions

10-02-2012

Innovation at the Community level

- Need to centre or anchor the innovation system to the community level
- Establish a Community Innovation System (CIS) to promote development from the bottom, not just from the state and business.
- Redifine community level elements
- Broaden the boundary to include the community as part of the interaction of Government, industry, university and other relevant actors
- Redifine institutions, incentives, regulations and policy to accommodate community level knowing for creating grassroots innovation!

10-02-2012

Definition: Community Innovation System

- An ability by a community to mobilise and use resources, organise knowledge and human capital training, deploy institutions, put in place incentives and regulations, to carry out the favourite experiments, activities and functions undertaken by citizens by converting their tacit and explicit knowledge into innovations.
- The active engagement and support by Governments, industries, universities and other actors in and with the community's efforts to create and transform existing knowledge into innovation by identifying and applying the knowledge converted into innovations to address social and environmental challenges at the grassroots level.
- Governments support through constructive policy, universities by providing top research to identify the knowledge that exists at the community level and industry by helping in the process of conversion of the community knowledge into innovation, and the community is empowered to use the knowledge inside to create innovation and wealth!

10-02-2012

Innovative thinking needed?

- Meanwhile as the policy pundits keep peddling competiveness and other aspirations to reach industrial status
- Many people in the rural areas and the urban townships suffer
- Life is static and often essential services for well being are unavailabe or if they exist are mostly inadequate!
- There is a need to think differently- out of the box of linear progress into co-evolution through the concept of the Community System of Innovation
- Try to address the problems of those who live in the rural areas now rather than later after the completion of tha manufacturing stage.(when this will take placen is still unknown or is hard to predict?)

10-02-2012

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From linear Progress to Co-evolution?

- What is needed is a strategy of co-evolution
- Where rural communities become modern
- Without necessarily becoming urban and industrial
- And all the services, education, health, energy, sanitation, clean water, transport and housing are upgraded by supporting the community system of innovation, equal to the support of innovation systems at the national, regional, sectoral or technology levels.
- By spreading the community system of innovation for broad based innovation for grassroots transformative livelihood changes from community ill-being into community comprehensive well-being.

10-02-2012

Co-evolution

- We may have to question elite expectaion of progress from rural and agricultural to manufacturing and industrial transformation as it took place in the West and even the NICs
- Supplant transformative linear stages of progress with the transformative strategy and policy of co-evolution of communities with urban and maufacturing areas in African countries
- Ubuntu, solidarity, sharing , trust and social capital for co-evolution must be cultivated and promoted
- By promoting as a 'brand' or 'logo' what is framed as the "Community System of Innovation"

10-02-2012

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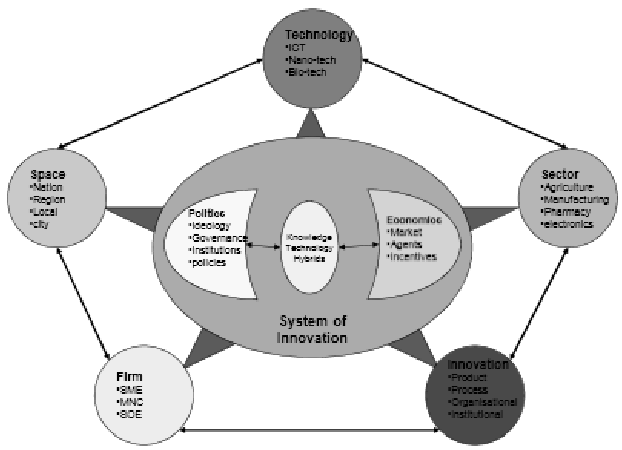
Priorities

- Priorities for the CIS are: rural services: health, agriculture, education, water, energy, transport and infrastructure
- Identifying through top researchers and research university work, local knowledge that can be turned into innovation
- This requires adding to the triple helicies an equal even if not even more significant or relevant component- communities as one of the pillars of the helicies
- And generating opportunities for wealth creation by deploying all the actors, activities and instituitions to support CIS

10-02-2012



10-02-2012

Knowledge indicators

- If we go for CIS and the African NSI
- We need to develop synthetic innovation indicators
- "Not everything that can be counted counts and not everything that counts can be counted"(Albert Einstein)
- This is what seems to apply for the moment to Africa.

10-02-2012

Concluding Remark: recommended key policy re-orienation

- Like the African NSI, the African CIS is still waiting to be made;
- There is a need to launch a broader CIS movement in Africa
- Co-evolution of rural and urban, agricultural and industrial sectors
- Modernise rural areas in partnership with manufacture , not in opposition
- From the Triple helicies we add the community and forge a quadra-helicies of (Government, universities, industry and the community) and plan policy, resources, research to support CIS
- Making the African NSI is... in itself a big social innovation,
- Work on both fronts: Community level innovative surge and wider African level system of innovation
- Africa selects the path of 'smart' co-evolutionary growth rather than linear and catch up which has been frustrating to date.

10-02-2012

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Thank You!!!

Mammo Muchie

10-02-2012

2/10/2012

Data gathering and developing and using innovation indicators

IDRC-UNU Research Project

Michael Kahn

Institute for Economic Research on Innovation
Tshwane University of Technology
September 2010

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In Memoriam

Chris Freeman 1921-2010

Co-developer with Bengt Lundvall of the innovation system concept, Analyst of long wave theory, Contributor to the economics of industrial innovation:

1

Freeman's contribution

The Frascati Manual (1963)
The (national) **system** of innovation approach(1987)
•Intervention of the State through public policy;
•Understand how enterprises design their strategies for R&D;
•Impact of education on the formation of human resources and training of technicians, researchers and other workers, and the social innovations related to such formation of human resources;
•Role of industrial structure
Toward the Oslo Manual (1992)
The economics of industrial innovation (1995)
•Rate of technical change & economic growth depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations.
•Systemic aspects of innovation affect rate of diffusion and productivity

Supply, demand and linkages

The shift in thinking

- Neo-classical economics explains industrial growth using Newton's maths with a focus on market equilibrium and the rational allocation of scarce resources. Neglects theories of choice, risk and uncertainty.
- Evolutionary economics analyses the process of technological & institutional innovation in which adaptive efficiency defines economic efficiency.

Nelson, Winter & Rosenberg

- Economic development driven by co-evolution of technology, organizational forms & governance
- Economic agents deal with uncertainty so that equilibrium is constrained
- History (path dependence) is critical to understanding the present
- There is wide variation in 'how things are done' at any one time
- Technologies evolve incrementally often without a future endpoint in mind
- Evolutionary economics assumes purposive action subject to Simon's 'bounded rationality'

Measuring Innovation (Smith, 2005)

- Measurement is theory laden: why do we measure what we measure? What underpins a measure e.g. patenting & legal frameworks; R&D and its link with economic growth
- Measurement implies commensurability, and what can and cannot be measured and compared.
- Innovation involves 'novelty' – what exactly does this mean?
- Rosenberg: R&D not always precursor to Innovation
- Kline & Rosenberg: 'Chain link' model. Innovation is
  - Non-sequential; involves feedback loops
  - A learning process with many inputs
  - Invention occurs as problem-solving within innovation activities

2/10/2012

- Innovation involves ‘novelty’ – what exactly does this mean?
- Innovation most frequently incremental
- Innovation involves non-R&D inputs – design, engineering, training, seeking new markets
- Innovation involves information exchange; ideas; networking
- “Innovative learning can be understood as change in the knowledge bases on which capabilities rest.” Neither is directly measurable → *quantify innovation expenditure*; estimate *sales of new products.*

Welcome to Oslo: the ‘subject’ approach

2.1	During the three years 2002 to 2004, did your enterprise introduce:		
	→ New or significantly improved goods. *Exclude the simple resale of new goods purchased from other enterprises and minor changes that only alter the appearance of the product.*	Yes ☐	No ☐
	→ New or significantly improved services.	Yes ☐	No ☐
			If no to **both** questions, please go to question 3.1.
2.2	By whom were these product (goods and services) innovations developed?		
	→ Mainly your enterprise or enterprise group	☐	Select the single most appropriate option only
	→ Your enterprise together with other enterprises or institutions	☐	
	→ Mainly other enterprises or institutions	☐	
2.2.1	Did these innovations originate mainly in South Africa or abroad?		
	☐ South Africa ☐ Abroad		
2.3	Were any of your goods and service innovations during the three years 2002 to 2004 new to your market or new to your firm?		

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	→ New to your market? Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets).	Yes ☐	No ☐
	→ Only new to your firm? Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market.	Yes ☐	No ☐

2.4	Using the definitions above, please estimate the percentage of your total turnover in 2004:	**2004 turnover distribution**
	→ Goods and service innovations introduced during 2002 to 2004 that were **new to your market**	
	→ Goods and service innovations introduced during 2002 to 2004 that were only **new to your firm**	
	→ Goods and services that were unchanged or only marginally modified during 2002 to 2004 *Include the resale of new goods or services purchased from other enterprises.*	
	Total turnover in 2004 = 100%	

3.1	During the three years 2002 to 2004, did your enterprise introduce any:			
	→ New or significantly improved methods of manufacturing or producing goods or services?	Yes ☐	No ☐	
	→ New or significantly improved logistics, delivery or distribution methods for your inputs, goods or service?	Yes ☐	No ☐	
	→ New or significantly improved supporting activities for your processes, such as maintenance and operating systems for purchasing, accounting or computing?	Yes ☐	No ☐	
3.2	By whom were these process innovations developed?			
	→ Mainly your enterprise or enterprise group	☐	Select the single most appropriate option only	
	→ Your enterprise together with other enterprises or institutions	☐		
	→ Mainly other enterprises or institutions	☐		
3.2.1	Did these innovations originate mainly in South Africa or abroad?			
	☐ South Africa ☐ Abroad			

5

5.1	During the three years 2002 to 2004, did your enterprise engage in the following innovation activities?		
A	Intramural (in-house) Research and Experimental Development (R&D) Creative work undertaken on a systematic basis within your enterprise to increase the stock of knowledge and its use to devise new and improved products and processes (including software development).	Yes ☐	No ☐
	If yes, did your firm perform R&D during 2002 to 2004:	Continuously ☐ Occasionally ☐	
B	Extramural or outsourced R&D Same activities as above, but purchased by your enterprise and performed by other companies (including other enterprises within your group) or by public or private research organisations.	Yes ☐	No ☐
C	Acquisition of machinery, equipment and software Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes.	Yes ☐	No ☐
D	Acquisition of other external knowledge Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations.	Yes ☐	No ☐
E	Training Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes.	Yes ☐	No ☐
F	Market introduction of innovations Activities for the market introduction of your new or significantly improved goods and services, including market research and launch advertising.	Yes ☐	No ☐
G	Other activities (including design) Procedures and technical preparations, including design, to implement new or significantly improved products and processes that are not covered elsewhere.	Yes ☐	No ☐

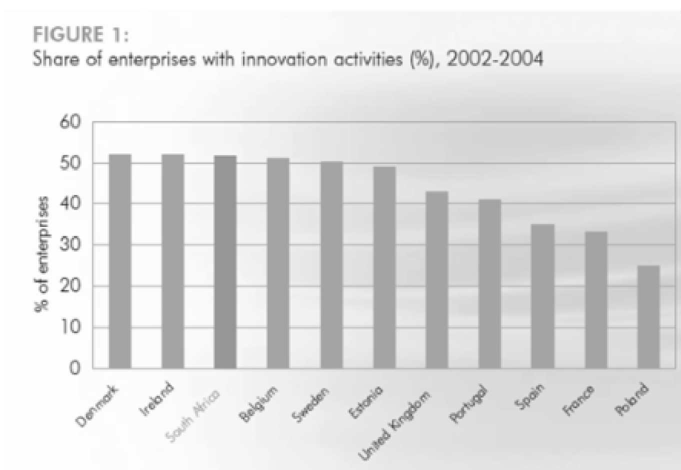
6.1	During the three years 2002 to 2004, how important to your enterprise's innovation activities were each of the following information sources? Please identify information sources that provided information for new innovation projects or contributed to the completion of existing innovation projects.					
	Information source		**Degree of importance** Tick "not used" if no information was obtained from a source.			
			High	Medium	Low	Not used
	Internal sources	Sources within your enterprise or enterprise group	☐	☐	☐	☐
	External sources					
	Market resources	Suppliers of equipment, materials, components or software	☐	☐	☐	☐
		Clients or customers	☐	☐	☐	☐
		Competitors or other enterprises in your sector	☐	☐	☐	☐
		Consultants, commercial labs or private R&D institutes	☐	☐	☐	☐
	Institutional sources	Universities and Technikons	☐	☐	☐	☐
		Government or public research institutes	☐	☐	☐	☐
	Other sources	Conferences, trade fairs, exhibitions	☐	☐	☐	☐
		Scientific journals and trade/technical publications	☐	☐	☐	☐
		Professional and industry associations	☐	☐	☐	☐
6.2	During the three years 2002 to 2004, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to benefit commercially. Exclude pure contracting out of work with no active co-operation.			Yes ☐	No ☐ If no, please go to question 7.1	

2/10/2012

Methodology

- An authoritative business register
  - National Business Register
  - Taxpayer or credit rating registers
  - Commercial databases
  - Chamber of Commerce members;
- Firms older than 3 years
- Stratified random sample across large, medium & small firms; cut off 10 employees
- Postal survey targeted at CEOs.
- Aim for 70% response rate
- Most of EU27; most OECD (except US); LACs, Tunisia, South Africa, Malaysia, China, Russia

Telling the story



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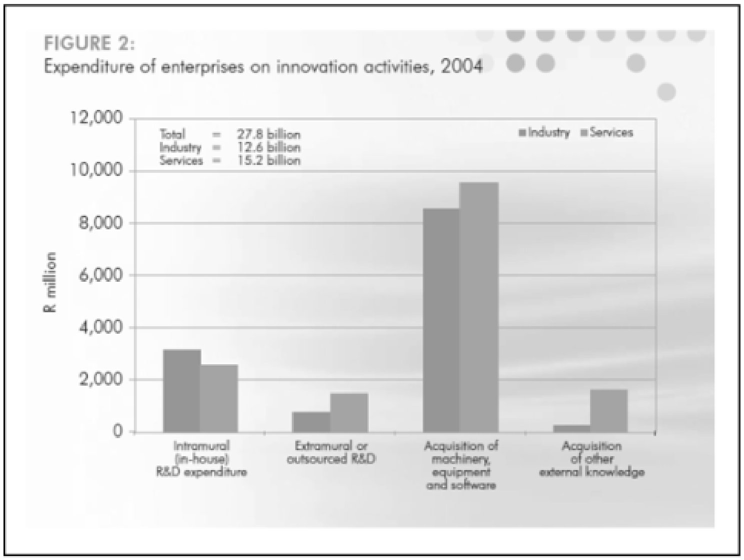


FIGURE 2:
Expenditure of enterprises on innovation activities, 2004
Total = 27.8 billion
Industry = 12.6 billion
Services = 15.2 billion
Industry
Services
R million
12,000
10,000
8,000
6,000
4,000
2,000
0
Intramural (in-house) R&D expenditure
Extramural or outsourced R&D
Acquisition of machinery, equipment and software
Acquisition of other external knowledge

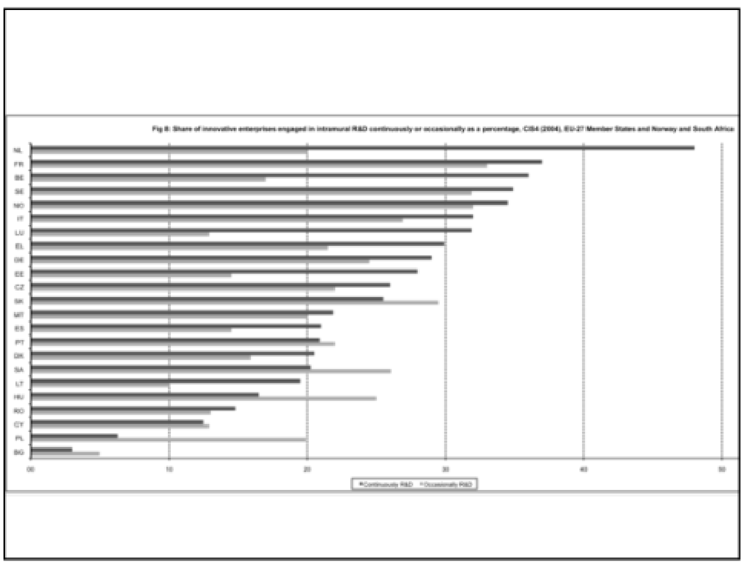
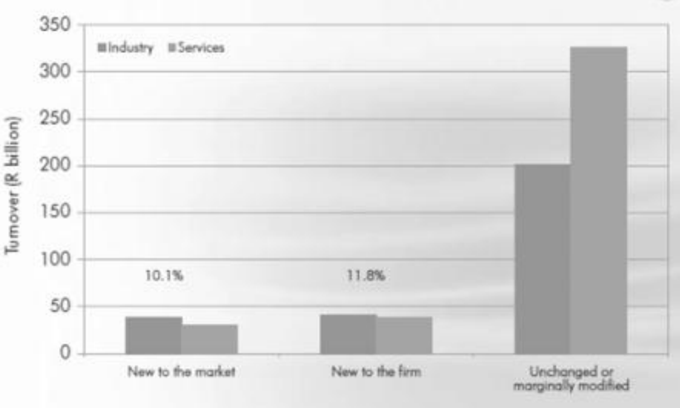


Fig 8: Share of innovative enterprises engaged in intramural R&D continuously or occasionally as a percentage, CIS4 (2004), EU-27 Member States and Norway and South Africa
Continuously R&D
Occasionally R&D

Table 15 Share of innovative enterprises by type of activity, CIS 4 (2004), EU-27 Member States and Norway and South Africa

	Enterprises engaged in intramural R&D	Enterprises engaged in extramural R&D	Enterprises engaged in acquisition of machinery, equipment and software	Enterprises engaged in acquisition of other external knowledge
Ireland	85.5	22.2	71.4	23.7
France	70.2	24.9	60.0	23.9
Netherlands	67.4	35.0	63.8	24.8
Sweden	66.1	28.4	65.5	41.1
Norway	65.9	40.3	30.4	21.9
Italy	59.1	21.1	90.6	20.2
Slovakia	54.8	26.1	77.3	23.7
Germany	53.8	20.9	72.9	23.5
Belgium	53.3	26.4	73.4	19.6
EU-27	52.2	22.0	75.1	21.5
South Africa	**51.7**	**19.3**	**54.1**	**28.3**
Greece	50.6	32.0	91.6	14.7
Czech Republic	48.7	24.3	75.6	24.3
Luxembourg	45.0	25.0	75.7	24.3
Portugal	43.8	29.0	86.0	24.8
Estonia	43.2	23.0	82.6	35.9
Hungary	42.4	16.1	75.5	17.3
Malta	42.4	9.0	49.3	13.2
Denmark	40.1	23.2	63.2	35.6
Spain	34.9	20.3	66.6	12.6
Lithuania	29.6	16.8	86.5	27.2
Romania	27.7	9.1	78.9	12.8
Poland	26.2	9.2	90.7	7.8
Cyprus	24.5	15.5	97.7	33.4
Bulgaria	8.6	12.6	65.9	24.5
SA Rank (1-25)	**11**	**18**	**23**	**5**

FIGURE 3:
Product (goods and services) innovators – breakdown of turnover by product type, 2004



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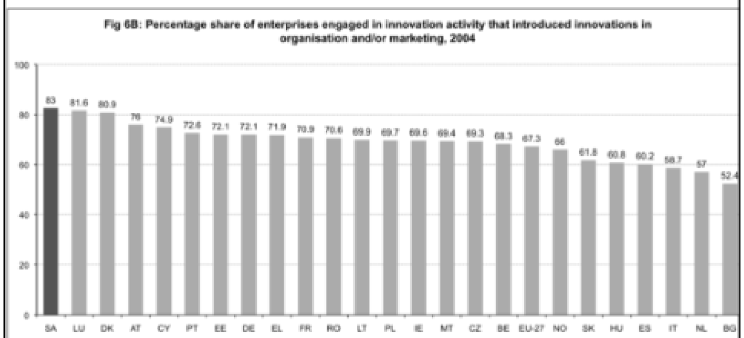
Fig 6B: Percentage share of enterprises engaged in innovation activity that introduced innovations in organisation and/or marketing, 2004
100
80
60
40
20
0
83
81.6
80.9
76
74.9
72.6
72.1
72.1
71.9
70.9
70.6
69.9
69.7
69.6
69.4
69.3
68.3
67.3
66
61.8
60.8
60.2
58.7
57
52.4
SA LU DK AT CY PT EE DE EL FR RO LT PL IE MT CZ BE EU-27 NO SK HU ES IT NL BG

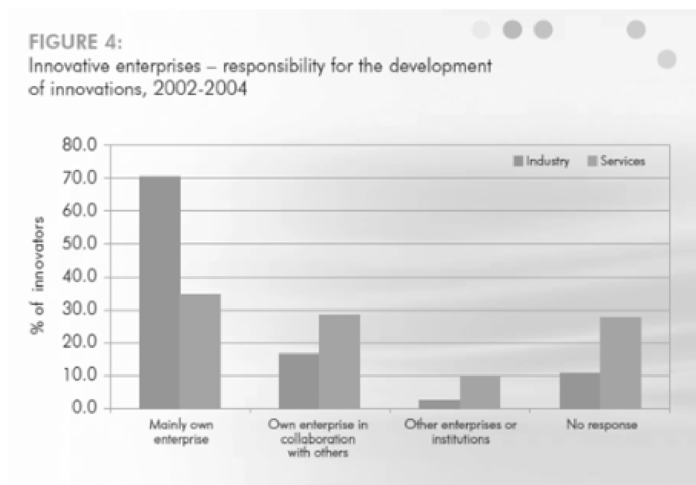
FIGURE 4:
Innovative enterprises – responsibility for the development of innovations, 2002-2004
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
% of innovators
Industry
Services
Mainly own enterprise
Own enterprise in collaboration with others
Other enterprises or institutions
No response

2/10/2012

FIGURE 5:
Proportion of innovative enterprises that introduced organisational or marketing innovations, 2002-2004

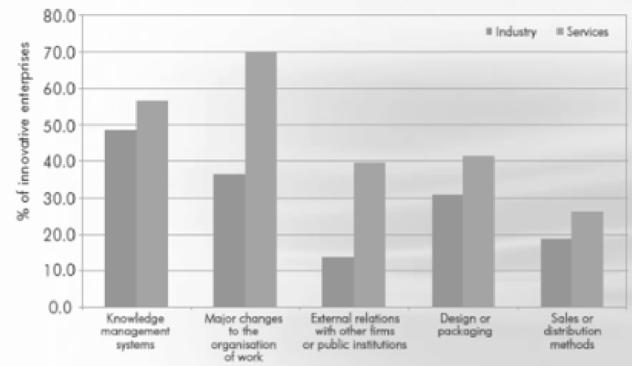

Fig 6B: Percentage share of enterprises engaged in innovation activity that introduced innovations in organisation and/or marketing, 2004

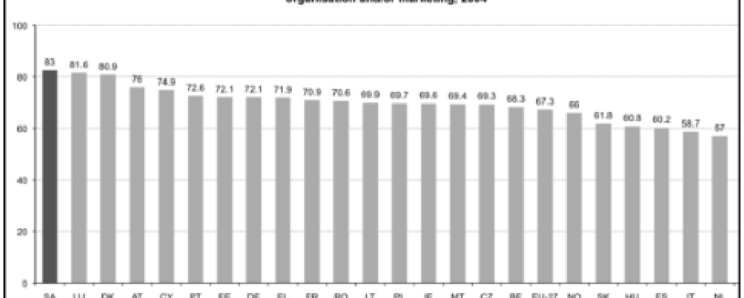

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FIGURE 6:
Sources of information for innovation rated as highly important by innovative enterprises, 2002-2004

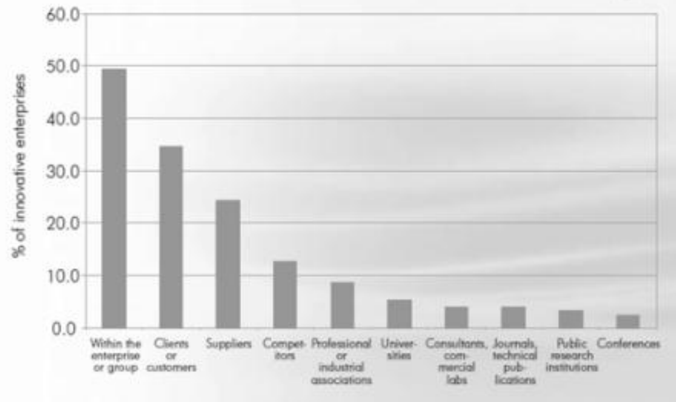
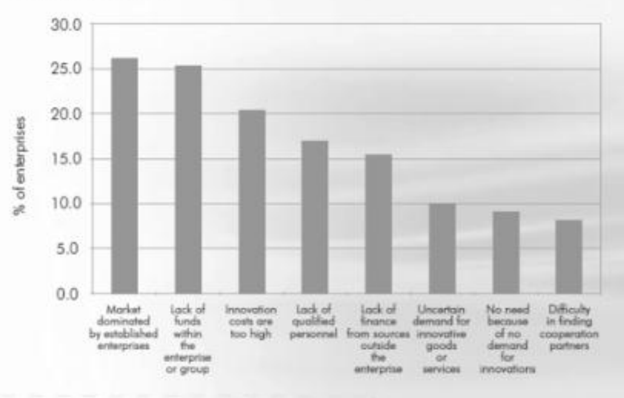


FIGURE 7:
Highly important factors that hampered innovation activities, 2002-2004



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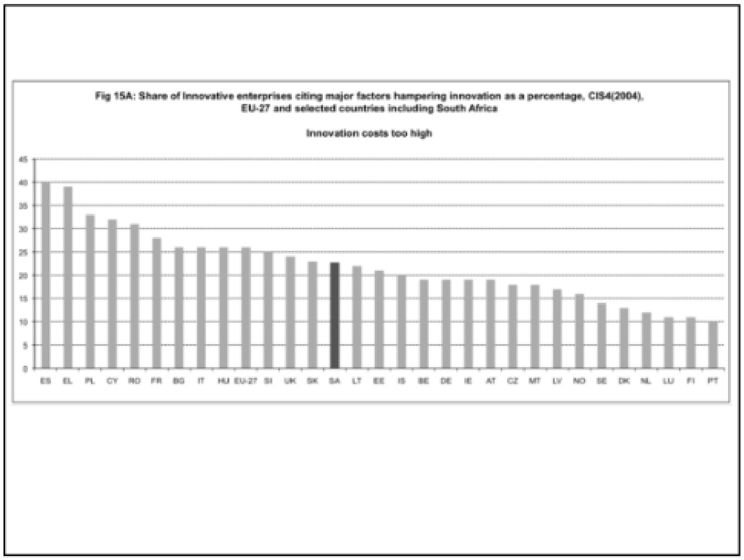

Fig 15A: Share of innovative enterprises citing major factors hampering innovation as a percentage, CIS4(2004), EU-27 and selected countries including South Africa
Innovation costs too high
45
40
35
30
25
20
15
10
5
0
ES EL PL CY RO FR BG IT HU EU-27 SI UK SK SA LT EE IS BE DE IE AT CZ MT LV NO SE DK NL LU FI PT

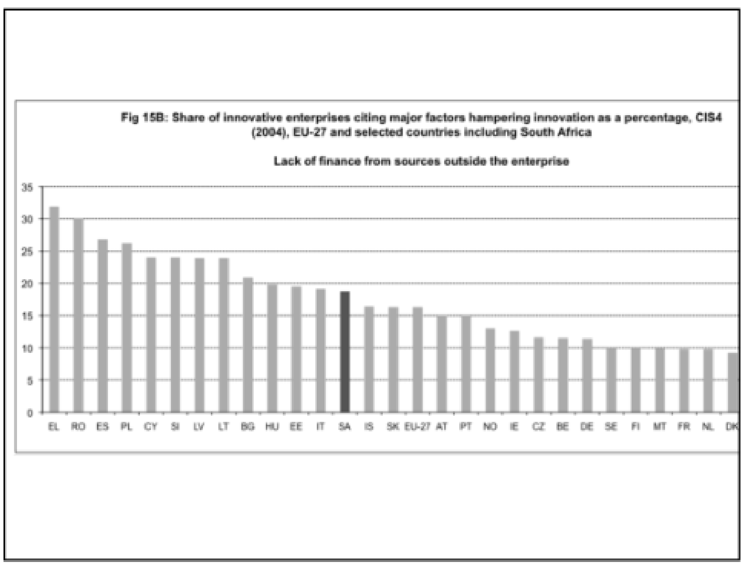

Fig 15B: Share of innovative enterprises citing major factors hampering innovation as a percentage, CIS4 (2004), EU-27 and selected countries including South Africa
Lack of finance from sources outside the enterprise
35
30
25
20
15
10
5
0
EL RO ES PL CY SI LV LT BG HU EE IT SA IS SK EU-27 AT PT NO IE CZ BE DE SE FI MT FR NL DK

FIGURE 8:
Highly important effects of innovation on outcomes for enterprises, 2002-2004

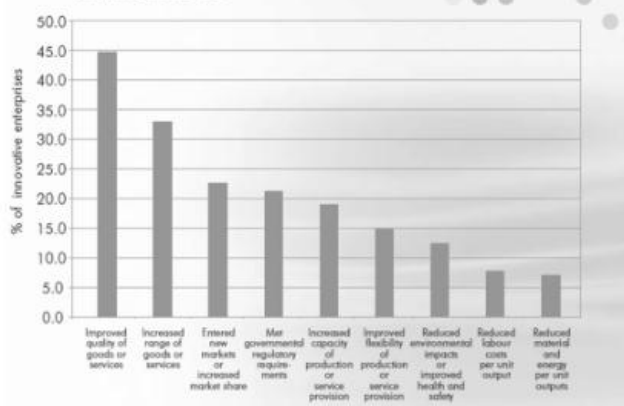

Table 6 Product innovators: proportion of turnover in 2004 attributed to the types of products

All Product innovators	Turnover generated (R millions)	Percentage turnover generated
Product innovations new to the market	67,848	10.1
Product innovations new to the firm	79,194	11.8
Products unchanged or only marginally modified	526,705	78.2
Total	**673,747**	**100**

Product innovators: Turnover in 2004 attributed to the types of products, by size of enterprise (%)

Size Class	1	2	3	4	Total
Product innovations new to the market	10.1	12.0	7.1	13.2	10.1
Product innovations new to the firm	9.8	17.8	23.6	19.2	11.8
Products unchanged or only marginally modified	80.1	70.2	69.2	67.6	78.2
Total	82.0	8.6	8.2	1.4	100

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	Product orientated effects			Process orientated effects				Other Effects	
	Increased range of goods and services	Entered new markets or increased market share	Improved quality in goods and services	Improved flexibility of production or service provision	Increased capacity of production or service provision	Reduced labour costs per unit output	Reduced materials and energy per unit output	Reduced enviromental impacts or improved health and safety	Met regulation requirements
Latvia	76,1	77,3	74,8	72,5	71,9	60,2	56,5	45,5	60,5
France	52,6	58,6	49,5	30,9	32,3	34,9	15,9	19,1	29,1
Luxembourg	48,2	34,5	53,2	37,6	30,3	16,3	7,6	15,3	37,6
Bulgaria	42,7	32,9	45,6	22,8	23,4	18,9	17,0	20,7	26,7
Ireland	40,7	32,8	32,7	22,1	23,5	19,3	10,1	11,1	13,8
Czech-Republic	40,6	25,7	40,0	26,8	25,3	16,9	13,7	15,5	7,0
Netherlands	38,8	33,1	46,9	33,9	30,5	20,9	12,8	12,3	14,2
Slovenia	38,1	32,2	49,6	30,8	31,0	28,4	17,2	18,6	15,5
Germany	38,0	31,7	37,7	27,5	19,9	15,1	9,5	10,3	10,2
United Kingdom	37,1	36,5	40,9	23,6	23,2			15,5	25,7
Greece	36,6	29,7	58,8	43,0	40,0	13,7	9,3	21,2	18,6
Estonia	35,2	33,2	34,2	22,2	22,8	15,2	12,3	9,2	15,6
Belgium	34,8	33,3	46,6	24,7	25,8	16,6	8,8	13,3	14,4
South Africa	**34,3**	**22,8**	**45,9**	**15,1**	**19,1**	**8,0**	**7,3**	**12,8**	**21,4**
EU-27	34,2	29,4	37,8	24,7	24,4	15,6	8,4	14,1	18,4
Slovakia	34,1	25,3	34,8	27,1	24,5	6,8	8,8	12,2	13,7
Poland	33,4	26,7	35,1	21,1	23,2	15,0	12,0	19,2	25,4
Hungary	31,5	19,6	35,1	20,9	21,9	4,1	6,2	13,2	19,4
Sweden	31,2	19,8	29,3	16,3	21,6	17,9	7,1	9,7	12,0
Iceland	30,5	19,3	23,4	16,0	15,3	13,8	5,7	2,9	7,2
Spain	28,1	19,6	35,2	25,2	32,5	12,7	7,0	16,2	23,0
Cyprus	26,6	17,1	29,8	64,7	56,9	27,0	8,2	29,8	46,8
Italy	25,4	15,1	34,1	18,7	23,2	18,1	4,4	14,7	19,4
Austria	25,4	20,8	35,3	23,1	19,0	7,0	4,9	8,2	13,5
Finland	25,3	21,6	24,2	15,9	17,1	13,0	5,9	7,2	9,8
Denmark	25,1	19,7	26,7	21,9	18,4	14,5	6,7	8,7	12,6
Lithuania	24,1	20,8	27,9	19,6	21,1	9,3	5,9	8,8	20,8
Norway	23,1	16,2	23,6	13,5	13,4	10,0	4,3	8,1	12,4
Malta	21,5	19,4	21,5	17,4	15,3	6,9	4,9	11,8	18,8
Romania	17,1	29,1	37,1	28,6	22,3	15,5		17,7	14,9
Portugal	9,7	15,4	9,5	8,8	6,1	17,9	25,8	12,6	12,5
SA Rank (1-31)	**14**	**18**	**8**	**29**	**24**	**26**	**18**	**17**	**9**

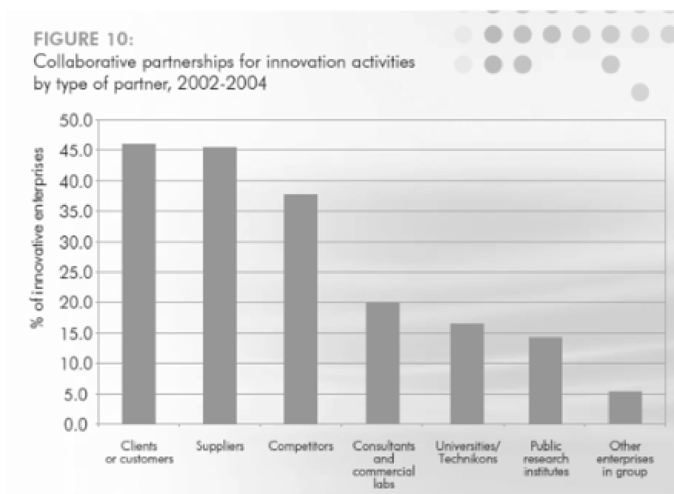

FIGURE 10:
Collaborative partnerships for innovation activities by type of partner, 2002-2004

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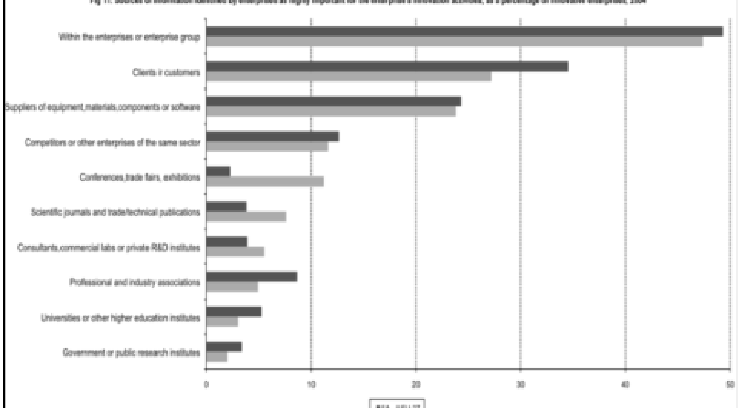
Table 19 Different types of co-operation partners of enterprises by country, as a percentage of innovative enterprises, EU-27 Member states and selected countries including South Africa

	All types of co-operation	Other enterprises within your enterprise group	Suppliers of equipment, materials, components or software	Clients or customers	Competitors or other enterprises in your sector	Consultants, commercial labs or private R&D institutes	Universities and Technikons	Government and public research institutes
Lithuania	56,1	16,7	45,5	34,5	25,4	24,9	12	9,6
Slovenia	47,3	15	37,5	33	20,4	19,7	19,5	13,2
Finland	44,4	23,5	40,8	41,4	34,2	32,7	33,2	26,4
Denmark	42,8	17,4	28,4	27,8	14,8	19	13,7	6,9
Sweden	42,8	17,2	32	27,9	10,8	19,8	17,4	6,4
Poland	42,2	12,7	28,2	16,4	8,5	7,9	6,2	8,7
South Africa	**39,9**	**37,2**	**45,4**	**46**	**37,6**	**19,9**	**16,5**	**14,2**
France	39,5	16,6	25,7	19,8	14,1	12,7	10,1	7,3
Netherlands	39,4	17,5	29,7	21,8	12,3	15	12,4	9,4
Latvia	38,8	6,1	32,6	28,7	25,1	18,3	13,8	12,2
Czech-Republic	38,4	13,5	30,7	26,1	15,3	15	13,1	7,4
Slovakia	37,7	14	31,7	30,2	21,2	18,6	14,8	11,4
Cyprus	37,0	5,9	24,5	4,2	12,8	16,9	2,2	1,7
Hungary	36,8	10,1	26,2	19,6	13,6	12,6	13,7	5
Belgium	35,7	16,9	25,9	21,2	9,5	15	13,2	9,2
Estonia	34,8	15,6	23,3	22,9	18,5	10	8,6	6,1
Norway	33,2	14	23,1	22,3	11,9	20,3	14,8	16,3
Ireland	32,3	16,7	23,2	25,2	6	10,1	10,1	5,7
Malta	31,9	16	22,2	16,7	5,6	13,9	4,2	4,2
United Kingdom	30,6	14,8	22,6	22,3	11,1	12,6	10	7,6
Luxembourg	30,5	20,3	24	22,2	14,9	11	10	8,2
Iceland	29,1	5,3	19,8	19,8	13,8	6,7	5	13,1
EU-27	25,5	9,5	16,5	13,9	8,3	8,9	8,8	5,7
Greece	24,0	3,6	11	7,8	11,3	6,5	6,4	2,5
Bulgaria	22,0	4,9	16,2	13,4	7,6	7,5	6	3,9
Portugal	19,4	5,7	13,9	11,5	6,8	8,7	7,5	4,8
Spain	18,2	3,8	9,5	4,2	3	4,1	4,7	5,2
Romania	17,5	8,7	13,8	10	6,6	4,9	3,7	4,3
Austria	17,4	8,2	7,5	7,8	3,9	7,3	10	5,2
Germany	16,0	5,2	7	8,1	4,3	2,9	8,5	4,1
Italy	13,0	3	7,3	5,1	4,8	6,4	4,7	1,5
SA Rank (1-31)	7	1	2	1	1	4	4	3

Fig 11: Sources of information identified by enterprises as highly important for the enterprise's innovation activities, as a percentage of innovative enterprises, 2004



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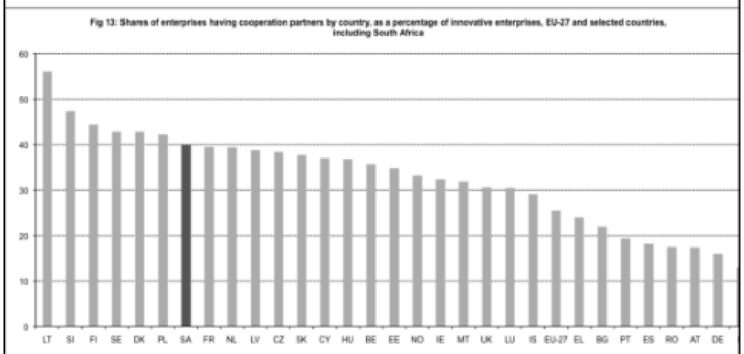
Fig 13: Shares of enterprises having cooperation partners by country, as a percentage of innovative enterprises, EU-27 and selected countries, including South Africa
60
50
40
30
20
10
0
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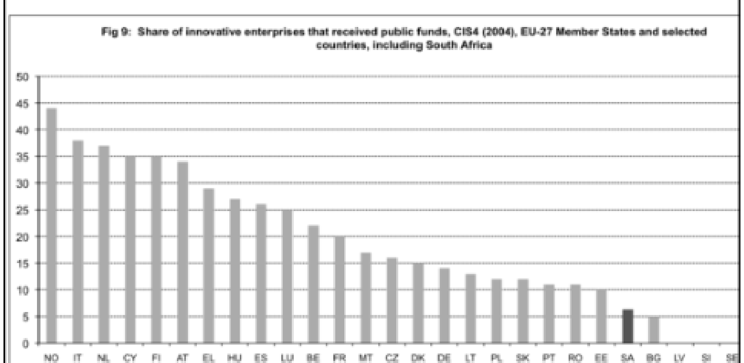
Fig 9: Share of innovative enterprises that received public funds, CIS4 (2004), EU-27 Member States and selected countries, including South Africa
50
45
40
35
30
25
20
15
10
5
0
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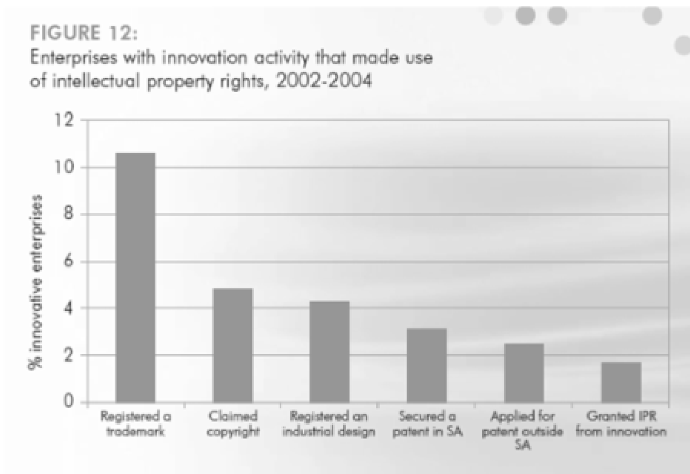


Table 23 Protection methods used by innovative enterprises

	Applied for a patent	Registered a trademark	Registered an industrial design	Claimed copyright
France	22.2	33.5	18.4	9.7
Germany	20.1	19.1	18.0	8.0
Denmark	19.6	25.0	9.8	9.5
Finland	18.2	19.9	9.6	2.3
Norway	17.1	22.1	8.6	11.5
Ireland	16.9	5.1	20.7	9.3
Netherlands	14.4	17.3	5.7	5.1
Italy	13.4	7.3	15.8	2.1
Spain	11.8	21.5	10.2	1.7
Belgium	11.0	13.4	4.3	3.5
Malta	9.0	7.6	3.5	:c
Lithuania	8.9	6.4	22.8	6.4
Luxembourg	8.8	9.4	21.0	12.3
Bulgaria	7.6	18.5	6.8	3.9
Portugal	7.0	19.1	4.3	3.3
Romania	6.9	7.4	17.1	3.4
Hungary	6.5	4.8	9.5	1.9
Estonia	5.5	2.0	18.6	2.9
Czech Republic	5.1	7.9	20.8	4.3
Poland	4.9	18.8	9.8	6.7
Slovakia	3.7	7.1	18.4	6.0
Greece	3.0	5.5	24.8	9.0
South Africa	*****2.5**	**10.6**	**4.3**	**4.8**
Cyprus	1.0	4.8	1.0	1.3
Slovenia	:c	:c	:c	:c
SA Rank (1-25)	**23**	**12**	**20**	**12**

Where is Innovation Going?

- The creation of a firm is an innovation (for the firm) and maybe for the market
- Firm creation and expansion is about risk management
- 10% of new firms survive to their 2nd birthday

Disruptive technology

Existing	Disruptive
Vertically integrated steel mills	Mini mills
High powered tubular steel motorcycles	Pressed steel welded Hondas
Mainframe computers	Microcomputers with HDDs
Polaroid instant photography	Digital
Electromechanical HDD	Silicon flash memory
Landline telephony	Mobile

Promoting Innovation

- Tertiary education increases the efficiency, size and novelty of new innovations; primary and secondary education enhance the capacity of an economy to accommodate or adapt these innovations.
- Access to venture capital.
- Competition, or the threat of competition, induces incumbent firms to innovate to maintain market share .
- Macroeconomic stability provides a predictable environment for innovators to make long-term investments.
- Property rights allow innovators to reap benefit.
- Openness to international trade provides a larger market for the sale of new products or processes, increases competitive intensity and fosters international knowledge spillovers

Open Innovation

- From Research and Develop (in-house) to Connect and Develop
- Look for synergy
- Release IP

NineSigma works with Clients

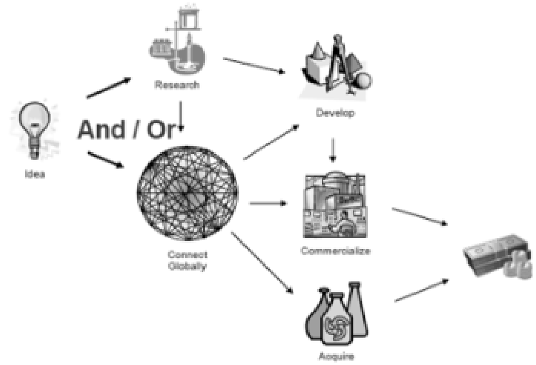
. . . to discover innovative ideas, technologies, products and services from outside their organizations

. . . to connect with the very best innovators and solution providers from around the world

. . . to quickly and cost-effectively solve their business needs

. . . and to transform their innovation processes

Open Innovation adds options to market success



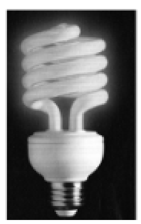
The Future of Open Innovation

- Consolidation of internal & external knowledge management
- Metrics-driven OI management processes
- Flexible expert ecosystems become the norm
- "Cradle-to-Cash" OI program integration across the value chain
- In-licensing and out-licensing are the norm
- R&D focus on "*First-to-Patent*" shifts to "*First-to-Market*"
- OI used as a risk-mitigating strategy

zynga@ninesigma.com

Innovation matters

- There are headline grabbing innovations: Cassette tape to Walkman to DRAMs to iPod
- But it is the softer innovations that really matter:
  - Clean water
  - Quality mass education
  - Safe and reliable mass transport systems
  - Clean and affordable food
  - Quality primary health care
- Government as a trusted intermediary is an innovation
- Shift thinking from "the poverty of technology" to the "poverty of politics"

How many  **does it take to**

change Eskom **?**

Innovation is about meeting demand

Innovation Systems in sub-Saharan Africa and innovation indicators

Watu Wamae
RAND Europe and The Open University

Research Training Workshop: Pretoria, 8th September, 2010

Outline

- Some basic notions of innovation
- Contextualising the theoretical link between innovation and development
- Some characteristics of innovation in SSA
- Learning as a fundamental process of innovation
- Changing innovation dynamics

Some basic notions ... What is innovation?

- Innovation is the process of converting new or existing knowledge to value for the "benefit" of individuals, groups or communities.
  - Schumpeter (1939), in his analysis of business cycles, was the first to highlight the importance of existing knowledge in creating value. He referred to innovations as *new combinations*, thereby underlining the fact that "existing elements" provide opportunities to produce "change" in innovation activities
- It is a technical process as well as a social and economic one, which leads to a product or process (Lundvall, 1992; Edquist, 1997; Johnson *et al.*, 2003).
  - a new or better product (or a product variety) - material (goods) or intangible (services)
  - a new process or way of producing goods and services - material (a technological process) or intangible (an organisational process).

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Some basic notions... What is an innovation system?

- An innovation system is a network in which actors interact and exchange both codified and tacit knowledge to undertake innovative activities.
  - Knowledge is the key commodity in an innovation system
  - A network provides channels through which knowledge flows
  - Learning is a fundamental process in innovation

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Some basic notions… What are the major components of an innovation system?

- *Organisations*: they are players or actors e.g. firms, universities, and policy-making agencies
- *Institutions:* they are the "rules of the game" (North, 1990; Edquist, 1997) - influence how organisations undertake innovative activities e.g. intellectual property rights and labour regulations
- *Linkages* are the interactions that occur within and across organisations and institutions - influence the nature and degree of knowledge flows through innovation systems and in so doing shape specific trajectories of specialisation and learning

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Some basic notions… Where does innovation take place?

- The innovation system framework gives firms a central role in the innovation process - the firm as the main unit of analysis, particularly in the sectoral approach.
  - The term "firm" is used here to refer to units that convert knowledge to value across different sectors.
  - Bell and Pavitt (1993) point out "failure to recognise the firm as the central player in the accumulation of technology has been the major short-coming of technology policy".

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Some basic notions... innovation and R&D

- Scientific discovery through R&D activities is not the autonomous determinant of technological progress.
- "R&D leaves out many other S&T activities and capabilities that play centrally important roles in creatively exploiting knowledge for economic, social and political aims (e.g. a wide variety of design and engineering activities)". Bell (2006:4)
  - This observation warrants further comment on the different forms of technological capabilities that underpin technological knowledge production and commercialisation.
- "If we characterise the impact of some innovations as 'major', 'basic' or 'radical', it only because of the continuous stream of incremental innovations following the introduction of a basic new design." (Verspagen, 2004)

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Some basic notions... innovation and development

- The shift from the narrow perspective of development as economic growth to development as a process of social transformation
  - Innovation is viewed as having substantial potential for achieving developmental effects
  - Innovation involves embedding beneficial technologies into the social fabric - it is a technical process as well as a social and economic one

"From a global growth and development perspective, it is indeed no longer the impact of the transfer of industrial technologies on economic development which should be at the centre of the debate but rather **the broader organisational, economic and social embedding of such technologies in a development environment** and the way they unleash or block particular specific development and growth opportunities. That process is in all likelihood much more complex in a developing country context than in a developed country one."(Freeman and Soete, 2009 p. 588-589)

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Contextualising the theoretical discussion on innovation and development

- Discussions about strengthening innovation systems focus almost exclusively on formal organisations and institutions.
  - And within this, a bias towards the manufacturing sector e.g. suggesting innovation in low and medium technologies is more attainable than innovation in high technology (Edquist, 2001; Lall and Kraemer-Mbula, 2005)
- The large and expanding informal segments of developing countries have been neglected in discussions of innovation systems
  - Recognition of the importance of informal organisations and institutions
  - Adapting the innovation systems framework in ways that adequately address them
- There are inter-linkages between the formal and informal sectors
  - formal sector innovations targeted at users in the informal sector
  - informal sector innovations targeted at users within the formal sector
  - informal sector innovations targeted at users within the informal sector

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Some characteristics of innovation in SSA

- Coexistence of a formal sector with a large and growing informal sector
- Dual knowledge system - traditional knowledge exists alongside modern knowledge
  - there are virtually no linkages between the two and fairly weak linkages for the most part within each subset of knowledge
  - large populations continue to rely on the traditional knowledge and techniques particularly in health and agriculture
- Learning opportunities through innovation related interaction are fairly limited
- Others
  - Innovation rather than R&D
  - Small and medium sized enterprises
  - Small markets ...

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Converting knowledge to value – learning as key in innovation for development

- The process of innovation encompasses a wide range of science and technology capabilities and activities
  - "the resources needed to generate and manage technical change, including knowledge, skills, experience, institutional structures and linkages", Bell and Pavitt (1993)
- Two categories of technological capabilities:
  - R&D specific capabilities
  - Non-R&D specific capabilities, which play a critical complementary role in converting knowledge to value) (i) operating or production capabilities (ii) **design, engineering and associated management capabilities**

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Core capabilities for innovation in SSA

- Design, engineering and associated management capabilities
  - the capabilities that play a direct (and critical) role in adapting and modifying specifications for integration into processes and products
- They may be viewed as

  (i) a *link* between the new knowledge that is generated by R&D activities and the use of knowledge in the production of goods and services

  (ii) the *connection* between end users and production of goods and services(user-driven innovation)

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Creating design, engineering and associated management capabilities

- In many developing countries, firms generally have limited capabilities for innovation:
  - "Those firms that are present may focus more on innovation for survival than on formal knowledge creation through research and development (R&D) activities, and they may have a low capacity to absorb knowledge from outside of the firm needed to create value and put new products on the market." (Gault, 2010:133).
- It involves a complex learning process within the firm
  - entrepreneurs must then adapt and up-grade the technological capabilities of their firms to meet the needs of the final consumers
- Adapting and up-grading of technological capabilities requires deliberate investment efforts in knowledge assets within the firm, which may involve substantial costs

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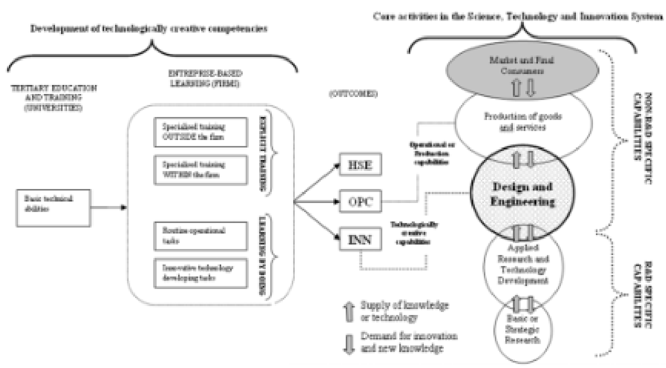
Creation and use of design and engineering capabilities



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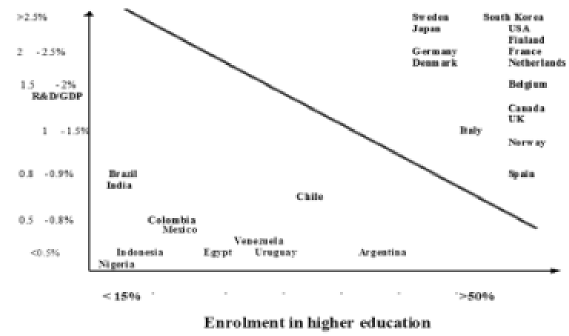
A possible reflection of technological capabilities = the learning divide (Sutz, 2007)



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Changing innovation dynamics

- Innovation systems are not static
  - Changes in components of the system (organisations, institutions and linkages) lead to the emergence of new interactions and innovation processes.
  - This evolutionary aspect of innovation leads to heterogeneity across sectors, regions and countries.

TABLE 1 GLOBAL DISTRIBUTION OF R & D EXPENDITURE: 1973 to 1999/2000

	1973			1990			1999/2000		
	GERD		GERD/ GDP	GERD		GERD/ GDP	GERD		GERD/ GDP
	US $ Billion[1]	Share %	%	US $ Billion[1]	Share %	%	US $ Billion[1]	Share %	%
A. Developed Countries[2]	97.3	97.1	2.4	343.3	83.8	2.3	574.8	76.1	2.3
B. (Ex) Centrally Planned[3]	(33.0)	(33.0)	(4.3)	24.6	6.0	-	21.9	2.9	-
C. Developing Countries (D) + (E)	2.9	2.9	0.4	42.0	10.2	-	158.4	21.0	-
D. 'Developing' Asia (R&D-intensive)[4]	-	-	-	20.6	5.0	-	98.5	13.0	-
E. Other Developing Countries	-	-	-	21.4	5.2	-	59.9	7.9	-
Latin America & Caribbean	0.8	0.8	0.3	11.3	2.8	0.5	21.3	2.8	0.6
Other Developing Asia	1.8	1.8	0.39	4.9	1.2	-	32.8	4.3	-
Africa	0.3	0.3	0.3	5.2	1.3	-	5.8	0.8	-
WORLD TOTAL	100.2	100.0	2.1	409.9	100.0	1.8	755.1	100	1.7

Source: Ely and Bell (2009)

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Changing dynamics and innovative activities

- Importance of global dynamics in R&D and innovative activities
- China (and India) is a the centre of the restructuring that is taking place
  - "Of course the biggest tectonic shift in the world's science stems from the burgeoning growth in the Far East - in China above all. Since 1999, China's R&D spend has risen by 20 percent each year - up to a level that's now second only to the US... Now they have more sequencing capacity than anywhere in the world - enough to sequence 10,000 human genomes in a year. And China strives to lead, too, in the quite different field of solar power" (Professor Martin Reis in the Reith Lectures, 2010)

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Changing dynamics – relevance to SSA context

- Implications for innovative activities...

  (i) modern and traditional knowledge

  In health – African researchers at KEMRI with local traditional herbalists in the "hunt for the next artemisinin" based on screening traditional herbal remedies

  (ii) "new combinations" of modern knowledge

  In health - The University of the Republic, in Uruguay, developed 'Bililed'– a lamp for treating severe jaundice in newborn babies

  (iii) new platform technologies

  ICTs, nanotechnology and biotechnology

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Changing dynamics – relevance to SSA context

- ICTs
  - Mobile phones: Mobile money transfer e.g. M-PESA; M-Health; M-Advocacy or Disaster management e.g. Ushahidi; M-KADI or phone numbers without phones
  - Internet: Education and training e.g. The Open University's Health and Education Training (HEAT) programme in Ethiopia ... Exploration of "thin client solutions" which use very cheap "dummy terminals" with only a keyboard, mouse, screen and remote desk software ; open-source Linux-based software)
  - ICT hybrids: Kiwanja.net has designed a software which allows messages to be sent via a mobile phone network on a computer without the use of internet ... can be used for communicating health and agricultural up-dates
- Nanotechnology
  - Energy production, storage and conversion; food processing and storage; disease diagnostics and drug delivery systems e.g. nano-size sticky "balls" of conventional TB drugs developed by CSIR to improve the efficiency of treatment; water purification e.g. the WaterBox and WaterStick already in use in Rwanda and Uganda etc.
- Biotechnology
  - Agriculture: e.g. tissue culture bananas in Kenya; sweet potato varieties in Uganda
  - Human and animal health (drugs and vaccines)

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Changing innovation dynamics - relevance to SSA context

- When trying to address the needs of low income earners it is not about taking existing technology from the developed markets, removing functionality, (or in the case of health producing generic drugs with lower levels of therapeutic benefits than the newest variants of the treatment) and lowering the price to try and fit within the perceived price range. It is about innovating to create products which meet the specific needs of end-users and this may involve the creation of functionality...

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Changing dynamics – relevance to policy design in SSA (measurement priorities)

- Innovation capabilities – technological learning as a fundamental process for innovation
  - The disarticulation which characterises innovation in SSA is to a large extent as a result of the deficiency in design, engineering and associated management capabilities
- Innovation activities
- Innovation linkages
- Innovation-related interactions

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The Interaction between Science, Technology and Innovation (STI) Indicators and the STI Policy Agenda

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IERI/UNU-MERIT Training Workshop
Tshwane University of Technology, Pretoria

University of Sussex
SPRU – Science & Technology Policy Research

8 September 2010

Origins and Motivation

1. Interest: Historical/institutional contexts shaping the development and use of technologies.
   (STI Indicators = technologies)
2. Observation of STI indicator development and use in Developing Countries 1960s – 1980s.
3. Interest in the emerging efforts to extend the use of these statistical tools (technologies) in Africa since 2000.

1

Outline

1. Focus and Argument
2. Shaping the STI statistical technology – OECD economies - 1920s to Frascati
3. Shaping the technology in developing countries: Phase 1 - Asia and Latin America (1960s – 1980s)
4. Some implications: What effects - 1960s to 1980s?
5. Shaping the technology in developing countries: Phase 2: Africa now - Some questions

1. Focus and Argument

Focus:

(a) R&D-related Statistics and indicators (Frascati Manual);

(b) developing Africa.

Argument:

A critical view of the value of this statistical Technology in that context

2

1. Focus and Argument

Focus:

(a) R&D-related Statistics and indicators (Frascati Manual);
(b) developing Africa.

Argument:

A critical view of the value of this statistical Technology in that context

Workshop Health Warning Component!

Critique of R&D statistics/indicators not novel:

- 1980s-90s (European) critique of R&D-centred (Frascati) technology → Oslo Manual and Innovation Surveys.
- Recent reviews of STI indicator experience (e.g. Smith, 2005; Gault, 2007; Soete & Freeman, 2009)
- Developing country literature (e.g. Sutz, 200?)

Broad gist of arguments is about 'gaps' in data, so leaving policy questions not illuminated

3

But perspectives and arguments here:

- Consequences not just relatively harmless 'gaps', but are actively negative – helping to shape policy agenda in 'distorted' directions,
- Especially in connection with 'early' STI system-building
- Statistics problem is socio-technical, not just technical – has involved a two-step process of socio-institutional shaping of the statistical technology
    - from 1920s to Frascati - 1960s
    - from Frascati to developing countries - 1960s +

Historically and institutionally shaped in two senses

- The object of measurement - the STI system - evolves and shapes the measurement system
- The system of statistical measurement (the technology) evolves in particular institutional contexts – and choices made.

Thus

- Frascati choices were not inevitable or 'inherent' – but reflected particular interests and particular historical times
- In other contexts the technology might have been different, and was: e.g.
    - Later in Europe (Critique ⇒ Oslo)
    - Contemporary Soviet Union

4

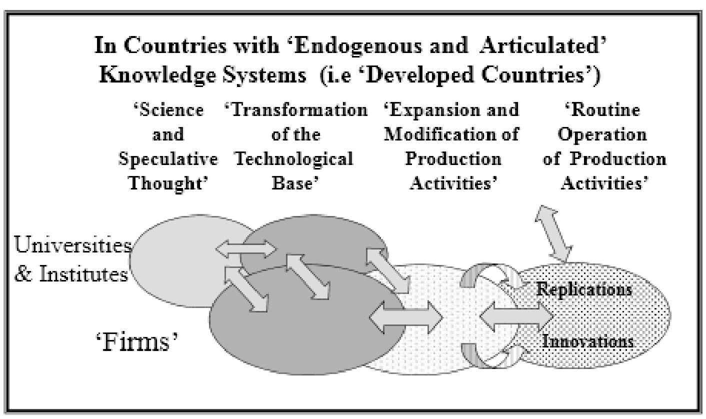
2. Shaping the Statistical Technology: 1920s to Frascati

Two phases:

- National level experiments: 1920s to 1950s

-- International standardisation: 1950s - Frascati (1962)

The Object of Measurement: Specialisation and differentiation in the STI system: by early-20th C



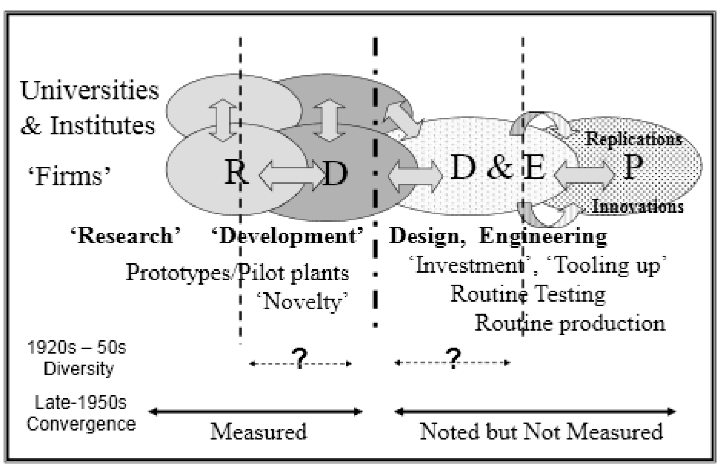
Source: Adapted from Francisco Sagasti (2004),

5

National shaping of the technology: US 1920s to 1960s

- The process (Phase 1)
  - Experimentation
  - Diversity
  - Debate
  - Dispersed expertise
- Multiple Interests
  - The scientific community
  - Government
  - Business
- The process (Phase 2)
  - Convergence

Choices: Measuring and Not Measuring Scientific, Technological and Production Activities, US 1920s – 1950s



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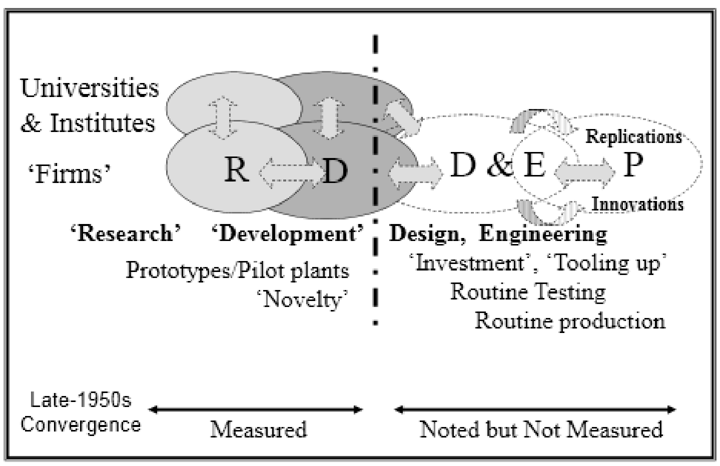
International standardisation: OECD and Frascati

Slightly different socio-political interests

Similar key choices

- Same exclusive emphasis on significant innovation
- Hence emphasis on R&D/Non-R&D boundary
- Same exclusive focus on measuring 'inputs'
  - 'outputs' noted, but not included
- Emphasis on an aggregate total of R&D
  - Little detail about component functions
  - No illumination of 'internal' interactions

Measuring and Not Measuring
"Scientific and Technical Activities": OECD Frascati - 1962



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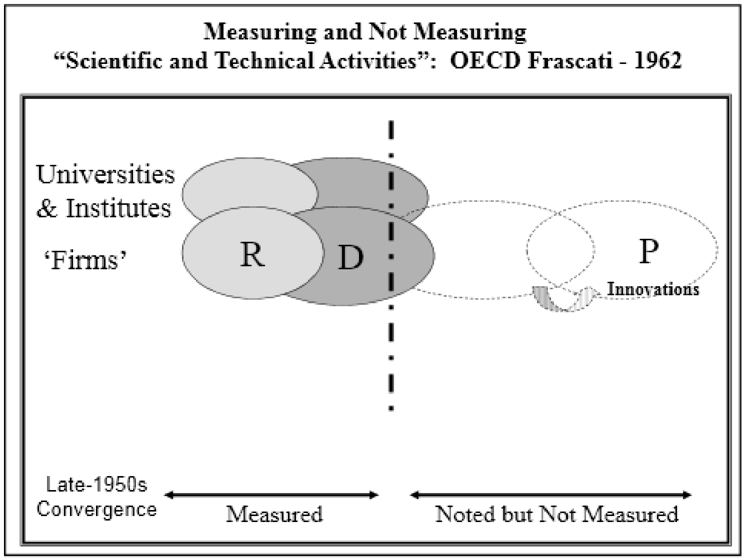
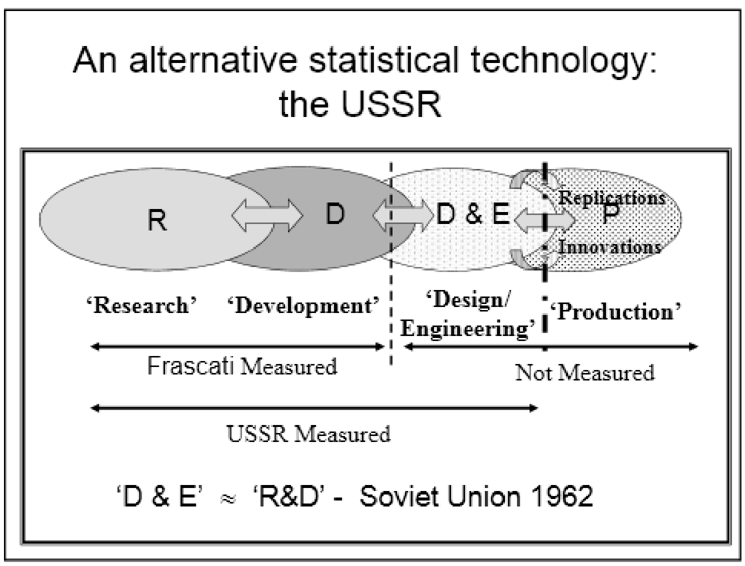


Measuring and Not Measuring
"Scientific and Technical Activities": OECD Frascati - 1962
Universities
& Institutes
'Firms'
R
D
P
Innovations
Late-1950s
Convergence
Measured
Noted but Not Measured



An alternative statistical technology:
the USSR
R
D
D & E
P
Replications
Innovations
'Research'
'Development'
'Design/
Engineering'
'Production'
Frascati Measured
Not Measured
USSR Measured
'D & E' ≈ 'R&D' - Soviet Union 1962

8

3. Shaping the technology in Developing Countries: 1960s – 80s

- The process
  - Experimentation
  - Diversity
  - Debate
  - Dispersed expertise
  - Convergence

Shaping the technology in Developing Countries: 1960s – 80s

- The process
  - Experimentation
  - Diversity
  - Debate
  - Dispersed expertise
  - Convergence

9

Shaping the technology in Developing Countries: 1960s – 80s

- The process
  - ~~Experimentation~~
  - ~~Diversity~~
  - ~~Debate~~
  - ~~Dispersed expertise~~
  - ~~Convergence~~
  - **Technology transfer**

The transfer process was usually embedded in a specific type of national institutional context

1. Multiple Interests
   - The scientific community
   - Government
   - Business

The transfer process was usually embedded in a specific type of national institutional context

1. ~~Multiple~~ Interest~~s~~ **Singular**
   - The scientific community
   - ~~Government~~
   - ~~Business~~

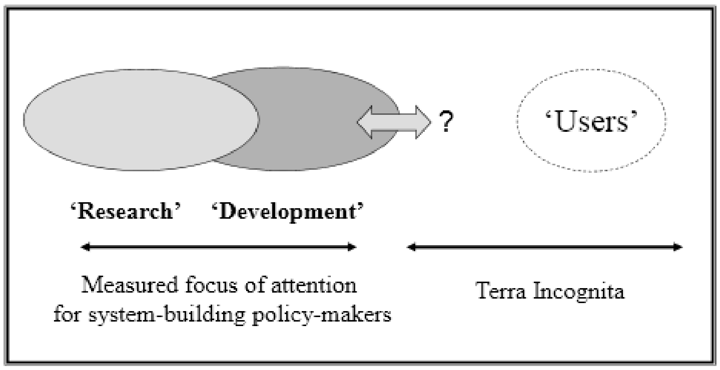
The transfer process was usually embedded in a specific type of national institutional context

1. ~~Multiple~~ Interest~~s~~ **Singular**
   - The scientific community
   - ~~Government~~
   - ~~Business~~
2. Scientific community usually had government responsibility for 'Science Policy' *
   (National research/science councils, etc)

i.e. they were the mandated STI system-builders

* Later 'science and technology policy', now often 'STI policy'

The Imported 'blueprint' (Map) for building STI systems in developing countries



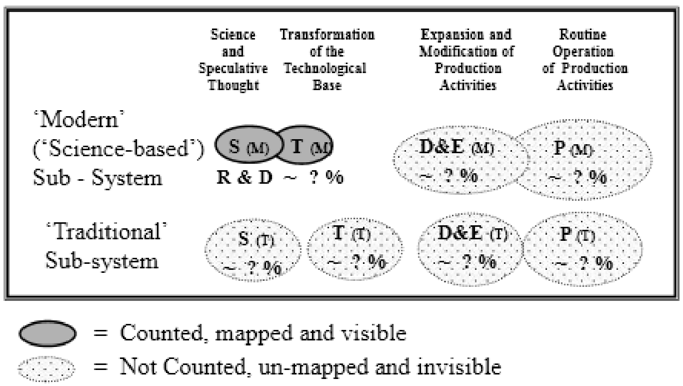
'Terra Incognita'

Two main parts:

- Non-R&D components of the 'Modern' STI system (especially D & E – as earlier)
- All of the 'traditional' or 'informal' knowledge/innovation system

12

An STI System Map of *'Exogenous & Dis-Articulated Knowledge Systems'* (Sagasti, 2004)



The transfer process was also embedded in a specific <u>international</u> institutional context

The donor community – in particular:

- Unesco (Science Policy Division)
- US NSF (International Office)

The international academic community, e.g.

- SPRU

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The prevailing advice

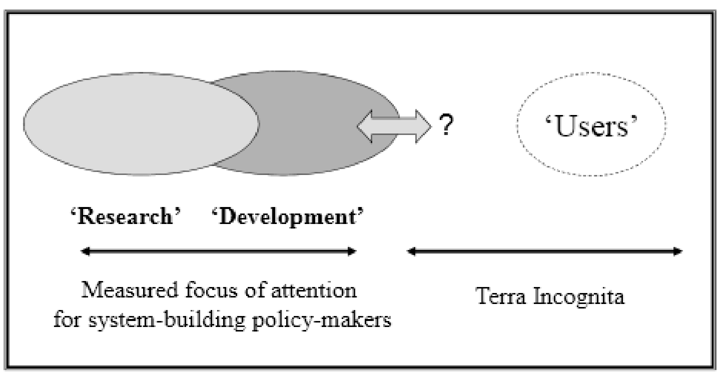
Not:

Observe the STI system in the ‘real world’; then map it and measure it to provide a policy tool to help develop and strengthen it.

But:

Build the ‘real world’ so that it looks like the map.

And let’s remember what that map looked like:



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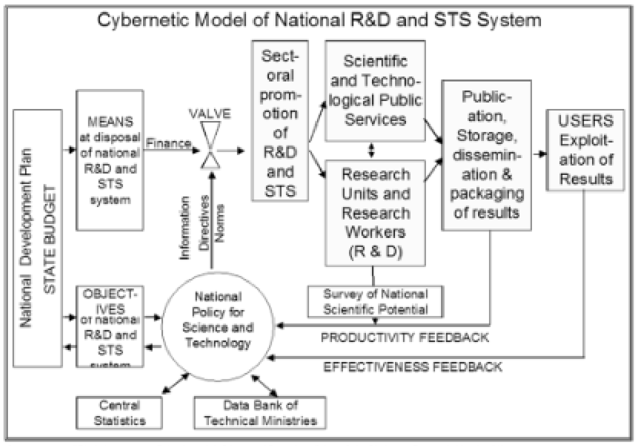
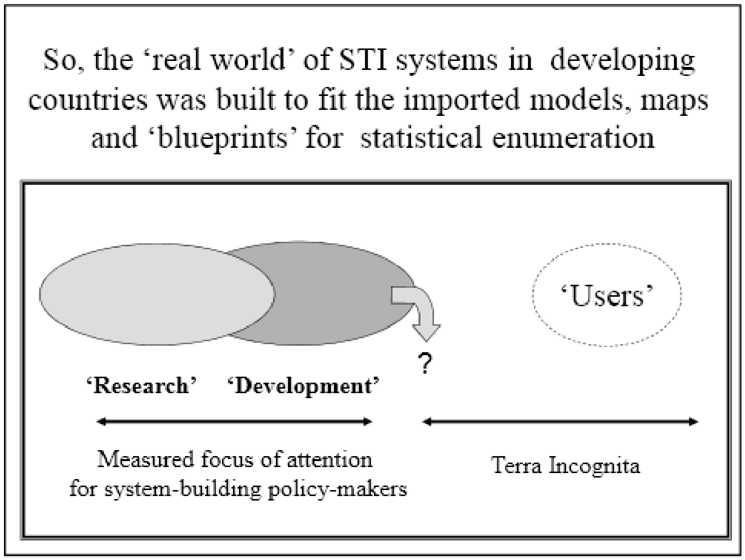
Building the 'Modern' STI System: A Unesco Map for System-Builders - 1979

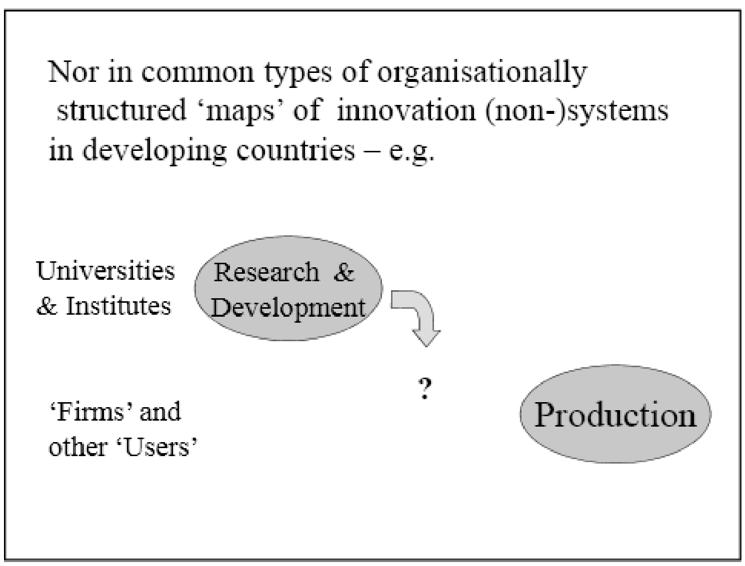


Source: Unesco (1979) *An Introduction to Policy Analysis in Science and Technology*; Science Policy Studies and Documents No. 46 (p.24).

So, the 'real world' of STI systems in developing countries was built to fit the imported models, maps and 'blueprints' for statistical enumeration

15

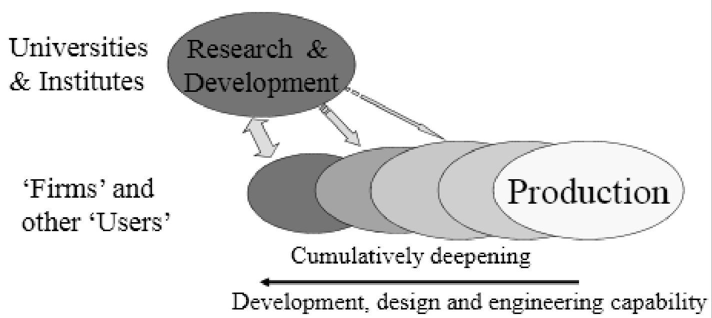

So, the 'real world' of STI systems in developing countries was built to fit the imported models, maps and 'blueprints' for statistical enumeration
'Users'
?
'Research' 'Development'
Measured focus of attention for system-building policy-makers
Terra Incognita


Nor in common types of organisationally structured 'maps' of innovation (non-)systems in developing countries – e.g.
Universities & Institutes
Research & Development
?
'Firms' and other 'Users'
Production

16

○○○○○○ increasingly well articulated **demands** on R&D

That development sequence is very neatly illustrated by the history of Multotec Process Equipment, Johannesburg. (Roberts, 2005)



6. What Effects: 1960s – 1980s?

Did this* matter for 'early stages' of STI system-building in Latin America and Asia?

A balance :

- Did this* yield positive utility for policy beyond what would otherwise have arisen?
- Did this* generate significant negative effects?

Some hypotheses ………..

* 'This' refers not just to the 'Frascati Technology' – but to that plus the institutional context within in which the technology was transferred, controlled, learned and used.

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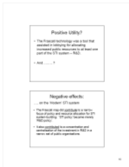
Positive Utility?
Negative effects:

The truncated and centralised blueprint for the '**modern' segment** of the system probably:

- Prolonged its dis-articulation, so reducing the impact from, and returns to, the investment in R&D.
- Slowed the development of pervasively dispersed non-R&D-based innovation.
- Slowed the development of pervasively dispersed R&D- supported innovation in 'firms'.

*These effects, in turn, probably reduced the **rate** of technical change in those societies, and also their potential ability to shape **directions** of change in the technologies they used.*

Negative effects:

…. on the 'informal' segment of the STI

The absence of this component of the STI system from the map for the system-building agenda probably reinforced all the effects in the 'modern' sector, but also in particular probably

- Slowed the attainable rate of poverty reduction

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In a world that faces increasing pressures to pursue much greater diversity of innovation as a basis for achieving much more significant poverty reduction and sustainability, the costs of building STI systems to fit the Frascati map are probably rising.

[And, I would argue, the use of Oslo and Innovation surveys – in the dominant socio-institutional context – probably makes only a very marginal difference].

5. Shaping the Technology in developing countries – Phase 2: Contemporary Africa

- Currently – substantial plans to develop STI indicators in Africa (AMCOST/NEPAD)
- The means are similar:
  - Not experimentation, diversity, debate and innovation,
  - But international technology transfer
- The 'Technology' is similar – focus on R&D statistics using the Frascati blueprint (+ some attention to Oslo technology)
- The national institutional contexts $\approx$ identical
- The international institutional context is very similar

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But the STI 'System Map' is probably even less appropriate in at least two ways.

1. Misaligned with a D&E-intensive sectoral structure of the economy

The structure of many African economies is highly D&E-intensive

Least Developed Countries	Sector value added As a proportion of GDP % In 2005	% change 1999 - 2005
Agriculture	28	- 18
Industry	27	+18
of which, Manufacturing	11	0
Other industry *	**16**	**+33**
Services	45	+7
All	**100**	**+71**

* Other industry includes principally mining, petroleum and construction (housing, sanitation, transport and other infrastructure)

21

But the STI 'System Map' is probably even less appropriate in at least two ways.

1. Misaligned with a D&E-intensive sectoral structure of the economy

2. Misaligned with the possibly (?) greater importance of traditional/Indigenous knowledge and innovation systems

So, What approach in Africa?

22

So, What approach in Africa?

1. Continue with Frascati/R&D as an initial base?
   - But simplify considerably in the light of real potential policy uses
2. Take explicit steps to 'endogenise' the development of the indicator 'technology'
   - Aim to make the map look like the STI system, not vice versa.

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The Role of Design and Engineering in African Innovation Systems-Building

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SPRU – Science & Technology Policy Research

A lecture at the
Institute for Economic Research on Innovation,
Tshwane University of Technology, Pretoria

US
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SPRU – Science & Technology Policy Research

7 September 2010

The Main Steps

1. Clarification of terms
2. The basic argument
3. Design-and-Engineering in innovation systems
4. D & E capabilities in developing countries
5. D & E: a **core** component of innovation systems ?
6. D & E activities widely neglected in policy
7. Building D-&-E Capabilities on Africa

1

1. Clarification of terms:

'Design and engineering' = ?

'Innovation System' = ?

'Innovation system building' = ?

'Design and engineering' = ?

Design – an activity or process:

- not just about creating the aesthetic form of objects
- more comprehensive: creates the full 'specifications' of products, processes and production systems.

Engineering

- not a sub-sector of manufacturing production (machinery industry)
- overlaps with design (activity/process of creating specifications'), but extends towards the realisation of those in concrete realities – various kinds of 'project management'.

2

'Innovation System' = ?

A { Knowledge bases; Activities; Actors/organisations; Interactions/links } Contributing to the creation, diffusion and exploitation of innovations

B { Framework Conditions; 'Institutional' contexts } Shaping how 'A' emerges, develops and functions

Multi/inter national **National** Sectoral Regional

'Innovation system building' = ?

Focus on 'core' – i.e. 'A' above.

- Not just autonomous emergence/evolution of the structure of knowledge bases, activities, actors and linkages;
- Purposeful and explicit function of public policy
    - more than policy about current expenditure (e.g. what kind of R&D), or capital expenditure (e.g. radio telescopes or molecular biology labs)
    - policy intended explicitly to shift the structure of 'A' into particular configurations at particular rates over the longer term.

3

Shifting the structural configuration
of the system 'core':

- The composition of knowledge bases
- The composition of activities carried out
- The composition of actors/organisations
- The properties of inter-actor knowledge links

2. The basic argument:

- Design and engineering activities (and hence underlying capabilities) constitute a key 'core' of science, technology and innovation (STI) systems – especially in Africa.
- But those activities and capabilities are woefully neglected in policy analysis and policy practice concerned with building African STI systems.
- Innovation policy in Africa will need to be much more innovative in order to address this 'gap'

4

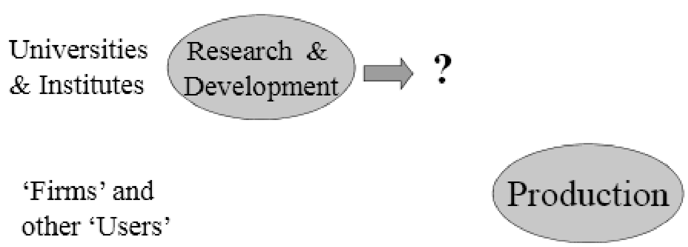
3. 'Design-and-Engineering': a Component of Innovation systems?

Not Evidently so in the main 'maps' of innovation systems for policy analysis

e.g. in the Conventional 'Linear' innovation Model

Research ⇒ Developm't ⇒ Production ⇒ Marketing

Nor in common types of organisationally structured 'maps' of innovation (non-)systems in developing countries – e.g.



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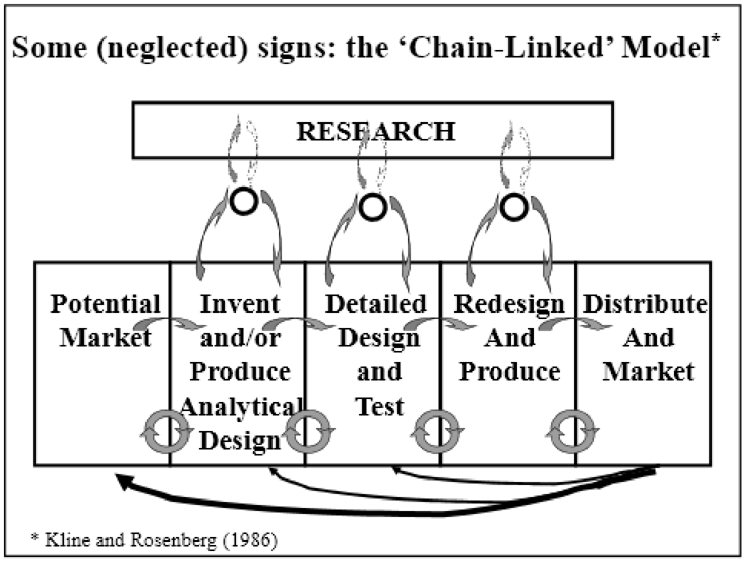
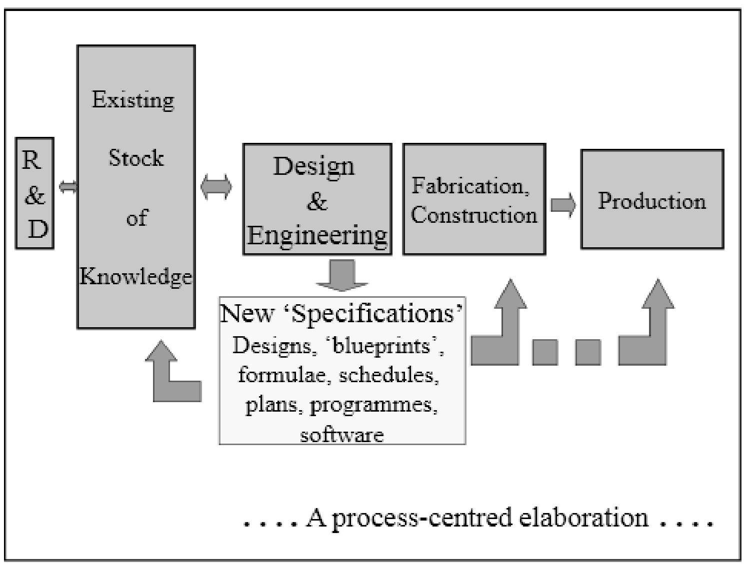
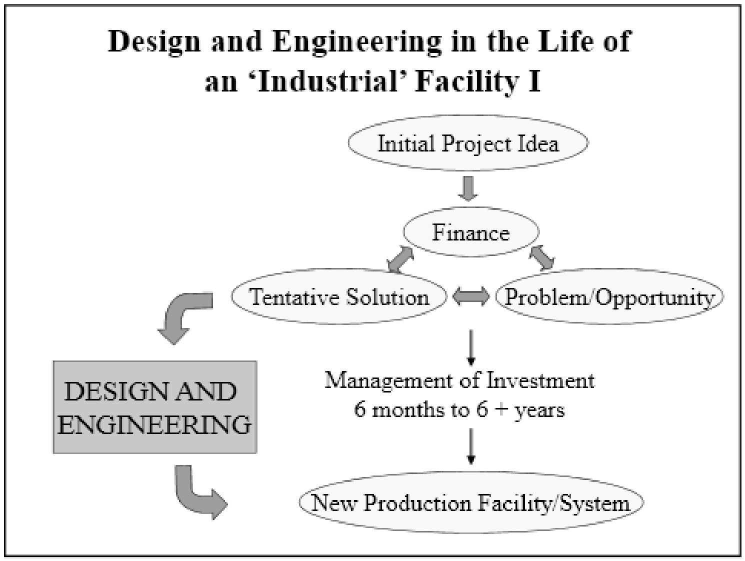
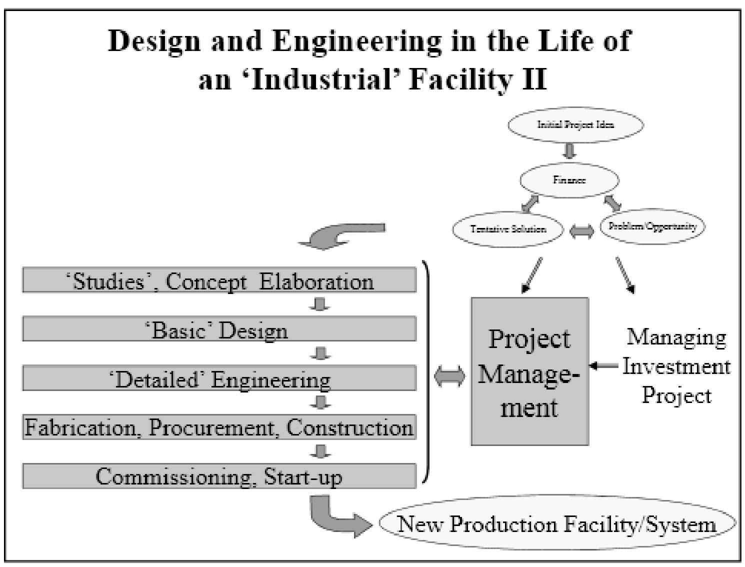

Some (neglected) signs: the 'Chain-Linked' Model*
RESEARCH
Potential Market
Invent and/or Produce Analytical Design
Detailed Design and Test
Redesign And Produce
Distribute And Market
* Kline and Rosenberg (1986)

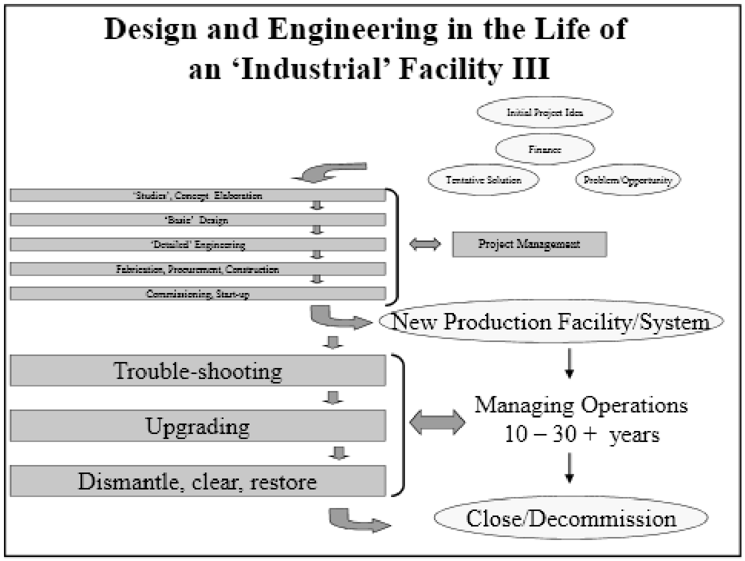

R & D
Existing Stock of Knowledge
Design & Engineering
Fabrication, Construction
Production
New 'Specifications'
Designs, 'blueprints', formulae, schedules, plans, programmes, software
. . . . A process-centred elaboration . . . .

6


Design and Engineering in the Life of
an 'Industrial' Facility I
Initial Project Idea
Finance
Tentative Solution
Problem/Opportunity
DESIGN AND
ENGINEERING
Management of Investment
6 months to 6 + years
New Production Facility/System


Design and Engineering in the Life of
an 'Industrial' Facility II
'Studies', Concept Elaboration
'Basic' Design
'Detailed' Engineering
Fabrication, Procurement, Construction
Commissioning, Start-up
Project
Manage-
ment
Managing
Investment
Project
New Production Facility/System

7


Design and Engineering in the Life of
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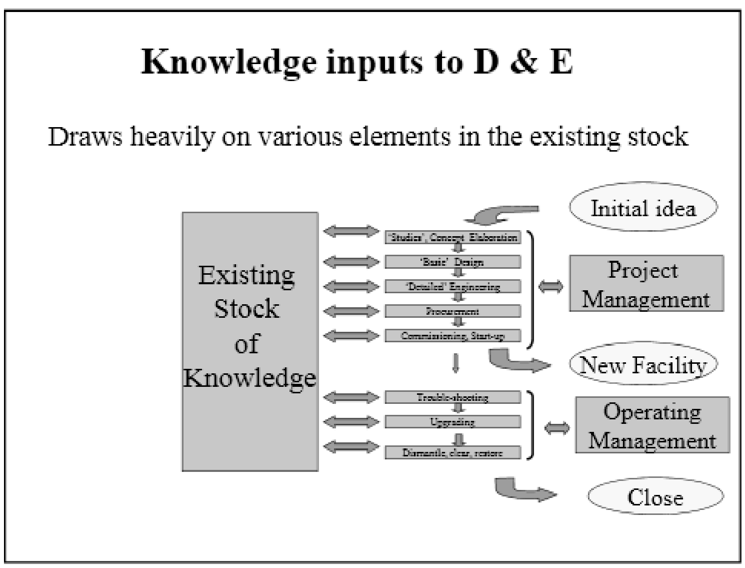
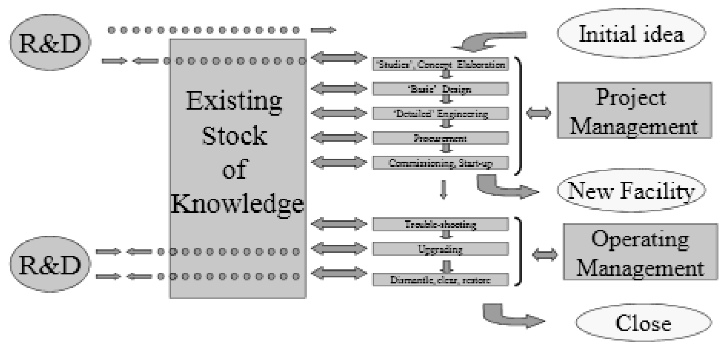
Initial Project Idea
Finance
Tentative Solution
Problem/Opportunity
'Studies', Concept Elaboration
'Basic' Design
'Detailed' Engineering
Fabrication, Procurement, Construction
Commissioning, Start-up
Project Management
New Production Facility/System
Trouble-shooting
Upgrading
Dismantle, clear, restore
Managing Operations
10 – 30 + years
Close/Decommission


Knowledge inputs to D & E
Draws heavily on various elements in the existing stock
Existing
Stock
of
Knowledge
Initial idea
'Studies', Concept Elaboration
'Basic' Design
'Detailed' Engineering
Procurement
Commissioning, Start-up
Project
Management
New Facility
Trouble-shooting
Upgrading
Dismantle, clear, restore
Operating
Management
Close

8

Process-centred D-&-E and R&D

Essentially an intermittent relationship – usually when the stock of knowledge is inadequate for the task facing D&E



4. D & E Capabilities in Latecomer/Developing Countries

Some anecdotes

- Australia - 1950s: The Snowy Mountains Hydro Scheme
- Korea - 1970s and 1980s: Posco and others
- Brazil - late-1970s: Petroquisa and the Copesul project
- South Africa - 1970s and 1980s: the mining industry

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Roles of Local D-&-E Capabilities in Developing Countries
(a process/facilities perspective)

1. Incremental D & E based innovation
   (a) shaping key features of new production facilities
      - reducing costs
      - meeting efficiency-raising adaptation needs
      - responding to local sustainability problems and aims

   (b) continuous 'upgrading' of existing facilities

2. Efficiency in managing outsourced D&E in investment/innovation (e.g. Brusoni, 2005)

3. Influence over local sourcing of inputs: for both investment and ongoing current production

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4. Role in structural change

(Hausmann and Rodrik (2003): 'Self discovery')

(a) Directly – D & E as production and export of knowledge services

- POSCO: from steel engineering to global software supplier
- SMEC: from local infrastructure engineering to global engineering contractor

(b) Indirectly – D & E as stimulus and initiator

- e.g. Korean Chaebol and 'Project execution' capabilities (Amsden and Hikino, 1994)

5. 'D & E': A **Core** Component of Innovation systems?

- A key system-linking (integration) role
- Scale: probably much larger than R&D

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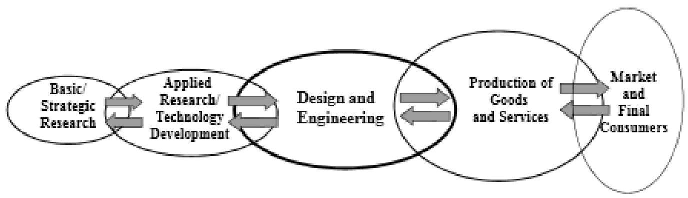
A key linking role in STI systems

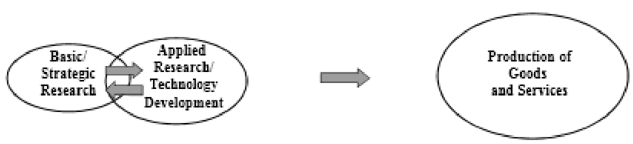


D & E capabilities are a key system component in two ways:

- In linking **existing** R&D and production activities
- In creating **new** R & D-related linkage structures

Linking **existing** R&D and production activities

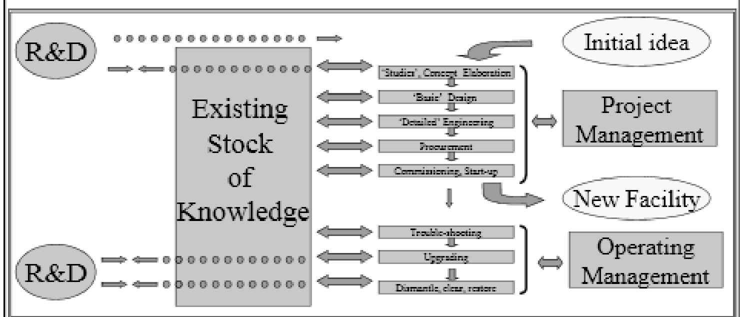
R&D-to-production links very rarely involve:



BUT are ....

12

••••••• significantly mediated by D & E activities.



D & E in system development and the emergence of **new** linkage structures

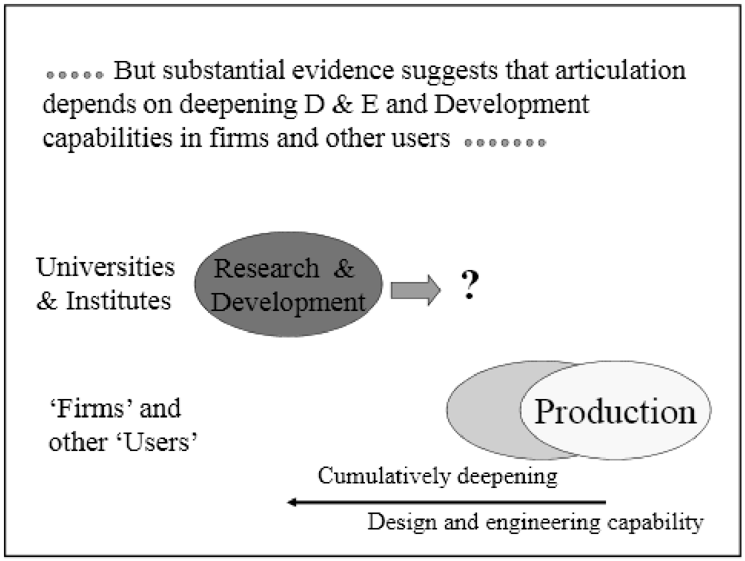
Common disarticulation of developing country systems

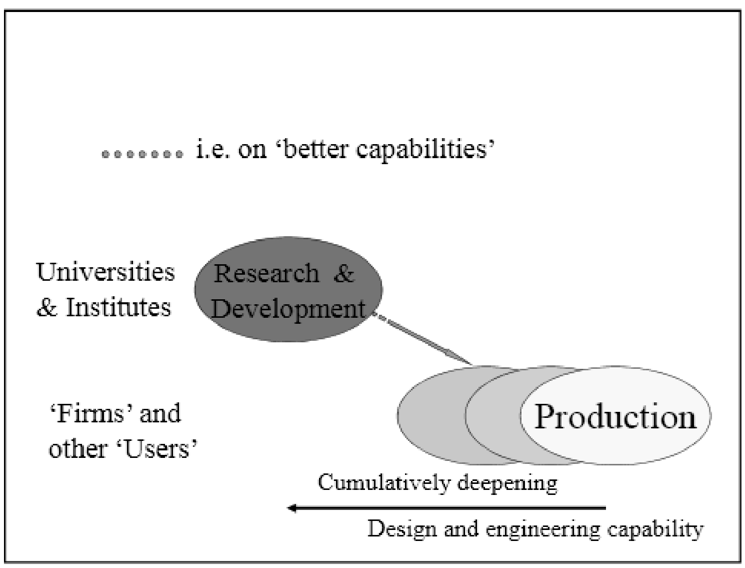
Universities & Institutes — Research & Development → ?

'Firms' and other 'Users' — Production

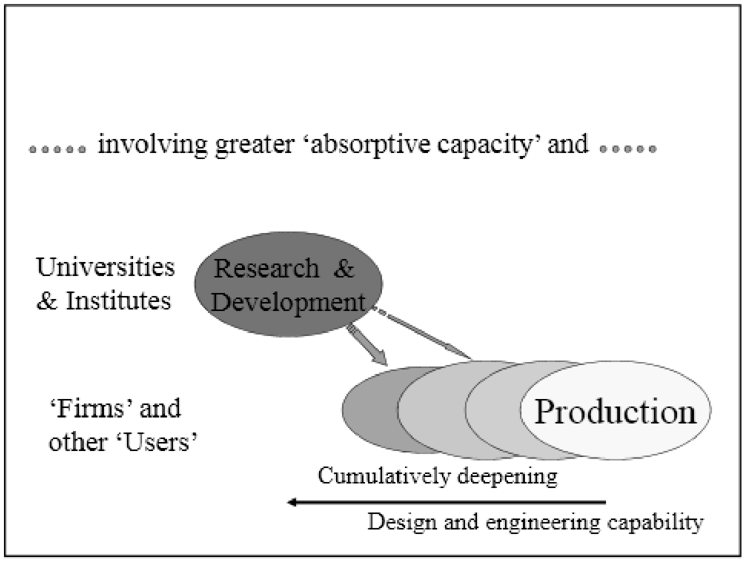
Frequently seen as problem calling for 'better links'•••••••

13

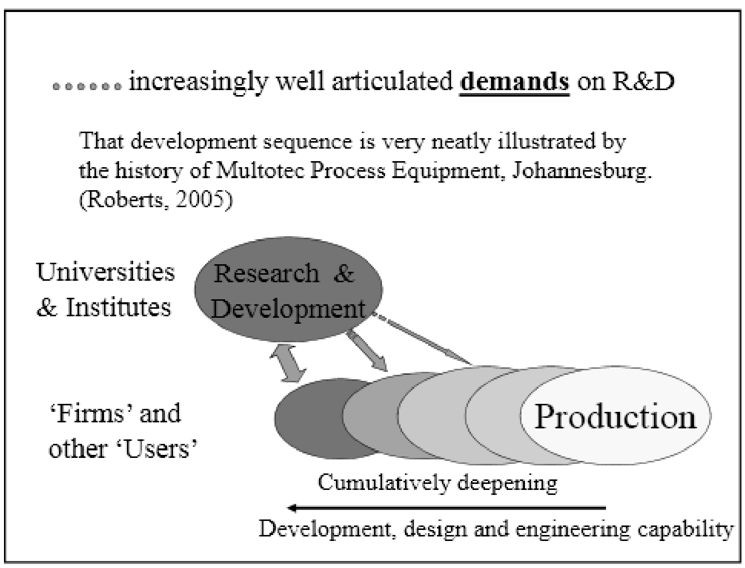

But substantial evidence suggests that articulation depends on deepening D & E and Development capabilities in firms and other users
Universities & Institutes
Research & Development
?
'Firms' and other 'Users'
Production
Cumulatively deepening
Design and engineering capability


i.e. on 'better capabilities'
Universities & Institutes
Research & Development
'Firms' and other 'Users'
Production
Cumulatively deepening
Design and engineering capability

14



..... involving greater 'absorptive capacity' and .....
Universities
& Institutes
Research &
Development
'Firms' and
other 'Users'
Production
Cumulatively deepening
Design and engineering capability



...... increasingly well articulated **demands** on R&D
That development sequence is very neatly illustrated by
the history of Multotec Process Equipment, Johannesburg.
(Roberts, 2005)
Universities
& Institutes
Research &
Development
'Firms' and
other 'Users'
Production
Cumulatively deepening
Development, design and engineering capability

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The scale of D & E activities
in the innovation system

Greater than R&D ?

The Main Activities of Scientists and Engineers* in the US (2003)

A. Research and Technological Development	10%
B. Design [Of equipment, processes, structures, models; plus computer programming and systems development)]	13%
C. Management/Supervision [Of people, projects, quality, productivity, etc.]	19%
D. All Other [Business, administration, and production (e.g. accounting, sales, maintenance); professional services (e.g. financial, healthcare, legal); teaching; miscellaneous]	58%

- Scientists and engineers: degree qualification in S or E discipline and/or employed in S or E occupation

Source US NSF SESTAT (2003)

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"Architectural and engineering design (AED) activities" UK 2004*

Purchased design services	£17 billion
Own account (in-house) design services	£27 billion
Total	£44 billion
GERD – civil and military	£20 billion

Health warning – there is almost certainly some unknown degree of overlap between AED and GERD

* Galinda-Rueda et al. (2008)

6. But D-&-E activities and capabilities are widely neglected in STI policy analysis and policy making

- In OECD economies – e.g. the UK
- In 'Emerging' economies – e.g South Africa
- In Developing economies - Africa

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In OECD Economies – e.g. the UK

Growing dissatisfaction with the idea that STI policy (and Management) is little more than R&D policy. In particular

- Design and related creative activities are poorly captured by conventional R&D concepts, categories and data:
  e.g. Salter and Gann, 2003; Dodgson et al., 2005
- Conventional concepts and indicators of innovative activity are especially inadequate in certain kinds of sector: e.g. NESTA, 2006(a); 2006(b)

In South Africa

e.g. the NACI (2006) Background Report for The OECD Country Review of South Africa's National System of innovation

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In Africa – e.g.

Africa's Science and Technology Consolidated Plan of Action

2006, New Economic Partnership for Africa's Development, African Ministerial Council on Science and Technology

The CPA ***"articulates Africa's common objective of socio-economic transformation and full integration into the world economy. …[and it] …places emphasis on developing an African system of research and technological innovation…"*** *(p.6)*

The main components of the CPA –

- Centres of Excellence focused on:
- Flagship Research and Development Programmes
- Organised in five main Programme Clusters
    - Biodiversity, Biotechnology and Indigenous knowledge
    - Energy, water and desertification
    - Materials sciences, manufacturing, laser and post-harvest technologies
    - ICTs and space science and technologies
    - Mathematical sciences

In effect, STI policy and system building =
R&D policy and system building

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"…it is crucial that adequate financial resources are mobilised. AMCOST … may consider … the following interrelated elements;

- ***Substantial increase in national R&D budgets, with each African country taking concrete actions to allocate <u>at least 1% of its GDP to R&D</u> …." (p.69)***

Subsequently in its Cairo Declaration in 2006, AMCOST recommended to the Assembly of Heads of State and Government of the African Union to:

"Promote research and development (R&D) and develop innovation strategies for wealth creation and economic development by allocating at least 1% of Gross Domestic Product (GDP) to R&D by 2010…."

So ?

A view from the UK:

*"Innovation policy needs to be **imaginative** .."*

(NESTA, 2006)

Surely even more so in Africa

- The structure of many economies seems particularly 'D & E – intensive'
- Issues to address enormously different from those currently at the centre of STI policy attaention

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7. Building D & E Capabilities in African Innovation Systems: Some key features

- Standard of basic academic training is critical but is only a foundation
- Beyond that, capability development must be undertaken very largely in and by firms – not public institutes
- Involves investment costs: explicit expenditure and management
- Returns to investment subject to risks of non-appropriability (Externalities = social benefit)
- So all the standards problems of 'market failure' arise .

But so also do the problems of system/coordination failure

- D & E learning and capability deepening is largely project-based and cumulative between projects.
- But in many fields only relatively large companies with international activities can provide cumulative continuity
- So, requires an appropriate organisational vehicle that:
  - has incentive to invest in capabilities
  - can accept (even promote) externalities
  - can link capability accumulation through projects
  - can do so on an international basis where needed

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Outline

- Introduction
  - Innovation strategies in the OECD and in the European Union
  - What is innovation?
  - Innovation systems
- OECD Innovation Strategy (IS)
- IS Products - 2010
- Key findings
  1. Empowering people
  2. Unleashing innovation in firms
  3. Creating and applying knowledge
  4. Applying Innovation to address global and social challenges
  5. Improving the governance and measurement of policies of innovation
- Measurement Agenda
- Development Agenda
- Next steps

Introduction

- OECD Council at Ministerial Level OECD countries (2007)
  - New players in the market – Brazil, China, India, …
    - Competition policy – innovation?
  - Aging population
    - Growth in productivity – innovation?
    - Health, education, training and immigration policies – innovation?
  - Global change
    - Sustainability or 'do no harm' – green innovation?
  - Conclusion: Innovation for sustainable productivity growth
- asked in 2007 for the Innovation Strategy for its meeting in May 2010

Introduction

- Parallel initiatives in European Union (EU)
  - Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation following the Hampton Court Summit (Aho report 2006)
  - *Putting Knowledge into Practice: A Broad-Based Innovation Strategy for the EU*, released in 2006
- Then (2008-2009) financial crisis
  - Bailouts – save the banks
  - Stimulus packages – build new and update old infrastructure
  - How to recover from the fiscal deficits – innovation?

Introduction

- What is innovation?
  - An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*.
- *Implementation* connects innovation to the market
- The Oslo Manual supports **a language of discourse**

- The activity of innovation is not an isolated event

*Para 146 in OECD/Eurostat (2005), the 3rd edition of the Oslo Manual

Introduction

- **Innovation Systems**

- **A systems approach** is implicit in the **Innovation Strategy** and the **Oslo Manual**
  - Actors
    - Governments, education and health institutions, business, foreign institutions, …
  - Activities
    - R&D, invention, innovation, diffusion of technologies and practices, HR development, …
  - Linkages
    - Contracts, collaborations, co-publication, grants, monitoring, …
  - Outcomes
    - Jobs, growth, wealth
  - Impacts
    - Wellbeing, culture change, global influence, …

- The activity of innovation is **dynamic**, **complex**, **non-linear** and **global**

OECD Innovation Strategy
High-Level Observations

- Innovation involves a wide range of activities
- Science is not the least important, but
- Innovation encompasses **more than R&D**
- Collaboration is important – domestic and foreign
- Knowledge comes from many sources

IS Products - 2010

- *Key Findings*
- *The OECD Innovation Strategy, Getting a Head Start on Tomorrow* (analytical synthesis)
- *Measuring Innovation, A New Perspective*
- Thematic Reports
  - Two examples of many
  - *Innovation and the Development Agenda*
  - *Innovation in firms, A Microeconomic Perspective*

Key Findings

- Five areas
  1. Empowering people to innovate
  2. Unleashing innovation in firms
  3. Creating and applying knowledge
  4. Innovation to address global and social challenges
  5. Improving the governance and measurement of policies for innovation

1. Empowering people to innovate

- People are the basis for innovation
  - Curricula need to change to address innovation
  - Access to education and quality to increase
  - High quality tertiary education is essential
  - Vocational education to connect to the workplace
- Life-long learning matters
- Entrepreneurial culture to be fostered
- Remove gender differences

1. Empowering people to innovate

- Governments to facilitate mobility
- Support innovative workplaces
- Empower consumers
  - Consumer policy
  - Consumer education
    - Participation in and benefiting from innovation

2. Unleashing innovation in firms

- Main job growth from innovation is in firms
  - Reduce barriers to firm entry and exit
  - Neutral tax climate – not anti growth
  - Flexible labour market policies
  - Support SMEs
- Access to finance is critical for firms
  - Well developed financial markets
  - Ease of access for new and small innovative firms
  - Best practices in financial reporting
    - Consistent reporting of intangibles such as R&D, patents, software, databases, organizational capital…

2. Unleashing innovation in firms

- Sound framework conditions
  - Stable macro-economic policies
  - Open and competitive markets
    - To facilitate the spread of knowledge
  - Tax policies conducive to innovation
  - Sound framework conditions attract investment

2. Unleashing Innovation in Firms

- Foster markets for innovative products and processes
  - Governments can foster markets &
    - Efficient regulation
    - Public procurement
    - Public investment (Internet is an example)

3. Creating and applying knowledge

- Support public research
  - Science drives innovation
  - Excellence in public research institutions
  - New forms of finance
  - Improved technology transfer
- Foster Public Sector Innovation
  - All levels of government
  - New measurement issues

4. Innovation to address global and social challenges

- Improve international STI co-operation and technology transfer
- Predictable policy to support innovation in developing countries
- Advance innovation as a tool for development

5. Improving the governance and the measurement of policies for innovation

- Policy coherence by treating innovation as a central component of government policy
- Co-ordinate across regions
- Foster evidence based decision making and policy accountability by
  - Recognizing measurement as central to the Innovation Agenda

Measurement Agenda

1. Improve the measurement of broader innovation and its link to macro-economic performance
2. Invest in high-quality and more comprehensive data infrastructure to measure the determinants and impacts of innovation
3. Recognize the role of innovation in the public sector and promote its measurement
4. Promote the design of new statistical methods and interdisciplinary approaches to data collection
5. Promote the measurement of social goals and social impacts of innovation

- Rooted in Blue Sky II, OECD (2007)

Development Agenda

1. Getting innovation on to the development agenda
2. Improving knowledge about innovation policy for development
3. Building government capacities for innovation in developing countries
4. Enhancing the horizontality of innovation for development
5. Joint action by international organizations and donors

In Kraemer-Mbula and Wamae (OECD 2010)

Next Steps

- Consultation with OECD Member Countries
- Support for the agendas by OECD Committees
- Changing the way innovation is promoted, measured and discussed, including the use of high-level fora
- Keeping development on the innovation agenda and innovation on the development agenda.

Further Reading

- CEC (2010), *Europe 2020, A Strategy for Smart, Sustainable and Inclusive Growth*, Brussels
- Gault, Fred (2010), *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management*, Cheltenham: Edward Elgar and Ottawa: IDRC.
- Kraemer-Mbula, Erika and Watu Wamae (eds), (2010), *Innovation and the Development Agenda*, Paris: OECD and Ottawa: IDRC.
- OECD (2009) *Innovation in Firms, A Microeconomic Perspective,* Paris: OECD.

Further Reading

- OECD (2010) at www.oecd.org
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  - www.oecd.org/innovation/
  - www.oecd.org/innovation/strategy
    - *Ministerial report on the OECD Innovation Strategy, Innovation to strengthen growth and address global and social challenges - Key Findings*
  - www.oecd.org/mcm20xx xx = 07, 09 and 10
- OECD (2007), Science, Technology and Innovation Indicators for a Changing World, Responding to Policy Needs, Paris: OECD.
- OECD/Eurostat (2005) *Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data*, Paris: OECD. www.oecd.org/sti/oslomanual

Innovation Strategies and the Role for Indicators

Fred Gault
Institute for Economic Research on Innovation (IERI) – TUT and UNU-MERIT

National Advisory Council on Innovation (NACI)
Seminar, September 10, 2010

Outline*

- Context
- Why innovation strategies?
- What is innovation?
- Innovation systems
- To build a strategy
  - Strategy components
  - Implementation
- Questions about Indicators
  - Examples: co-publication; micro-data analysis, user innovation, size dependence; comment; composite indicators, questions
- Challenges

* Presentation draws upon Gault (2010), *Innovation Strategies for a Global Economy*, Cheltenham: Edward Elgar and Ottawa: IDRC.

Context

- **Industrialized countries** (2006-2007)
  - New players in the market – Brazil, China, India, …
    - Competition policy – innovation?
  - Aging population
    - Growth in productivity – innovation?
    - Health, education, training and immigration policies – innovation?
  - Global change
    - Sustainability or 'do no harm' – green innovation?

Conclusion: Innovation for sustainable productivity growth

Ch 1

Context

- (2008-2009)
  - Bailouts – save the banks
  - Stimulus packages – build new and repair old infrastructure
  - How to recover from fiscal deficit – innovation?
- **Africa**
  - Competition
    - Relations with Brazil, China, India …
  - Young population
    - Media age 19 – 24, compare Germany, 44
      - Education, training, employment policies – innovation?
    - Lower life expectancy
    - HIV/Aids
      - Healthcare policies
  - Global change is happening in Africa
  - Financial crisis affects aid and trade

Why Innovation Strategies?

- There are reasons for innovation strategies
  - Ten -Year Innovation Plan of South Africa - DST
    - …help drive South Africa's transformation towards a knowledge -based economy, in which the production and dissemination of knowledge *leads to economic benefits and enriches all fields of human endeavour*
  - Gauteng Innovation Strategy
    - To accelerate innovation in all its forms, in order to bolster and support *the broader strategic objectives of employment creation, and sustainable social and economic development*

Ch 6

Why Innovation Strategies?

- National Industrial Policy Framework (NIPF) Industrial Policy Action Plan (2007)
  - The NIPF sets out the government's broad approach to industrialization in the context of the Accelerated and Shared Growth Initiative for South Africa (ASGI-SA) and its *targets of halving unemployment and poverty by 2014* through accelerated growth of at least 6 per cent from 2010
- Human Resources Development Council
  - …to contribute to our national goals which include *reducing poverty and unemployment, promoting justice and social cohesion and improving national economic growth.* (Deputy President Kgalema Motlanthe, March 30, 2010)

Why Innovation Strategies?

- 'Together Doing More and Better, Medium Term Strategic Framework, A Framework to guide the Government's Programme in the Electoral Mandate Period (2009-2014)'
  - Many strategic priorities (para 28) including the need to: *speed up economic growth and transform the economy to create decent work and sustainable livelihoods.*
  - The Presidency, July 2009

What is innovation?

- What is innovation?
  - An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*.
- *Implementation* connects innovation to the market
- The Oslo Manual provides **a language of discourse**
- The activity of innovation is not an isolated event

*Para 146 in OECD/Eurostat (2005), the 3rd edition of the Oslo Manual

Ch 3

Innovation systems

- **Innovation Systems**
- **A systems approach** is implicit in the **Innovation Strategy** and the **Oslo Manual**
  - Actors
    - Governments, education and health institutions, business, foreign institutions, …
  - Activities
    - R&D, invention, innovation, diffusion of technologies and practices, HR development, …
  - Linkages
    - Contracts, collaborations, co-publication, grants, monitoring, …
  - Outcomes
    - Jobs, growth, wealth
  - Impacts
    - Wellbeing, culture change, global influence, …
- The activity of innovation is **dynamic**, **complex**, **non-linear** and **global**

Ch 2

To build a strategy

- Narrow?
  - Tax credits for R&D or for ICT use
    - One department involved
- Broad?
  - Whole of government approach
    - Many departments involved needing high level co-ordination.
- Which?
- How is a strategy constructed?

Ch 6&7

Strategy components

- **Markets**
  - Brand recognition
  - Lead market
  - Competitive engagement
  - Financial services
  - …
- **People**
  - Labour force
  - Demographics
  - Migration
- **Innovation Activities**
  - Technologies and practices
  - User innovation
  - User-driven innovation
  - Open innovation
- **Public institutions**
  - Infrastructure
  - Procurement
  - Priority setting
  - Standard setting
  - Public finance
  - Government direct support
  - Education, training and research
  - Health
  - Monitoring and evaluation
- **International Engagement**
  - Big science
  - International co-operation
  - Global challenges

Implementation

- Select components, decide how to co-ordinate and how to add high-level advice
  - NACI is an example of high-level advice
  - So is the Human Resource Development Council (HRDCS)
  - Role of the Presidency?
- Decide how to monitor, evaluate and change the system – leading to policy learning

Ch 8

Questions about indicators

- Indicators can support monitoring, benchmarking, evaluation, foresight and research
- Some questions about what is needed.
  - Snapshots or longitudinal analysis?
    - Comparative statics or dynamics?
  - Macro aggregates or micro data?
    - Firm characteristics or aggregates for firms? Access?
  - Framework conditions or just activities?
    - Assess the impact of government policies on innovation?
  - Linkages? (Contracts, co-publication, mobility, …)
  - Composite indicators?
  - Outcomes and Impacts?

Examples Co-Publication

- Co-publication
  - Uses publicly available data bases on publication
  - Requires cleaning of the addresses
  - Provides linkage maps connecting
    - Geography
    - Institutions (Government, business, higher education …)
    - Subject matter
    - www.statcan.gc.ca/88f0006x1998010-eng.pdf

Examples
Micro data analysis

- Micro data analysis
  - Innovative firms not performing R&D
    - Characteristics compared with R&D performing innovators
    - Follow-up analysis on the impact of programmes to support non-R&D innovators – entrepreneurs/ problem solvers
    - OECD (2009), SA Innovation Survey 2005

Ch 10

Examples
User innovation

- User innovation
  - Follow-up survey to 2005 Innovation Survey
    - Process innovators are asked if
      1. They did it themselves
      2. In collaboration, or if it was
      3. Done by others
    - 1 is user innovation, 2 may be, 3 is capital investment
    - User innovators have a higher propensity to share the knowledge gained at no cost
      - Implications for IP policy and for government support programmes.

Ch 5

Examples
Size dependence

- Size dependence
  - Propensity to do R&D or to innovate depends on the size of the firm (Ch 1) and OECD (2007:74)

Size class	%	Cumulative %
1-4	60	
5-9	16	76
10-19	11	87
20-49	8	95
50+	3	100...(rounding)

Comment

- A policy to support growth of firms is a policy so support growth in:
  - R&D
  - Innovation
  - Trade
  - Training
  - Community participation

Composite Indicators

- NESTA
- Has produced a pilot index which is being worked on
- http://nestainnovation.ning.com/
- EU
- Commissioner Geoghegan-Quinn has nominated a High Level Panel, chaired by Professor Andreu Mas-Colell, to advise her and the European Commission on an indicator measuring Europe's progress towards a more innovative economy. At the Spring European Council, EU leaders agreed that such an indicator should be produced to complement the Europe 2020 target of investing 3% of GDP in R&D. The Panel members are leading business innovators and economists.
- http://ec.europa.eu/commission_2010-2014/geoghegan-quinn/hlp/members/index_en.htm

Challenges

- Indicators for activities in the informal economy?
  - UNU-MERIT / IDRC Case Study Project
- Policies to promote innovation in the informal economy?
  - Policy experiments
    - Monitoring, evaluation, and change
  - Where do these policies fit?
- More analysis of SMEs?
- Is Public Sector innovation an issue?

Further Reading

- CEC (2010), *Europe 2020, A Strategy for Smart, Sustainable and Inclusive Growth*, Brussels
- Gault, Fred (2010), *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management*, Cheltenham: Edward Elgar and Ottawa: IDRC.
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- OECD (2007) *OECD Reviews of Innovation Policy, South Africa*, Paris: OECD.
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  - *Measuring Innovation, A New Perspective*
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  - www.oecd.org/innovation/strategy
    - *Ministerial report on the OECD Innovation Strategy, Innovation to strengthen growth and address global and social challenges - Key Findings*
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- OECD (2007), Science, Technology and Innovation Indicators for a Changing World, Responding to Policy Needs, Paris: OECD.
- OECD/Eurostat (2005) *Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data*, Paris: OECD. www.oecd.org/sti/oslomanual

Building African Capacity in Science, Technology and Innovation Indicators

Presentations of the Training Team

UNU-MERIT Workshops

Dakar, Senegal

September 27 – October 1, 2010

Technical Report to IDRC: Supplementary Document 3
Technical Report: Building African Capacity in Science, Technology and Innovation Indicators
IDRC Grant Number: 104753
March 30, 2012

Contents

Introduction

This document provides the four lectures delivered by the Project Manager as part of two UNU-MERIT Training Workshops held in Dakar, Senegal, September 27 to October 1, 2010.

The lectures were attended by the case study team members engaged in the Project from Senegal and as well as by graduate students from Senegal who held IDRC grants to support empirical work as part of their doctoral research. One of the graduate students was also a member of the case study team. As these were UNU-MERIT training workshops, the case study team members and the graduate students were able to benefit from the entire programme and the networking opportunities.

As the PowerPoint slides are printed two to a page, not all are readable. However, more than enough is readable to show how the training materials were presented. Copies of the presentations have been provided to IDRC for the archive should the reader require more detail.

Building the Knowledge Base for Innovation

Fred Gault
UNU-MERIT and the Institute for Economic Research on Innovation (IERI) – Tshwane University of Technology, South Africa

Design and Evaluation of Innovation Policy in Developing Countries (DEIP)
Dakar, Senegal, September 27, 2010

Outline

- Knowledge
- Innovation
- Innovation Systems
- Knowledge
  - How acquired
  - Classification
  - Where acquired
  - Flows
- Development
- Innovating out of poverty
- Summary
- References

Knowledge

- "Knowledge is a capacity for action" – Nico Stehr
- Getting to knowledge
  - Data ➔ Information ➔ Knowledge
  - Knowledge can be *codified* or *tacit* or a mix
- "The role of the knowledge ecology* is to form the research capabilities and *the knowledge base for innovation"* – Dominique Foray

* Foray regards an ecology as having weak links

Innovation

- What is 'innovation'?
  - An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*.
- *Implementation* connects innovation to the market.
- The Oslo Manual supports **a language of discourse**
  - Includes an Annex on its interpretation in developing countries inspired by work in Latin America
- The activity of innovation is about problem solving. It is not an isolated event

*Para 146 in OECD/Eurostat (2005), the 3rd edition of the Oslo Manual. The Oslo Manual can be downloaded at no cost from www.oecd.org/sti/oslomanual

Innovation Systems

- **A systems approach** is implicit in most **Innovation Policies** and the **Oslo Manual**
  - Actors
    - Governments, education and health institutions, business, foreign institutions, …
  - Activities
    - R&D, invention, innovation, diffusion of technologies and practices, HR development, …
  - Linkages
    - Contracts, collaborations, co-publication, grants, monitoring, …
  - Outcomes
    - Jobs, growth, wealth
  - Impacts
    - Wellbeing, culture change, global influence, …
- The activity of innovation is **dynamic**, **complex**, **non-linear** and **global**

Knowledge
How acquired

- Knowledge is acquired in different ways and in different places
  - Ways of acquiring knowledge:
    - Formal R&D
    - Formal acquisition of knowledge
      - Education, training, licensing, contracts (FDI,…), …
    - Learning by doing, using and interacting (DUI)
    - Learning from history and culture
      - indigenous knowledge

Knowledge Classification

- Classifying knowledge*
  - Know

• What	School	Density of lead
• Why	Post secondary	Laws of physics
• How	Workplace	DUI
• Who	Networks	This workshop

  - What, Why and How ➔ Human Capital
  - Who ➔ Network Capital

*Lundvall and Johnson 1994

Knowledge Where acquired

- Places where knowledge is acquired
  - Institutions of education (including teaching hospitals)
  - Government research organizations
  - Business enterprise/workplace
  - Private non-profit organizations/households
- Learning is important for innovation
  - But, *learning to learn* is more important
    - Policy implication for
      - colleges, training programmes, ...
      - Absorptive capacity, comparisons and benchmarking

Knowledge Flows

- Knowledge is
  - Generated
    - R&D, DUI, history, ...
  - Transmitted
    - Codified (patents, licences, publications, web texts,...)
    - Tacit (training, contracts, mobility of people (diaspora), FDI, trade...)
  - Used
    - As a capacity for action, to change something, conrol, to innovate, ...

Development

- Middle income economies
  - Links form, knowledge spills over, innovation systems evolve (many, not one), leading to growth
- Least Developed Economies (LDCs)
  - Knowledge ecology does not transform into innovation systems – easily
  - Dealing with the challenge

Innovating out of poverty

- Encourage entrepreneurs, and communities to find out what they are good at doing and support these activities
  - Agriculture
    - Use of ICTs to facilitate <u>linkages</u>
      - Connect to markets
      - Use government institutions (Ag research, Gov services)
      - Seek codified knowledge ...
      - Manage finance
    - Community based problem solving building <u>social capital</u>
      - New crops, social innovation
      - New ways of growing existing crops
      - New tools (managing the IP)

Innovating out of poverty

- Financial services facilitating <u>linkages</u>
  - Money transfer
  - Banking services
  - Insurance
  - Empowering the unbanked (women)
  - ...
- Public services providing <u>effective governance</u>
  - Digital land registries, on the web
  - Training
  - education

Innovating out of poverty

- Support knowledge flows
  - From universities and other public research organizations to business
    - Has to overcome problems of distance, literacy, culture
  - From/to technical colleges
    - Responding to local needs
    - Building community awareness
  - From outside of the country, but in ways that include transfer of knowledge
    - Local suppliers of goods and services

Innovating out of poverty

- Measure knowledge activities
  - Inputs, outputs and outcomes
  - Build the feedback mechanisms
  - Using the indicators to support
    - Policy
    - Community debate
    - Learning

Observations

- Knowledge in this discussion is a capacity for action
- Knowledge comes from many sources and can be combined to produce new knowledge
- Knowledge policy is not just education policy
- Knowledge creation, transmission and use is part of innovation systems
- Build on knowledge at the bottom of the pyramid...

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The Development of an Innovation Strategy: Experiences from Africa

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Design and Evaluation of Innovation Policy in Developing Countries (DEIP)
Dakar, Senegal, September 29, 2010

Outline

- What is an innovation strategy / policy?
  - Context
  - Motivation
  - Implementation, evaluation and learning
- What is innovation?
- What is an innovation system?
- How to build an innovation strategy
  - Components
  - Implementation
- Developing countries
  - Studies
  - Measurement
  - Lessons
- Discussion
- Further reading

What is an Innovation Strategy / Policy?

- An innovation strategy or policy is an intention of government to influence the activity of innovation for a reason (jobs and growth). It may or may not include targets.
  - An example is a tax policy to promote capital investment in ICTs
  - Another example is to encourage university industry collaboration

Context

- **Industrialized countries** (2006-2007)
  - New players in the market – Brazil, China, India, …
    - Competition policy – innovation?
  - Aging population
    - Growth in productivity – innovation?
    - Health, education, training and immigration policies – innovation?
  - Global change
    - Sustainability or 'do no harm' – green innovation?

Conclusion: Innovation for sustainable productivity growth

Context

- (2008-2009)
  - Bailouts – save the banks
  - Stimulus packages – build new and repair old infrastructure
  - How to recover from fiscal deficit – innovation?
- **Africa**
  - Competition
    - Relations with Brazil, China, India …
  - Young population
    - Median age 19 – 24, compare Germany, 44
      - Education, training, employment policies – innovation?
    - Lower life expectancy
    - HIV/Aids
      - Healthcare policies
  - Differences between LDCs and middle income countries
  - Global change is happening in Africa
  - Financial crisis affects aid and trade

Motivation

- There are *reasons* for innovation strategies
  - Ten -Year Innovation Plan of South Africa - DST
    - …help drive South Africa's transformation towards a knowledge-based economy, in which the production and dissemination of knowledge *leads to economic benefits and enriches all fields of human endeavour*
  - Gauteng Innovation Strategy
    - To accelerate innovation in all its forms, in order to bolster and support *the broader strategic objectives of employment creation, and sustainable social and economic development*

Motivation

- National Industrial Policy Framework (NIPF) Industrial Policy Action Plan (2007)
  - The NIPF sets out the government's broad approach to industrialization in the context of the Accelerated and Shared Growth Initiative for South Africa (ASGI-SA) and its *targets of halving unemployment and poverty by 2014* through accelerated growth of at least 6 per cent from 2010
- Human Resources Development Council
  - …to contribute to our national goals which include *reducing poverty and unemployment, promoting justice and social cohesion and improving national economic growth.* (Deputy President Kgalema Motlanthe, March 30, 2010)

Implementation, evaluation and learning

- The implementation of an innovation policy involves responsible departments. This may or may not involve co-operation
  - In the tax example, only the tax department may be involved
  - The collaboration example could involve the higher education and industry departments, granting councils and others
- Once a policy is designed (perhaps it is part of a party platform) and implemented (by public institutions), it can be monitored and evaluated and changed, expanded or ended.
- Policy evaluation leads to policy learning.
- Policy learning can also come from policy experiments.
- *Implementation* is the most difficult part of innovation policy

What is innovation?

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- *Implementation* connects innovation to the market
- The Oslo Manual supports **a language of discourse**
  - Includes an Annex on its interpretation in developing countries inspired by work in Latin America

- The activity of innovation is not an isolated event

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What is an innovation system?

- **Innovation Systems**

- **A systems approach** is implicit in **Innovation Policy** and the **Oslo Manual**
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    - Governments, education and health institutions, business, foreign institutions, …
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  - Impacts
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How to build an innovation policy

- Decide objectives and targets
- Choose components
- Design connections
- Include high-level advice to government from other stakeholders
- Then plan
  - Implementation
  - Evaluation
  - Policy learning and change
- Choice has to be made about scope
  - Whole of government, multiple independent activities, single activities, sectoral strategies, …

Components

- **Markets**
  - Brand recognition
  - Lead market
  - Competitive engagement
  - Financial services
  - …
- **People**
  - Labour force
  - Demographics
  - Migration
- **Innovation Activities**
  - Technologies and practices
  - User innovation
  - User-driven innovation
  - Open innovation
- **Public institutions**
  - Infrastructure
  - Procurement
  - Priority setting
  - Standard setting
  - Public finance
  - Government direct support
  - Education, training and research
  - Health
  - Monitoring and evaluation
- **International Engagement**
  - Big science
  - International co-operation
  - Global challenges

Developing Countries: Studies

- Country studies provide lessons - OECD (China, Chile and South Africa) and the World Bank
- The principal issue is capacity to develop and implement policy
  - World Bank examines three dimensions

    Departments: institutional capacity, that includes policies, procedures, legislation and the systems of goals and incentives that constitute the "rules of the game"

    Projects: organizational capacity, groups of individuals bound together for a specific purpose, with objectives and internal mechanisms, staff, and money to achieve them

    People: human capacity, people with the ability to define objectives, design and implement programs, raise resources and deliver

Developing Countries: Studies

- South Africa as an example OECD(2007: 11)
  - Weaknesses
    - Strategy *implementation capacity* in the state's part of the innovation system
    - Mental models of how the innovation system operates *overly focused on the role of the state*
    - Governance of the state components of the innovation system *insufficiently holistic*
    - …
  - Threats
    - HIV/AIDS, Social unrest, demographic pressures due to birth rate in the 1990s

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Developing Countries: Studies

- South Africa (con't)
  - Strengths
    - Open, participative governance with mechanisms in place for *cross-departmental co-ordination*
    - High percentage of BERD in GERD
    - *Linkage* between major industries and knowledge infrastructure
    - International business and academic *networks*
    - ...

Developing Countries: Measurement

- Part of innovation policy making is measurement and evaluation
- The New Partnership for Africa's Development (NEPAD) Office of Science and Technology is running a project involving 19 African countries to conduct and report on R&D and innovation surveys (CIS-like)
- They are based on Frascati and Oslo respectively
- First results in the *African Innovation Outlook* late 2010

Developing Countries: Measurement

- NEPAD OST project is supported by Sida
  - Builds a community of
    - measurement experts and innovation policy experts
  - Leading to an equivalent of the
    - OECD Working Party of National Experts on Science and Technology Indicators (NESTI)
  - Providing a community of discourse that can use indictors for monitoring, benchmarking, evaluation, foresight or research
  - Phase II of the project is under consideration as is the establishment of the African Observatory for Science, Technology and Innovation (AOSTI) in Equatorial Guinea

Developing Countries: Lessons

- A summary of lessons (not from any one country)
  - Capacity to make and implement policy
  - Political will to co-ordinate policy (whole of government, some departments, single department)
  - Engagement of business as a key part of the innovation system
  - Culture of measurement, leading to greater measurement capacity and -
  - Evaluation, policy learning and change
  - Comparisons and benchmarking

Discussion

- What other lessons can be learned from the development of innovation strategies or policies?
- What are the benefits or dangers?

Further Reading

- OECD Reviews of Innovation Policy
  - (2007) Chile, South Africa, (2008) China
  - See also Kraemer-Mbula and Wamae (2010)
- World Bank Studies
  - http://www.worldbank.org/oed/africa_capacity_building/country_studies.html
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Indicators of Science, Technology and Innovation

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Dakar, Senegal, September 27, 2010

Outline

- Manuals – the SNA
- Science and Technology
- Indicators of S&T
  - R&D
  - Patents
  - Technological Balance of Payments
  - Human Resources for S&T
  - Bibliometrics

  - OECD
    - R&D
    - Technological balance of payments
    - Patents
  - OECD/Eurostat
    - Canberra (Human Resources)
    - Oslo (Innovation)
- Technology
  - Advanced Technologies
  - Biotech
  - ICTs (goods and services)
  - Nanotech
  - Emerging technologies (and practices)
  - Knowledge Management
- Innovation
- References

Manuals

- The *System of National Accounts, 2008* (2008 SNA) is an updated version of the *System of National Accounts, 1993* (1993 SNA). It is the fifth version of the SNA, the first of which was published over fifty years ago.
- SNA 2008 is prepared by the:
  - Statistical Office of the European Union (Eurostat);
  - International Monetary Fund (IMF);
  - Organisation for Economic Co-operation and Development (OECD);
  - United Nations Statistics Division and regional commissions of the United Nations Secretariat; and the
  - World Bank.
- The 2008 SNA is published jointly by these five organizations.
- http://unstats.un.org/unsd/nationalaccount/sna2008.asp

Manuals

- Manuals are codified knowledge
  - They are guidelines for the collection and interpretation of data (GDP, R&D, innovation...) and for international comparisons of data, statistics and indicators.
  - They are supported by an international infrastructure
    - Examples of many: ISIC, ISCED and ISCO
    - ISIC – International Standard Industrial Classification of all Economic Activities, Rev 4 – most countries still use Rev3.1
      - http://unstats.un.org/unsd/cr/registry/isic-4.asp
    - ISCED – International Standard Classification of Education
      - http://unstats.un.org/unsd/class/family/family2.asp?Cl=223
    - ISCO-88 – International Standard Classification of Occupations
      - http://www.ilo.org/public/english/bureau/stat/isco/index.htm
- Manuals provide a language of discourse and they behave like a technology

Manuals

- For language to evolve manuals must be revised to reflect changes in the economy and society
- This requires support for the work and a willingness to participate
- Examples in science, technology and innovation are:
  - Eurostat and the relevant Commission DGs and member states of the EU
  - OECD and member countries
  - RICYT and member countries
  - UIS
  - NEPAD is moving in this direction.

Science and Technology

- Science and technology is different from innovation.
  - S&T includes R&D and related S&T activities
  - There are ministers of S&T, rarely of innovation
  - S&T happens in
    - Higher education, research labs and in business
  - Innovation involves people in firms connecting to the market. They do not necessarily do R&D (OECD 2009)
  - These are fundamental differences

Indicators of S&T – R&D

- R&D, OECD (2002)
  - The Frascati Manual (FM)
    - Provides a definition of R&D (para 63), and examples of what it includes and does not include
    - Free Download at:
      - http://browse.oecdbookshop.org/oecd/pdfs/browseit/9202081E.PDF
    - R&D is a performance measure, not a funding measure
    - Designates sectors for measurement: government, higher education (includes hospitals); business enterprise; private non-profit; and, abroad (funding only).

Indicators of S&T – R&D

- R&D expenditure is a measure of the formal creation of knowledge
- R&D human resources (FTE or Head Count) are an indication of the size of the commitment to the creation of knowledge.
- The aggregate measure is the GERD
  - Gross (not Net) Domestic (not National) Expenditure on (performance, not funding) R&D

Indicators of S&T – R&D

- GERD is used for target setting
  - Africa 1% of GDP
  - EU 3% (2% from business, 1% from public sector)
  - U.S. > 3%
- R&D performance is supported by public policy
  - Grants, contracts, tax credits, technical assistance, scholarships and training support....

Indicators of S&T – R&D

- R&D data are gathered by surveys
  - Surveys have to be repeated, ideally annually, to train respondents and to ensure good time series data
  - Example surveys
    - www.statcan.gc.ca, click on Science and Technology or Information and Communication Technology ...

Indicators of S&T – Patents

- Patents, OECD (2009)
- The Patent Manual
- Guidelines on collecting and interpreting data on triadic families of patents. (Patents filed at the European Patent Office (EPO) and the Japan Patent Office (JPO) and granted by the US Patent and Trademark Office (USPTO))
- Resulting data provide a rich resource for analysis about existing and emerging technologies – and the relative specialization of countries
- Examples of use are in the *OECD Science, Technology and Industry Scoreboard* or *Outlook*

Indicators of S&T – Technological Balance of Payments

- TBP Manual, OECD (1990)
- Guidelines on collecting and interpreting data on payments and receipts for
  - R&D services
  - Intellectual property licenses for patents, copyrights, trademarks and technical assistance
  - Brings together R&D and IP measurement
- Raises interesting analytical questions
  - What does a positive balance mean? Is it good?
  - What about a negative balance?

Indicators of S&T – Human Resources for S&T

- HRST, OECD / Eurostat (1995)
- The Canberra Manual
- Identifies HRST by S&T occupation (ISCO2 and3) and by qualification (3rd level in S&T, ISCED 5 and 6)
- HRST can be
  - Qualified & employed
  - Qualified & not employed
  - Not qualified but employed

Indicators of S&T – Human Resources for S&T

- Used to analyse HRST
  - Stocks and flows
  - Employment
  - Nationality
- Data are collected and distributed through Eurostat for the EU
- OECD and partners work on the 'Career Paths of Doctorate Holders' See: www.oecd.org/sti/cdh

Indicators of S&T – Bibliometrics

- There is no OECD bibliometrics manual
- Bibliometrics is the study of:
  - Publications in selected journals
  - Citations of articles published and, on occasion,
  - Co-publication
- Bibliometrics and similar patent analysis can provide S&T indicators
  - OECD Science, Technology and Industry Scoreboard 2009, Chapter 2

Technology

- There has been work on the production and use of technologies and practices
  - Advanced Technologies
  - Biotech
  - ICTs (goods and services)
  - Nanotech
  - Emerging technologies (and practices)
  - Knowledge Management

  - See the reference material for publications and manuals

Innovation

- What is innovation?
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Innovation

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- **A systems approach** is implicit in the **Innovation Strategy** and the **Oslo Manual**
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    - Jobs, growth, wealth
  - Impacts
    - Wellbeing, culture change, global influence, …
- The activity of innovation is **dynamic**, **complex**, **non-linear** and **global**

Innovation

- Innovation indicators and Innovation Surveys are the subjects of the next talk.

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Innovation Insights from Projects in African Countries

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The Economics of Knowledge and Innovation (EKA)
Dakar, Senegal, October 1, 2010

Outline

- Innovation definition
- Innovation systems
- Producer or user innovation
- User innovation
- Case studies
  - Innovation on farms (farmers)
  - Telephone banking (firms)
  - User innovation in firms
  - Innovation in the informal sector (firms)
- Observations
- Next steps

1

Innovation Definition

- We know what innovation is from earlier lectures:
  - An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*.
- *Implementation* connects innovation to the **market**
- The Oslo Manual supports **a language of discourse**
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    - Wellbeing, culture change, global influence, ...
- The activity of innovation is **dynamic**, **complex**, **non-linear** and **global**

Producer or user innovation

- Producer innovation
  - New or significantly improved products
    - Developed by the producer and put on the market
- User innovation
  - New or significantly improved products
    - Developed by a user for own use
      - And linked to the market (?). Here is a research question.

User Innovation

- Firms
  - New or significantly improved process
    - Transformation, delivery, organizational, market development
    - Done by the firm – user innovation (process)
    - Purchased from outside but 'new to the firm' – process innovation
    - Done in collaboration with others – needs more information
  - The firm sells products, not processes. It uses processes
  - The firm can be considered an 'end user' of process technologies or practices

User Innovation

- End user or consumer (could also be a firm)
  - New or significantly improved product done by user
    - Transferred back to producer as prototype
      - CIS survey should pick this up as product innovation done by others or user innovation (product)
    - User starts business and sells the product
      - CIS survey sees this as firm innovation – producer innovation (product)
    - User shares IP with a peer community
      - Where is the market? Is it innovation? – a research question
    - User does not share the IP, but uses the new or significantly improved product
      - In a firm, this is process innovation
      - For a consumer what is it?

Case Studies

1. Innovation on farms
   - Part of PROmoting Local INNOVation in ecologically-oriented agriculture and natural resoure management (PROLINNOVA), based on an initiative in KwaZulu-Natal, Farmer Access to Innovation Resources (FAIR)
   - Study of two examples of crops
     - New cash crop requiring co-operation of small holders and larger farm – resulted in increased revenue

Case Studies

1. Innovation on farms (con't)
   - New way of growing an existing crop that reduced labour
   - Lower yield resulted but research goes on
   - Both examples are cases of user innovation with the community (Case 1) and the farmer (Case 2) deriving potential benefit
   - FAIR supports group problem solving and decisions on how the knowledge is to be managed

Case Studies

1. Innovation on farms (con't)
   - Several issues to be considered
     - Role of government agricultural research station
       - Part of framework conditions
     - Policy implications of findings
       - Receptiveness of policy department
     - Common issues with other grass roots innovation activities giving rise to greater impact of small projects
       - Literacy? User innovation and IP issues? Is there a role for ICTs?

Case Studies

2. Telephone banking
- Originally a user innovation in Kenya (M-Pesa)
  - Means of transferring money
- South Africa provides full banking service
  - Supported by regulation (Framework conditions)
  - Implications for user (but subject for another study)
    - Saving in time and cost of going to branch
    - Opportunity to accumulate savings to start business ...
    - Empowering and inclusive
  - Implications for service providers

Case Studies

2. Telephone Banking (con't)
- Implications for service providers
  - Service platform built on ICT network
  - Provides banking services
    - Users make more demands and banks offer more products
    - Insurance services (cattle, ...)
    - ...
  - Designed for poor and unbanked but is attracting middle class
    - Case of disruptive technology? (mix of technology and services)
  - Study to monitor change in product mix of service providers, related revenue, and other issues – labour use

Case Studies

2. Telephone banking (con't)

- Policy implications
  - Banking, insurance and ICT regulations
  - Consumer policies
  - SME policies – Spaza shops offering related services
  - ...
- Issues
  - Literacy, ICT access, community role

Case Studies

3. User innovation in firms

- Based on Mozambican innovation survey
  - Looks at follow-up question to the question on process innovation and then conducts interviews
  - Examines sharing of the resulting IP and the resources allocated to the user innovation
  - Also looks at other inputs to process innovation
- Policy issues
  - Support for user-innovators – link to implementation of Mozambique's STI Strategy (MOSTIS) – and sharing of IP
  - R&D and non-R&D innovation policy
  - Literacy?

Case Studies

4. Innovation in the informal sector
- In Senegal the informal sector is larger than the 'modern' sector
- Study firms in the sector
  - Interviews
  - Qualitative and quantitative questions
    - Transient merchants
    - Merchants with canteens in markets
    - ICT firms
    - Shopping centres
    - People working in the firms

Observations

- Common themes
  - Finding ways to be more productive
  - Getting around literacy barriers
  - Use of ICTs
    - Hardware
    - Services
  - Role of framework conditions
    - Regulation
    - Support programmes
    - Tax laws
    - ...

Next Steps

- Case Study Teams
  - Complete field work
  - Produce report by end of February
  - Four reports plus additional chapters from other sources to be published in 2011.
- Then?

References

- Readings

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- Related Reading

- AU (2010), *The African Innovation Outlook*, Tshwane: African Union

Building African Capacity in Science, Technology and Innovation Indicators

Four Reports

from

Case Study Teams

Technical Report to IDRC: Supplementary Document 4
Technical Report: Building African Capacity in Science, Technology and Innovation Indicators
IDRC Grant Number: 104753
March 30, 2012

Contents

Introduction

This document provides the reports of the four case studies of this project in the order in which they were published in the UNU-MERIT website. They result from the work of the case study team members and, to varying degrees, from the mentoring by the members of the training team.

The reports are included as part of the Technical Report so that a programme officer, or a principal investigator, who is considering running a project like 104753 can see the quality of the work that can be expected as a result of critical adjudication of the responses to the Call for Proposals, the provision of training materials and training, and the mentoring that led to the final product. At each stage, the intent was to transfer the capacity to do this kind of work to the members of the case study teams and to develop them as a network, connected through the team of trainers and mentors to other networks of people engaged in development work.

The documents that follow are taken directly from the UNU-MERIT website and they are listed here with the URLs so they can be retrieved independently.

Zita, Julia Eva Baltazar and Avelino Hermineo Lopes (2011), *User Innovation in the Business Enterprise Sector of Maputo Province in Mozambique*, UNU-MERIT Working Paper 2011-062, pp. 28, www.merit.unu.edu/publications/wppdf/2011/wp2011-062.pdf

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Letty, Brigid, Zanele Shezi and Maxwell Mudhara (2012), *Exploration of agricultural grassroots innovation in South Africa and implications for innovation indicator development*, UNU-MERIT Working Paper 2012, 2012-00X, pp. 81, www.merit.unu.edu/publications/wppdf/2011/wp2012-023.pdf

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User innovation in the business enterprise sector of Maputo Province in Mozambique

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User Innovation in the Business Enterprise Sector of Maputo Province in Mozambique

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Abstract

Evidence of user innovation in firms in Maputo Province is presented. This results from a case study of firms that had previously been identified in the Mozambican National Innovation Survey 2009 as process innovators. While the observations are too few to support statistical inferences, they demonstrate the presence of user innovation in firms and they suggest further work on the policy implications, especially related to support for innovation in firms that perform no research and development. The case study found little evidence of the sharing of knowledge gained through user innovation, in contrast with findings from industrialized countries but closer to results from the newly industrialized country of Korea.

JEL Codes: O31, O33, O34

Key words: User innovation, development, knowledge sharing

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November 2011

1. Introduction

The Mozambique Science, Technology and Innovation Strategy (MOSTIS) was approved in June 2006. It makes the case for the stimulation of innovation to promote economic development and poverty reduction. One of the points raised in the strategy is the importance of the process by which individuals and groups “devise new ways to solve immediate problems” (Ministry of Science and Technology 2006: 55). This case study probes the solution of immediate problems in the production processes of private sector firms in Maputo Province, and the economic consequences of doing this. This activity is a form of user innovation (von Hippel 2005).

User innovation in firms is important in all economies, but more so in developing economies where there is limited capacity to invest in new capital goods or software systems. An alternative to buying production technologies is to make existing technologies and practices perform better or, in extreme cases, to develop the production technologies needed by the firm. User innovation can also be done by consumers, under certain circumstances (Gault 2011), but that is outside the scope of this paper which is focused on the firm.

The purpose of this project is to establish the presence of user innovation in firms that have been identified by the Mozambican National Innovation survey 2009 as process innovators. The survey gives a wealth of data about innovative and non innovative firms but limited information about the presence of user innovation in the innovative firms. Probing for user innovation, by investigating a few firms in the Province of Maputo, has established the presence of this activity, with implications for indicator development and for the place of such indicators in the development of evidence-based policy.

2. User Innovation in developing countries: key aspects of previous research

User innovation can be defined as an innovation developed by the end user who gains benefits by using this innovation, rather than the producer who benefits from selling it (von Hippel, 2005). For instance, it is user innovation when the manufacturer modifies existing production equipment or creates a new piece of equipment for its own use to reduce costs and/or to improve product quality. As noted by von Hippel, empirical studies undertaken in developed countries have found a significant amount of user innovation activity.

This type of process-centred user innovation has also been examined in a long stream of firm-level studies of innovation in a range of developing countries at different stages of late industrialization across different countries in Asia and Latin America – but to a much more limited extent in Africa. Most of this work has centred on innovation in manufacturing industry, though only sometimes adopting the ‘user innovation’ terminology

The first major programme of research in this area was initiated by Jorge Katz and colleagues in Latin America during the late 1970s and early 1980s. A large component of their work focused on industries producing standardized products (e.g. steel, cement and chemicals); and this highlighted the importance of accumulating capabilities in user firms to generate their own (mainly new-to-firm) process innovations (Katz 1987). Sanjaya Lall's work was particularly important for developing what came to be a widely used framework for analysing the development of firm-level innovation capabilities in developing countries (Lall 1992). Within this a clear distinction was made between firms' internal product- and process-centred innovation capabilities, and in his research on India he demonstrated the significance of the latter for generating process-centred user innovation – again in process-based industries like steel and cement (Lall 1987).

A large body of work in this area has examined experience in Korea. Much of this has focused on the development of firms' internal capabilities to introduce sequences of increasingly complex products by 'catching-up' firms in industries like automobiles, electrical/electronic goods and semi-conductors – for example, the industry case studies in Linsu Kim's study of Korea's transition from *Imitation to Innovation* (Kim 1997). Such studies appear superficially to have been about those firms' product innovation (largely new-to-firm 'imitation' of products already available in international markets). But closer examination shows it to have been very heavily concerned with user innovation, centred on the process technology that those firms required to manufacture their products competitively. For example, between 1989 and 1994 the annual number of applications by Korean firms' for Korean patents relating to semi-conductors increased about six-fold to 3,336. Almost all of these (95 per cent) were manufacturing process patents, and it was the large process-using, semiconductor producers like LG, Samsung and Hyundai that made the vast majority of these applications (Kim 1997: 163-165). Thus a massive base of process-centred user innovation appears to have underpinned the rapid and export-intensive growth of this industry's production of increasingly complex products.

Other studies have identified extensive user innovation in the development of process-based industries in Korea. In particular Enos and Park (1988) examined the early technological development of the chemical and steel industries and highlighted the ways in which Korean firms made intensive efforts to build up their innovative capabilities. In large part these capabilities were used to develop streams of user-innovation to improve the performance of the process technologies that firms had originally acquired from suppliers in advanced economies – in the petroleum, synthetic fibre and steel industries (pp. 74-86, 132-142 and 190-207 respectively).

Almost all this research was based on case studies of individual firms and industries, and these provided limited opportunities to draw insights from controlled comparative analysis. However, an important break from this tradition was made in a comparative study of the development of innovative capabilities in two steel companies in Brazil (Figueiredo 2001, 2002, 2003). This identified differences in management and strategy that underlay differences between the two firms in the intensity with which they developed these capabilities and in the intensity with which they applied them to generate streams of performance-improving innovation in the processes they used.

Important insights from this large body of work include the following.

The incidence and economic significance of user innovation

- The incidence of such user innovation is widespread. These studies indicate that manufacturing firms in developing countries commonly complement externally sourced technology with internally generated process innovation, starting at early stages in the development of manufacturing industries in those countries. Thus very many firms in developing countries do not follow common influential prescriptions about how they should introduce change in the process technologies they use - i.e. that they should rely on external sources, typically in more advanced economies, and that they consequently do not need to engage in innovation before they begin to close in on using technology at the international frontier (e.g. McArthur and Sachs, 2002).

- In general, such user innovation involves incremental change to the process technologies already in use in the firm. Such new-to-the-firm innovation is not merely about adaptation to 'fit' better with local contexts. It is also about improvement beyond the initial performance of acquired technologies.

- On their own, individual 'steps' in such paths of improvement typically yield only small advances in performance, but the cumulated economic significance of continuous streams of small steps is often considerable. For example, Dahlman and Fonseca (1987) showed that, in a number of major process units in a steel plant in Brazil, user-implemented modifications and improvements over periods of around seven years after they had reached initial design capacity more than doubled their rate of output from those initial design levels. Such findings reflected similar patterns to those found in studies in advanced economies – for instance Hollander (1965) showed how productivity gains from user-generated incremental improvements to U.S. rayon plants during their operating lifetime could be just as significant as the one-step gains from investment in new plants that embodied novel processes.

The underlying accumulation of capabilities to innovate

- The origins of such cumulative paths of incremental innovation are typically rooted in specific resources and capabilities in the user firm. For the most part these differ from the resources and capabilities for routine operations and also from those used to undertake formally organized R&D. Although they may overlap in part with both, they typically consist of specialized technical, process engineering and managerial competences organized within maintenance departments, engineering sections, quality enhancement groups, process improvement teams and the like. Thus, although sometimes described as resulting from 'learning-by-doing', these paths of cumulating incremental process improvement do not arise merely as a more or less automatic consequence of repetitive 'doing' of routine production (Wamae 2009). They are the consequence of purposeful innovative acts undertaken by specific capabilities in the firm (for a critique of common perspectives on 'learning-by-doing', see Scott-Kemmis and Bell (2010).

- Consequently, a key activity underpinning such paths of user innovation is the prior process of building up those capabilities. In particular, their effective acquisition and accumulation depends on explicit expenditure and strategic managerial effort to implement suitable 'learning mechanisms' – involving for example: specialized training; special arrangements (e.g. with suppliers) to acquire particular kinds of skill; know-how and experience; and, intensively managed internal processes for embedding such competence in the user firm.

- The explicit learning mechanisms by which process-using firms acquire and develop their innovation capabilities are typically embedded in a cumulative process by which successively 'deeper' levels of capability are developed in the user firm. These levels have been described in several studies as running from: (i) capabilities for executing simple and minor improvements to existing facilities and production procedures, through (ii) those needed for much more complex design, engineering and management roles in collaborating with suppliers to set up new, more advanced and innovative process facilities or procedures; to (iii) R&D-type capabilities required to generate new knowledge as an input to the design and engineering of novel processes. As a result the time paths for building such progressively deeper level of capability for undertaking user roles in innovation can take decades not years (Bell 2006).

Interconnections and longer term evolution

- These studies demonstrate that process-centred user innovation is often intimately interconnected with product innovation. It is often the main source of 'product quality' that shapes product competitiveness, especially in international markets. At the same time, the introduction of new or improved products typically requires at least some degree of change in the production process used.

- Also 'pure' forms of user-implemented innovation (whether product- or process-centred) are only one end of a spectrum that involves varying degrees and forms of collaboration and interaction between the internal innovation activities of users and complementary contributions from external suppliers. Thus although relatively 'pure' forms of user-responsibility for process innovation in developing country firms seem to be concentrated in more incremental (new-to-the-firm) innovation, user-roles do not simply vanish in more substantial innovation steps involving external suppliers. In such situations user firms' innovative capabilities and activities commonly interact with those of external suppliers in a wide variety of complementary arrangements. This again reflects common patterns in advanced countries that is perhaps especially the case in large-scale process-type industries (e.g. cement, steel and other metals, chemicals, paper, and mining) - see e.g. Laestadius (1998) and Pisano (1997) for experience in the paper and pharmaceutical industries respectively.
- Consequently, it is not surprising that many of these studies indicate that capabilities to generate relatively incremental forms of process innovation constitute an initial nucleus in the longer term development of more diverse capabilities for engaging in more novel forms of innovation in a widening array of interactions with other actors in local innovation systems.

- Similarly, the benefits of investment in cumulatively deepening innovation capabilities over long periods are likely to be much greater than those that accrue simply to the initial process-using and incrementally innovating firm. Individual engineers and managers embodying such valuable capabilities may migrate to other firms or to set up their own firms to supply services, process equipment or specialized process software – thus contributing to the diversification of production in the domestic economy. Indeed, the specialized innovation-generating departments and sections of user innovators may spin off as complete entities to set up new firms. For example, the highly successful Korean steel company, Posco, built up strong internal innovation capabilities and consolidated these into a distinct subsidiary company, Posec. This was later spun off and became a successful competitor in the global market for steel engineering services and specialized steel engineering software.

Cutting across these observations, a body of evidence now exists to demonstrate both considerable differences in the rate at which firms have accumulated successive levels of innovation capability and substantial variation in the intensity of user innovation actually implemented - including cases where firms generated no improvement in process performance at all over many years (Bell et al. 1982). Questions therefore arise about the factors that affect such inter-firm differences.

Here the literature has been much less successful in systematically illuminating the key issues on a generalizable basis. This reflects the heavy reliance on case studies of individual firms and industries within individual developing countries. Nevertheless three points seem important. First, the characteristics and strategic behaviour of individual firms have a strong influence on their development of strong user innovation capabilities. But second, the prevailing economic contexts in which firms operate have a very strong influence on those firm-level characteristics and behaviours, and hence government policies shaping those contexts matter (Lall 1992). Third however, the most common instruments of ‘technology and innovation policy’ in developing countries seem to have limited importance, especially in the early stages of developing user innovation capabilities in industrial firms. These policy instruments focus very heavily on increasing R&D activities, and primarily located in public organizations like universities and research institutes. Consequently, apart from sometimes providing a small flow of technologically informed human capital between such organizations and manufacturing firms, they appear to have little influence on fostering the development of non-R&D capabilities *within industrial enterprises* – the core base for large proportions of the user innovation that have been examined in the literature reviewed above.

However, the development of CIS-type innovation surveys in a growing number of countries opens the possibility of going beyond the limits of firm and industry case studies as a basis for illuminating policy issues about user innovation in industry in developing and emerging economies. The opportunity they provide for much more systematic comparative analysis of inter-firm, inter-industry and inter-country differences opens up much greater possibilities for illuminating those policy issues. One such study is a recent analysis of user innovation in Korean firms that makes use of CIS-like data (Kim and Kim, 2011). Another is the study reported in this paper – an initial exploration of user innovation in Mozambique based on a CIS-type innovation survey.

3. Methodology

3.1 Innovation and official statistics

While there is widespread appearance of user innovation in developed countries, little of it appears in official statistics. Official statistics as those presented by statistical offices, central banks, regulators or other official bodies to describe the state of a particular activity. They need not be gathered by government organizations and in some countries they are produced by research institutes under government contract. For innovation the most widely used example of a survey gathering official statistics is the European Union Community Innovation Survey (CIS) which was the model for the questionnaire used in the Mozambican National Innovation Survey 2009. Both CIS and the Mozambican Innovation Survey use guidelines given in the Oslo Manual (OECD/Eurostat 2005).

One of the objectives of this study was to explore the possibility of including firm-based user innovation in Mozambican official statistics on innovation in the future. Process innovation in firms was chosen as the focus of the study as firms use processes, they do not sell them. If the firm improves is production process for its own benefit, it is a user innovator.

To probe firm-based user innovation, the question of interest was that on process innovation, and the follow up question.

> Who developed these process innovations?
> 1. Mainly your enterprise or enterprise group
> 2. Your enterprise together with other enterprises or institutions
> 3. Mainly other enterprises or institutions

The results of the follow up question in the survey are given in Table 1. For Maputo Province, the fifteen enterprises that reported process innovation, and responded to the follow up question, were included in the case study.

Table 1: Answers for Innovation Process Question in Mozambique

Province	Quantity	Who did the innovation	Quantity
Maputo	15	Your enterprise	10
		Together with others	3
		Others	2
Gaza	3	Your enterprise	3
		Together with others	0
		Others	0
Inhambane	.	Your enterprise	.
		Together with others	.
		Others	.
Sofala	4	Your enterprise	2
		Together with others	2
		Others	0
Manica	3	Your enterprise	2
		Together with others	0
		Others	1
Tete	4	Your enterprise	2
		Together with others	2
		Others	0
Zambezia	1	Your enterprise	0
		Together with others	1
		Others	0
Nampula	3	Your enterprise	2
		Together with others	1
		Others	0
Niassa	1	Your enterprise	1
		Together with others	0
		Others	0
Cabo-Delgado	0	Your enterprise	0
		Together with others	0
		Others	0
Total		Your enterprise	22
		Together with others	9
		Others	3
Total enterprises engaged in process innovation*			**34**

Source: Mozambican National Innovation Survey 2009
. No Answer
* Based on available responses

3.2 Samples

The Mozambican National Innovation Survey 2009 sampled manufacturing firms with 25 or more employees in the list given by Mozambican National Enterprises Register. Although the Oslo Manual recommends 10 employees or more, 25 employees or more was used to reduce the population and save on survey costs.

The size of the total population was 903 enterprises and the questionnaire was administered to all. In total, 140 firms responded and the response rate was 16%. Among these, fifteen enterprises were selected in Maputo Province which had reported process innovations in the reference period, 2008-2009.

For the case study, all fifteen process innovators in Maputo province were contacted and responses were received from all fifteen enterprises. Respondents were willing to discuss their process innovation activities.

3.3 Questionnaire design and data collection

Based on the studies carried out in this field by other countries, a questionnaire fitting to the Mozambican situation was prepared and pilot tested. Note was taken of a 2007 questionnaire used by Statistics Canada (Schaan and Uhrbach 2008, Statistics Canada 2008).

A personal interview approach to capture information was adopted as the most effective for information gathering and for guaranteeing a high response rate. The questionnaire was first tested in 5 enterprises and two questions that created problems were revised before the full data collection took place. An English translation of the questionnaire is provided in the Appendix.

4. Findings

4.1 Results from the survey

The first observation follows from the Mozambican Nation Innovation Survey 2009 (Table 1) and it is that 65% of firms that were process innovators managed the innovation themselves, 26% did it with others and, for 9%, the process innovation as done by others. This pattern is evident in Maputo Province where the results from the 15 firms were 67% (10), 20% (3) and 13% (2) respectively. While not a statistical sample, Maputo Province shows the same behaviour as Mozambique and, as a consequence, findings from this case study could have wider applicability. The results that follow are classified according to their response to the follow-up question in Section 2.

Mainly your enterprise or enterprise group

For the ten enterprises that responded that the innovation was done by "Mainly your enterprise or enterprise group", there were seven in services, two in manufacturing and one in construction. The distribution was the following.

Services (7)
1 Software consultancy (software development and modification)
2 Auditing and consultancy (software development and modification)
2 Cleaning services (modification of equipment related to cleaning)
1 Engineering consultancy (no information on its user innovation)
1 Services offers (modification of procedures in services offers)

Manufacturing (2)
1 Metal mechanics (modification of equipment and procedures for metal mechanics)
1 Cement packing (modification of equipment and procedures for cement packing)

Construction (1)
1 Construction (modification of equipment and procedures for construction)

Nine of the enterprises modified equipment, software or practices and one firm provided no information. None adopted new equipment, software or practices by developing it on their own.

The important finding is that all enterprises that were process innovators and reported that the innovation was done "Mainly your enterprise or enterprise group" in the case study were user innovators. If this is the case for all process innovators in the Mozambican innovation survey, there is a significant population of user innovators in Mozambique. If the statistics were more plentiful, there could be problems caused by firms having more than one process innovation, but reporting only for one.[1]

Your enterprise together with other enterprises or institutions

There are three enterprises in this category, all in service industries
1 Graphic services (modification of graphic printing procedures)
1 Cleaning services (modification of practices for cleaning services)
1 Telecommunications services (modification of telecommunication services)

While all three were modifiers of services, there are outstanding questions about the role of the other enterprises or institutions. This is needed to determine whether this is user innovation on the part of the enterprise, in which case the enterprise is in the lead. If the collaborator is leading it is not user innovation, but it is process innovation.

Mainly other enterprises or institutions

[1] We are thankful to Professor Youngbae Kim for this observation.

There are two enterprises in this category, one is a service enterprise and one is a manufacturer.

1 Cleaning services (new to the firm innovation in cleaning practices)

1 Manufacturing of hygiene and cleaning products (new to the firm innovation in practices related to manufacturing)

These enterprises were process innovators, but they were not user innovators as the new practices came from outside the enterprise.

4.2 Indicators

What is clear from the case study results is that indicators of user innovation could be produced from innovation surveys, easily, if the assumption is made, based on this case study, that all enterprises that do the process innovation on their own are user innovators. Of course, this is a strong assumption and more data are required to show to what extent it holds. However, the estimate following from this assumption is only an under bound for user innovation as some of the enterprises that collaborate will be user innovators and some not. The distinction is whether the enterprise with the process innovation is in control of the collaboration or not. If it is, it is a user innovator. If it is not, it will be a process innovator, but not a user innovator. The source of the innovation would then be the partner in the collaboration. Finally, for process innovators where the innovation is done mainly by others, there is no user innovation.

Focusing on process innovators where the innovation was done mainly by the enterprise or the enterprise group

The ten process innovators in this category were described in the previous section. These enterprises took the modification of technologies seriously, as most (8) engaged in the activity continuously, as opposed to occasionally (2), they did it as part of a formal programme (7), and it was funded internally in eight cases, by customers in one and from other sources in one case. There was a dedicated budget in five cases, in four cases it came out of the maintenance budget, and in one case from another source. In most cases, then, adoption by modification was an on-going and formal activity, budgeted from within the enterprise and with a dedicated budget.

A significant point is that none of the ten enterprises had their own R&D unit. All of the knowledge needed to modify the technologies was coming from learning by doing, using and interacting. This is not an exceptional result as firms in many OECD countries exhibit a higher propensity to innovate than to do R&D (Gault 2010: 60). This observation is important as it means that such firms in Mozambique cannot benefit from R&D support programmes.

Looking outside of the business unit, four knew of other firms doing similar modifications and six co-operated with other business units. However, four did not co-operate and did the work internally, of the six that did co-operate, three worked with other business units in the firm, one worked with a supplier and one with another external firm. This is consistent with the self-contained approach of these firms that fund the work mainly from within, do the modification continuously and either do not co-operate or do so only with other business units in the firm.

It is not then surprising to find that nine out of ten did not share the technologies that resulted from their work on modification. The one firm that did share, gave the technology away in order to gain feedback and more expertise, an act that is not uncommon in developed countries for a variety of reasons (von Hippel 2005), but, based on the data available, it is not common in Mozambique and it is also quite low in Korea (Kim and Kim 2011). The free revealing of knowledge in recently industrialized countries and in developing countries is a topic for further research.

Of the ten firms, half protected their intellectual property and half did not. Of the half that did there was no preferred approach. They used secrecy, trademarks, confidentiality agreements, copyrights, and combinations of these.

Finally, six of the firms reported that the technology modifications done by them had been adopted by other firms, in two cases by suppliers of the original technology and in four cases by other firms that used the original technology. The assumption is that these knowledge transfers took place for a fee, as only one firm shared such knowledge.

5. Implications for policy

There are several reasons why user innovation in firms is important to innovation policy. The first is that, as indicated in extensive previous research on the subject, process-centred user innovation in developing countries potentially has considerable developmental significance. In its own right it can yield substantial productivity gains while also contributing to competitiveness in product-related ways – e.g. through increased product quality or in supporting other kinds of product-centred innovation. But also, over the longer run, it seems to act often as an initial nucleus of innovation capability that lays a basis for the evolution of wider and 'deeper' firm-level capabilities to innovate; and those evolving capabilities within firms commonly constitute a basis for innovation-related interactions with other actors in the local innovation system, so constituting an important forces for the closer articulation of system structures.

The second reason for addressing issues about process-centred user innovation is that it appears to be more intensive, perhaps with greater developmental significance in process-based industries producing relatively standardized (or commodity-type) products – e.g. (i) primary industries like petroleum and mining, (ii) materials-intensive industries like cement, steel or aluminium, and (iii) natural resource-based industries like pulp and paper or other bulk agro-processing. These kinds of industry are particularly important in Mozambique and other African countries, and that importance is likely to increase over the next decade and beyond. So at least in principle, they are likely to focus fairly centrally in policies for technology and innovation in such countries.

But third, this calls for a significant shift in emphasis within the portfolio of technology and innovation policies in many of these countries. Currently the emphasis is often heavily concentrated on supporting R&D - principally undertaken in organizations like universities and research institutes, rather than in firms. In this respect, the implications of the finding of this case study mirror those of prior research. In firms that do not do R&D, all but one of the fifteen firms in the case study, and all of the firms that did the process innovation on their own, the problem solving that creates value by improving the production process requires policies that are quite different from those that usually support R&D, even in the business sector. That is why it is important to establish the presence of this phenomenon in Mozambican firms as an input to the policy debate as part of implementing the Science, Technology and Innovation Strategy of 2006. There are policy initiatives in place, of which the Scientific Innovator Program is an example, for which the Ministry of Science and Technology is responsible. However, this initiative is directed at individuals and not at enterprises. The needs emerging from this study are for initiatives directed at enterprises.

Two broad approaches to policy could support user innovation in firms that do no R&D. One is the provision of expert advice on management, financing, network connections, and human resource development. This is more than a venture capital activity, it requires the engagement of entrepreneurs who have succeeded and are willing to share their knowledge with the firms that are user innovators. The second is to develop policy mechanisms for supporting firms in acquiring and accumulating their own innovative capabilities in the form of various kinds of non-R&D competence – i.e. primarily the various kinds of engineering and related managerial competence that plays the key role in user innovation.

There is then a fourth reason to understand user innovation. Work by von Hippel (1988 and 2005), de Jong and von Hippel (2009) and Gault and von Hippel (2009) in industrialized countries suggests that firms that are user innovators have a higher propensity to give away, or freely reveal, the intellectual property that results from the problem solving in the firm. This has implications for intellectual property policy. In the case where free revealing was common, consideration could be given to creating a patent-like instrument, with a review process similar to that for a standard patent application, giving recognition to the originator of the knowledge, but also making the knowledge freely available. On the other hand, the results of this study, and the work of Kim and Kim (2011), suggest that there is not a high propensity to give knowledge away in Mozambique or Korea and that the existing intellectual property regime is functioning.

Kim and Kim (2011) contrasted the 3.2% of firms in Korea that give knowledge away with Canada and the Netherlands where the figure is over 20%. Their explanation was that there is a lack of trust in Korea and there is also the close buyer-supplier relationship dominated by the chaebols. This is an important insight and it suggests additional work in Mozambique to see if there is an issue of trust that prevents sharing of knowledge or if other factors are important – such as differences between innovative behaviour in different types of industry, or the limited intensity of innovation across industrial firms and hence limited opportunities for the *reciprocal exchange* of knowledge that underpins much of the reported 'sharing' of technology in user innovation. Understanding this would lead to a third set of policy questions.

6. Conclusion

This is a report of a case study that followed the first innovation survey of Mozambique. Both the case study and the survey were new initiatives and there is still much to learn. The case study has clearly identified the presence of user innovation in Mozambique and these findings suggest the development of statistical indicators in this area to support consideration of related policy initiatives.

Finally, much has been learned about developing, testing, and administering a questionnaire, analysing the data and managing a case study. This forms a basis for future work. But also, as illustrated in both this study and in previous research in this area, parallel and hopefully interacting case study work is also critically important in developing important areas of understanding that cannot, realistically, be expected to be generated by innovation surveys alone. Again a basis for such future work has been explored in this study.

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Appendix: Questionnaire for the case study in an English translation

Republic of Mozambique

Ministry of Science and Technology

INNOVATION QUESTIONNAIRE: CASE STUDY OF MAPUTO PROVINCE

PROTOCOL OF THE QUESTIONNAIRE

This survey comes as a continuation of the previous investigation, in order to evaluate the innovative processes of firms carrying out such activities.

First, let us thank you and your colleagues for responding to the Mozambique Nation Innovation Survey 2008. This survey helps the Minister of Science and Technology to develop policy to help firms like yours.

Second, let us reassure you that we are here from the Ministry of Science and Technology and that anything said today will be kept confidential and used only for analysis. Under no circumstances will MCT release or disclose any information pertaining to your firm.

Section A: Process innovation Mainly by your Enterprise or Enterprise Group

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: Mainly by your enterprise or enterprise group.

A-1. Can you tell us if this involved developing a wholly new process or modifying an exisiting process?

A-2. Why did you do it?

To make the process do better what it was doing [ ]
To expand the capabilities of the process [ ]
Other [ ]
If 'Other'please describe the reason

Section B: Process innovation Mainly By your Enterprise Together with Other Enterprises or Institutions

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: By your enterprise together with other enterprises or institutions.

B-1. Can you tell us if this involved developing a wholly new process or modifying an existing process?

B-2. Why did you do it?

To make the process do better what it was doing [ ]
To expand the capabilities of the process [ ]

Other [ ]
If 'Other' please describe the reason

B-3. What was the relationship with the other enterprise or institution?

Client	[ ]
Supplier of the process technology	[ ]
Competitor	[ ]
Public sector organization	[ ]
Other (please specify)	[ ]

B-4. What was the reason for the collaboration?

They had useful knowledge	[ ]
They used our firm as an experiment	[ ]
We lacked the resources to do the work ourselves	[ ]
Other (please specify)	[ ]

Section C: Process innovation Mainly By Other Enterprises or Institutions

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: Mainly by other enterprises or institutions.

C-1. Can you tell us if this involved developing a wholly new process or modifying an existing process?

C-2. Why did you do it?

To make the process do better what it was doing	[ ]
To expand the capabilities of the process	[ ]
Other	[ ]

If 'Other' please describe the reason

C-3. What was the reason for using an outside enterprise or institution?

They sold the product we required	[ ]
They used our firm as an experiment	[ ]
We lacked the resources to do the work ourselves	[ ]
Other (please specify)	[ ]

Section D: General

D-1. How frequently is the modification (development) of technologies carried out in your business unit?

Continuously [ ]

Occasionally [ ]

D-2. How is the modification (development) of technologies carried out in your business unit?

Formal Program [ ]
Informal Program [ ]

D-3. How is the modification (development) of technologies funded in your business unit?

Internally [ ]
By customers [ ]
From other funding sources [ ]
By suppliers [ ]

D-4. Which budgets are used for technology modification (development)in your business unit?

Part of the maintenance budget [ ]
Dedicated budget for each project [ ]
Part of the R&D budget [ ]
Other budget [ ]
Part of the innovation budget [ ]

D-5. Does your enterprise has separate R&D unit / R&D budget?

Yes [ ]
No [ ]

D-6. Do you know of other firms that have carried out (developments) similar to yours?

Yes [ ]
No [ ]

D-7. Does your business cooperate with other business units, firms or institutions to modify(develop) technologies?

Yes [ ]
No [ ]

D-8. Who did your business cooperate with for the modification (development) of technologies?

Suppliers [ ]
Other business units in firm [ ]
Consultants [ ]
Clients [ ]

Industrial associations	[ ]
Universities	[ ]
Commercial labs	[ ]
Competitors	[ ]
Federal government labs	[ ]
Colleges	[ ]
Provincial labs	[ ]
Private non-profit	[ ]
Other type	[ ]

D-9. Does your business unit share the technologies that it has modified (developed) with other firms or institutions?

Yes	[ ]
No	[ ]

D-10. How does your business unit share the technologies it has modified (developed)?

At no charge	[ ]
In exchange for something of value (i.e., free equipment)	[ ]
Other method	[ ]
For a fee	[ ]

D-11. Why did your business unit choose to share the technologies that it modified (developed)?

To allow a supplier to build a more suitable final product	[ ]
Gain feedback and expertise	[ ]
Nothing to lose (no direct competition)	[ ]
Enhance reputation	[ ]
Other	[ ]
Contractual obligation	[ ]

D-12. Does your business unit use any method to protect your process Intellectual Property (IP)?

Yes	[ ]
No	[ ]

D-13. If yes, how do you protect your IP?

Confidentiality agreements	[ ]
Patents	[ ]
Secrecy	[ ]
Trademarks	[ ]
Copyrights	[ ]

Other [ ]

D-14. To the best of your knowledge, have any of the technology modifications (developments) in your business unit been adopted by the following:

Supplier of the original technology [ ]
Other firms that use the original technology [ ]

That completes our formal interview. Is there anything you would like to tell us about how the Ministry could help support your activities like those you have just described?

Thank you very much for your time.

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Mobile banking: Innovation for the poor

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Mobile Banking: Innovation for the Poor

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Abstract

Access to, and the cost of, mainstream financial services act as a barrier to financial inclusion for many in the developing world. The convergence of banking services with mobile technologies means however that users are able to conduct banking services at any place and at any time through mobile banking thus overcoming the challenges to the distribution and use of banking services. This research examines the factors influencing the adoption of mobile banking by people at the Base of the Pyramid (BOP) in South Africa, with a special focus on trust, cost and risk

Data for this study was collected through paper questionnaires in townships around Gauteng. This research has found that customers in the BOP will consider adopting mobile banking as long as it is perceived to be useful and to be easy to use. But the most critical factor for the customer is cost; the service should be affordable. Furthermore, the mobile banking service providers, both the banks and mobile network providers, should be trusted. Trust was found to be significantly negatively correlated to perceived risk. Trust therefore plays a role in risk mitigation and in enhancing customer loyalty.

JEL Code : O31, O32, O33.
Key words: Mobile banking, Base of the pyramid, indicators

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1.0 Introduction

Millions of people in South Africa and across the developing world do not have access to banking services. Faced with barriers related to cost, geography and education, these individuals have no way of securely transferring funds, saving money or accessing credit (BASA 2003). One solution to this problem, which has drawn particular attention from stakeholders in Africa, is mobile banking.

Mobile banking offers a potential solution for the millions of people in emerging markets that have access to a cell phone, yet remain excluded from the financial mainstream. It can make basic financial services more accessible by minimising time and distance to the nearest retail bank branches (CGAP 2006) as well as reducing the bank's own overheads and transaction-related costs. According to the International Telecommunication Union (ITU), over 90% of South Africans use a mobile phone (ITU 2009), while only 40% have a bank account (African Executive 2008). Mobile banking presents an opportunity for financial institutions to extend banking services to new customers (Lee et al. 2007).

Despite the obvious potential benefits of mobile banking, questions remain about whether low-income customers will adopt the relatively new technology at a scale sufficient to make it worth offering. Understanding adoption behaviour allows for the providers of mobile financial services to engineer their offerings in order to optimise uptake by consumers. This research therefore examines the factors influencing the adoption of mobile banking by the Base of the Pyramid (BOP) in South Africa.

From an innovation perspective, the analysis examines the provision of new or significantly improved services to people at the base of the pyramid and, to a lesser extent, the impact of doing this of consumers on producers. The analysis suggests statistical indicators that could be used to describe changes in products being offered and in the way they are used by consumers.

Data was collected through the use of a paper questionnaire in townships around South Africa's main economic hub of Gauteng. While this introduced an acknowledged bias into the study, in that the population surveyed was urban and not rural and also in a more economically successful region rather than in a deprived region, the results were sufficiently robust to encourage further work on the use of mobile banking, the role of innovation, and the impact on the consumer. The research found that customers in the BOP would consider adopting mobile banking as long as it was perceived to be useful, easy to use and affordable. The study also found that trust played a key role in risk mitigation and in enhancing customer loyalty.

2.0 Background

The financial services sector in South Africa is sophisticated, world class and highly regulated. Historically however this sector had concentrated its services on middle to upper income consumers and corporate businesses, ignoring the large numbers of people excluded from the formal financial system. The Financial Sector Charter of 2005 applied regulatory pressure on banks to extend their banking services to the 18 million unbanked (Centre for Inclusive Banking in Africa 2011). The banking sector's response to this was the launch of the Mzansi account, described as "best- effort" attempt to bring entry- level customers into the banking sector SA (Naidoo 2011). On paper the Mzansi account appeared successful, according to the Finscope (2010) survey, by December of 2010, there were 4.9m Mzansi account holders,. This represented about 15% of the 32m SA adult population, compared with 13% in 2009 and 11% in 2008. These numbers are however misleading as only about 60% of the 4.9m accounts which were opened are active. High levels of dormancy occur as the Mzansi product fails to meet customer needs. Customers are still required to travel to bank branches or ATM's to make transactions. Branches are expensive to set up, and are only open for limited trading hours (9am to 3pm). Banking executives described how it was counterintuitive to expect a consumer to spend 20 rand in taxi fare to come in to a branch to deposit 50 rand (Naidoo 2011).

Examining the bank's challenges, many banks have struggled to make traditional business models profitable in a BOP context, given lower profit margins and high costs. In a 2011 Financial Mail article, four of SA's largest banks have admitted to losses on conventional Mzansi accounts (Naidoo 2011). Traditional models therefore did not suit either the consumer or service provider and it required an innovative approach to create banking models more suitable to the low income context. For this reason many banks began experimenting with various mobile banking models. Mobile banking reduces the costs related to branch overhead, creating the potential for a viable business model at the BOP and therefore presenting an opportunity for banks to expand market penetration by reaching previously unbanked customers (Lee et al. 2007).

The convergence of telecommunication and financial services has created opportunities for the emergence of mobile banking solutions. Mobile banking services provide convenience and efficiency to customers, saving them time and money. For some customers in low-income communities, this can remove the barrier of an expensive and time-consuming visit to the nearest bank branch and in so doing encourages interaction with the formal economy (CGAP 2006).

These changes in the traditional banking model can be regarded as innovative using the definition of innovation as found in the Oslo Manual.

> "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." (OECD/Eurostat 2005: paragraph 146)

In South Africa, the financial sector aims to reduce the number of unbanked people (BASA, 2003). Mobile banking and other forms of mobile money transfer have been cited as a secure means for the previously unbanked to access and transfer funds, to save money, and to access credit for low-income housing or financing agricultural development as well as insurance products and services (BASA 2003; GSMA 2009).

However, while research has been conducted into areas of mobile commerce and mobile banking, there has been little research into mobile banking in a BOP context. While mobile banking may offer opportunity for expanding financial inclusion in low-income markets, questions remain about customer adoption, and about the behaviour of customers at the BOP. Will low-income customers view banking through their mobile phones as reliable or risky? (CGAP 2006). How important is the cost factor versus the benefit of mobile banking, and how does this affect the decision of a low income individual to adopt a mobile banking service? Do customers at the BOP behave differently from middle and upper income people?

Do people at the BOP perceive risk and cost differently? Do they have sufficient knowledge about mobile banking service providers, services and products to trust them? These questions have been insufficiently tested in the literature around the adoption of technology in a low income market context.

Policymakers, as well as mobile banking service providers themselves, must understand the needs of the consumer, including factors influencing the intention to use or adopt mobile banking in the low-income economic segment, in order to stimulate demand and secure healthy returns on investment (CGAP 2006). A clear understanding of these factors will enable mobile banking service providers to develop suitable marketing strategies, business models, processes, awareness programmes and pilot projects (GSMA 2009). This understanding will also guide policymakers in crafting policy suitable to encouraging financial inclusion.

Various studies have been conducted in South Africa and other countries into mobile commerce and mobile banking, but with a focus on different factors and contexts. Wu and Wang (2005) looked at the impact of cost on the adoption of mobile banking in middle class populations. In South Africa, two studies examined factors influencing adoption of cell phone banking (Brown et al. 2003; Walker 2004), but both were urban-based and relied on email to contact some respondents, failing, therefore, to accommodate the majority of the population in the BOP segment which lacks access to the internet.

This case study contributes to existing research by assessing the relevance and effects of perceived usefulness, ease of use, cost, trust and risk in influencing the adoption of mobile banking services. From an innovation perspective, the knowledge gained from the analysis provides potential inputs to innovation both at the firm level and at the level of the policy maker. The study focused on the previously unbanked or under-banked consumer base in the BOP economic segment in South Africa (SA). As product and policy are engineered to encourage mobile banking adoption and adoption amongst the previously unbanked, from an innovation perspective, this forms an example of market development.

In the study, five questions were investigated.

1. What are the main factors influencing the adoption of mobile banking by the BOP?
2. How does the customer at the BOP perceive risk with regards to mobile banking?
3. What influences the customers at the BOP to trust mobile banking?
4. How do customers at the BOP perceive the cost of mobile banking?
5. How does perceived usefulness and perceived ease of use influence the adoption of mobile banking at the BOP?

2.1 Defining the BOP

Prahalad (2005) argued that the global poor constitute a “fortune at the Base of the Pyramid” and that the private sector should target these vast untapped rural markets in developing countries with low-cost services and appropriate business strategies. According to Prahalad (2005) there are more than four billion people at the BOP living on less than $2 per day purchasing power parity (PPP), in both developing countries and least-developed countries. Several different definitions of the Base of the Pyramid have emerged since Prahalad coined the term. This study draws on various definitions, ranging from $2 per day PPP (Prahalad 2005; Karnani 2007; Louw 2008) to an average household income of $29.61 or R4,664 per month (Chipp and Corder 2009; SAARF 2009). The presence of the extensive Social Grant system in South Africa has meant that the ‘base’ sits at a higher income level than in other developing markets.

For the purpose of the survey, people with incomes of less than R5, 000 per month were regarded as belonging to the BOP. Alternatively, if income was not provided, then the South African Living Standard Measure (LSM) was used to identify people classified as LSM 5 or below as recommended in the All Media Products Survey (AMPS) 2008B (SAARF 2009).

2.2 Distribution in the BOP

Distribution, the task of getting goods and services into low income markets, is often cited as being one of the biggest challenges in serving BOP markets and can be a major obstacle to overcome for many firms (Anderson and Billou 2007). The developing world unlike the developed world, is often characterised by fragmented or nonexistent distribution channels (Anderson and Billou 2007). This affects the flow of goods into and out of low income markets. Banking is no exception to this challenge as the distribution of banking services is dependent on a range of infrastructural necessities. This negatively impacts on the poor’s ability to generate income and improve their quality of life (Vachani and Smith 2008).

Jenkins et al. (2010) see appropriate innovative technology and partnerships as enablers in expanding reach and distribution in low income markets. Mobile banking may be regarded as such a technology as it expands the reach of banking services to those marginalised from the formal financial system.

Anderson and Billou (2007) describe that companies which are successful and profitable in serving the poor have pursued strategies of experimentation in developing a unique combination of product and service offering. The above mentioned authors describe a 4A’s model of availability, affordability, acceptability and awareness which provides a framework against which innovation in BOP products and services may be assessed. Mobile banking aims to offer availability, affordability and accessibility to its target consumers, this study will test how these attributes are perceived by the end consumer.

3.0 Description of the Innovation

Mobile Commerce (m-commerce) is defined as a business transaction conducted through mobile communication networks or the Internet (Siau and Shen 2003). M-commerce can offer value to consumers by providing convenience and flexibility through time and place independence (Kim et al. 2009, Venkatesh et al. 2003).

Mobile banking is an application of m-commerce which enables customers to access bank accounts through mobile devices to conduct and complete bank-related transactions such as balancing cheques, checking account statuses, transferring money and selling stocks (Kim *et al.*, 2009; Tiwari and Buse 2007). Luo, et al. (2010) defined mobile banking as an innovative method for accessing banking services through a channel whereby the customer interacts with a bank using a mobile device (e.g. mobile phone or personal digital assistant (PDA)). This is also consistent with the definition of innovation in the Oslo Manual (OECD/Eurostat 2005).

There are challenges associated with m-commerce, and specifically mobile banking. Mobile devices with a small screen size, limited screen resolution and an uncooperative keypad may make it difficult for the customer to use mobile banking (Kim *et al*. 2009). Mobile banking is also vulnerable to information and transaction eavesdropping risk, just like other e-commerce applications such as Internet banking (Siau *et al.* 2003).

3.1 Mobile Banking technology solutions

Currently, mobile banking is implemented through three different technology solutions: browser-based applications, messaging-based applications and client-based applications (Kim *et al.*, 2009; Tiwari and Buse 2007).

The browser-based application is essentially a Wireless Access Protocol (WAP)-based internet access (Kim *et al*. 2009). This requires a compatible mobile phone which is WAP-enabled. The mobile phone is used to access banking portals through the Internet.

On the messaging-based applications, the communication between the bank and the customer is carried out via text messages. For example, by using a registered mobile number, the customer sends a predefined command to the bank then uses text messages to conduct transactions with the bank. An example of messaging-based applications is the Unstructured Supplementary Service Data (USSD), which has compatibility with most mobile phones. Existing mobile banking applications based on USSD includes WIZZIT in South Africa (WIZZIT 2005), M-PESA in Kenya and Tanzania (Camner and Sjöblom 2009), M-PESA in South Africa (Nedbank 2010a) and FNB mobile banking (FNB 2010a).

On client-based applications, special software is installed in the mobile phone. An example of a client-based application is what is called the SIM Toolkit standard (STK) (Tiwari and Buse 2007). For instance M-PESA in Kenya uses the STK technical platform (Safaricom 2007; Camner and Sjöblom 2009).

3.2 Mobile banking in South Africa

According to the objectives of South Africa's Financial Sector Charter (BASA 2003), banks are expected to increase effective access to financial transaction services to the low-income segment of the population (LSM 1-5) (SAARF 2009).

In October 2004, the Banking Council of SA announced the launch of the Mzansi account as part of the requirements of the Financial Sector Charter, which regulates the financial services industry (BCSA 2005, BASA 2003). The Mzansi bank account was developed to provide an entry-level account to the poorest segment of the population, which falls into category LSM 1–5 (BASA 2010). By the end of 2005, 1.4 million Mzansi accounts had been opened. This figure increased at a rate of 21% year-on-year to approximately 3.9 million accounts by the end of 2009 (BASA 2010). This was a product innovation targeted to a particular market.

South African banking regulation requires that companies offering mobile banking service are in possession of a banking licence, which has prompted partnerships between mobile companies and financial services firms. The following section outlines the main mobile banking initiatives in South Africa:

3.2.1 M-PESA Money Transfer (Nedbank Cellphone Banking)

M-PESA is a money transfer service which was first introduced in Kenya in March 2007 by Safaricom in partnership with Vodafone (Safaricom 2007). The M-PESA service enables users to deposit, withdraw and transfer money using a mobile phone at M-PESA agents countrywide (Safaricom 2007). The M-PESA application is installed on the SIM card and works on all handset brands. M-PESA is widely used in Kenya and Tanzania (Camner and Sjöblom 2009), it is free to register and the user does not need to have a bank account (Safaricom 2007). This is a clear case of product innovation.

In August 2010, Nedbank and Vodacom officially launched M-PESA money transfer in South Africa (Nedbank 2010b). M-PESA is based on the Unstructured Supplementary Service Data (USSD) technology; it is currently available for Vodacom subscribers (Vodacom SIM card holders and ported SIM cards) (Nedbank 2010b). The registered M-PESA user does not need to have a bank account, there are no monthly fees and no minimum balance is required (Nedbank 2010b).

3.2.2 WIZZIT Cellphone Banking

Another example is the initiative by WIZZIT Bank, a division of the South African Bank of Athens. A WIZZIT cellphone banking system was launched in November 2004 in an attempt to provide solutions to the previously ‘unbanked’ society in SA (WIZZIT 2005). WIZZIT uses the ‘pay-as-you-go’ model, i.e. users pay per transaction (20c per 20 seconds on MTN and Vodacom) and there are no monthly fees (WIZZIT 2005).

3.2.3 Standard Bank Cellphone Banking

Standard Bank, in conjunction with MTN, implemented MTN Banking, a mobile money service which was based on wireless internet gateway (WIG) technology, which the client needed to install on a SIM card (Standard Bank 2005). The cellphone banking services are implemented using two options; the WAP-based option and a new cellphone banking option which works on any type of phone (Standard Bank 2010). To use Standard Bank’s cellphone banking, the user needs to have an account with the bank.

3.2.4 ABSA Cellphone Banking

ABSA has implemented two cellphone banking options; WAP-based (Internet through a cellphone) and WIG-based technology, which is enabled through secure SMSes (ABSA 2010). With the WIG cellphone banking, the banking menu is downloaded to the SIM card, which allows for a convenient selection of transactions and the secure transmission of encrypted information between the cellphone and the bank (ABSA 2010). The ABSA WIG cellphone banking is currently available for Vodacom and MTN subscribers.

3.2.5 FNB Cellphone Banking

FNB has implemented cell phone banking based on the WAP and USSD technology available to all FNB account holders. In addition, FNB has introduced eWallet, which is a money transfer service (FNB, 2010a); as well as Pay Wallet which enables FNB Corporate, Commercial and Public Sector clients to electronically pay their unbanked recipients directly to their cellphones (FNB 2010b). This allows the recipients to have immediate access to their funds at any full service FNB ATM without the need of a bank card.

The examples above illustrate the various different mobile banking options in South Africa. The penetration of these products into the lower income segments is, however, limited. A clearer understanding of the factors which would enhance adoption would be beneficial in order to build scale in the mobile financial services sector.

4.0 Triggers for the innovation

In South Africa, only 40% of people have a bank account (African Executive 2008), yet 90 percent of the population have access to a cell phone (ITU 2009). That ratio is mirrored across the developing world, presenting an obvious opportunity to use mobile technology for expanding financial inclusion.

As well as the strong demand-side ‘pull’ for innovation around mobile banking, there is also a supply-side incentive. Banks in South Africa have built their business models around the needs of a particular market, taking account of the behaviour of middle to high income customers. The branch model is rarely sustainable for a low-income market, given the high costs related to opening and operating a physical presence in often far-flung communities with low population density. Add to that the much lower levels of income at the BOP, and profit margins on a traditional branch model are virtually eroded altogether.

When the Financial Sector Charter was introduced, requiring that banks do more to provide financial services to the unbanked or under banked, (BCSA 2005; BASA 2003), financial institutions in South Africa began to examine different options for reaching the BOP. This was reinforced by a realisation that the mid to high income market in South Africa was largely saturated, whilst the vast lower-income market had yet to be tapped.

The incumbent banks introduced the Mzanzi account, but this met with limited success. The main four banks have all explored options around mobile banking in recent years, due to the significantly lower cost-per-transaction, as well as the ability to reach many more customers whilst reducing overheads.

As discussed above, the main banks are each exploring different approaches to mobile banking, with varying degrees of success. They have yet to reach the unbanked or under banked markets at scale. Measures of the various activities begin to suggest indicators that could be used for monitoring the diffusion of new products and their use by the poor.

5.0 Frameworks and Analysis

This section critically reviews the literature pertaining to mobile banking in a South African BOP context. It discusses a technology acceptance framework for mobile banking and reviews the constructs within the framework, which include perceived usefulness, perceived ease of use, perceived risk, perceived cost and trust. The variables (risk, trust and cost) are added to the extended technology acceptance model (TAM2) (Venkatesh and Davis 2000) to develop a research model to investigate factors affecting adoption of mobile banking by the BOP in South Africa.

Since the late 1980s, technology adoption research has focused on exploring the determinants of users’ intentions to use new technologies. Many theories have been developed to study Information Technology (IT) adoption issues, including the theory of reasoned action (TRA) (Fishbein and Ajzen 1975), the technology acceptance model (TAM) (Davis 1989), the extended technology acceptance model (TAM2) (Venkatesh and Davis 2000), the theory of planned behaviour (TPB) by Ajzen (1991), the innovation diffusion theory (Rogers 1995) and the unified technology acceptance user technology (UTAUT) (Venkatesh et al. 2003).

TAM suggests that perceived usefulness (PU) and perceived ease of use (PEOU) are the two most important factors in explaining individual users' adoption intentions and actual usage (Davis, 1989). Davis (1989) defines PU as the degree to which a person believes that using a particular system will enhance his or her job performance. In addition, PEOU refers to the degree to which the person believes that using the system will be free of effort (Davis 1989).

TAM has been extensively tested and validated and is a widely accepted model, which can be modified or extended using other theories or constructs (Taylor and Todd 1995; Venkatesh and Davis 2000; Wu and Wang 2005; Luarn and Lin 2005; Zhang et al. 2008; Yen et al. 2010).

Venkatesh and Davis (2000) introduced social and organisational factors such as subjective norms, impression, quality of output and work relevance into the TAM model, and proposed the so-called extended TAM model (TAM2).

In a study focused on investigating the drivers of mobile commerce, Wu and Wang (2005) combined TAM2 with Rogers' innovation diffusion theory (IDT) Rogers (1995). The PU and PEOU constructs from the TAM2 model were combined with the 'Perceived risk' and 'Cost' constructs. Wu and Wang (2005) also added the compatibility constructs from the IDT model.

Luarn and Lin (2005) conducted a study in Taiwan, where TAM and the theory of planned behaviour (TPB) by Ajzen (1991) were combined. The study investigated the possible factors affecting the behavioural intentions of mobile banking users. These factors include perceived usefulness (PU), perceived ease of use (PEOU), perceived credibility, self-efficacy, and perceived financial cost (Luarn & Lin 2005).

In a study by Lee (2009) in Taiwan which investigated the factors influencing the adoption of internet banking, the TAM and TPB were integrated, and perceived risk and perceived benefit constructs were added to the research model. Lee discussed the following five antecedents of perceived risk: performance risk, social risk, financial risk, time risk and security risk.

For the purpose of this study, a research model was developed combining relevant constructs from across the literature, which is outlined in Figure 2.2. The model consists of the original determinants of TAM2, which are PU and PEOU as well as the dependent variables Adoption of mobile banking and Actual Usage (AU). It also adds additional determinants from the literature: Perceived Cost, Trust, and the five facets of Perceived Risk, which are each explained in further detail below.

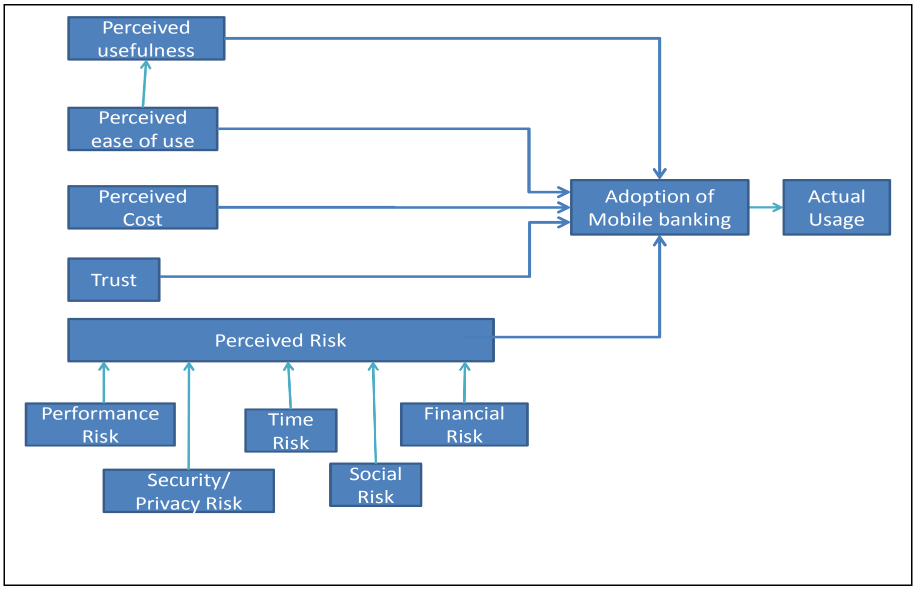

Figure 1: Research Model based on TAM2 with perceived risk, trust and perceived cost

The following section reviews the literature around the additional determinants of perceived risk, trust and perceived cost in more detail.

5.1 Perceived risk of mobile banking

Various studies on consumer perceptions of risks have been conducted in the context of online banking (Tan and Teo 2000; Im et al. 2008; Wu and Wang 2005), but the perceived risk variable has only been modelled as a single construct, which fails to reflect the characteristics of the perceived risk (Lee 2009).

Lee (2009) conducted a study on perceived risk in the context of Internet (online) banking adoption, where risk was divided into five facets (performance risk, social risk, financial risk, time risk and security risk) (Lee 2009). Given the similarities between mobile banking and Internet banking (Brown et al. 2003), these five risk facets were also used for the purpose of this study. As defined by Lee (2009), these five risks can be described for mobile banking as follows.

- Performance risk: refers to losses incurred by deficiencies or malfunctions of mobile banking servers (Lee 2009). According to Littler & Melanthiou (2006), a malfunction of a banking server would reduce customers' willingness to use Internet banking services, and the same applies for mobile banking.
- Security/privacy risk: defined as a potential loss due to fraud or a hacker compromising the security of a mobile banking user. In a similar study, Luarn and Lin (2005) used the construct 'perceived credibility', which is defined as the extent to which a person believes that using mobile banking will have no security or privacy threats. For this study, security/privacy risk will be considered to be similar to a lack of credibility.
- Time/convenience risk: this refers to a loss of time and any inconvenience incurred due to delayed payments or difficult navigation (Lee 2009).
- Social risk: refers to the possibility that using mobile banking may result in disapproval by one's friends/family/work group (Lee 2009).
- Financial risk: defined as the potential for monetary loss due to transaction errors or bank account misuse (Lee 2009).

Lee (2009) and Lee et al. (2007) found that all five risks: security, financial, time, social and performance risks, emerged as negative factors in the intention to adopt online banking. However, social risk was found to have an insignificant effect on the intention to adopt online banking (Lee 2009).

A study by Im et al. (2008) found that when deploying a technology perceived by users to be high risk, managers need to emphasis ‘ease of use’. When deploying a technology perceived to be low risk, managers need to focus on communicating the ‘usefulness’ of the technology (Im et al. 2008).

A study by Tan and Teo (2000) on the adoption of Internet banking revealed that perceived risk is a significant determinant. Brown et al. (2003) applied Tan and Teo's Internet banking adoption framework to the mobile banking context. Brown et al. (2003) found perceived risks to be significant factors affecting mobile banking adoption. However, in their studies, perceived risk was modelled as a single construct (Tan and Teo 2000; Brown et al. 2003).

For this study, all five risk facets will be adapted as antecedents of perceived risk in the research model (as outlined in Figure 2.1). As per the literature review, it is hypothesised that security, financial, time, social and performance risks are more likely to have a negative effect on the adoption of mobile banking.

5.2 Perceived cost

Perceived cost is defined as the extent to which a person believes that using mobile banking will cost money (Luarn and Lin 2005). The cost may include the transactional cost in the form of bank charges, mobile network charges for sending communication traffic (including SMS or data) and mobile device cost.

A study by Wu and Wang (2005) on mobile commerce acceptance showed that perceived cost had minimal significance when compared to other variables such as perceived risk, compatibility and perceived usefulness. A further qualitative investigation on the same study was conducted, which revealed that perceived cost is normally a major concern when a technology is first introduced (Wu and Wang 2005). However, when there is an emergency or sudden need, the utility benefits outweigh the cost issues. The study by Wu and Wang (2005) was conducted on respondents with an average income level of US$650 per month (equivalent to approximately R5000). This income level was regarded as being appropriate, implying that the users could afford mobile commerce (Wu and Wang 2005).

This study however focuses on the BOP context, a population with low disposable income. According to Karnani (2009), people at the BOP have very low purchasing power and are price sensitive. According to Guesalaga and Marshall (2008), the consumption pattern of the BOP in developing countries concentrates mainly on basic needs such as food, housing and household goods; with less spending on information and communication technology (ICT). Therefore, perceived costs should be considered with regards to the adoption of mobile banking in a BOP context.

For this study, perceived cost is included in the research model as having a direct effect on the adoption of mobile banking (as outlined in Figure 2.1). Hence, it is anticipated that the perceived cost of mobile banking services is likely to negatively influence the adoption of mobile banking.

5.3 Trust in mobile banking

Customer trust is recognised as critical for the success of mobile banking. With the surge of both electronic commerce (e-commerce) and mobile commerce (m-commerce), studies have been conducted on the conceptual structure of trust, the formation of the mechanisms of trust and the effects of trust (Bhattacherjee 2002; Kim et al 2009; Kim et al. 2010; Shin 2010).

In a study by Kim et al. (2009) which examined the effect of initial trust in mobile banking user adoption, trust was defined as a psychological expectation that a trusted party will not behave opportunistically. In Kim et al. (2010), trust was defined as a feeling of security and willingness to depend on someone or something.

Kim et al. (2009) further makes a distinction between initial trust and experience or knowledge-based trust. This study will focus on initial trust, as users are less likely to have experience with service providers with regard to the use of mobile banking.

A study by Siau and Shen (2003) classified trust into two categories: trust of technology and trust of mobile banking service providers. This is supported by Lee et al. (2007) in a study that focused on three trust dimensions: trust in bank, trust in mobile network provider and trust in wireless infrastructure.

A study by Bhattacherjee (2002) provided a definition and measurement of the consumer's trust of an e-commerce service provider, based on the three dimensions or typology of trust: ability, integrity and benevolence. Bhattacherjee (2002) defined these as follows:

- Ability refers to the perception of the consumer about the competency and salient knowledge of the mobile banking service provider to deliver the expected service;
- Integrity refers to users' perceptions that the service provider will be fair, honest and adhere to reasonable conditions of transactions;
- Benevolence refers to the extent to which a service provider will demonstrate receptivity and empathy towards the user. The service provider will make a good faith effort to resolve users' concerns and intends to do good to the users beyond profit motives.

For the purpose of this study the three dimensions of trust: ability, integrity and benevolence (Bhattacherjee 2002), will be used, together with trust from the three perspectives of bank, mobile network provider and wireless infrastructure (Siau and Shen 2003; Lee et al. 2007).

To better understand how customer trust influences the adoption of mobile banking, the concept of brand loyalty and customer loyalty is also introduced in this study.

In a study by Lin and Wang (2006), brand loyalty is simply defined as the repetitive purchase of preferred brand products or services. It further defines customer loyalty as a customer's favourable attitude toward the mobile vendor that results in repeat buying behaviour (Lin and Wang 2006). For the purpose of this study customer loyalty will be used. According to Reichheld and Schefter (2000), earning customer loyalty in an online business is dependent on first earning customer trust. A study by Harris and Goode (2004) found that trust is positively and directly associated with customer loyalty for online services. Given that mobile banking is considered an extension of Internet banking (Brown et al. 2003), it is therefore proposed that a customer's trust in a mobile banking service provider is likely to positively influence the adoption of mobile banking.

In conclusion, the literature highlighted various factors affecting the adoption of technology, several of which are regarded as significant for the context of this study. These factors were used to construct a research model. This model was used to investigate the effects of the original determinants of the TAM2 model (PU, PEOU) on the adoption of mobile banking by the Base of the Pyramid (BOP) economic segment in South Africa, as well as the effects of additional determinants: perceived risk, trust and perceived cost.

For this study, the following hypotheses are proposed, assuming a BOP context:

Hypotheses based on TAM2
H1: Perceived usefulness (PU) influences the adoption of mobile banking.
H2: Perceived ease of use (PEOU) influences the adoption of mobile banking.
H3: Perceived ease of use (PEOU) influences perceived usefulness (PU).

Perceived Cost Hypothesis
H4: The perceived cost influences the adoption of mobile banking.

Perceived Trust Hypothesis
H5: Customers' trust in mobile banking service providers is likely to influence the adoption of mobile banking.

Perceived Risk Hypothesis
H6: The level of perceived risk is likely to influence the adoption of mobile banking.
The hypotheses are integrated to the research model as outlined in Figure 3.1.

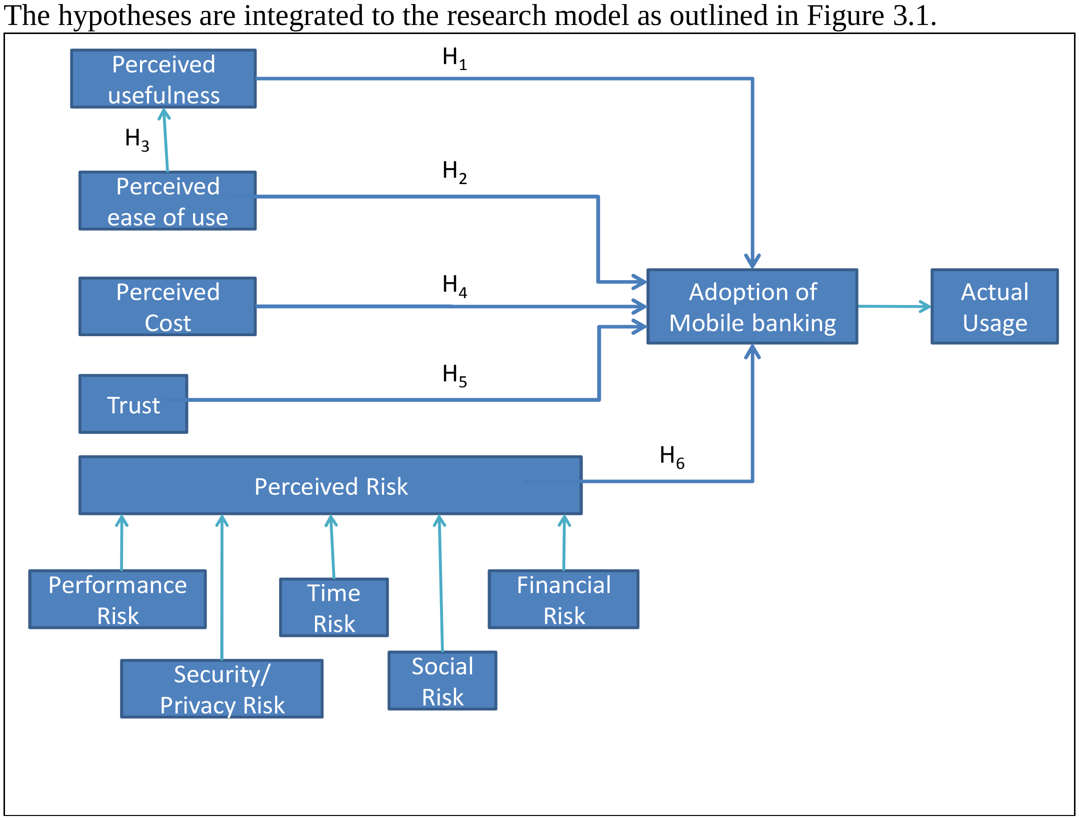

Figure 2: The research model with hypotheses based on TAM2 with the addition of perceived risk, trust and perceived cost

6.0 Methodology

The research followed a quantitative research methodology. Survey questionnaires were used for standardisation purposes to allow for aggregation of results.

The investigation aimed to identify whether the independent variables are statistically significant factors in the adoption of mobile banking. The research established the effect of independent variables, which included perceived risk, trust, perceived cost, perceived usefulness, and perceived ease of use on dependent variables, i.e. the adoption of mobile banking.

6.1 Population

The population was defined as individuals with a mobile phone and a bank account in South Africa, with an income of less than R5,000 per month, or a person in a category not higher than LSM 5, based on AMPS 2008b (as in Appendix A) (SAARF 2009; Chipp and Corder 2009).

According to ITU (2009), over 90% of the South African population has a mobile phone. Mobile banking solutions are compatible and can work on all types of mobile phones (Kim et al. 2009; Tiwari and Buse 2007).

More than 15 million people (over 16 years old) are estimated to be in the BOP economic segment in South Africa (Louw 2008; Chipp and Corder 2009). According to a report by the Banking Council of South Africa, over 3.9 million Mzansi accounts were opened by the end of 2009 (BASA 2010). A total population of mobile phone owners with bank accounts, who fall in the BOP economic segment, is assumed to be more than 500,000.

6.2 Unit of Analysis

The unit of analysis was defined as a mobile phone owner with a bank account in South Africa, with an income of less than R5,000 per month or a person in a category not higher than LSM 5, based on AMPS 2008b (SAARF 2009; Chipp and Corder 2009). To better understand the perception of people at the BOP, the research also included the population within the BOP who do NOT have bank accounts or cell phones. This allowed for comparison of adopters, potential adopters and non-adopters of mobile banking.

6.3 Sampling and size of sample

The sampling method was non-probability judgement sampling focused on informal settlements, rural areas or townships, which qualify as the BOP segment described under unit of analysis. Approximately 450 questionnaires were prepared and circulated. A total of 316 responses were received. Of these, seven (7) responses had to be discarded due to invalid or incomplete data entries. Thus, the sample comprising of a total of 309 respondents was used for analysis.

6.4 Data Collection

A paper based survey questionnaire was prepared and distributed to the intended BOP population, in townships or informal settlements in Gauteng Province, South Africa.

About 99% of the respondents were based in Soweto Township in order to reduce the costs of distributing hard-copy surveys. The remaining 1% of the respondents were based in Tembisa and Midrand.

The operational definition or measurement instrument for perceived usefulness, perceived ease of use and the five facets of perceived risk constructs were adapted from Lee (2009). The measurement instrument for the perceived cost construct was adapted from Wu and Wang (2005). The measurement instrument for the three dimensions of trust: ability, integrity and benevolence, was adapted from Bhattacherjee (2002), and the instrument from the perspective of trust from the bank, network operator and wireless network was adapted from Gu et al. (2009).

A five-point Likert scale was used for the survey.

6.5 Pre-test

A pre-testing (pilot study) was conducted to validate the instrument. It was sent to four respondents in two batches, who were selected on a convenience basis and were asked to comment on length, format, general understanding and wording of the scales.

6.6 Questionnaire

The first section of the questionnaire focused on the respondent’s demographic information, including gender, age, level of education, work status, income level, and whether the respondent had a bank account and mobile phone (Appendix A). The respondents were also requested to indicate whether they currently use mobile banking and the time it took for them to access the nearest bank branch. To verify the respondents’ BOP economic category, respondents were requested to indicate household items they possess in order to categorise them according to LSM (as indicated in Appendix A).

The second section asked respondents about their perceptions of mobile banking, based on the variables in the research model using the 5-point Likert scale from 1 (“strongly disagree”) to 5 (“strongly agree”).

The questionnaire aimed at identifying whether the independent variables were statistically significant factors influencing the adoption of mobile banking.

6.7 Data Analysis

Descriptive statistic (such as mean and frequencies) analysis was conducted on the demographics data. Statistical analysis was conducted on the data collected from the returned questionnaires.

In this study, dependent variables were categorised into three groups; adopters, potential adopters and non-adopters. ANOVA was used to compare the means of the three groups to test for statistical significance at 0.05 level.

Discriminant Analysis was used to determine which independent variables were the best predictors of the dependent variable’s outcome. Of these, the possible outcomes were current usage of mobile banking, interest to use mobile banking in the future or no interest to use mobile banking in the future. A various combination of independent variables, which included perceived usefulness, perceived ease of use, perceived risk, trust, and perceived cost was tested to establish the best combination of predictors.

The Pearson Correlation Coefficient (T-Test) was used to establish the correlation between the selected construct; perceived usefulness (PU) and perceived ease of use (PEOU), and between trust and perceived risk. This test was conducted to establish any possible indirect effect of certain independent variables on the adoption of mobile banking.

6.8 Scale Results

The composite reliability was estimated to evaluate the internal consistency of the measurement model. All the main constructs had Cronbach's alpha above 60; greater than the recommended benchmark of 0.60 (Wu and Wang 2005).

6.9 Limitations

The survey was mainly conducted in historically black-dominated townships and shopping centres close to such townships, limiting variety in terms of race. The survey questionnaire was in English, which may have led to misinterpretation and misunderstanding. The townships in Gauteng Province were urban and more affluent than townships in other parts of South Africa.

7.0 Research Results

7.1 Demographics

The sample largely reflected the age distribution of the South African adult population, and was roughly evenly split between male and female.

The majority of the respondents (71%) had either matriculated or had some high school education. A high percentage of the respondents (37.9%) were unemployed.

A total of 308 respondents (99.7% of the total respondents) had an income level of less than R5, 000, therefore representing the Base of the Pyramid (BOP) economic segment.

Approximately 84% of the respondents had a mobile phone, while approximately 72% of the respondents had a bank account

The majority (66%) of respondents take less than 20 minutes to access the nearest bank branch.

It is clear that these figures are a result of conducting the survey in townships in Gauteng Province which are urban and served by branch banks. The ITU figures quoted in the Introduction showed that 90% of South Africans used a mobile phone, but only 40% had a bank account (ITU 2009). The survey showed that, even with almost all of the respondents having an income of less than R5, 000, and 37.9% being unemployed, they were well educated, 84% had a mobile phone and 72% had a bank account. However the hypotheses posed in Section 5 remain relevant.

Descriptive Analysis Results:

7.2 Current use or intention to use mobile banking services

The results shows that approximately 30% of the respondents used mobile banking services (Group A), with 58% currently not using the mobile banking service, but interested (Group

B). The remaining 12% of the respondents indicated no interest in using mobile banking services (Group C).

About 96% of the respondents who currently use mobile banking have bank accounts. It is interesting to note that about 4% of the respondents who currently use mobile banking do not have bank accounts; they currently use mobile banking for money transfers.

Do you have or use a cell phone?	Yes	261	84%
	No	47	16%
Do you have a bank account?	Yes	224	72%
	No	85	28%

Table 1: Cell phone and bank account ownership

Approximately 63% (114) and 77% (138) of the respondents, who **indicated an interest** in using mobile banking in the future, were in possession of bank account and mobile phone respectively. The remaining 37% (66) and 23% (42) of respondents did not have a bank account and mobile phone respectively; this is a potential opportunity for both the banks and mobile network providers to provide access to bank account and mobile phone services in order to encourage adoption. Of the respondents who indicated **no interest** in the use of mobile banking in the future, 39% (15) and 16% (6) of respondents did not have a bank account and mobile phone respectively. This may be a contributing factor to the lack of interest.

Use of Mobile Banking	No. of Responses	%	Possession of Bank Account	No. of Responses	%	Possession of mobile phone	No. of Responses	%
Yes	91	29.4%	yes	87	96%	yes	91	100 %
			no	4	4%	no	0	0%
No, but interested	180	58.3%	yes	114	63%	yes	138	77%
			no	66	37%	no	42	23%
No, not interested	38	12.3%	yes	23	61%	yes	32	84%
			no	15	39%	no	6	16%
Total	309		yes	224	72%	yes	261	84%
			no	85	28%	no	48	16%

Table 2: Summary and comparison of bank account possession, mobile phone possession and mobile banking usage

7.3 Results and Analysis

The statistical tests showed that all except one of the hypotheses tested were supported by the data. The hypotheses also probe factors affecting the success of innovation.

The analysis of variance (ANOVA) results supported the hypotheses that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are both likely to influence the adoption of mobile banking, while correlation results indicated that perceived ease of use is likely to influence perceived usefulness (Appendix C).

ANOVA tests also supported the hypotheses that perceived cost and customer trust in mobile banking providers is likely to influence adoption of mobile banking (Appendix C&D).

Statistical tests on the data did not support the hypothesis that the level of perceived risk is likely to influence adoption. However the data did show a significant negative correlation between trust and perceived risk.

Discriminant analysis indicated that perceived usefulness and perceived cost were significant predictors of mobile banking.

Perceived usefulness had the highest Mean, and perceived risk had the lowest Mean, as factors affecting the adoption of mobile banking.

No	Hypotheses	Results	Reason
H1	Perceived usefulness (PU) is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 31.15, Pr<0.0001, Alpha=0.05
H2	Perceived ease of use (PEOU) is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 11.83, Pr<0.0001, Alpha=0.05
H3	Perceived ease of use (PEOU) is likely to influence Perceived usefulness (PU).	Supported	Correlation results, Rho=0.59808, Pr<0.0001, Alpha=0.05
H4	The perceived cost is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 11.76, Pr<0.0001, Alpha=0.05
H5	Customer's trust in mobile banking service providers is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 5.29, Pr=0.0055, Alpha=0.05
H6	The level of perceived risk is likely to influence the adoption of mobile banking.	Not Supported	ANOVA results, F value = 0.60, Pr=0.5495, Alpha=0.05

Table 3: Results Summary of Hypotheses

8.0 Discussion of Results

Five of the six hypotheses were supported by the data, consistent with previous literature in most cases (Appendix E).

In the cases of perceived usefulness and perceived ease of use, the research findings supported the literature by showing that both these factors are likely to influence the adoption of mobile banking by individuals at the BOP. The data was also consistent with previous research by indicating that perceived ease of use is likely to influence perceived usefulness – i.e. if mobile banking is perceived by BOP customers to be easy to use, it is viewed as more useful.

The research findings also supported previous literature by suggesting that perceived cost was likely to influence mobile banking adoption at the BOP. Likewise with customer trust: the respondents demonstrated high levels of trust across all three perspectives -- the banks, mobile network providers and wireless infrastructure. This was consistent with the literature, which suggests that customer trust influences mobile banking adoption at the BOP.

The hypothesis around perceived risk was the only case where the data departed from previous literature. The results showed that perceived risk had no significant effect on the adoption of mobile banking by the BOP, and that respondents remained neutral on how they felt about the perceived risk of a mobile banking service. None of the five facets of perceived risk (security, financial, time, social and performance risks) were shown to influence adoption, in contrast to previous studies.

However, the results also showed a significant negative correlation between trust and perceived risk. This implies that when respondents perceived mobile banking service providers as trustworthy, the respondents' perception of risk likely to be lower. Considering that the respondents perceived the mobile banking service provider to be trustworthy (Figure 5.7), this might explain why respondents did not express risk concerns.

To conclude the results section, this research showed that people at the BOP will adopt mobile banking services, which are new or significantly improved services to them, when the value and benefit of mobile banking is evident. People at the BOP will also adopt mobile banking when it is perceived to be easy to use. The easier it is to use mobile banking, the more it will be perceived as useful. Perceived cost and customer trust in mobile banking providers were also shown to be significant factors influencing the adoption of mobile banking in the BOP, meaning that people at the BOP will adopt mobile banking when it is perceived to be affordable and when providers (both the banks and mobile network provider) are perceived to be trustworthy. Customer trust in mobile banking service providers had a direct effect on the customer's loyalty. Trust had a negative significant correlation with perceived risk, and trust can play a role in mitigation of risk. The results show perceived risk had no effect on the adoption of mobile banking services by the BOP.

9.0 Implications for policy and business

This study yielded findings with important implications for both business and policymakers.

The first finding is around the opportunity for banks and mobile providers to reach under-banked or unbanked customers using mobile banking through the offering of new or significantly improved products and providing the market conditions needed to make the innovation work. . The results showed that while only 30% of the respondents are currently using mobile banking, 58% of the respondents are not using mobile banking but have an interest in using it in the future, indicating significant demand for the service.

The research also provides insight for banks and mobile providers into the behaviour patterns of customers in low income markets, revealing that usefulness, ease of use, cost and customer's trust in the service provider, are all critical when introducing services and products to customers to the BOP.

More specifically, this means that mobile banking service providers need to continuously strive to simplify the mobile banking application used for transactions. Their marketing campaigns should focus on demonstrating the simplicity, usefulness and cost benefit of using mobile banking. Furthermore, mobile banking service providers need to build trust with customers, providing secure services and delivering on promises made in marketing initiatives. Crucially, mobile banking service providers need to drive down the costs of mobile banking.

The increased use of mobile banking services will be beneficial to both the mobile banking service provider and the users. The mobile banking service provider will be able to reduce expenditure by limiting dependence on physical bank branches, while users will benefit from reduced travel costs and more free productive time.

The research suggests that policymakers looking to expand financial inclusion and reduce the number of unbanked individuals should consider the benefits of mobile banking, especially given the latent demand among customers at the BOP. A policy response could include the offering of public services through mobile platforms, both to introduce people to a culture of paperless transactions and to educate them for this purpose. Mobile public services would benefit those already engaged in mobile banking and they would provide an entry point for those who were not.

10.0 Conclusion

In conclusion, various studies and real-world case studies point to the power of mobile banking for reaching unbanked or under-banked individuals at the BOP. However questions remain about the behaviour patterns of potential users in low-income communities, and around the factors that might influence the adoption of this relatively new technology.

This research drew on previous literature to construct a research model for testing which factors influence adoption of mobile banking services at the BOP. It found that perceived usefulness, perceived ease-of-use, perceived cost and the level of customer trust in the mobile banking provider were all important factors influencing the take-up of this new technology.
The research indicated the latent demand for mobile banking services, and provided key insights for mobile banking providers and policymakers looking to encourage the spread of mobile banking in order to expand financial inclusion in low-income communities.

The propensity to use mobile phones and then to use them for mobile banking provide some basic indicators which could be produced as part of community profiles to which service providers could respond. Other variables measured in this study, such as trust in and the influence of cost of mobile banking services could be considered for more comprehensive surveys, leading to indicators of use to industry and in support of public policy debate.

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APPENDICES

Appendix A: Survey Questionnaire: Factors affecting adoption of mobile banking
Section A: Demographic details
Please complete the section by marking with a cross (X) the options applicable to your statement.

	User Demographics	Categories	Mark applicable with cross (X)
Q1	Where do you stay? (Provide area & province)	Area:……………………………… Province:………………………	
Q2	**Gender**	Male	
		Female	
Q3	**Race**	Black	
		White	
		Indian	
		Coloured	
Q4	**What is your age?**	…………….years	
Q5	**Work Status**	Employed / Working	
		Housewife	
		Student	
		Self- Employed	
		Unemployed	
		Pensioner/Retired	
Q6	**Income Level**	No income	
		Between: R1 – R999	
		Between: R 1000 – R 1999	
		Between: R 2000 – R 2999	
		Between: R 3000 – R 4999	
		Between R 5000 – R6 999	
		R 7000 and higher	
Q7	**Education Level**	No Formal or Some primary school	
		Primary school completed	
		Some high school or Matriculated	

		Technical/apprentice ship	
		College / University/ Post matric	
Q8	Do you have or use a cell phone?	Yes	
		No	
Q9	Do you have a bank account?	Yes	
		No	
Q10	Time to get the nearest bank (branch)	Less than 20 Minutes	
		Less than 45 Minutes	
		More than 1 hour	
Q11	Do you use mobile banking?	Yes	
		No, but I will use if affordable, trustworthy, other reasons.	
		No, not interested	
Q12	If yes on Q11, What do you use mobile banking for? (Mark with X all applicable)	Buy airtime	
		Check account balance	
		Transfer money	
		Pay store accounts (Pay City Council accounts)	
		Pay electricity	
		Cash withdrawal	
		Others	
		Not Applicable	
Q13	Do you have any of the following at home? (Mark with X whatever is applicable)	Hot running water at home	
		Washing Machine	
		Motor vehicle in the household	
		DSTV	
		Home telephone	
		Vacuum cleaner	
		PC Desktop/ Laptop	

Section B: Five-point Likert Scale Questionnaire

Please complete the following questionnaire on a scale of 1 to 5. 1-strongly disagree, 2-diagree, 3- neutral, 4-agree and 5- strongly agree.

Item	Construct	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q14	I think that using mobile banking would enable me to accomplish my tasks more quickly.	1	2	3	4	5
Q15	I think that using mobile banking would make it easier for me to carry out my tasks.	1	2	3	4	5
Q16	I think that mobile banking is useful.	1	2	3	4	5
Q17	Overall, I think that using mobile banking is advantageous.	1	2	3	4	5
Q18	I think that learning to use mobile banking would be easy.	1	2	3	4	5
Q19	I think that interaction with mobile banking does not require a lot of mental effort.	1	2	3	4	5
Q20	I think that it is easy to use mobile banking to accomplish my banking tasks.	1	2	3	4	5
Q21	Mobile banking services may not complete transaction because of network problems.	1	2	3	4	5
Q22	Mobile banking services may not perform well and process payments incorrectly.	1	2	3	4	5
Q23	When transferring money through mobile banking, I am afraid that I will lose money due to careless mistakes such as wrong input of account number and wrong input of the amount of money.	1	2	3	4	5
Q24	When transaction errors occur, I worry that I cannot get compensation from banks.	1	2	3	4	5
Q25	I'm sure that if I decided to use mobile banking and something went wrong with the transactions, my friends, family and colleagues would think less of me.	1	2	3	4	5

Q26	When my bank account incurs fraud or hacking, I will have a potential loss of status in my social group.	1	2	3	4	5
Q27	Using mobile banking services would lead to a loss of convenience for me because I would have to waste time fixing payments errors.	1	2	3	4	5
Q28	It would take me lots of time to learn how to use mobile banking services.	1	2	3	4	5
Q29	I would not feel totally safe providing personal privacy information over mobile banking.	1	2	3	4	5
Q30	I'm worried about use mobile banking because other people may be able to access my account.	1	2	3	4	5
Q31	I would not feel secure sending sensitive information across mobile banking.	1	2	3	4	5
Q32	I think the mobile phone cost for mobile banking is expensive.	1	2	3	4	5
Q33	I think the access (airtime) cost is expensive to use	1	2	3	4	5
Q34	I think the transaction fee (bank charges) is expensive to use	1	2	3	4	5
Q35	Mobile banking service providers have the skills and expertise to perform transactions in an expected manner.	1	2	3	4	5
Q36	I think my bank have access to the information needed to handle transactions appropriately	1	2	3	4	5
Q37	I think my bank is fair in conduct of customer transactions.	1	2	3	4	5
Q38	I think my bank fair in customer service policies following a transaction.	1	2	3	4	5
Q39	I think my bank is open and receptive to customer needs.	1	2	3	4	5

Q40	I think my bank make good-faith efforts to address most customer concerns.	1	2	3	4	5
Q41	I believe banks are trustworthy.	1	2	3	4	5
Q42	I believe mobile network providers are trustworthy.	1	2	3	4	5
Q43	I believe wireless infrastructure can be trusted.	1	2	3	4	5

Appendix B: Results of the Demographic Characteristics

Demographics	**Categories**	**No of Responses**	**%**
Geographical location	Soweto Gauteng	307	99%
Gender	Male	142	46%
	Female	167	54%
Race	Black	309	100%
Age	16 – 24 years	70	23%
	25 – 34 years	114	37%
	35 – 50 years	110	35%
	Over 50 years	15	5%
Work Status	Working	97	31.4%
	Housewife	13	4.2%
	Student	29	9.4%
	Self- Employed	38	12.3%
	Unemployed	117	37.9%
	Pensioner/Retired	15	4.9%
Income Level	No Income	111	35.9%
	R1-R999	96	31.0%
	R1000 – R1999	34	11.0%
	R2000- R2999	24	7.8%
	R3000 – R4999	43	13.9%
	R5000 – R6999	1	0.3%
Education Level	No Formal or Some primary school	7	2.3%
	Primary school completed	34	11.1%
	Some high school or Matriculated	211	71.2%
	Technical/apprenticeship	15	4.9%
	College / University/ Post matric	32	10.6%
Do you have or use a cell phone?	Yes	261	84%
	No	47	16%
Do you have a bank	Yes	224	72%

account?	No	85	28%
Time to get the nearest bank (branch)	Less than 20 Minutes	204	66%
	Less than 45 Minutes	88	29%
	More than 1 hour	16	5%
Do you use mobile banking?	Yes	91	30%
	No, but I will use if affordable, trustworthy, other reasons.	180	58%
	No, not interested	38	12%

Appendix C: Summary of ANOVA Results

Source (Independent Variable)	**DF**	**DF2**	**Mean**	**F Value**	**Pr>F (at 0.05)**
Perceived usefulness (PU)	**2**	**305**	**4.04**	**31.15**	**<0.0001**
Perceived ease of use (PEOU)	**2**	**305**	**3.82**	**11.83**	**<0.0001**
Perceived cost	**2**	**305**	**3.08**	**11.76**	**<0.0001**
Trust	**2**	**305**	**3.61**	**5.29**	**0.0055**
Ability (facet of trust)	2	305	3.51	8.11	0.0004
Integrity (facet of trust)	2	305	3.72	0.50	0.6095
Benevolence (facet of trust)	2	305	3.61	3.48	0.0320
Perceived risk (PR)	**2**	**305**	**2.86**	**0.60**	**0.5495**
Performance risk (facet of PR)	2	305	2.89	0.73	0.4851
Financial risk (facet of PR)	2	305	2.82	1.43	0.2401
Social risk (facet of PR)	2	305	2.94	1.00	0.3678
Time risk (facet of PR)	2	305	2.51	1.08	0.3416
Security/privacy risk (facet of PR)	2	305	3.06	2.09	0.1254

Appendix D: Overall Results

Perceived usefulness has the highest Mean, and perceived risk the lowest Mean, as factors affecting the adoption of mobile banking.

Variance between the factors

Importance of Factors	**Factors**	**Mean***	**Standard Deviation**
1	Perceived usefulness (PU)	4.04	0.63
2	Perceived ease of use (PEOU)	3.82	0.64
3	Trust	3.61	0.51
4	Cost	3.09	0.78
5	Perceived risk (PR)	2.86	0.66

Mean: where 1= disagree and 5= agree, to be a factor affect the adoption of mobile banking.*

Appendix E: Results Summary of Hypotheses

No	Hypotheses	Results	Reason
H1	Perceived usefulness (PU) is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 31.15, Pr<0.0001, Alpha=0.05
H2	Perceived ease of use (PEOU) is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 11.83, Pr<0.0001, Alpha=0.05
H3	Perceived ease of use (PEOU) is likely to influence Perceived usefulness (PU).	Supported	Correlation results, Rho=0.59808, Pr<0.0001, Alpha=0.05
H4	The perceived cost is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 11.76, Pr<0.0001, Alpha=0.05
H5	Customer's trust in mobile banking service providers is likely to influence the adoption of mobile banking.	Supported	ANOVA results, F value = 5.29, Pr=0.0055, Alpha=0.05
H6	The level of perceived risk is likely to influence the adoption of mobile banking.	Not Supported	ANOVA results, F value = 0.60, Pr=0.5495, Alpha=0.05

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The informal ICT sector and innovation processes in Senegal

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The Informal ICT Sector and Innovation Processes in Senegal

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Abstract
This paper investigates the informal information and communication technology (ICT) sector in Senegal with a view to developing indicators that could be used to improve the understanding of the innovation process. Three approaches are used to gather the information needed for the analysis: a review of literature; a questionnaire to collect data; and, a life story to provide context to the research. The analysis provides examples of innovation in the informal ICT sector and examines the relationship of social factors to these examples. As the informal sector dominates the Senegalese economy, the paper contributes to the understanding of innovation driven economic growth in that sector, and to the factors linked to transition of economic activity from one sector to another.

JEL Code: O31, O33.
Key words: Informal economy, innovation indicators, information and communication technologies, ICT, social

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Figures and tables

Acronyms

ANSD:	Agence Nationale de la Statistique et de la Démographie (National Statistics and Demographics Agency)
CC:	Taxpayer Code
CCBM:	Comptoir Commercial Bara Mboup
CRISES:	Centre de recherche sur les innovations sociales (Centre for Research on Social Innovations)
ICT:	Information and Communication Technology
ILO:	International Labour Organization
IMF:	International Monetary Fund
IPU:	Informal Production Unit
NINEA:	Numéro d'Identification National des Entreprises et Associations (Business and Association National Identification Number)
SMB:	Small and Medium-sized Businesses
SYSCOA:	Système Comptable Ouest Africain (West African Accounting System)
UNACOIS:	Union Nationale des Commerçants et Industriels du Sénégal (Senegal National Union of Traders and Manufacturers)
VAT:	Value Added Tax

1. Introduction

The 1970s saw the beginning of the economic crisis in Africa. A series of programmes and projects was launched across the continent to find a way out of the crisis, under the leadership of the International Monetary Fund (IMF) and the World Bank. However years of drought, and the oil crisis of the 1970s, caused additional problems.

With its colonial heritage, the Senegalese economy experienced destabilisation resulting from its trading economy (based mainly on groundnut farming), set up during French colonisation, making it vulnerable to the instability of international market prices and climate-related hazards. The unstable international context and the failure of the policies implemented up to that time took Senegal to its limit, and it was therefore necessary to change direction and modify strategies. The new strategies were aimed at setting the economy back on its feet, but paradoxically they had serious social consequences and aggravated the problems.

Structural adjustment programmes resulted in the devaluation of the CFA Franc (financial adjustment) and at the same time, changes in some labour-related legal provisions did not produce the expected results in Africa, as a whole, and in Senegal in particular. The problems of unemployment, poverty and dependence grew.

The extensive deregulation of the economy that resulted from this reduced the vulnerabilities of the Senegalese economy, but it also had negative repercussions on poverty and employment. Privatisations and drains on public expenditure resulted in cuts to social budget, putting a large number of Senegalese people out of work.

The disengagement imposed on the State and its very limited intervention in the daily lives of the population completed the process of a succession of crises creating very difficult economic and social conditions for the country and its population. This situation put the population in circumstances that demanded self-reliance, giving rise to so-called *informal activities*. Implicit during the 1970s, this informal sector, defined as *unstructured* by the International Labour Organization (ILO), has grown in Senegal to the point of competing with today's modern sector. At present, it is a very important component of the Senegalese economy. For more than two decades, the informal sector's contribution to GDP has always exceeded that of the modern sector (see Annex 1) and a significant proportion of the population currently lives on what have been referred to as odd jobs and casual work. Initially perceived as a temporary anomaly, the informal sector has been able to establish itself firmly within society and the economy. Its social legitimacy is no longer contested. It may be fraudulent for some people, in breach of all or part of the legislation for others, but the informal sector has become a sector in its own right, acknowledged on its merits for reducing unemployment, promoting a spirit of enterprise and solidarity, producing goods, providing services at affordable prices, and creating wealth. Today, the informal sector is recognized as playing an important role in the national economy but, above all, it is instrumental in improving living conditions. It is characterised by ingenuity and a highly developed spirit of enterprise.

Given the importance of the informal economy in Senegal, this study sets out to answer the following questions.

- What are the adaptation mechanisms of the informal sector in Senegal?
- What are the innovations in this sector and what are the processes?
- How are these innovations integrated into the Senegalese market?

An objective of answering these questions is to understand the innovation process in the informal sector in Senegal and to understand the mechanisms and procedures used for validating the sector and integrating it into the Senegalese market. The questions are important as the sector has not been studied from the perspective of the role of innovation and its contribution to informal economic activity. This approach also emphasizes both innovative and entrepreneurial activities and the need to understand their contribution.

The informal sector in Senegal includes many industrial activities and this study is restricted to those related to information and communication technology (ICT) goods and services, largely because of the significant growth in this area in recent years. Having chosen the activity to study, the approach has been to examine the processes of innovation that enable people engaged in these activities to survive on the market and even become leaders in some areas.

2. Informal sector concepts and definitions

The concept of an *informal sector* was introduced by Keith Hart (1973) in a study on Ghana in 1971 and came to public attention in 1972 in the report on Kenya drafted under the World Employment Programme sponsored by ILO since 1969. The first definition was laid down in 1976 by ILO: "this is a sector consisting of businesses employing fewer than ten people, free of any administrative and legal regulation, employing family labour, working flexible hours, having recourse to informal credit facilities and manufacturing end products, as opposed to intermediate products" (BIT 1976).

The informal sector was widely discussed in the economic and sociological literature, and since it represented an important and growing part of employment in developing countries, an operational statistical definition was proposed during the 15th International Conference of Labour Statisticians in 1993. This finally resulted in an international recommendation for a statistical definition of the informal sector.

The informal sector may be broadly defined "as consisting of units engaged in the production of goods or services with the primary objective of generating employment and incomes for the persons concerned. These units typically operate at a low level of organisation, with little or no division between labour and capital as factors of production and on a small scale. Labour relations - where they exist - are based mostly on casual employment, kinship or personal and social relations rather than contractual arrangements with formal guarantee" (BIT 1993a).
This was followed by a statistical definition, according to which "the informal sector is regarded as a group of production units which, within the System of National Accounts, form part of the household sector as individual enterprise."

The initial elements of the definition (and in particular the reference to the characteristics of the economic unit and not those of the individual) indicate why the definition related to the *informal sector* and not *informal labour*. The aim of the international definition was to fit the informal sector into the System of National Accounts in the *household* institutional sector, and not within any *dualist* framework. Walter (2006)put forward the idea that specialists are divided between two approaches:

- The informal sector: set of informal economic activities
- Informal activity: transverse approach to the economy, according to the definition laid down by ILO.

The plethora of studies and theories available indicates a variety of characteristics attributed to this sector of activity. The definitions proposed evolve over time, but they also vary from theory to theory and from one author to another. In 1972, the Kenya Report had already proposed a multi-criteria definition consisting of the seven criteria below:

- Ease of access to the activity;
- Use of local resources;
- Family ownership of the enterprise;
- Small scale of operation;
- Labour-intensive techniques;
- Skills acquisition outside the formal schooling system;
- Unregulated and competitive markets.

Sethuraman (1976) increased these criteria to fifteen, with the approval of ILO. However, it is worth noting that rarely does an informal activity satisfy all these criteria at a given time.

The sociologist, Abdoulaye Niang, has put together a more exhaustive definition of the informal sector: "The informal sector consists of all trading activities, production of goods, commercial value services and savings, credit transfer and resource distribution associations, all on a scale, whether large or small, that partially or wholly sidesteps the legislation and/or predominant norms that govern activities and practices of the same category" (Niang 1996).

This definition identifies the informal sector in contradistinction to the formal sector, using the terms *legislation* and *norms*. It means that the informal sector encompasses any activity that is developed aside from the established rules for structuring the sector of the economy, and hence its *illicit* nature. If it is illegitimacy that most often initially defines informality, it is important to know what laws or aspects of the law are not complied with.

For Bruno Lautier (1994), "it may be laws relating to the payment of taxes or social security contributions, laws governing working conditions, health and safety, laws delimiting spaces in which the activity can be exercised, ground occupancy plans, etc."

Others would add unfair competition, tax fraud, the black market, corruption or theft of public property (taken less and less seriously nowadays). However, non-compliance with the rules as a criterion for deciding whether an activity is informal must be systematic, and not occasional or circumstantial. Faced by a multiplicity of registration procedures, it is difficult for some participants to register on all the regulatory lists.

In view of this difficulty in pinning down its nature, some authors refuse to grant the term *informal sector* the status of a theoretical concept (De Miras 1990, Lautier 1994). More recently, Godfrey (2011) has reviewed the definitions of the informal economy as a step towards the development of a theory.

Furthermore, the activities of the informal sector are varied and differ in size, nature, open-endedness, etc. Gabriel Boissy (1997) typifies them in three categories.

- The subsistence informal sector and refuge of the poor: laundry workers, domestic servants, hairdressers, small repairers, tailors, blacksmiths, part-time drivers and apprentices, street sellers, window dressers, etc.
- The transition informal sector: using conventional equipment and technology for producing goods and services with a high trading value and including arts and crafts, such as photography and jewellery, building crafts, localised commerce at street markets and shops, etc.
- The modern informal sector, or that of the well-off in the informal sector: activities in this category have the stamp of Small and Medium-sized Business (SME) but their partial or total reluctance to comply with the administrative and legal requirements keeps them within the informal sector (production of crafts, art and buildings, large traders, transporters, etc.).

Two ways of conceiving the informal sector have been proposed. The first considers a large sector, relatively well-integrated into the rest of the economy and based on a competitive framework. In contrast, the second is more restricted, with little integration and mainly based on subsistence.

After reviewing these widely diverse definitions of the informal sector, a decision was taken to adopt an operation definition to guide the case study. This is the definition proposed by the National Statistics and Demographics Agency of Senegal (ANSD). It defines the informal sector as "all the production units with no statistical number and/or no formal, written accounting". The criterion of written accounting was introduced in order to avoid excluding from the investigation those production units that for wholly contingent reasons have a statistical number (NINEA: Business and Association National Identification Number), but still cannot be considered formal units (in terms of their organisation and production methods) for which the keeping of accounts is a good indicator. So, units with a NINEA, but no written accounts are considered as informal.

This choice seems more relevant for assessing the power and macroeconomic role of the informal sector in its interrelations with the Senegalese production system. In particular, it allows to reintegrate the informal sector in a disciplined manner into the System of National Accounts, within the privileged domain of macroeconomic analysis.

Among the various administrative registers in force in Senegal, the NINEA and the taxpayer code (CC) have been chosen insofar as any productive activity must by law have been assigned these numbers. They are required for satisfying a number of institutional obligations and are prerequisites for access to certain administrative functions (taxation, social security, etc.).

3. History of the informal sector in Senegal: social and economic role

The informal sector is a worldwide phenomenon, and not restricted exclusively to developing countries. The workforce of the informal sector is continuously increasing and introducing new characteristics: rural workers moving to the city, people deprived of an education, the former unemployed, those affected by staff cuts in the modern sector and even modern sector personnel who opt to take on more than one job.

Senegal has one of the biggest informal economies in sub-Saharan Africa. As the leading employer in the country, the informal sector drives the economy. Indeed, between 1995 and 2004, it generated 97% of the jobs in Senegal, where unemployment and underemployment affect more than a quarter of the population (World Bank 2007).

The workforce in Senegal’s informal sector, estimated at 161,000 in 1960, grew to 475,000 in 1980, 638,000 in 1991 and one million in 1996. In the second quarter of 2003, there were 281,600 informal production units (IPU) in the Dakar region, employing 434,200 people in non-agricultural trading, i.e. approximately a quarter of the population of Dakar. Today, Senegal’s economically active population amounts to some four million people, but only around 300,000 are registered with the Social Security department, ample evidence of the fact that the majority of businesses are informal.

Thus, millions of Senegalese people excluded from the formal economy have to rely on a less conventional economy, which has proved to be more dynamic and better suited to their distributive logic. Today, the informal sector employs 60% of the economically active population.

This sector has developed a great deal over the last two decades and some of the business that began informally have now become players on the international market. This is the case for Comptoir Commercial Bara Mboup (CCBM), which has been in existence for 25 years and works in partnership with the South Korean company, Samsung CCBM.

In 1993, the government tried to force informal workers to pay value added tax (VAT). They refused, explaining that they had no legitimate accounts comparable with those of legitimate businesses. It was therefore impossible to determine the sum to be paid to the State. Three types of tax, especially suited to their method of working, were therefore created: clearing tax, business tax and flat-rate tax.

The government tried to lever informal work into a more conspicuous position, in administrative terms, by putting in place programmes and structures to organise and register it, thereby broadening the fiscal base. Furthermore, informal sector workers and employers organised themselves around trade union structures to increase their productivity. There are now some twelve trade unions in Senegal, the largest of which is the National Union of Senegalese Traders and Manufacturers (UNACOIS) with a membership of 100,000.

There is a duality between the informal sector and the so-called modern sector. The two are both partners and competitors in a complex Senegalese market, where demand is diverse. They are in partnership because some legitimate local industries need intermediaries to redistribute their merchandise. The informal sector has a national distribution network. In addition, some companies subcontract some of their work to informal employers. The aspect of competition relates mainly to imports. The effectiveness of informal networks abroad results in the import of new products, a considerable advantage for expanding the customer base.

The statistical data available on the Senegalese informal sector, although incomplete, show how important it is in terms of the labour market and the significant contribution it makes to national wealth. The few qualitative assessments that have been made of its structure seem to indicate that it has a fully developed organisational capacity and an ability to adapt, making it a dynamic and often competitive player in the domestic market.

The most valuable advantage in the eyes of the Senegalese population is the proximity of the informal sector. It follows social demand and adapts to it. For instance, it offers mobile telephone services in the most remote parts of the country. Other advantages include its offer of lower prices for products of practically identical quality to those of legitimate businesses. Furthermore, the informal sector anticipates the requirements of the population. Indeed, there is a strong Senegalese diaspora in the United States and Europe. These people send home high-tech devices that need to be repaired when they develop faults. It could be said that the informal sector develops support facilities even before a product is widely market in Senegal. It has a capability for innovation that even the modern sector lacks.

4. The informal ICT sector in Senegal

The informal ICT sector has seen spectacular development throughout Africa and particularly in Senegal. The pace at which these technologies are being distributed is very fast, rising from an average of 44% in 2002 to 64% in 2007, representing net growth of 20% over this period.

Table 1 Changes in ICT indicators in Senegal between 2002 and 2007

Indicator	**2002**	**2007**
Fixed lines per 100 inhabitants	2.1	2.2
Mobile telephones per 100 inhabitants	5.1	29.3
International bandwidth per user (bit/s)	752	2079
Proportion of households with home computers	1.7	7.8
Proportion of households with Internet access	0.5	1.0

Source: International Telecommunications Union (2008)

This table illustrates the diversity of ICT developments in Senegal. Although all indicators rose between 2002 and 2007, the growth in mobile telephones significantly outstripped all other areas, and explains why ICT-related activities in Senegal are centred on mobile telephones.

The informal ICT sector in Senegal is mainly involved in activities related to the mobile telephone, whether provided locally or at a distance.

It should also be borne in mind that mobile telephones form the ICT subsector which has boomed in Africa, with the possibility of expansion into rural areas, even though coverage is still low, opening up new markets and new business opportunities to the Senegalese informal sector, acknowledged for its extensive capacity to adapt to social demands.

In Senegal, the three mobile telephone operators (SONATEL, TIGO and SUDATEL) are working increasingly with the informal sector, especially for marketing their products. These three operators have succeeded in providing coverage for the entire national territory. At present, in all areas in Senegal (urban and rural), the population is equipped with mobile telephones and has a network enabling it to communicate with the rest of the world.

Senegal is engaged in a struggle to reduce the digital divide. This has facilitated ICT development in our country, but has also given rise to and boosted the development of the informal ICT sector, and activities in this sector are numerous and diverse.

Table 1 shows that there is a growing number of mobile telephone, computer use and internet access. Table 2 provides a categorization of the activities in the informal sector and this study finds that people interviewed in the informal ICT sector where involved in providing hardware and related services. To a lesser extent, they were engaged in the manufacturing of good.

Table 2 Suggested categorisation of informal ICT sector activities

Sector	**Telecommunications**	**Computers/internet**	**Digital audiovisual**
Primary	N/A	N/A	N/A
Secondary	Production of goods and equipment	Antenna manufacture	Assembly of computers and peripheral devices
Tertiary			
Commerce	Sale of computer accessories	Sale of accessories	Sale of accessories
	Sale of recharge cards	Sale of computer hardware	Sale of audiovisual equipment
	Sale of telephones and accessories	Sale of software and firmware	TV programme distributors
Services	Sale of telephones	Advisory services	Sale of CDs, VCDs, DVDs
	Access (call centres, cyber centres, call boxes)	Office electronics (photocopies, data input, scanners, downloads, burning CDs, etc.)	
	Call centres		
	Hardware repairs	Hardware repairs	Hardware repairs
	Antenna installation		
	Mobile phone decoding	Networking and wiring	
	Maintenance and servicing	Maintenance and servicing	Maintenance and servicing
	GMS telephone chargers	Application developers and website designers	
	Fleet collectors-payers	Webmaster	
	Training courses	Training courses	Training courses
	Advisory services	Advisory services	Advisory services
			Audiovisual productions
			Video libraries

Source: Yam Pukri (2009)

5. Research methodology

The aim of this research was to verify the following hypotheses:

- The informal ICT sector in Senegal is based on proximity and adaptation to community living conditions;
- In common with the Senegalese informal sector in general, the ICT sector has first and foremost a social role.

The study was conducted in a number of stages and should support the creation of indicators that could be used to improve the understanding of the innovation process in the Senegalese informal sector. It should also permit the understanding of the informal sector's capacity to adapt within the Senegalese economy and to examine the innovation process in the informal sector, in order to obtain greater detail on the characteristics that innovative businesses have in common and what differentiates the innovators.

Innovation in the informal sector in general and in the ICT subsector in particular should be understood by means of a methodical approach that best reconciles a number of analysis paths, since such complex facts cannot be explained by a single phenomenon. In order to improve the analysis the combinations of three different approaches have been used: review of the literature, survey and life story.

Review of the literature

To achieve the objective of gaining a better understanding, a review of the relevant innovation literature has been conducted (African Union 2010, Gault 2010, Kraemer-Mbula and Wamae 2010, OECD/Eurostat 1997, 2005), adopting a generalised approach at the outset, followed by a more in-depth and detailed study compared to the research topic, with questions likely to lead to research and produce new knowledge. The innovation review complemented the review of literature on the informal economy already discussed in Sections 2 and 3.

Researching the documentation was of primary importance to this study. It permitted to refine the research topic and more precisely direct the study. Since there is practically no university research documentation in Senegal, the search was extended. Libraries, documentation centres and scientific information services likely to shed some light on the study topic were visited in person or electronically.

Indeed, the reading has provided a clear overview of the informal sector in Senegal, and a more detailed picture of the ICT subsector. The new information and communication technologies were a great help in obtaining additional information.

Survey

The first phase of the survey was exploratory. Information was collected at ANSD, at the departments in charge of the informal sector and within the Informal Production Units (IPU) themselves.

It was necessary to establish relations of trust with members of the informal sector in order to create appropriate conditions for obtaining as much information as possible from the people targeted. In order to understand innovation in the informal ICT sector and assess its adaptive potential, it isn't enough to know how things are organised and who the players are. What is of primary importance is how the players in this sector perceive innovation. In this way, the information gathered and the initial contacts established enabled to adopt a snowball sampling method, since the ANSD does not have a database on informal production units.

After preparing data gathering tools, it is necessary to test them before putting them to effective and systematic use, in order to ensure that they were suitable and sufficiently precise, and would enable to gather useful information. Thus, the preliminary survey led to the revision of the questionnaires and a restatement of the research questions and hypotheses to arrive at those given in Section 1 and in Section 5.

The questionnaire (see Annex II) was applied in a specific manner to the actors in the informal ICT sector and commerce. It consists of six parts, relating to the:

- Respondent
- Creator of the IPU
- Nature and structure of IPUs and their activities
- Work organisation
- Trading and marketing
- Partnership

Sampling

First, the sites at which the ICT-related IPUs were located in Dakar have been identified, where almost all the IPUs in Senegal are located. This initial work enabled us to identify the following sites:

- Alizé market
- Sandaga market
- Colobane market
- Pikine market
- Grand Yoff market
- Parcelles Assainies market

All these sites exhibit tight-knit groups of IPUs specialising in ICT (sale, repair, decoding, networks, telecommunications, etc.).

Then the snowball sampling method was applied to the survey: the people interviewed were used as sources for identifying other IPUs. A person of interest was asked to complete the questionnaire and then asked to recommend other people likely to be suitable for the study. This method was justified by the fact that, within this culture, all the players know one another and in particular, each one acknowledged the specialists in each field. To make sure that our sample included individuals who really carried some weight in the sector and were of direct interest to this study a number of 100 IPUs has been selected.

Life story

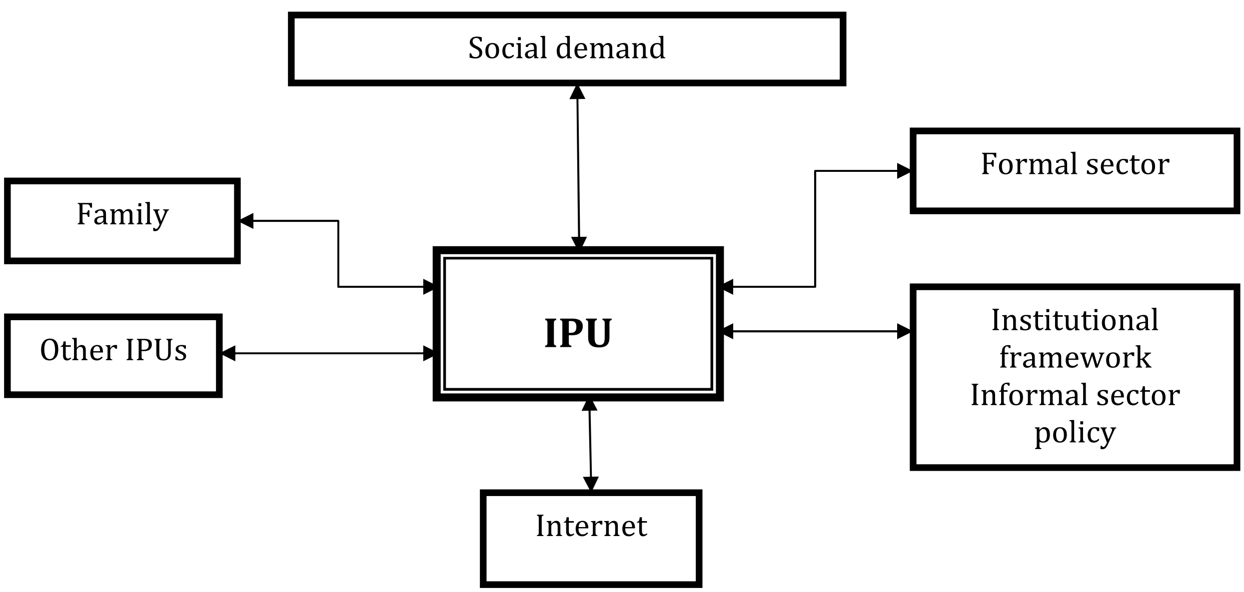
As the ideas became clearer and the hypotheses took shape, it seemed logical to synergise both qualitative and quantitative information, and for this reason the life story method has been added.

It allowed understanding the perceptions and opinions of key participants in respect of innovation within the sector and how the actor saw his role and requirements within the system.

Analysis model

The exploratory phase of this study led to a logical framework and a specific analysis model. From this point onwards, the innovation in the informal ICT and trading sector has been treated as satisfying specific social requirements. From the choice of activity through to customer relations and methods of organising the work, it can be seen that different strategies are used, according to the objectives. In other words, the innovation in the informal ICT and trading sector could simply be considered within the framework of a process involving a multitude of factors and realities, the outcome of which was to underline the effect of social demand in boosting growth. Identifying the variables highlighted the relationships between them. The phenomenon, that it’s to understand here, is the process of innovation in the informal sector of ICT and trade. However, it could not be discerned in isolation from reality and the role that the sector seemed to be playing, but above all from the meaning that the actors in this sector attribute to it. Innovation is a multi-dimensional phenomenon that can be explained only by a wide range of factors. It was therefore conceivable that the accumulation of factors would ensure that we would better understand this phenomenon. This is why, in addition to the technological, financial and human factors involved in innovation, it necessary in this case to add the social dimension to better understand the phenomenon under investigation.

Figure 1 Analysis model



6. Analysis and interpretation of survey results

Description of participants

The survey results permitted the identification of the various players in the informal sector, involved in ICT. They are mainly the IPUs, the formal sector, the State and the social group. In this study, the formal sector combines all the businesses that satisfy the regulations and laws governing the sector of the economy, as well as the State, consisting of the government and its agencies, on the one hand, and the local communities and the services they offer on the other. As for the social group, it combines the family and relatives, religious associations and the district. The social group is a set of people with common characteristics or common goals.

Characteristics of Informal Production Units (IPU)

The informal ICT sector in Senegal is predominantly male. This is shown extensively in this study. In fact, 94% of the IPU respondents to this survey were male. Since the population of Senegal is predominantly female (52%), these results cannot be interpreted as representative of the Senegalese population. It does not mean that women play almost no part in the informal sector, but rather that they specialise in other sectors, such as trading food products, selling garments, etc. The informal ICT sector remains for the present a very masculine domain.

The informal sector is above all a survival sector. People enter it primarily to find a job. Self-employment is the key expression for participants in this sector. The table below shows how the people surveyed are distributed in terms of their positions in the IPU.

Table 3 Distribution of respondents according to position in the IPU

Position	%
Junior employee	20.0
Technical manager	10.0
Administration	11.0
General manager/manager	57.0

The majority of respondents (57%) were general managers/managers of IPUs. Other positions in the IPU are junior employee (20%), technical manager (12%) and administrative staff (11%).

IPUs were generally personal achievements. Thus, 43% of IPUs were set up by the respondent. This backs up the thesis that self-employment is predominant in this sector. The individual sets up the activity and manages it. The IPUs are the products of the efforts of one person.

Table 4 IPU creators

Creator	Yourself	A friend	A cousin	Your father/ mother	A third party	Your brother/ sister	The family	Your uncle/ aunt	Associates
%	43.0	4.0	4.0	7.0	7.0	8.0	3.0	5.0	19.0

IPUs are very characteristic of the family, representing 27% of creators as shown in the table above. Another dimension to be taken into account is associates who set up IPUs employing the members of the association. This represents 19% of creators.

The informal ICT sector largely consists of young people which are consistent with a median age in Senegal of 18. The specific nature of the activities generally demands a certain level of knowledge of ICT and young people are often better suited to working in this sector, especially since older people are generally poorly educated.

Furthermore, IPU creators are mostly male (90%), backing up the idea that the informal ICT sector is a predominantly male domain. 46% of them have monogamous marriages.

Table 5 Distribution of IPU creators according to marital status

Marital status	%
Married, monogamous	45.5
Married, polygamous	18.2
Single	34.3
Divorced	1.0
Widowed	1.0

The fact that most players in the informal ICT sector are very young means that there is a high proportion of single people (34%). In this very young population, most people were in the 15-30 year age group.

The dominant ethnic group in this sector is the Wolof, at 57%. They are followed by the Poular at 18% and the Serer at 10%. The other ethnic groups that we found were the Diola and the Mandingo. These actors were natives of Dakar (28%), Diourbel (25%) and Louga (12%).

The working language is Wolof (98%). This is justified by the fact that the majority of actors are Wolof, and also originate from the locality in which Wolof is the most widely spoken language, i.e. Dakar and central Senegal. However, one should also point out that these IPU participants speak other national languages (Poular, Serer, Diola, Mandingo) as well as foreign languages (French, Arabic, Spanish and Italian).

Table 6 Distribution of IPU creators according to religious affiliation

Religion of UPI creator	%
Tidiane	23.2
Mouride	52.5
Layenne	2.0
Catholic	4.0
Muslim, no affiliation to a sect	18.2

In Senegal, the informal sector is known for its assimilation into the Mouride community. They form a majority in this sector. The results of the study do not contradict this. Creators of IPUs are generally Muslim (95.9%), including 52.5% from the Mouride Brotherhood. Founded at the beginning of the 20th century by Cheikh Ahmadou Bamba, Mouridism developed in Senegal and spread throughout Africa and the other continents. The Mourides, forming approximately 25 % of the population, are now the most influential religious community in Senegal, if not in the whole of West Africa, and play a very important economic and political role (Brisson 2008, Dowden 2008).

The levels of education of IPU creators are as follows: Koranic school (51%), general secondary school (34%) and primary school (15%). Creators of IPUs generally go from Koranic school to the French school and are finally employed in the sector.
None of the IPUs visited had NINEA registration or an accounting compliant with the West African Accounting System (SYSCOA).

How IPUs operate
IPUs are well-known for their particular mode of operation. Human, financial and technical resources are managed based on a form of logic that is different from bureaucratic logic.

Table 7 Distribution of work in the IPU

Criteria	%
Skill	33.3
kinship	30.0
Friendship	24.4
Age	12.2

In most cases, work is distributed on the basis of strictly social criteria (kinship and friendship 55%). Skill remains the criterion of choice (33%). Distribution based on age related criteria is also used, although in only 12% of cases of the study population. This shows that the way the UPI operates is very much determined by social factors. Senegalese society is still very tied to social cohesion and respect for elders in all fields.

The different phases in setting up an IPU are financing, equipment acquisition, cooperation and target market identification. Once the activity has been launched, it operates all the year round. Some periods of the year can be considered propitious for IPU activities. These include religious festivals, religious events, new year, return to school, weekly markets and school holidays. These periods are capitalized on in various ways:

- Purchase of new equipment;
- Purchase of increased quantities, especially of second-hand products;
- Work reorganisation, increasing working hours, diversifying activities and changes in working hours;
- Lowering of prices;
- Forming many relationships outside the framework of commercial activities;
- Importing spare parts and assembling them;
- Purchasing the maximum number of products and then slashing prices;
- Purchasing computer products and turning them over rapidly at low profit;
- Ordering telephones and reselling them in exchange for mobiles that need repair;
- Bringing in a new product to attract customers;
- Delivering devices on time and cutting the prices of services;
- Bringing in extra staff, using members of the family;
- Setting up a computer system for handling sales;
- Selling fast-moving products, such as CDs.

Methods of remuneration in IPUs vary widely and most often depend on the creator of the activity, but are also affected by how the activity develops.

Table 8 Remuneration in the IPU

Mode	%
Monthly	27.8
Weekly	1.1
Daily	5.6
Irregular	65.6

Remuneration in UPIs is generally irregular (65%). Since the activity is usually precarious, remuneration is dependent on an income which fluctuates and is unstable. This is particularly true of IPUs that handle repair work, decoding, maintenance and servicing. IPUs handling sales pay on a monthly basis (28%).

Methods of remuneration also vary. There are three methods of remuneration: commission-based, quota-based or monthly wage.

Table 9 Methods of remuneration in IPUs

Payment method	%
Commission	46.7
Quota	30.0
Wages	23.3

Identifying IPU activities

The survey results show that IPU activities in the field of ICT are varied and manifold. These activities relate mainly to:

- Sale of recharge cards and telephones;
- Maintenance and servicing of computer systems;
- Decoding mobile telephones;
- Sale of computer hardware and office electronics;
- Sale of audio-visual equipment;
- Sale of CDs, VCDs, DVDs;
- Repairs;
- Services.

The predominant activity of those listed above is the sale of recharge cards, telephones and accessories (41.2%). Mobile telephone decoding and repair are also handled (24% of IPU activities). Note than an IPU can exercise more than one activity at a time.

In addition, 83% of the IPUs surveyed had been in existence for 10 years or more. This fits in with the fairly recent development of the ICT sector in Senegal, which dates from the beginning of the century.

Source of information for IPU activities

The main source of information for the IPU on setting up its activities remains the market, or in other words, the needs of society. These needs therefore determine the proposed activity. For instance, many people set up ICT-related activities (mobile telephone, internet, decoding, telephone accessory sales, etc.) because it is an area that has seen strong growth over a few years and provided jobs for many unemployed people.

Table *10 Sources of information for setting up an IPU*

Source	%
Family	22.2
Market	56.6
Religious associations	5.1
Business culture	2.0
Community living conditions	4.0
Internet	10.1

In Senegalese society, setting up a business is synonymous with taking control. The idea can originate from anywhere, but the objective remains the same. Inspiration comes from society and experience.

Setting up an IPU is often motivated by a number of factors, such as market demand (31.3%), something to do (20.2%), advice from a third party (17.2%) or simple imitation (15.2%).

Table 11 Idea for setting up the IPU

Motivation	%
Market demand	31.3
Social demand	9.1
Something to do	20.2
Advice from a third party	17.2
Imitation	15.2
More freedom	7.1

Material and financial resources for the IPU

In order to exercise its activities, the IPU needs material resources. Depending on the size of the IPU and the activities it exercises, the material resources it uses are mainly the telephone (77% of respondents), computer (57% of respondents), toolkit (38% of respondents), printer (22% of respondents), photocopier (22% of respondents) and scanner (17% of respondents).

Investments in terms of equipment for the IPU are mainly related to acquiring machinery, hardware and software.

These activities are generally carried out in a workshop (30%), shop (24%), kiosk (16%), market stall (13%) or in the street (11%).

IPU activities are generally financed from own funds, family resources and “tontines”. Some IPUs resort to savings and credit schemes run by banks and religious associations to finance their activities, but the numbers are not significant.

Table 12 Sources of IPU financing

Source	%
Own resources	88.9
Family resources	5.1
Tontines	1.0
Mutual savings and loan associations	3.0
Banks	1.0
Religious associations	1.0

Thus, one can see that IPUs are mainly dependent on the creator’s own resources and to some extent on family resources. The way in which IPUs operate is not always compatible with working with banks, which are formal structures with strict rules. The size of an IPU and its level of resources do not allow it to conduct transactions with the banks. Therefore, over and above their own resources, creators of IPUs can only count on family funds to sustain their activities, linking them even further to family and social factors.

Links and obstacles

This section gives an overview of the relationships among those involved in the sector, and the main obstacles they confront.

Links

IPUs maintain relations with the modern sector, the State and naturally with the social group. However, it is important to stress the fact that the majority of IPUs (93%) do not belong to a network. In terms of partnerships and cooperation, their main partners are in the informal sector (53%).

Table 13 Distribution according to IPU partners

Partner	%
Informal sector	6.0
Modern sector	8.0
NGO	1.0
Religious association	9.0
No partners	23.0
Family	6.0

Relations with customers and suppliers are based on trust, as well as work.

Table 14 Relations with customers and suppliers

Type of relation	Customers (%)	Suppliers (%)
Trust	76.0	45.0
Work	13.0	42.0
Family	7.0	9.0
Place of origin	4.0	4.0

Table 14 shows that relations in the informal ICT sector are based fundamentally on trust (76% for customer relations and 45% for supplier relations).
IPUs are often customers of the modern sector (60%), and to a lesser degree, suppliers (15.3%). They can also be in competition with the modern sector (19.4%).

Competition in the sector is very strong. The main competitors are players within the same sector, and to a lesser extent the formal sector. The factors that most influence competition are price, followed by product quality. IPUs therefore use the social network as a means of achieving market occupancy. Furthermore, they have the advantage of very easy accessibility. Product prices usually vary according to the market, the customer and the period of the year. The final price is often determined by bargaining.

Links with the formal sector: partners and competitors at the same time
The informal sector maintains links with the formal sector and these are much stronger in the field of ICT. The informal ICT sector is for the most part a customer of the modern sector, which very often subcontracts to informal businesses to distribute their products among the population. However, it is sometimes a competitor, since they both share the same market.

Table 15 IPU links with the modern sector

Nature of link	%
Customers	60.2
Suppliers	15.3
Competitors	19.4
No links	5.1

Table 15 shows that the informal sector works in close cooperation with the modern sector as with customers (60%) and suppliers (15%), and as a competitor (20%). Most of the time the informal ICT sector acts as an interface, or intermediary between formal business and society, since it is closer to the population and has a more in-depth knowledge of its aspirations in relation to its standard of living.

Links with the State
For the State, one of the main characteristics of this sector is its unregulated nature and its non-compliance with fiscal requirements. This is reflected in a considerable loss of income for the administration, which is why the State and the informal sector have been in conflict for some considerable time.

Table 16 IPU relations with the State

Nature of relations	%
Business tax	41.8
Tax	37.8
No problems	3.1
Conflicting relations	17.3

Table 16 shows that relations between the State and the informal sector revolve around three main points: payment of business tax, payment of tax and conflict. IPUs hoping to receive some assistance from the State or state departments amount to only 3% of the population studied.
In general, in view of the growth in informal economic activities and the regulatory problems that this poses, the attitude of the Senegalese State has been marked by indecisiveness. The administrative authorities have for some time been vacillating between coercive measures for taxing the informal sector (often seen as a potential solution for resolving budgetary tensions) and an indulgent approach largely justified by the severity of the social consequences that would follow the adoption of repressive measures against informal businesses.

This lack of clarity in the State's attitude towards the informal sector means that informal businesses do not feel under any particular pressure from the public authorities. Indeed, rarely do informal businesses report the conflicts which they have experienced with State officials. Furthermore, it seems that situations involving legal action on the part of the authorities rarely lead to the payment of fines by unscrupulous businesses.

Relations with the social group

The family plays a decisive role in setting up and developing IPUs. Religious associations also play a part, even though it is a very much smaller part.
IPUs originate in society (family, religious affiliation, social network). They are the primary locations that express the distributive logic of the informal sector, based on social values, such as solidarity (ndimbaleunté), hospitality (téranga), dialogue (disso), etc.

Table 17 Influence of social values on turnover

Social value	%
Solidarity (ndimbaleunté)	36.4
Sharing (seddo)	5.1
Honesty (djoub ak ngor)	31.3
Dialogue (disso)	12.1
Hospitality (teranga)	4.0
Courage (diom)	9.1
Reserve (mandou)	1.0
Perseverance (gorgolou)	1.0

The social values that most contribute to increasing the sales of IPUs are (with the name of the value in Wolof language in parentheses) solidarity (ndimbaleunté), honesty (djoub ak ngor) and dialogue (disso). Numerous arguments to justify this choice of social values were put forward by survey respondents. For these people, solidarity is a Senegalese national value, since people like to help each other. It strengthens ties insofar as these IPUs are family businesses, and everything involves the family. This solidarity is evidenced by subscriptions, loans between those involved and participation in the events that occur, whether happy or sad. Furthermore, it is this solidarity that enables IPUs to compensate for their limitations through complementary relations. Solidarity is also a means of finding and keeping customers (credit arrangements). This social value is sometimes impressed on them within religious associations called Dahira in Wolof language.

For these IPU respondents, honesty is the value that leads to success. It allows trust to be established, reassuring customers and keeping them loyal. A reassured customer always comes back and can even lead you to other customers.

Courage is an essential value for anyone who wishes to achieve a place in society. It is perceived as proof of self-sacrifice in order to survive in the world of business. Getting up early and spending a long day at work is not an easy option, and therefore courage is need as well as perseverance to hold on and keep pressing ahead.

Hospitality is a deeply-ingrained Senegalese value and some people have benefitted from it on their way through life. Giving the customer a hearty welcome is a way of winning his trust and reassuring him.

Obstacles

The problems faced by IPUs are many and varied. The type of obstacle encountered can be technical, financial, material, human or others. Each problem has a particular response. The table below summarises the difficulties encountered by the IPUs surveyed and the solutions brought to bear.

Table 18 Problems and solutions

Problem	Solutions
Technical problems arise when the product is damaged by the customer, the merchandise is faulty, (Chinese) product quality, and also because of the high cost of software and logistics.	• the product in question is sent to a friend, a superior, an expert in the family or a technician; • the formal sector is called upon to install machines and software; • the product is ordered from another supplier; • the problem is solved amicably with the customer; • the software used is “cracked”.
The causes of financial problems include: • non-payment for the product by some customers; • the scarcity of some parts and the high cost of importing from Europe; • shortage of capital for purchasing merchandise and replacing stock.	• reaching an agreement with the supplier (taking merchandise on credit and then paying it off); • help from the family; • lending from an association or friends; • lending from banks or savings institutions; • using money from subscriptions; • drawing on savings; • contacting the owner of the IPU; • falling back on cheaper mobiles to accumulate more capital; • holding promotional sales; • hiring out machines; • asking for payment before performing the service; • contacting the foreign partner; • increasing subscriptions to consolidate stocks; • asking your spouse; • doing additional work to pay certain overheads; • suspending activities and starting up again later using your earnings; • staying within your means.
Human problems faced by IPUs include: • difficulty in preparing a sales project; • the hypocrisy of some co-workers; • insufficient training for young repairers; • shortage of technical staff; • sometimes difficult relations with competing street sellers.	• delegating surplus work or work to be done to a friend; • temporary staff recruitment; • help from family members (cousins, children, nephews); • not allowing work to accumulate; • consulting more experienced people or asking someone who has better knowledge of the market; • taking advantage of peak times to sell more; • getting up early and returning home late.
The institutional problems faced by IPUs are often linked threats from the authorities to move you on.	Some people prepare a place to move on to and others handle the problem by improving relations.

Types of innovation

This study revealed the types of innovation that are possible in the informal ICT sector, and they will be evaluated in future studies. These include social innovation for which a definition is provided and organisational and marketing innovations which are discussed in the third edition of the Oslo Manual (OECD/Eurostat 2005). Technological innovation through decoding and other activities could also be investigated. This section gives information for identifying these three types of innovation.

Social innovation

The first type of innovation found in the informal ICT sector is social innovation**,** defined by its purpose, which is inclusion in a given social, human and economic environment. In this case, the innovation is thought up by the community and has a social purpose. Action is taken within a framework that allows communities to preserve their identities and structures. These innovations are integrated in order to adapt to a precise social and economic environment. Participants in the informal ICT sector try to profit from this situation, whilst complying with society's requirements and demands.

For the Social Innovation Research Centre (CRISES 2009), social innovation is understood to mean "intervention initiated by social players to satisfy an aspiration, provide for a need, introduce a solution or take advantage of an opportunity to act in order to change social relations, transform an action framework or propose new cultural directions"

Organisational innovation

This type of innovation consists of a new way of organising work. In the informal ICT sector in Senegal, ways of building and coordinating activities differ from all the theories put forward on organising work in the economic system. Work organisation, from human resource management to methods of remuneration, follow norms of distributive logic based on the social factors and values such as hospitality, honesty and sharing.

The way that work is distributed and the deadlines and methods of remuneration in these IPUs clearly show how the work is organised.

Marketing innovation

Marketing consists of sales methods and winning customer loyalty. Innovation in this field appears in different ways. The strategy of market occupancy in the informal sector generally involves using social networks. This enables the IPU to maximise sales and services offered, and provides the IPU with a ready-made customer base.

Table 19 Market occupancy strategy

Strategy	%
Social network	54.0
Advertising	2.0
Price	7.0
Accessibility	33.0
Quality of work	4.0

The accessibility of IPUs is often a decisive element in customer loyalty (33%). IPU marketing also involves pricing mechanisms, which entail negotiating with the customer to reach an understanding. The survey confirms that negotiation occurs in 88% of transactions, with only 12% being fixed price. Negotiation gives the customer the feeling of participation in arriving at the price of the products and services to be purchased. This way of doing things is important in a society in which everything is negotiated and all things are based on dialogue.

Marketing approaches are based on monitoring the market environment to improve adaptation to market conditions. The socioeconomic environment determines this type of behaviour.

7. Life story: Serigne Mboup, CEO of the CCBM group

If there is a paradigm for success in the business world of Senegal, it is represented by the story of Serigne Mboup, CEO of the Comptoir Commercial Bara Mboup (CCBM), an illustration of successful transition from the informal to the formal sector. At 45, the polygamous Mr. Mboup, who early on mastered the workings of business, remains an inescapable figure on the Senegalese business scene. 'Serigne', as he is known to his friends, is an exemplary product of the informal sector.

Having inherited with his brothers a flourishing business from his father who died in 1992, and with fluency in Arabic, he very quickly learned how to adapt to the new requirements of the business world. Through enormous sacrifice, he built on the recurrent themes of the philosophy of work, as though led by his spiritual guide, Sheikh Ahmadou Bamba.

At the age of 23, Serigne Mboup joined his father and worked side-by-side with him. Three years later, in 1992, Bara Mboup died, leaving his children a legacy of hard work which had to be conserved and brought to fruition. Serigne therefore took on the heavy burden of moving the business forward.

The departure of the Mauritanian traders after the political unrest of 1989 and the gap they left to be filled was a launching pad for him.

His father had decided to invest in food products and Serigne was left to manage this business. It was the beginning of a great adventure in the business world. Serigne began his pursuit of economic power.

Serigne Mboup took over as head of the CCBM group, a Senegalese benchmark in trade and industry. Founder of businesses and unknown to the world before 2000, Serigne came to the forefront in Sénégal with his imposing Touba Sandaga commercial centre, built in the middle of the Sandaga market in Dakar. In November 2001, he was privileged to have the President of the Republic in person at its inauguration.

His initiative was soon imitated by other promoters. Commercial centres of the same kind sprang up like mushrooms everywhere in the city centre. He moved into other sectors, diversifying his activities. Master Office for office electronics, SBMA for food and cleaning products, Pridoux specialising in setting up and running mini-markets, Espace Auto importing and selling vehicles, CCBM estate agents which was to take on the construction of an ultra-modern building in Soweto Square, a project that took some time to materialise, Africa Transit, CCBM Voyages, Digital Planet which experienced some problems and many of the showrooms that opened their doors have now closed. Not to mention his involvement in the renewal of the taxi fleet with his project for 50 taxis entrusted to women drivers and inaugurated by the First Lady of Senegal. All these enterprises, created since the ascendancy of the CCBM group, enabled Serigne Mboup to employ over 1000 people. Today, although he would rather not talk about the profits of his holding company, he has stated that his turnover is around 30 billion CFA Francs (60 million U.S. Dollars).

With the success of his activities on record, Serigne Mboup has been acknowledged by the Senegalese government, and for some years has been awarded a number of public contracts, including:

- A contract for providing vehicles for deputies currently in office, involving the supply of 150 Hover 4×4 vehicles, worth a total of 2.5 billion CFA Francs;
- A contract for building the future Senate Building, worth 10 billion CFA Francs;
- Other smaller contracts.

Serigne's distinguishing feature is his boldness in taking on innovative activities, the latest of which, 'Sister Taxi', was launched in 2007, a fleet driven only by women and intended to rid Dakar of its polluting taxis. This revolutionary project has been very successful in the Senegalese capital. For the first time ever, women can be seen driving taxis in Dakar, an outcome of inclusive innovation.

His working method, based on trust and Senegalese social values, has been fully acknowledged by the Senegalese people. The enterprise culture embodied in his services is based on five values: ambition, creativity, performance, responsibility and solidarity. His strategy centres on diversification and job creation. This can be seen in the group's activities. For instance, Taxi loans on a no-deposit basis, means that people can benefit from a taxi and pay for it on a daily basis. This proves once again that the group's activities are first and foremost based on trust, solidarity and the responsible attitudes of those who benefit. He has a pioneering vision that includes inclusive innovation and is a leader in the fields of services distribution and industry, making his products accessible to all consumers, whatever their economic situation and gender.

8. Policy implications and outlook

From the outset, the Senegalese authorities understood the importance of the informal sector in contributing to economic growth, job creation and, consequently, poverty alleviation.

Therefore, to make the informal sector more visible, a number of measures were taken at administrative and fiscal levels. One of the first measures was the acceptance of groups, associations or collectives representing the sector in discussions with the public authorities and local communities. Then, after talks among stakeholders, taxes were introduced for this sector of activities, and monitoring undertaken with a view to formalising informal production units. In 2000, a ministry was set up to take charge of relations with the informal sector. Despite all these measures, analysis of the policies implemented provides clear evidence of the conflicts that exist between government institutions and the informal sector in Senegal.

Any alternative policy for the informal sector must take account of the following:

- The dynamic equilibrium of relations with this sector and the customer base must be respected. The locations of the informal production units are based on the results of market research conducted by the units themselves;
- Although individualised, the informal economy is based on nested social networks which must be measured and acknowledged;
- Structuring activities in the sector and relations with government institutions;
- Creating a framework for integrating these informal units in development policies;
- Supporting the sector's activities to set up the tools for appropriate and continuous monitoring.

This case study on the informal sector and innovation in Senegal has produced some important results on the sector and inclusive development. It provides a basis for setting up facilities for measuring innovation in the sector. Because of its informal nature, this sector has been marginalised by innovation studies. This study shows that the informal sector can be investigated by researchers so that it can better be taken into account by development policymakers. The study also that indicators can be developed that provide information on economic and social activities in the informal sector and their impacts.

The results obtained from this study raise new questions that merit in-depth examination. Since any kind of innovation is measured over periods of time, measuring innovation in the informal sector is bound to require much more time. These results merely provide a basis for creating innovation indicators for the informal sector.

This study also confirmed the need for countries like Senegal to investigate the field of innovation and the informal sector. This continues to be a field about which very little is known by researchers, and even more importantly, by policy-makers.

The informal sector plays a decisive role in the Senegalese domestic economy and a clearer understanding of this sector is required so that it can be better integrated into the national innovation system through appropriate policy intervention. But first, its potential must be understood (operating modes, relations, standards, values, etc.).

The informal sector adapts to the Senegalese market and the explanation for this goes beyond the simple fact that the formal sector is not able to fully satisfy the demand for employment. There are other reasons behind this adaptation, exhibited by the informal sector's approach to everyday life in Senegal.

This study could be followed up by working on the policies and institutions confronted by this sector and the innovative practices it implements.

Furthermore, this study was intended to extend into other informal sectors, such as commerce, transport, restoration, arts and crafts, etc. It would also be interesting to measure innovation within small and medium-sized and intermediate businesses (SMB/IB) that interface the formal and informal sectors.

9. Conclusion

The informal sector in Senegal benefits from and has achieved a prominent place in the national economy because of its capacity to create jobs and its contribution to GDP. This explains the interest in this sector and consequently the study conducted on the informal ICT sector and its innovation processes.

Conducting the study was a question of examining the informal sector's adaptation mechanisms within the Senegalese context, discovering innovations, understanding the related process and how IPUs manage to integrate into the market economy. This work provided answers to the questions posed in Section 1 and it was managed by means of a three pronged approach: a review of the literature; a survey, based on a questionnaire developed for the case study; and, a life story to provide context to what was learned from the literature and the data gathered.
This work shows that the informal ICT sector has developed only recently (since 2000). It has evolved to satisfy the specific ICT-related needs of society. The adaptation mechanisms in this sector involve taking account of the social and economic realities of the population. Observation of these social realities is the basis of the innovations noted in this sector. These innovations (social innovation, organisational innovation and marketing innovation) reflect Senegalese society and how it is organised. They are based on Senegalese values and on distributive logic, in contrast to the profit motive that prevails in the capitalist system.

Moreover, the sector is very heterogeneous. Of the workforce, 94% are men, mainly young men, and 34% are educated to general secondary level. Some 51% have attended Koranic school. However, problems such as a lack of technical training and conflicts between players are worth noting. The informal sector has led to more flexible State taxation policies, but one need to recognise that there is a real problem of institutional maturity. All public actions undertaken in respect of the informal sector are directed towards reprimanding, whereas some thought could be given to finding policies that are more suited to the Senegalese economy.

The study of the informal sector and innovation has helped to understand how the sector is structured, what the various activities are and how it operates. Even though the objectives set at the beginning of the study were ambitious, the results obtained confirm the hypotheses proposed in Section 5. The informal ICT sector is indeed based on proximity, both geographical and closeness of relationships based on trust, and on the adaptation to the living conditions of the community. It is clear from the findings of this study that the informal ICT sector plays a social role in providing employment, reducing poverty, and raising the capacity of the participants through learning by doing and other forms of knowledge transfer.

The informal ICT sector is based on the logic of proximity and adaptation to community living conditions.
Observation has shown that the informal ICT sector, in its activities and above all its operating modes, follows a basic social logic benchmarked on Senegalese society. Its originality stems from its marketing strategies which are in stark contrast to those used in the so-called formal sector and which are innovations as defined in the Oslo Manual.

The informal ICT sector has an important social role
Like any informal sector in Senegal, the informal ICT sector is important above all for the social role it plays. It is first and foremost a survival activity, for individuals and families alike. Capitalizing on this experience in the study of the informal sector and innovation processes has helped expand the fields of investigation of this sector and led to the following lessons learned:

- The importance of treating the informal sector as an entity in its own right with specific operating modes and work organization methods and innovations. Simply defining the informal sector in contrast to the formal sector has meant that policy makers have been slow to come to terms with this sector, which plays a decisive role in the Senegalese economy, but which could contribute more with appropriate government policies;
- The need to set up a framework involving all the actors in the sector, to boost its dynamism and enhance the profitability of its innovative approaches;
- The importance to the participants in the informal ICT sector of specific ICT training courses. Furthermore, they would earn more if they had an average education, enabling them to familiarize themselves with ICT. This is a case both for the provision of basic education as well as technical education and for encouraging the young, who populate the informal ICT sector to participate more in such education.

This study has enabled to better understand informal ICT businesses, helping to expand the field of investigation of the informal sector. From this, the following lessons have been drawn:

- Deeper knowledge of the informal sector, in terms of its ICT activities;
- The need to put a place a framework involving all stakeholders to make the sector more dynamic and encourage innovation;
- Developing the skills and building the capacities of the actors to raise the level of education;
- Recognition of the sector as an entity with its own operating modes and organisational methods, as well as latent know-how that could be exploited;
- Economic participants to be taken into account in innovation and development policies.

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Annex 1: Gross Domestic Product (GDP) by sector of activities

In billions of currents CFA	1990 actual	1991 actual	1992 actual	1993 actual	1994 actual	1995 actual	1996 actual	1997 actual	1998 actual	1999 actual	2000 actual	2001 actual	2002 actual	2003 actual	2004 actual	2005 actual	2006 actual	2007 Prelim. actual	2008 Prov.
TOTAL VALUE ADDED	1 399	1 416	1 421	1 457	1 960	2 195	2 318	2 434	2 651	2 787	2 935	3 157	3 261	3 501	3 715	3 992	4 232	4 662	5 213
Primary sector	294	302	280	315	395	485	490	509	544	571	599	625	551	650	627	715	685	696	874
Secondary sector	295	299	329	328	447	499	536	543	598	613	644	734	786	807	876	900	959	1 085	1 180
Tertiary sector	810	814	812	815	1 118	1 212	1 292	1 381	1 509	1 604	1 691	1 798	1 924	2 044	2 212	2 378	2 587	2 881	3 159
.modern sector	620	624	692	667	909	946	1 016	1 083	1 169	1 210	1 242	1 351	1 485	1 578	1 729	1 842	1 947	2 178	2 433
.informal sector	779	791	729	791	1 051	1 249	1 301	1 351	1 481	1 578	1 692	1 806	1 776	1 923	1 986	2 150	2 285	2 484	2 780
+TAX NET ON THE PRODUCTS	158	169	169	151	193	240	274	293	317	380	397	419	457	486	528	601	662	743	731
GDP	1 556	1 585	1 589	1 608	2 153	2 435	2 591	2 727	2 968	3 167	3 332	3 575	3 718	3 987	4 243	4 593	4 894	5 405	5 944

Source : Agence Nationale de la Statistique et de la Démographie (http://www.ansd.sn/publications/annuelles/autres_donnees/Agregat_macro_2009.htm), Accessed January 24, 2012

Annex 2: Informal ICT and Trade Sector QUESTIONNAIRE

Name of Informal Production Unit (IPU) (Optional): …...………………….........................
……………………………………………………………………………………………
…………………………………
Address (Optional)**:**………………………………………………………………………
………………………………..…………………………………………………………………
……………………………………………………
Telephone N°
(Optional):………………………………………………………………………………

1. Information on the respondent		
Name - First name		
Gender	☐Male	☐Female
Position in the IPU	☐Junior employee	
	☐Technical manager	
	☐Administration	
	☐General manager/Manager	
	☐Other (please specify):	

2. Socio-demographic information on the owner/creator/manager of the IPU					
2.1 Who created the IPU?					
☐You alone	☐Your Father/Mother	☐Your brother/sister	☐Your uncle/aunt		
☐A friend	☐A third party	☐The family	☐Associates		
☐A cousin	☐Other (please specify):				
2.2 Gender	☐ Male	☐ Female			
2.3 Matrimonial status					
☐Married, monogamous	☐Married, polygamous	☐Single	☐Divorced	☐Widowed	☐Other
2.4 What is your ethnic group ?					
☐ Wolof	☐ Serer	☐ Toucouleur	☐ Diola	☐Mandingo	
☐Other Senegalese ethnic group (please specify):					
☐ Foreigner (please specify):					
2.5 Languages spoken (you can check more than one box)					
☐ Wolof	☐Serer	☐Toucouleur	☐Diola	☐Mandingo	
☐French	☐English	☐Spanish	☐Chinese	☐Arabic	
☐Other languages (please specify)					
2.6 Place of origin:					
2.7 Religion practiced or brotherhood					
☐ Tidiane	☐ Mouride	☐ Layenne	☐Catholic	☐Protestant	
☐ Animist	☐ Other (please specify):				
2.8 Level of Education					
☐ None	☐Primary	☐ General secondary	☐ Technical secondary	☐Higher	
☐ Professional training	☐Koranic school	☐ Other (please specify):			

2.9 Socio-professional trajectory (please number in sequence)				
Unemployed	☐	☐	☐	☐
French school	☐	☐	☐	☐
Koranic school	☐	☐	☐	☐
Craftsperson	☐	☐	☐	☐
Employed in the modern sector	☐	☐	☐	☐
Other	☐	☐	☐	☐

3. Nature and Structure of the IPU and its activities		
3.0a. Do you have a NINEA registration number? ☐Yes ☐No	**3.0b. Does your business have** ☐Written SYSCOA-compliant accounting? ☐No SYSCOA-compliant accounting? ☐Other (please specify) ?	If the business has a NINEA registration number and formal accounting to SYSCOA standards, end of interview for this IPU.
3.1 How long has your IPU been in existence?		

3.2 How would you categorise your activity ?				
☐Sale of recharge cards, telephones	☐Maintenance and servicing	☐Mobile telephone decoding	☐Computer and peripheral device assembly	☐Sale of computer hardware, office electronics
☐Sale of audiovisual equipment	☐Sale of CDs, VCDs, DVDs	☐Asset creation	☐Repairs	☐Services
☐Other (please specify):				
3.4What material resources does your IPU use to conduct its activities?				
☐Computer	☐Printer	☐Scanner	☐Telephone	☐Photocopier
☐Repair kit	☐Fax	☐Other (please specify):		
3.5 What kind of premises do you have for conducting your activities ? (you can check more than one box)				
☐Street	☐Stall in the street	☐Vehicle	☐Market stall	☐Workshop
☐Shop	☐Kiosk			
3.6 How did the idea for this activity originate?				
☐ Market demand	☐ Social demand	☐ Something to do	☐ Advice from a third party	☐ Imitation
☐ More freedom	☐ Fewer constraints	☐ Other (please specify):		

3.7 What are the general stages in carrying out the activity? (please number in sequence)				
Identifying targets	☐	☐	☐	☐
Financing	☐	☐	☐	☐
Equipment	☐	☐	☐	☐
Cooperation	☐	☐	☐	☐
Human resources	☐	☐	☐	☐

3.8 Are there especially favourable periods in the year for conducting your activities?				
☐ Religious festivals	☐ Religious events	☐ End of year	☐ Return to school	☐ Weekly markets
☐ Fairs				
3.9 How do you take advantage of these favourable periods?				

☐ Investments	☐ Pricing strategy	☐ New product	☐ Work organisation	☐ Special offers
3.10 How did this happen?				
3.11 What problems have you had to face in conducting a new activity? (you can check more than one box)				
☐Technical	☐Financial	☐Human	☐Organisational	☐Institutional
☐Other (please specify)				
3.12 How have you overcome these problems ?				
Technical:				
Financial:				
Human:				
Organisational:				
Institutional:				
Other (please specify):				
3.13 Over the last few years, has your business invested in the following activities?				
☐Acquiring a machine	☐ Acquiring outside knowledge	☐Training	☐ Buying software	
☐Other (Please specify):				
3.14 What sources of information have you used for setting up your activities?				
☐ The family	☐Market	☐State and State departments	☐Religious associations	☐Business culture
☐ Community living conditions	☐Internet			
3.15Which types of financing do you use for keeping your activities going?				
☐Own resources	☐Family resources	☐Tontines	☐Mutual savings and loan associations	☐Bank
☐ Religious associations	☐Other (please specify)			
3.16 Which of the following social values have helped you to increase turnover?				
☐ Solidarity (Ndimbaleunté)	☐ Sharing (seddo)	☐ Honesty (djoub ak ngor)	☐ Dialogue (disso)	
☐ Hospitality (teranga)	☐ Courage (diom)	☐ Reserve (mandou)	☐ Perseverance (goorgolou)	
3.17 Give an explanation for each value checked?				
Solidarity:				
Sharing:				
Honesty:				
Dialogue:				

Hospitality:
Courage:
Reserve:
Perseverance:

4. WORK ORGANISATION				
4.1 How many people work in the IPU?				
4.2 How is the work distributed?				
☐Based on skill	☐Based on kinship	☐Based on friendship	☐Based on age	
4.3 How are employees are paid?				
☐Monthly	☐Weekly	☐Daily	☐ Hourly	☐ Irregularly
4.5 What are the methods of remuneration				
☐Commission (sales)	☐Quotas	☐ Wages		

5. COMMERCE AND MARKETING				
5.1 What is your main strategy for market occupancy?				
☐Social network	☐Advertising	☐Price	☐Accessibility	
☐Other (please specify):				
5.2 Do your product prices vary according to:				
☐Market	☐Customer	☐Place	☐Time	
☐Other (please specify):				
5.3 What is your main pricing mechanism?				
☐Bargaining	☐Fixed price			
5.4 What are your customer relations based on?				
☐ Trust	☐ Work	☐ Family	☐ Religion	☐ Place of origin
5.5 Who are your main suppliers?				
☐ Wholesalers	☐Outside partners	☐Retailers (traders)	☐Formal businesses	
5.6 What are your supplier relations based on?				
☐ Trust	☐ Work	☐ Family	☐ Religion	☐ Place of origin
5.7 How would you assess the competition in your field of activity?				
☐Very strong	☐Strong	☐Average	☐Weak	☐Very weak
5.8 Who are your main competitors?				
☐Formal sector	☐ Participants in the same sector	☐Foreign participants		
5.9 What do you think is the most important factor in being competitive?				
☐Proximity	☐Product quality	☐ Affordable price	☐Capital	
☐Other (please specify)				
5.10 What innovative strategies do you adopt for facing this competition?				
☐Cutting prices	☐Using new sales	☐Improving product quality	☐Other (please specify)	

	techniques	(packaging, etc.)	

6. PARTNERSHIP AND COOPERATION				
Does your IPU belong to a group or network?				
☐Yes		☐No		
If yes, please specify the group:				
Who are your IPU's partners in implementing an activity?				
☐Informal sector	☐Modern sector	☐State	☐NGO	☐Religious association
☐Other				
What links does your business have with the so-called modern sector? (you can check more than one box)				
☐Customer	☐Supplier	☐Competitor	☐Associate	
What relations does your business have with the State and State departments?				
☐Business tax	☐Tax	☐Subsidy	☐No problem	
3.14 Has your business benefitted from public financial support for new activities?				
☐Yes	☐No			
If yes				
☐Local authorities	☐Government	☐Other		

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An exploration of agricultural grassroots innovation in South Africa and implications for innovation indicator development

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South Africa

Abstract

The core of this paper consists of two case studies of 'grassroots' innovation led by innovative smallholder farmers in a village in South Africa – one about developing an alternative production practice for growing potatoes, and the other about introducing a new cash crop (cherry peppers) and the establishment of a new marketing relationship. One of the purposes of the study was to explore questions about the development of innovation indicators that might support policy and management concerned with this kind of innovation. The case studies are therefore located in the context of a review of existing science, technology and innovation indicators and their limitations with respect to this area of agricultural innovation. Another purpose was to identify and clarify the position of 'grassroots' innovation within other perspectives on different kinds of innovation system (or mode of innovation) in agriculture in developing countries. The case studies are also therefore set in the context of a review of literature about these other system perspectives, focusing in particular in 'formal' and 'informal' systems, and on 'grassroots' and 'participatory' modes of innovation involving interactions between formal and informal systems. The combination of case studies and broader reviews leads to two main conclusions: (1) grassroots and other participatory modes of agricultural innovation merit much greater policy attention than they have received; but (2) the base of available analysis and indicators about these approaches to innovation and their effectiveness is still inadequate to inform and support policy and management in this area. The paper therefore concludes with a discussion of steps that might be taken to improve the available information, understanding and indicators about these modes of innovation.

JEL Codes: O13, O17, O33.

Key words: Agriculture, innovation, grassroots innovation, informal economy

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1 INTRODUCTION[1]

This paper explores a set of issues at the intersection of three areas of debate about innovation in agriculture in developing countries in general and in South Africa more specifically. The first of these, our primary focus, is about ‘grassroots’ agricultural innovation: one of several modes of agricultural innovation that, in contrast to more conventional modes, involves significant roles being played by farmers in initiating and exercising control over the innovation process, and often also in executing significant parts of it themselves. The second area is about disadvantaged ‘smallholder’ production: the segment of agriculture where, it is argued, the potential benefits of more widespread and intensive grassroots innovation seem to be especially large. The third is about the further development and greater use of ‘innovation indicators’ in policy-oriented analysis of agricultural innovation – focusing here on policy analysis concerned with the allocation of resources to support grassroots modes of innovation in smallholder agriculture – and also other participatory modes (see below).

Although significant involvement of farmers in the process of innovation is a key characteristic of grassroots innovation, this does not mean that this mode of innovation is exclusively ‘internal’ to the innovating farm or rural community. ‘Grassroots’ is not another term to describe forms of innovation based only on highly localized ‘informal’ or ‘traditional’ knowledge systems. While those forms of knowledge may be involved, grassroots innovation also often draws extensively on ‘external’ sources of knowledge – not only existing knowledge but also new knowledge recently created on experiment stations or in agricultural research centres. Indeed, an important aim of those who foster this approach to innovation is to strengthen such links to external knowledge sources – but via mechanisms that are substantially demand-pulled rather than simply supply-pushed.

With this emphasis on significant elements of initiation, control and execution by farmers and their organizations, grassroots innovation is one among a wider spectrum of closely related approaches being explored to develop new ways of achieving agricultural innovation in developing countries. These depart from the broad approach most commonly used, and they have attracted increasing attention in policy debate over the last decade. Some of this debate has focused on developing new ways of organising the provision of agricultural services – for example in the form of ‘demand-driven’, ‘demand-led’ or ‘community-based’ services (e.g. Chipeta 2006, Anderson 2007, World Bank, 2007: 172-176, Feder et al. 2010). Most of the discussion in these studies has concentrated on extension-centred services, only part of the whole bundle of services involved in innovation (see, for example, Figure 1 in Feder et al. 2010). In contrast, the demand-driven characteristics of grassroots innovation encompass a wider range of innovation-related services, including knowledge-creating and technology-developing research services that lie behind what are normally considered to be extension activities.

Thus grassroots innovation overlaps with what have been described as ‘participatory’ modes of agricultural research or technology development. These involve strengthened demand and influence by farmers on centralized agricultural research, as well as their greater direct involvement in actually undertaking experimentation and research – either via participation in these activities organized by formal research organizations or independently in their own

[1] Sections 1-3 and 4.1 draw substantially upon unpublished work by Martin Bell.

‘informal R&D’ (Biggs and Clay 1981). As with demand-led extension services, these participatory and informal modes of innovation have been the subject of recently increasing debate about how to organize and manage agricultural innovation (e.g. Ceccarelli et al. 2009, Sanginga et al. 2009a, Scoones and Thompson 2009).

Grassroots and participatory modes of innovation are therefore seen as being closely related ways of achieving innovative change in agriculture. Although the paper later highlights differences between them, the stress here is on their common features. Both of them constitute ways of organising innovation activities that are substantially different from the dominant modes that have been used for the last fifty years or more in developing countries. They not only blur the common sharp distinction between research and extension activities, but also, with significant involvement of the technology-users (farmers) in the innovation process, they are also more decentralized than conventional modes in which innovative activities are much more centralized in formally organized research institutes. In summary, they both involve patterns of specialization, division and coordination of innovative labour that differ significantly from conventional patterns of high specialization and sharp differentiation between (i) research and technology development, (ii) technology extension, and (iii) technology use.

Consequently the bundle of closely related ‘grassroots-participatory’ modes of innovation is broadly contrasted with the bundle of ‘conventional’ modes in this paper. It is examined in two ways: first by reviewing some of the existing literature covering the whole spectrum, and then by reporting on two case studies specifically focused on grassroots innovation in South Africa.

Variations on these grassroots-participatory forms of farmer-driven innovation can and do occur in many types of agricultural production. Indeed it is important to recognize that the core features of these modes of innovation are not even confined to agriculture. In particular, key characteristics of the role of technology-users in the division of labour between different innovation actors, as well as features of the interaction and coordination between these actors, have many similarities with what has been described as ‘user innovation’ in many industries in the advanced economies. The numerous studies of such user innovation in the advanced economies, have covered for instance: not only agriculture (as in the Netherlands - Klerkx and Leeuwis 2008), but also residential construction, scientific instruments, security software and banking services in the US (Slaughter 1993, von Hippel 1976, Franke and von Hippel 2003; Oliveira and von Hippel 2011); and sports-related consumer products in Canada and the US (Franke and Shah 2003, Lüthje et al. 2005, Baldwin et al., 2006).[2]

In other words, the types of innovation process that are bundled together here as ‘grassroots-participatory’ modes of innovation, are not radically novel or revolutionary approaches to innovation. But, nor are they ‘second rate’ and ‘inferior’ approaches. They simply incorporate ways of achieving innovative change in production that are different in several respects from other ways, while many of their core characteristics have long been embedded in innovation processes occurring across a wide range of circumstances.

[2] Aspects of the similarity of user-intensive forms of innovation across agricultural/non-agriculture and developing/developed country contexts have been explored in Douthwaite et al. (2001) and Douthwaite (2002).

The focus in this paper is on their occurrence in one rather broad set of circumstances: which is commonly described as 'smallholder' agriculture. This is usually distinguished from other kinds of agriculture in developing countries that are described as 'commercial' or 'large-scale'. This distinction is unduly simple, and the focus on farm size and commercialization as the key distinguishing features is misleading because: substantial parts of 'smallholder' agriculture involve commercial production for markets.

Nevertheless the distinction is widely used as shorthand to refer to a dual structure of the agricultural sector that has other equally important distinguishing characteristics. In particular, in contrast to the large-scale/commercial segment of agriculture, smallholder production has most of the following characteristics: (i) it is poorly supported by capital, with limited or no access to irrigation or other means of water control, paved roads, agricultural machinery and so forth; (ii) it involves high levels of agro-ecological heterogeneity, with correspondingly complex farming systems; (iii) it is typically based not only on rain-fed agriculture, but also on relatively marginal agricultural land, being consequently vulnerable to multiple forms and high levels of stress and wide output variation; and (iv) it is weakly integrated with supporting knowledge institutions, credit systems and markets for inputs and outputs. Such differences are, of course, matters of degree, and in most developing countries the total number of farms is spread across these differences in continuous, albeit highly skewed, distributions. But as we elaborate later, the distribution in South Africa, the immediate context for the innovation case studies in this paper, is particularly sharply differentiated in an extreme form of agricultural dualism.

The focus of this paper on smallholder agriculture seems timely because the last few years have seen a renewed interest in its developmental roles, along with a growing recognition of the importance of innovation in sustaining those roles. The renewed interest has been prompted partly by a greater recognition since the 1990s of the persisting co-location of smallholder agriculture and a large proportion of the world's most extreme forms of poverty. As summarized by Hazell et al. (2010), more than two-thirds of the world's three billion rural people live on small farms of less than two hectares: "These people include half of the world's undernourished people, three-quarters of Africa's malnourished children, and the majority of people living in absolute poverty" (p.1349). Interest in the potential roles of smallholder agriculture has been further stimulated by perceptions of the threats from climate change and by rising world food prices in the late 2000s that drew increased attention to widespread problems of food insecurity in smallholder contexts. At the same time, as summarized by Lipton (2010: 1402), the evidence suggests that the proportion of farmland in low income countries that is cultivated in smallholdings has been rising, not falling as was expected by proponents of the growth strategies pursued over recent decades. Also, in several surveyed developing countries, farmland has shifted toward the lowest size categories between 1986 and 2002 (p. 1402), while Jayne et al. (2010) in a review of five African countries suggest that many small farm households "are approaching landlessness" – with at least 25 per cent of small-scale farm households controlling less than 0.11 hectare per capita (p. 1386).

Responses to the growing recognition of these issues have involved sharply differing views about the potential roles of smallholder/peasant agriculture (relative to large/commercial forms of production) in delivering poverty reduction and food security, especially in Africa. The consensus that emerged from one of the most comprehensive examinations of the evidence about the future potential for smallholder farming in developing countries was broadly positive.[3] Starting from a question about whether small farms actually do have a future in low-income countries, the integrating overview (Hazell et al. 2007) concluded: "The case for smallholder development as one of the main ways to reduce poverty remains compelling". (p.ix), and this view was repeated in the later synthesis (Wiggins et al. 2010a): "Overall this collection of papers suggests that small farm development is not only desirable for its impacts on poverty, but also feasible". (p. 1346).

This type of generally positive perspective is, of course, bounded and narrowed in various ways: only certain types and proportions of smallholders are likely to be able to develop the agricultural component of their livelihoods in ways that significantly reduce their poverty and enhance their food security; they are likely to be able to follow such routes or pathways only in local contexts with certain economic, institutional, social and political characteristics; and significant policy interventions will usually be needed even to exploit the more positive of those socio-political and economic spaces. Consequently, as stressed by Jayne et al (2010), "There is no one future for small farms in Africa…" (p. 1384). Instead there are several different pathways from current situations, with different groups of smallholder facing differing constraints in pursuing them. One illustration of such diversity is provided by Brooks et al. (2009) who identify nine different pathways to improve, or diversify away from, increasingly challenged maize production in Kenya.

Other perspectives are much more negative about the potential of smallholder agriculture, sometimes simply dismissing it as irrelevant to achieving either poverty reduction or more widely dispersed food security. For example, the influential development economist Paul Collier has argued that peasant agriculture is unable to meet contemporary challenges, and that "large organizations are better suited to cope with investment, marketing chains and regulation". Consequently he decries the fact that "… for years global development agencies have been leery of commercial agriculture, basing their agricultural strategies instead on raising peasant production". He dismisses this view as resting on "a giant of romantic populism", and asserts that: "… contrary to the romantics, the world needs more commercial agriculture, not less" (Collier 2008).

Underlying such different opinions about the prospects for smallholder and larger-scale commercial agriculture are different views, often only implicit, about the relative potential for change and innovation in smallholder production – virtually non-existent for those with views like those of Collier, but perhaps significant in the view of others, provided more effective approaches are taken to innovation. But there is virtually no systematic evidence to sustain either view.

Yes, there is a large body of descriptive case studies of different modes of innovation in smallholder agriculture but, as we show later, very little of that permits general conclusions to be drawn about the potential effectiveness of any of them individually, or even of all of them together. There are also numerous estimates of the rates of return to various kinds of agricultural R&D (aggregated by countries, institutes or crops), but we have found none about the rate of return to expenditures on any or all modes of innovation centred on

[3] This examination involved several steps. It originated in a workshop in the UK organised by the International Food Policy Research Institute (IFPRI), the Overseas Development Institute (ODI), and Imperial College, London – with the proceedings published in IFPRI (2005). An integration of that work with the wider literature was subsequently added (Hazell et al. 2007); and most of the original papers plus the integrated review were published with an updated overview (Wiggins et al. 2010b).

smallholder production. There are, of course, econometric studies of the economic *consequences* of innovation, and these can point to very broad and general characteristics of directions of innovation that would be desirable in smallholder agriculture. For example, Lipton (2010) identifies the kind of ideal poverty-reducing innovation trajectory - one that would result in (a) innovation-induced reductions in relative farm prices slower than the innovation-induced growth of total factor productivity, and (b) innovation-induced growth of land yields rising faster than increases in labour productivity – so pulling up rural wage rates or employment.

But what does one actually do by way of resource allocation to innovation in order to achieve innovation *outcomes* along those lines? What kinds of organizational systems and processes are most likely to be effective in raising the rate of implemented innovation in smallholder production, and in aligning its trajectory in the most beneficial directions? In particular, what scales of resource allocation to which forms of farmers' experimentation, innovation and demand-pulling on the formal R&D system are likely to provide the most effective complement to more centralized knowledge-production, technology development and provision of support services?

There seems to be very little information to inform policy decision-making about such questions. This takes us to the third of the intersecting areas of interest we cover in the paper – about the development and use of innovation indicators in policy-oriented research about innovation in smallholder production.

Policy decision-making about resource allocation to innovation and about broad aspects of its organization is widely supported by various types of analyses that draw heavily on an underlying body of indicators of various aspects of the innovation process and its outcomes. This is especially the case with respect to policy-oriented analysis of innovation in industrial production. In this area the long-standing availability of data and indicators of R&D inputs to innovation has been complemented in recent decades by a wealth of information about many other aspects of innovation – in particular about inputs to innovation other than R&D, about features of the process by which it is achieved, and about neglected aspects of the innovation outputs from it.

But policy about innovation in agriculture in developing countries seems to be much less richly supported by innovation-related data and indicators - as suggested in a number of recent studies (Spielman and Birner 2008; ASTI 2009; Daane et al. 2009). We explore this issue with particular respect to indicators and analysis to support policy-making concerned with grassroots-participatory innovation in smallholder agriculture. We suggest both broad steps that need to be taken and some of the more detailed issues that would need to be addressed.

The paper is organized as follows. Section 2 elaborates on the role of innovation indicators in policy-oriented analysis, outlining the status of their development and use with respect to innovation in industry and services in comparison with agriculture. Section 3 provides a review of the available literature about grassroots-participatory innovation in smallholder agriculture in developing countries in general. Section 4 sets the background for the specific case studies of grassroots innovation: the smallholder agricultural sector in South Africa, the village and organizations involved and the approach taken to the research. Section 5 presents the results of those studies. Section 6 discusses a number of detailed issues about policy research and indicator development that emerge from the previous sections, and Section 7 sketches a number of action steps to scale up such research and indicator development and bring them into the mainstream of policy analysis for agricultural development.

2 INNOVATION INDICATORS: AN OVERVIEW OF SCOPE AND ORIGINS

Three broad aspects of innovation indicators are outlined here. The first two, dealing with the aspects of innovation activities they illuminate and the paths of development they follow, relate primarily to indicators that have been developed to illuminate innovation in the industrial and service sectors in advanced economies, the focus of relatively intensive and diverse approaches since the middle of the twentieth century. The third is concerned specifically with the development of indicators relating to innovation in agriculture.

2.1 Aspects of innovation illuminated by innovation indicators

Table 2.1 provides a highly selective list of the main aspects of innovative activity that are commonly reflected in indicators of innovation – or more generally, in science, technology and innovation (STI) indicators. These fall under five broad headings: *inputs* to innovation, the *actors* involved, the innovation *process*, the *outputs* from that process, and the wider *impacts and consequences*.

In relation to that framework, the focus of this study on grassroots-participatory modes of innovation is concerned primarily with issues about *actors* and *processes*. It is about divisions of labour between innovation actors which, compared with patterns in more conventional modes, involve more significant roles being played by farmers; and it is about processes of innovation that involve particular kinds of knowledge, particular patterns of knowledge flows and sources, and particular forms of organizational scale, structure, process and behaviour. At the same time, though, important policy and management issues about grassroots-participatory modes of innovation raise questions about the inputs to them, the outputs from them and the wider impacts and consequences that follow – all addressed in a comparative way with respect to more conventional modes of innovation.

It is important to emphasize that the kinds of innovation indicators that currently happen to be widely available have been developed to meet changing interests and needs over time, as well as to reflect growing understanding about innovation. Consequently the array of STI-related phenomena currently illuminated by indicators (as in the selective list in Table 2.1) reflects considerable change and development that has occurred since the mid-twentieth century when STI indicators began to be compiled and standardized within and between countries.

Between the 1950s and 1970s the main focus was on the inputs to innovation. These were identified primarily as inputs of research and development (R&D) - or more precisely, inputs of new knowledge derived from R&D. This perspective was reflected in the first major step to develop internationally standardized STI indicators: the OECD manual of standard practice for surveys of research and experimental development – the Frascati Manual (OECD 1963)

Through the 1970s and 1980s it became increasingly clear that indicators based on statistics collected under Frascati standardization reflected only very limited aspects of innovation. In particular R&D encompassed only part of the spectrum of scientific and technological inputs contributing to innovation, omitting other significant and often quantitatively more important kinds of technological, engineering and marketing activities involved in implementing innovation. At the same time, the omission of systematic indicators covering the outputs from

Table 2.1 Aspects of Innovation Commonly Illuminated by Innovation Indicators

1. INPUTS to Innovation

e.g. ***- Research and Development (R&D)***
- e.g. - Expenditure
  - Numbers of scientists, engineers, technicians

- Design and engineering (D&E)
- e.g. - Expenditure
  - Numbers of scientists, engineers, technicians

- The existing stock of knowledge
- e.g. Numbers and types of patents in relevant areas

- Other

2. Innovation ACTORS

e.g. ***- Funding Sources***
- e.g. - Government, Business enterprises, Other

- Performers of R&D or D&E
- e.g. - Government, Business enterprises, Universities, Other

- Firm-types
- e.g. - Large, small
  - High-tech, Low-tech
  - Local, MNC affiliate

- Types of Individual
- e.g. Old, young, 'stars', 'gatekeepers';

- Other

3. Innovation PROCESS

e.g. - Types of knowledge used
- e.g. - 'Science', 'Technology'
  - Research-derived, experience-derived;
  - Patented, not-patented

- Knowledge flows and sources
- e.g. - intra-firm, external
  - Type of external (customer, supplier, university, etc.)

- Organizational scale, structure, process and behaviour
- - Numerous characteristics

- Other

4. OUTPUTS from Innovation Process

e.g. ***- Inventions*** *(Intermediate outputs)*
- e.g. - patented, not patented

- Implemented innovations
- e.g. - Radically novel/incremental; New to world/new to market/new to firm
  - Technological (Process, product)/Organizational

- Additions to stock of knowledge
- e.g. Published academic papers

- Other

5. IMPACTS AND CONSEQUENCES

e.g. ***- Economic performance***
- e.g. Costs, productivity, exports, product/output profile and structure, growth

- Socio-political changes
- e.g. (Un)employment, gender roles and positions, leisure patterns, military power

- Environmental impacts
- e.g. Local wastes, emissions and ecology, global impacts.

- Other

innovation was increasingly seen as a major constraint on useful analysis - in particular the omission of indicators to reflect difference in their qualitative significance, as well as the exclusive focus on technological innovations and the neglect of organizational types of innovation. Other limitations were noted with respect to indicators reflecting aspects of the *process* of innovation. These were coming to be seen as increasingly important issues because the innovation process links innovation inputs and outputs, and differences in the way this process occurred seemed to have important effects on the input-output relationship. But available indicators threw little light on such differences or their implications. The significance of these limitations became even more evident as the 'systemic' nature of innovation was increasingly recognized as important, leading to a greater focus on interactions and knowledge flows between different actors as central to the effectiveness of the process of innovation.

These concerns led to a second major step in the international standardization of STI indicators: the OECD Guidelines for Collecting and Interpreting Innovation Data – the Oslo Manual (OECD 1992). The growing number of innovation surveys conducted under that framework led to a greatly increased availability of data to develop a new array of indicators – in particular: (i) about other, non-R&D inputs to innovation, (ii) about the outputs of innovations and their differing degrees significance, as reflected in their technological novelty (new to the world, to the market and to the firm), and (iii) about knowledge flows between actors involved in the process of innovation.

Over the next decade the scope of these standardized innovation surveys was further extended (Gault 2010: 37-44) in two ways: (i) to cover innovation in service industries as well as in manufacturing that had been the sole focus of the initial surveys, and (ii) to include forms of 'organizational' innovation that often seemed to be as important as the technological forms that had hitherto been the focus of attention. These developments were incorporated in revisions of the Oslo Manual and OECD/Eurostat (2005), the latest version, coves a substantially wider range of aspects of innovation than the first in 1992.[4]

2.2 Innovation indicators: data sources and paths of development

Innovation indicators are perhaps most commonly thought of as being based on sources of internationally comparable data such as those discussed above in connection with the development of the Frascati and Oslo Manuals: large-scale surveys, organized at a national level by government statistical agencies and applying internationally standardized definitions and methods. But this type of indicator accounts for only a small proportion of the indicators commonly used in analysing innovation activities. It is just the tip of a deep iceberg (Level A in Figure 2.1). The rest of the iceberg can be roughly split into two strata.

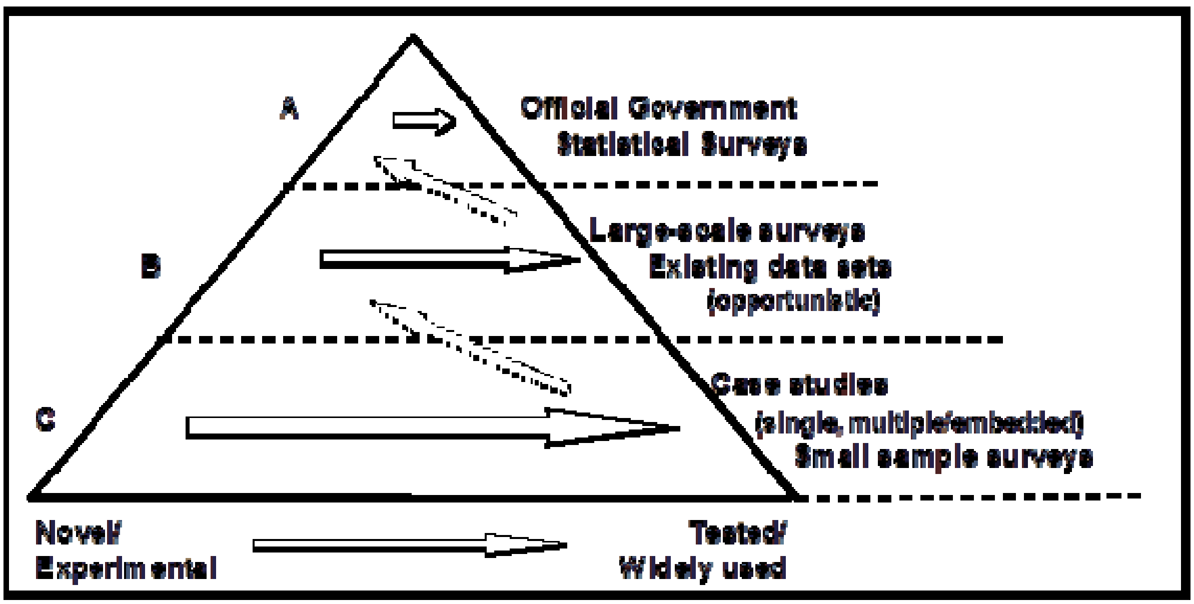
At the base (Level C) are indicators derived from, and largely used within, a wide range of case studies and small sample surveys. The cases in such studies may be about individual units of analysis (e.g. people, organizations or industries), or they may be about small groups of such entities – for instance, multiple contrasting cases embedded within a single comparative analysis. They may also rest on data from small-scale surveys – for example surveys of small samples of firms in an industry case study. This whole spectrum of analysis depends heavily on the use and development of indicators to reflect the characteristics of

[4] An interesting reflection of the broader scope of the later perspectives is provided by a change in the title – covering "Innovations" in general in 2005, rather than focusing only on "Technological innovations" in 1992.

interest. These may be expressed in numerical form, but they may also consist of qualitatively described classifications and differentiated categories. Almost all of the literature reviewed later in Section 3 is located at this level in the iceberg.

The level above that (Level B) consists of indicators derived from much larger original surveys designed to cover samples or populations numbered in hundreds or thousands of units. They may also be derived more opportunistically from existing data sets that have been compiled for other purposes – for example from the public administration of the patent system, or from statistics already collected about economic production or international trade. The first type of survey (purpose designed) may be undertaken by individual academics and research groups, or by organizations like consultancy firms; and they may be one-off or regularly repeated events. Here again a large and widening array of indicators has been developed to reflect a host of different aspects of innovative activity.

Figure 2.1 Innovation-related data and indicators: Sources and development paths



Source: Bell (unpublished)

However the constant development of new indicators is not merely located *at* one or other of the three levels. Figure 2.1 also illustrates a different kind of change involving horizontal and vertical *movement through* the iceberg. On the horizontal axis, indicators often start as novel and experimental constructs designed for the idiosyncratic purposes of particular studies. Over time some of them are found to be particularly useful and are replicated and re-used in different studies. As they are tested and perhaps refined, some may become well established and widely used as 'standards' for commonly analysed problems and questions. In such instances, particular indicators may rise vertically up the iceberg. If they have been initially developed and refined in case-study applications at Level (C), they may be adopted for use in larger scale surveys, perhaps initially on an experimental basis again – thus shifting both upwards and leftwards in Figure 2.1. Similarly, some types of well-tested indicators based on data from large-scale surveys at Level (B) may come to be seen as illuminating particularly important issues at a national level, and data to construct them may be sought via official government surveys at Level (A).

An important feature of these kinds of development paths is the evolution of conceptual consolidation and indicator standardization. As particular questions about aspects of innovation emerge as especially interesting or as particularly relevant to policy or management concerns, the growing body of research in that area tends initially to develop a diversity of different ways of conceptualising the phenomena involved. Different approaches to classification, measurement and indicator development follow, and for a time it is often difficult or impossible to do either of two things: (i) compare meaningfully between different analyses that are supposedly about similar issues, and (ii) combine the results of such analyses in order to derive more aggregated and generalizable observations. Such phases of diversity and disaggregation can occur at both Levels B and C in the iceberg structure, but are inherently less likely at Level A.

But such diversity of concepts and indicators may come to be consolidated and standardized as part of the process of moving to the right across Levels B or C. This may permit aggregation and comparison - for example in meta-analyses of large bodies of case study material. On the way, of course, diversity and individuality is lost; compromises are made to achieve standardization; and simplification inevitably loses sight of aspects and issues thought important by some of the participants in the process.[5] These difficulties may be particularly significant as one moves upwards in the structure because, for example, case study analysis typically works with a much wider diversity of questions and data categories than large surveys. Consequently considerable simplifications, omissions and compromises are likely to be required to move up from Level C to Level B. Those may be greater still in efforts to harmonize and simplify into international frameworks at Level A the diversity of approaches that have been developed in different countries at Level B.

This issue is a matter of considerable importance later in the paper (Section 3) where a review of two different bodies of case-study literature about grassroots-participatory innovation suggests that in one of them hardly any of this conceptual consolidation and indicator standardization has taken place. Diversity and differentiation still dominate even after thirty years, and little or no comparative or aggregated analysis of the material is possible.

The aspects of STI indicator development noted above highlight the importance of a simple issue. The process of developing the types of indicators that are most commonly discussed (those at the standardized tip of the iceberg structure) has been deeply embedded in a system of research and analysis. This system does not simply use those indicators. It creates them, develops them and aligns them with the interests and needs thought important by the participants – though for the most part so far those have been participants in the advanced economies.

This process underpinned the development of the first major step in the international standardization in the Frascati Manual. This did not simply drop into use as the result of a bureaucratic initiative. Its development was deeply embedded in and emerged from a large number of experiments and disparate surveys designed to try and measure the scale and

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[5] But this is not necessarily a one-way street. Elements of renewed diversity may be introduced if needs and interests call for them. Indeed, the design, management and funding of research can combine consolidation and standardization with elements of newly needed experiment and diversity - as reflected in the successive revisions of the Frascati and Oslo manuals.

composition of various kinds of scientific and technological activity. Starting with surveys by the US National Research Council in the 1920s, these were undertaken in different ways by individual academics and a wide variety of government organizations in the United States, Canada, the UK and several other European countries over subsequent decades until diversity began to converge around the methodology of the US National Science Foundation in the late 1950s. With minor variations, it was this long-evolved framework that became the core of the system that was standardized in the OECD manual.

The same was true of the other major steps in indicator development noted above. For example most of the key elements of the Oslo Manual emerged from several decades of detailed analyses and experiments with indicators relating to such things as patterns of knowledge flow among innovation actors, the role of non-R&D inputs to innovation, the nature and role of innovation outputs with varying degrees of 'significance', the characteristics of organizational innovations, or the particular characteristics of innovation in the service sector.

In other words, in the context of the advanced OECD economies, the innovation indicators that have come to be available internationally at Level A have been 'grown' endogenously within a deep system of research and analysis, and largely by evolving first through Levels B and C.

In contrast, it has been common for developing countries to skip directly to Level A at the top of the iceberg by transferring the necessary 'technology' (frameworks, methods and practices) from the more advanced economies. For example, this approach to developing their indicator systems is currently being followed by governments in a number of African countries (NEPAD 2005). When such imitated indicators adequately reflect aspects of innovation activities that are important in the different contexts, it is a huge advantage to be able to by-pass the costs and time that would otherwise be needed to develop a portfolio of appropriate indicators *de novo*. Governments can fairly rapidly generate useful information that is instantly comparable with corresponding information about a wide range of other countries.[6]

This potential advantage is not available, however, with respect to grassroots-participatory modes of innovation in agriculture because existing innovation indicators can shed little direct light on these particular modes of innovation. But even that dim illumination may be useful in a less direct way because a significant part of the work on indicator development in the advanced economies has been concerned with identifying different modes of innovation and their relative effectives in achieving innovation outputs.

For example, a pioneering study of different ways of organising and managing innovation in industrial firms (Burns and Stalker, 1961) distinguished between 'mechanistic' and 'organic' modes of innovation. This study was clearly located at Level C in the iceberg structure – based on observations in about twenty firms, with the distinction between the two modes resting on qualitatively descriptive indicators derived from contrasting observations of eleven

[6] But when the existing array of readily imitable indicators is less well aligned with the more important aspects of innovation activity in the new contexts, the consequences can be less fortunate. The existence of highly visible indicators about relatively low priority aspects of innovation activities and processes can help to keep policy makers' attention focused on those issues; while the absence of adequate indicators about higher priority issues can help to leave those issues low on the policy makers' agenda – or even off it altogether.

aspects of organization and behaviour. One of the main conclusions of this work was that, although there were differences in effectiveness between the two modes, neither was pervasively superior in all circumstances. Each of them was more effective in achieving different kinds of innovation in different circumstances.

This has subsequently been a common theme in the analysis of innovation. For example, in another pioneering study, Pavitt (1984) used a small number of indicators derived from a survey of innovations to demonstrate that different ways of organising innovation were used in different kinds of industry.[7] This led directly to later studies that identified different kinds of 'sectoral innovation systems' that could be characterized by a relatively small number of indicators. Particular modes of innovation were found to be sector-specific – i.e. found to be effective for achieving some forms of innovation in some kinds of sector, but not for achieving other kinds of innovation in others.

The creation of rich data sources from Oslo Manual-type innovation surveys has opened up new ways of examining this issue. These have drawn heavily on indicators about the *process* of innovation (in particular about different types of knowledge, different patterns of knowledge flow, and different kinds of organizational structure and behaviour); and they have integrated those indicator arrays via cluster analysis methods to identify distinctly different ways of undertaking innovation. For example, Jensen et al. (2007) identified two different modes of innovation in Danish manufacturing firms: a 'Science-Technology-Innovation' (STI) mode and a 'Doing-Using-Interacting' (DUI) mode. Neither of these was pervasively more effective than the other. Each was relatively successful for particular kinds of firm in particular circumstances, and the combination of the two was most effective in yet other kinds of situation. In another example, Tether and Tajar (2008) used a purpose-designed survey to identify three different ways of undertaking innovation in European manufacturing and service firms. One of these was an 'organizational-cooperation' mode of innovation. This differed substantially from more conventionally recognized forms of technological product and process innovation and, as in other studies of this type, it was found to be characteristic of innovation in a particular kind of context – in this case among particular groups of service sector firms.

As noted above, these kinds of analysis and application of innovation indicators can illuminate questions about grassroots-participatory modes of innovation in agriculture only rather indirectly. That may be useful in two respects. The first is about research design and methods – for example about the use of cluster analysis techniques to address questions about different modes of innovation and their relative merits. The second is about underlying perspectives in addressing policy or management questions about grassroots-participatory *processes* of innovation – in particular about recognising the context-specificity of different ways of achieving innovation, rather than setting up the questions in terms of identifying single best ways of organising innovation pervasively across all agricultural circumstances.

But, with respect to more specific issues about innovation indicators and grassroots participatory modes of innovation, the kinds of studies sketched above offer nothing that would be useful. In other words an imitative approach to indicator development is more or less impossible since there is virtually nothing relevant to transfer. The key issue must

[7] Although this analysis developed and used indicators based on a Level B-type survey, it relied heavily on prior case studies that had identified some of the variables that seemed relevant to the differentiation of sector-specific modes of innovation.

therefore be about a process of endogenous creation and development. The main purpose of this paper is to examine the extent to which that is under way (Sections 3) and to explore how it might be taken further forward (Sections 4-7).

2.3 The development of agricultural innovation indicators

The approach to developing and using agriculture-related STI indicators has been similar in several respects to that outlined above in connection with manufacturing and services. There is a body responsible for supporting and coordinating the national compilation of internationally comparable statistics - not the OECD but the Agricultural Science and Technology Indicators (ASTI) initiative at the International Food Policy Research Institute (IFPRI), one of the component organizations of the Consultative Group for International Agricultural Research (CGIAR). Also, the ASTI-supported collection and processing of data about agricultural R&D follows the basic principles and methods of the OECD Frascati Manual.

However, in one important respect the two approaches have been different: the range of innovation indicators is much more limited for agriculture than for the industrial and service sectors. There has not been for agriculture an equivalent process to the continuing development of new data and indicators about manufacturing and service sector innovation that followed the initial development of the Frascati framework. Nevertheless, a new impetus to engage in such a process has emerged in the last few years. This opening up of what may be a new phase of debate about innovation indicators is a potentially important part of the context for the issues about grassroots-participatory innovation that are discussed later in this paper. Comment is therefore provided here about two aspects of that situation: (i) the relatively narrow range of existing agricultural STI data and indicators, and (ii) aspects of the recent debate about widening that range.

(i) The narrow range of Agricultural STI indicators

The statistics and indicators developed through the ASTI initiative via national Level A-type surveys cover only a relatively limited range of the categories listed earlier in Table 2.1. The main focus is on *inputs* to innovation, but this covers only R&D and its funding and performance by formally organized R&D actors in government, higher education, large business enterprises and the donor-NGO community. Innovation *output* data and indicators are also available, but on a less systematic and regular basis via Level B-type surveys or case studies at Level C. These include, for example, data about new varieties released from plant breeding, from which it is possible to develop estimates of the rate of release (an indicator of the scale of output from R&D)[8] or the speed of release relative to the start of the research (an indicator of the performance efficiency of R&D). It is also common to collect data about the *implementation* of innovation by farmers, usually described as their 'adoption' of new technologies developed by formally organized R&D. These data permit estimates of the rate of adoption – an indicator commonly used to reflect the output performance of R&D.

Considerable use is also made of statistical data about the economic aspects of agricultural production, providing indicators of such things as the scale of production, land yields, capital and labour productivity, and total factor productivity. These in turn are commonly used to assess *ex post* the long-term impacts of R&D-based innovation, as in numerous estimates of the rate of return to R&D – in aggregate or disaggregated in various ways (e.g. by crop-

[8] Alene et al. (2011) provide a recent example of the use of this indicator, as well as the limitations and difficulties, in a study of the effectiveness of agricultural R&D in Sub-Saharan Africa.

specific categories). Similar impact analyses are used *ex ante* to assess the prospective returns to R&D so helping to shape both the overall scale of resource allocation to R&D and its orientation towards particular purposes – hence, it is hoped, influencing both the rate and direction of innovation.

One kind of limitation cuts across these indicators of inputs, actors and outputs: apart from the execution of formally organized R&D by large farming enterprises, these parts of the system of indicators take virtually no account of farmers as actors in the innovation system, either as suppliers of inputs to innovation or as producers of innovation outputs. Instead, farmers (especially smallholder farmers) only come into the picture as 'adopters' of ready-to-use technologies after they have been developed by non-farmer actors. This is reinforced by a limitation in the treatment of innovation outputs. There appears to have been no development of indicators to reflect qualitative differences in the 'significance' of innovation outputs – for example, distinguishing between 'radical' or new to world/new to market innovations and those that are 'incremental', 'new to farm' or 'new to village'. Since farmer roles are likely to be more concentrated at the end of the spectrum concerned with incremental or new to farm/village innovations, the statistical invisibility of that type of innovation (compared to the kind of innovation that, for example, meets the formal requirements to be registered as a 'new variety') adds to the statistical invisibility of farmers as actors in the innovation process.

Consequently, if it happens to be the case that farmers themselves play more significant roles in the innovation system than merely adopting innovations developed by other actors, the STI indicator framework would be failing to measure perhaps a large part of the innovation system. The review of literature about grassroots participatory innovation in Section 3 of this paper suggests that this may not be an entirely fanciful speculation. There is evidence that farmers, including smallholder farmers, *do* play more significant roles. What is unclear is quite what those roles are, how significant they are, and how that significance varies across different agricultural circumstances.

The possible importance of farmers in the innovation process highlights a further large gap in the framework of available indicators of agricultural innovation. Very little attention is given to aspects of the innovation *process* – Block 3 in Table 2.1 earlier. There is little or no structured data about different forms of knowledge used in innovation – for example, research-derived and experience-derived knowledge, a distinction that has been found to be important in a growing number of studies of different modes of innovation in the advanced OECD countries. Nor are data available about knowledge flows in innovation. The general presumption is that, as a fairly uniform pattern, most of it flows one-way to innovation-adopting farmers from formal public or private R&D organizations – a pattern found to characterize only some modes of innovation but not others in OECD economies. In connection with organizational aspects of the innovation process, structured data and indicators are available about very macro-level differences and changes (e.g. between public and private or national and international). Also, at the level of case studies, some attention has been given to extremely micro-level issues such as management practices in laboratories. But there seems to be no structured information about differences in broader aspects of organizational structure and process in undertaking innovation - in particular those concerned with different forms of division of labour between various actors, including farmers, and the modes of coordination between them.

This process-related gap in the framework of available STI indicators is matched by a gap in the large body of analysis that seeks to explain differences in what are commonly taken to be aspects of the output or impact (or performance) of innovation activities - for example rates of adoption of technologies or, more indirectly, rates of growth of agricultural productivity. In very broad terms, the explanatory factors most commonly examined are about characteristics of (i) the technology adopting farmers, (ii) the market and other aspects of the socio-institutional context of farms, (iii) the technology (e.g. its appropriateness and profitability), and (iv) the scale of R&D inputs. Very rarely examined are aspects of the *process* of innovation.[9]

However, as noted earlier, studies of innovation in the manufacturing and service sectors in OECD economies have suggested that differences in aspects of process influence the relationship between inputs and outputs. Moreover, when integrated with differences in knowledge inputs and types of output, these kinds of process-related differences were important in differentiating modes of innovation that seem to be particularly effective in particular circumstances. As suggested later in this paper, there seem to be grounds for thinking that similar relationships may hold for modes of innovation in the context of smallholder agriculture. For example, there is fragmentary evidence to suggest that, compared with conventional modes of plant breeding, grassroots-participatory may be associated with (i) the development of more appropriate (and hence more profitable) innovations in risk-prone and heterogeneous environments, (ii) faster varietal release, and (iii) faster rates of technology adoption. In some circumstances they may also be associated with lower inputs of formal R&D personnel 'per unit of innovation'. This is in principle potentially important issue in contexts where such staff resources in formal R&D are extraordinarily scarce - such as most of those in Africa, including South Africa (Beintema and Stads 2011).

(ii) A new debate about widening the range of agricultural STI indicators

Over the last five years or so there has been renewed interest in agricultural STI indicators, especially with reference to their adequacy for informing policy and management in developing countries. A combination of three issues appears to have prompted this interest. Firstly, as with concerns about indicators relating to innovation in industry in OECD countries in the post-Frascati/pre-Oslo years, growing interest in bringing innovation system perspectives to bear more strongly on agricultural innovation (e.g. World Bank, 2007) appears to have prompted questions about the adequacy of an indicator framework that concentrates so heavily on indicators of only R&D inputs. Secondly, the revival of interest in policy issues about agricultural development, especially in Africa, has contributed to raising questions about agricultural innovation higher up the agendas of policy-makers and donors. Thirdly, more specifically the Bill and Melinda Gates Foundation has committed substantial new funding to work concerned with agricultural STI indicators.

Three initiatives can be used to reflect some of the main features of this renewed interest: (i) a number of studies and an international consultative conference organized by The Technical Centre for Agricultural and Rural Cooperation (CTA) (Daane, et al., 2009); (ii) a consultation

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[9] An exception is the study of long-term agricultural development in Japan from the late 19th century by Hayami and Yamada (1991). This sought to explain different phases of productivity growth in agriculture and it brought 'institutional aspects' centrally into that analysis. Among these were aspects of what is discussed here as the 'process' (or 'mode') of innovation; and one form of process in which experienced farmers (*rono*) played significantly active roles was identified as particularly important in explaining high rates of productivity growth (especially in land yields) at the end of the 19th century and early 20th.

workshop organized by the Agricultural Science and Technology Indicators initiative (ASTI, 2009); and (iii) the exploratory development of a new overall agricultural STI indicator (Spielman and Birner, 2008; Spielman and Kelemework, 2009).[10]

The reports on all three of these initiatives frame their questions about indicators in 'innovation system' perspectives, and this leads to a common emphasis on exploring the development of a wider range of indicators than those currently available. This was particularly clear in the ASTI workshop about "Identifying *Supplementary* Indicators". After an opening component about adopting an agricultural innovation system perspective, its agenda centred on four aspects of a possibly wider array of indicators: (i) deepening the traditional input indicators, (ii) extending output indicators beyond immediate outputs (e.g. new plant varieties or published papers) to include longer term impacts and the impact pathways running to them from R&D; (iii) identifying process indicators covering, for example, linkages in R&D networks; and (iv) developing indicators about aspects of the international dimensions of national systems. The exploratory study by Spielman and Kelemework (2009) provided a similarly extensive perspective – integrating 41 different indicators of aspects of innovation systems into a single Agriculture, Development and Innovation Index (ADII).

However this emphasis on widening the scope of the current indicator system may deliver less than initially promised. In the case of the ASTI workshop, for example, one of the main conclusions was that "rather than expanding the number of indicators," ASTI should "invest more in the analysis and use of the current set of indicators" (p.2). This was especially so in the case of additional input indicators where the conclusion was that the necessary data should only be collected in response to a clear need expressed by policymakers.

More positive views about widening the scope of indicators arose only in connection with output (or performance) indicators. In particular, following an introduction about innovation system frameworks, the CTA initiative (Daane, et al., 2009) concentrated almost entirely on performance indicators running along impact pathways from short term outputs to longer term impacts concerned with such broad concerns as improved rural livelihoods, sustainable use of natural resources, competitive agro-product chains, and equitable development. The conclusions from the ASTI workshop were also positive about improving output indicators. However, rather than widening the range of these, the recommendation was that any increased effort in this area should focus on collecting more systematically a limited range of existing types of indicators (e.g. about new varieties, 'new technologies', patents and publications)[11].

From the perspective of this paper, it was in the treatment of process indicators that the initial questions about widening scope were most significantly narrowed down. Apart from the limited direct attention given to the process category in these reports, one other issue

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[10] These are not the only initiatives in the area, but they seem to reflect the broad features of what has been happening more widely.

[11] The part of the discussion that centred on "new technologies" raised a particularly interesting issue about how to define them. This led to the conclusion that: "The great disadvantage when trying to measure new technologies is that there is no internationally accepted standard for what constitutes a new technology ….. Therefore in order to construct a meaningful output indicator, it is necessary to develop a definition of what constitutes a new technology and the various forms it can take." (p.6). This is reminiscent of the discussion about qualitative differences in the significance of industrial innovations that led to the classification of different types of innovation output in the Oslo Manual.

contributed to this narrowing. The perspective on innovation systems seemed to be interpreted only at an aggregated national level and in terms of a fixed structural system configuration. This involved *given types* of inputs (largely inputs of formally organized R&D), *given types* of actors (largely the array of formally organized R&D performers), and *given types* of linkages (largely those that run among the R&D actors and from those innovation-producing organizations to technologically passive innovation-adopting farmers). These system dimensions might be quantitatively increased (e.g. higher levels of R&D expenditure) or strengthened (e.g. more numerous links among formal R&D performers). But the structure of elements in 'the' national system was seen as essentially fixed.[12] Hence, there was little interest in possible indicators of *different types* of innovation processes which, relative to the 'standard' existing system configuration, might involve for example the use of *different types* of knowledge by *different types* of innovation actor, involving *different kinds* of knowledge linkages, and perhaps leading to *different types* of innovation outputs and *different kinds* of technological change paths in smallholder agriculture.

This interpretation was particularly striking in the development of the Agriculture, Development and Innovation Index (ADII) by Spielman and Kelemework (2009). The primary purpose of the ADII was to permit benchmark comparisons to be made between the overall innovativeness of aggregated national agricultural innovation systems. What was not considered in this or the other reports was the possibility that qualitatively different structural configurations of innovation process might exist in particular circumstances at levels of aggregation below the national entity. This forecloses on policy debate about whether differences in such sub-national modes of innovation might have important implications for system outputs and performance, and hence about whether some of them might be much more widely used than at present. Sections 3-7 in this report explore whether such questions might be relevant in the case of grassroots-participatory modes of innovation, and whether this might warrant the development of different kinds of innovation indicator.

3 GRASSROOTS AND PARTICIPATORY INNOVATION: PREVIOUS ANALYSIS AND INDICATOR DEVELOPMENT

As noted earlier, grassroots innovation, as examined later in the case studies in this paper, are treated together with a much wider range of modes of innovation in smallholder agriculture with broadly similar features that distinguish them from more conventional ways of organising agricultural innovation. The significance of these different ways of innovating began to be recognized by agricultural and social scientists and development officials in the late-1970s. Then, over the thirty years since the early 1980s their use, predominantly in smallholder contexts, has expanded in scale while developing a widening diversity of approaches.

Three strands of literature have contributed to, and reflected on, these efforts to implement new forms of agricultural innovation. The first consisted of a number of studies that opened

[12] This interpretation of the innovation system perspective therefore loses sight of its main original purpose in the works of its originators like Chris Freeman, Richard Nelson and Bengt-Åke Lundvall – to act as a framework for analysing *difference* in system configurations and characteristics. It also has no connection with the extensive literature about different modes of innovation as reflected, for example, in structurally different 'sectoral' innovation systems.

up new perspectives in the 1960s and 1970s, acting as a stimulus to the initiatives taken from the 1980s. The second and third have run in parallel with the initiatives undertaken since then, but they have examined them in different ways. One has compiled extensive case studies to promote and report on grassroots-participatory activities, but has contributed little to developing innovation indicators to aid policy and management analysis. In effect, this body of case studies has not moved very far horizontally across Level (C) in the iceberg illustrated earlier in Figure 2.1. The other also consists of case studies, but has been more focused on evaluating grass-roots-participatory innovation. This body of work has contributed substantially to the development of innovation indicators in this area – in effect, moving a considerable distance across Level (C). These three strands of commentary are reviewed below.

3.1 Early perspectives on alternative modes of innovation: Emerging system concepts

The alternative modes of innovation that attracted increasing attention in the 1980s were prompted in large part by three areas of growing understanding about agricultural innovation in developing countries: (i) the limitations of the formally organized innovation system, (ii) the significance of informal and decentralized innovation by farmers, and (iii) the potential gains from linking more closely the formal and informal systems.

(i) The limitations of prevailing formally organized innovation systems

Concerns in the first of these areas focused on the limitations of the innovation process that had underpinned the Green Revolution in the 1960s and 1970s. A key feature of this process was its organizational specialization and centralization. It involved a high level of specialization and division of labour between the component activities involved (e.g. between basic research, applied research, technology development and testing, extension activities and finally the implementation and use of technologies). The 'front-end' of these activities, together with several others, was often highly centralized internationally (e.g. in the international centres like CIMMYT and IRRI that came to constitute the CGIAR). Beyond that, within individual developing countries, applied research, technology development and testing, and even extension, were commonly concentrated in central locations at considerable distances from the final activities of implementing and using the new technologies.

As it manifested itself in developing country contexts, this combination of activities has frequently been described as a 'linear', one-way, technology-transfer process. But it is worth bearing in mind that it was no such thing in the context of the advanced economies where, by the mid-twentieth century, these arrangements had evolved over two centuries or more. In those contexts the process did not merely involve a one-way flow of knowledge and technologies from researchers to farmers. Knowledge and information also flowed in the other direction from farmers to researchers, together with farmer-driven influence and demand on the R&D process. At the same time this bi-directional R&D system was linked into a network of other actors, many of them business enterprises, which developed and supplied various component elements of the technologies finally used. Those complex interacting networks of innovation actors were embedded in wider institutional contexts. Two parts of these were particularly important in ensuring that the activities on the 'supply side' of the innovation process (in particular the increasingly specialized and differentiated upstream R&D activities) were reasonably well aligned with farmers' needs and conditions on the demand side: (i) commercial markets in the case of private supply-side actors, and (ii) the political influence and representation of farmers and farming communities in the case of publicly funded suppliers. These institutions were combined in differing ways across societies and over time, and their effectiveness also varied, but in general they played an important system-integrating role – in effect ensuring that supply-side actors were ‘accountable’ to clients – through either commercial or political mechanisms.

As it evolved over time, that complex, interactive, networked and institutionally embedded system had been highly effective in the advanced economies in generating the technological basis for agricultural innovation and development.[13] However, the system was much less effective as it travelled outside the advanced economies from about the 1920s. Arguably this was because, as attempts were made to move it around the world, only some of the component parts of the system were moved – usually just the upstream, centralized, publicly funded and publicly performed R&D components.

Nevertheless, even when elements of this R&D spine of the system were transferred to developing countries such as Mexico, the Philippines and India in the 1940s - 1960s, they were again highly successful. They developed the Green Revolution technologies that transformed agriculture and rural livelihoods in large parts of the developing world, especially in Asia and Latin America. These parts were characterized by: (i) considerable agro-ecological homogeneity over substantial areas, combined with relatively simple farming systems; (ii) significant capital support for farming in the form of infrastructure such as roads and irrigation, and perhaps also machinery; (iii) relatively low levels of risk of wide yield variations; and (iv) relatively strong connections to supporting institutions such as markets for inputs, outputs and credit. In those contexts the new technologies for high-yielding rice, maize and wheat production, were rapidly introduced on both large and small farms, albeit more slowly on the latter.

However, the revolution was much less successful in contributing to agricultural change in other large parts of the developing world with different contexts for agricultural production. It was increasingly argued that this reflected limitations in the underlying centralized innovation process. This was seen as being unable to provide the kinds of technology needed in differentiated, complex, usually rain-fed and risk-prone agro-ecological environments with limited access to infrastructural capital goods and markets.[14] This was particularly problematic because farming in these contexts typically provides a substantial, though variable, part of the livelihoods of large proportions of smallholder and ‘resource-poor’ farmers in Asia, Latin America and especially Africa. Efforts therefore began to be made to explore alternative approaches to research and innovation that would be more effective in these types of context.

(ii) The significance of informal and decentralized innovation systems

This second area of growing understanding was about kinds of innovative activity that were organized in a radically different way: the informal and decentralized innovative activities of resource-poor farmers themselves. Part of this understanding came from studies that challenged the stereotypical characterization of resource-poor farmers as ‘irrational’ technological laggards who persisted in using apparently inefficient and outmoded agricultural technologies. For example several studies in the early 1970s demonstrated that mixed cropping was a rational strategy for African farmers – e.g. Leakey (1970) and Belshaw and Hall (1972) in East Africa, and Norman (1974) in Northern Nigeria. These studies called

[13] Though many have questioned the extent to which, in recent decades, innovation has been led by the dominant influence of market institutions towards increasingly industrialised forms of agriculture.

[14] The introduction of farming systems research by some centralised R&D organizations had limited success in addressing the challenges faced in these kinds of context.

into question the value in those regions of centralized agricultural research and extension that had hitherto concentrated on supposedly superior single-cropping strategies.

These studies also drew attention to the existence of significant bodies of local technical knowledge that underpinned persisting use of such local technologies. Often described as ‘indigenous technical knowledge’, these knowledge systems were frequently seen merely as repositories of static understanding inherited from the past, along with the ‘outdated’ operational technologies with which they were associated. However, a growing number of agricultural scientists began to report on the technological creativity of farmers engaged actively in various forms of continuing experimentation, testing and technology development. For example Brammer (1980) reported on applied research being undertaken by peasants in Bangladesh, noting that “some innovations don’t wait for experts”. Biggs (1980) summarized other Asian examples, noting that:

> “These examples show that the rural communities in different parts of Asia are not mere passive recipients of technology that is transferred to them from Western countries or formal research and development programmes. In agricultural communities there continues to be a dynamic and productive informal research system in its own right…” (p.25)

Richards (1985) identified such patterns of creative technology development by smallholder farmers in Sierra Leone and Nigeria. He also noted the disconnection between such grassroots innovation and the activities of formally organized agricultural R&D:

> “The conclusion to these case-studies is simple to state. West African food-crop producers are inventive, but development agencies rarely harness this inventiveness because they misunderstand the nature of both the agriculture and politics of communities where food production is a major interest. The consequences of these misunderstandings continue to permeate research and development directed at the small-holder farming sector.” (p. 116)

(iii) New perspectives on the linking of formal and informal innovation systems

As increasing recognition of the limitations of large parts of the formal agricultural R&D system began to merge with greater understanding of the innovative activity of smallholder farmers, there was increasing interest in exploring how the two kinds of innovation process might interact more effectively. This interaction was, for example, the focus of a workshop in 1978 (Chambers 1979) where one contribution (Bell 1979) sharply contrasted two types of interaction. Focusing on the local knowledge of farmers, he described one type as an ‘inside-to-out’ flow of technical *knowledge* that would be “extracted from its indigenous context” for use in contributing to centralized research and development. The other flowed from ‘outside-to-in’, so “augmenting and reinforcing” indigenous capabilities for creating, acquiring and absorbing technical knowledge. (pp. 49-50).

Biggs and Clay (1981) provided an important step in elaborating on that interaction, with an emphasis on the ‘augmenting and reinforcing’ perspective. They identified a dual structure in agricultural R&D systems, involving (i) a formal and centrally organized component and (ii) its informal counterpart. Noting the importance of the two components but also their limitations when acting on their own, the authors argued that in principle they were highly complementary. However the interaction between the two was highly variable in practice - as indicated by the dotted links (A) and (B) in Panel 1 of Figure 3.1. In some circumstances, as in the development of dwarf wheat varieties at CIMMYT in Mexico in the 1960s, these links were strong: important understanding from farmers' experience and problems was acquired by the formal system via Link (A) to inform research; and new technologies were effectively transferred via Link (B) for on-farm testing and use by farmers. But in other circumstances, such as those faced by resource-poor farmers in complex, heterogeneous and risk-prone environments, both of those connections were typically very weak or non-existent.

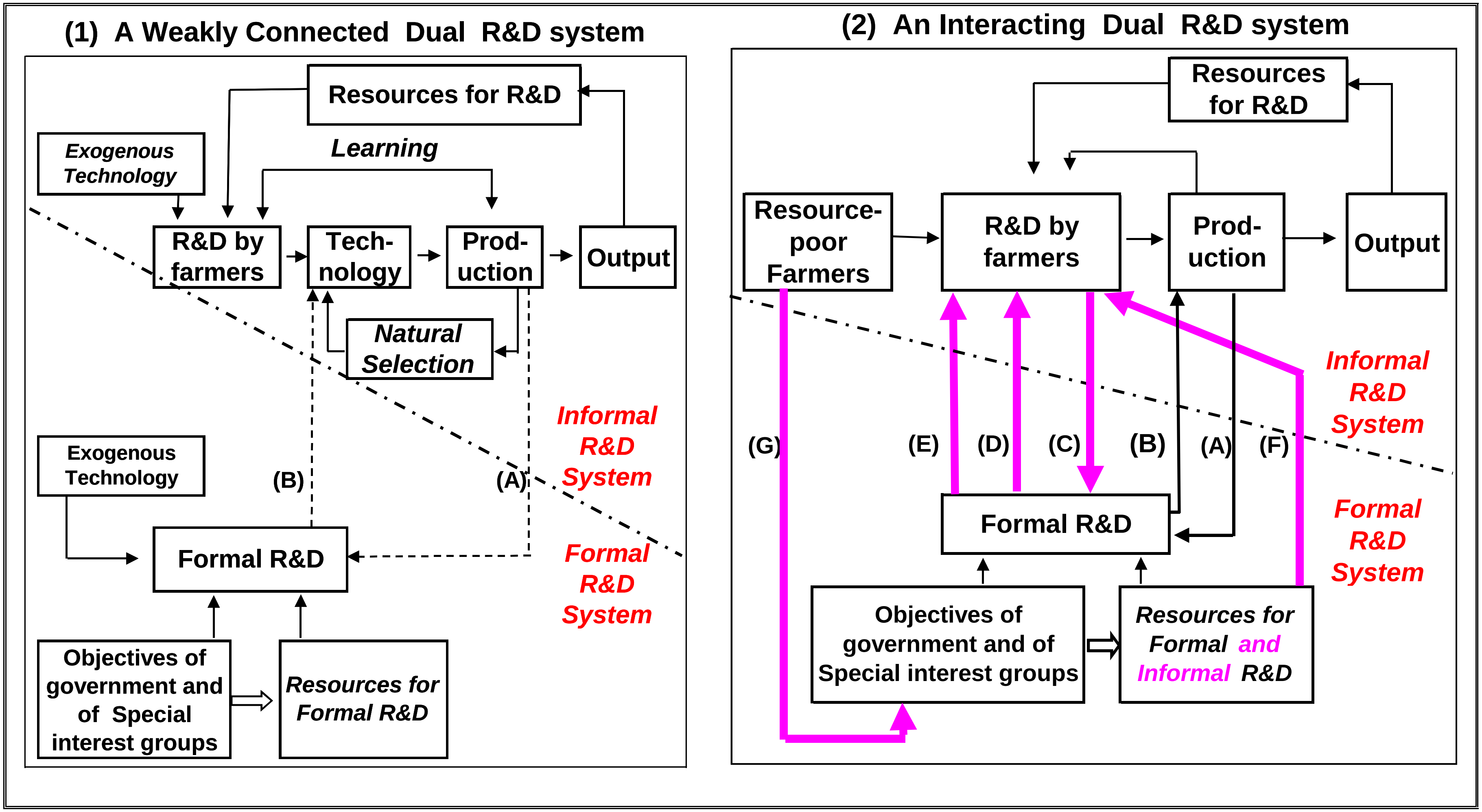
The authors further argued that the overall innovation process would gain from a wider range of stronger relationships between the two component sub-systems – as in Panel 2 of Figure 3.1. Formal R&D activities would be more effective if they included greater participation by farmers from the informal component of the dual system – so providing not only stronger and more pervasive feedback gathered by scientists and extension agents from the experience of farmers' production (Link A), but also knowledge provided by farmers from their own R&D activities at earlier stages of decision-making about objectives and plans for formally organized R&D (Link C). At the same time, local informal R&D would be more effective if the formal component of the system took more explicit steps to strengthen and reinforce the informal, rather than concentrating solely on trying to provide 'finished' technologies for adoption more or less directly in farmers' production (Link B). This would involve also providing greater opportunities for farmers to test, adapt and improve new technologies that were supplied into their R&D activities (via Link D), as well as supplying flows of knowledge, skills and methods to strengthen farmers' own R&D capabilities (via Link E).[15]

The authors argued that the decentralization of innovative activity achieved by these forms of greater farmer participation in the process could result in overall system gains – in two ways. First, innovation activities would not only achieve faster rates of innovation, they would also shift innovation in directions that more effectively addressed locally relevant demands, needs and opportunities. Second, other win-win gains might be particularly important in an era of tightening resource allocation to formal R&D and extension:

> "A further reason for strengthening local participation in technical innovation is the high cost of developing location-specific technologies for a diversity of environments …. Where farmers and groups can be encouraged to choose and adapt crop varieties, cultivation practices and input use to their own environment, the scale of the responsibilities weighing upon the formal system will be reduced to more manageable proportions." (p. 333)

[15] Others were less sanguine about the benefits of such complementary interaction. Richards (1985) for example noted that interventions by the formal R&D component in some circumstances could be diversionary, slowing down the rate of change in indigenous innovation activities. Consequently he argued that the formal component of the system might consider two kinds of strategy. One would be 'positive' - along the lines of the augmenting and reinforcing approach emphasised by Biggs and Clay. But the second would be a 'minimalist' strategy' that maintained a 'space' for peasant R&D by focusing specifically on the kinds of problems that farmers could not handle adequately by themselves.

Figure 3.1 A Dual Agricultural R&D System: Alternative Modes of Interaction



Source: Adapted in Bell (unpublished) from Biggs and Clay (1981)

But the potential for such strengthening was seen as highly constrained. Biggs and Clay were perhaps the first to raise the point that greater inclusion of smallholders in the overall innovation system would both raise costs for the farmers and involve re- allocating resources between the two components of the system – i.e. introducing Link F in Panel 2 of Figure 3.1. This highlighted the importance of the fact that both components of the innovation system were deeply embedded in wider political and institutional contexts.[16] These contexts shaped the modes of innovation undertaken, the resources allocated to them and the social distribution of benefits arising from them.[17] The implication was that if greater resources beyond those of smallholder farmers themselves were to be allocated to their informal innovation activities (via Link F), then resource-poor farmers would need to compete with other interest groups and effectively influence government objectives (Link G) in order to change the distribution of resources between formal and informal innovation.

From the mid-1980s variations on these ideas about the two forms of innovation and their interaction attracted growing attention from funders of agricultural development and practitioners in national and international research and extension organizations, and also in a wide range of development NGOs. Projects to implement and test new forms of 'participatory' R&D and 'grassroots' innovation proliferated. In effect, a growing body of experiments were made to develop and implement radically novel ways of organising agricultural innovation.

At the same time, as noted earlier, two parallel streams of studies over the next twenty-five years examined the experience of these projects. Yet the two strands were surprisingly disconnected, with very limited cross-linking between them. One, reviewed in Section 3.2 below, was a widely publicized body of work that provided a rich descriptive reportage on numerous projects and programmes, using qualitative analytical perspectives on their key features and effectiveness. But it has neither developed nor used systematic indicators of innovative activities to support that analysis. The other, reviewed in Section 3.2, was a much less visible stream of work that has been more systematically evaluative, and has developed and applied not only an analytical framework to reflect key features of these non-conventional approaches to innovation, but also a set of indicators to illuminate analysis and policy.

3.2 Promoting and reporting on 25 years of innovation: An indicator-free approach

Much of this first strand of literature consisted of detailed case-study observations of the proliferating experiments and innovations. Many of these have been published as individual

[16] At least in some parts of the discussions on this issue the term 'institutions' was used to refer not merely to 'organizations' (e.g. research institutes), but more widely to social political and cultural structures, processes and norms that shaped innovative activity. Biggs and Clay (1981) for example noted that "economically and politically superordinate elements within agricultural societies" would be likely to capture disproportionate shares of the benefits from innovation, while special interest groups and vested interests embedded within organizations would be likely to shape the activities of, and the technologies generated by, formal research programmes.

[17] In this respect, these ideas about the importance of the institutional, including political, context of agricultural R&D systems in developing countries anticipated an important component of the later development of innovation system concepts with reference to industrial innovation in advanced economies (e.g. Freeman, 1988; Lundvall, 1992; and Nelson, 1993).

reports, journal papers and book chapters.[18] But a large number have been compiled in a series of widely publicized books. Six of these, probably the more widely known, are listed in Table 3.1, and these are used as the main basis for the review in this section of the paper.[19]

Table 3.1 Grassroots/Participatory Innovation: Selected Compilations of Case Studies since 1989

Chambers et al. (1989) *Farmer first: Farmer innovation and agricultural research*	Proceedings from a seminal 1987 workshop and included 7 illustrative cases of practical applications of participatory methods. Most projects involved inside-to-out knowledge flows from farmers to improve centralized research.
Haverkort et al. (1991) *Joining Farmers' experiments: Experiences in participatory technology development*	Drew on 16 illustrative cases of participatory technology development, highlighting the importance of outside-to-in processes designed to support and reinforce farmer innovation.
Scoones and Thompson. (1994) *Beyond farmer first: Rural people's knowledge, agricultural research and extension practice*	A wide array of papers included 26 reviews of cases of participatory projects and autonomous farmer innovation. These highlight under-emphasized dimensions of changing innovation processes – concerned with knowledge and power relationships; participatory behaviour, attitudes and methods; and institutional constraints.
Reij and Waters-Bayer (2001) *Farmer innovation in Africa: A source of inspiration for agricultural development*	Provides outlines of 28 cases of farmer-led innovation and participatory projects supported through two donor-funded programmes in the 1990s. Notes limitations of previous participatory innovation activities as scientist-led to support centralized R&D. Stresses farmer innovation and farmer led initiative as more effective basis for developmental innovation. Emphasizes aim of strengthening farmer capabilities to sustain continuous and cumulative innovation paths.
Scoones and Thompson (2009) *Farmer first revisited: Innovation for agricultural research and development*	Examination of twenty years' experience included reviews of about 27 specific cases of bottom-up, farmer-centred technology development and innovation projects. Notes flourishing proliferation of methods, processes, actors and networks, aims and perspectives, with growing emphases on personal and professional behaviours and reflexivity. But participatory/grassroots activity is still only marginal to mainstream practice. So questions about governance of innovation systems, bureaucracy and political processes are important.
Sanginga et al. (2009a) *Innovation Africa: Enriching farmers' livelihoods*	Included 18 case studies of African experience of grassroots/participatory activities. These explore moving beyond the formalities of participation to more collaborative partnerships, and emphasize the need to embrace a wide range of actors and market-led processes in innovation systems. Again the call is for more emphasis on farmer-led innovation capability building, both in farmer groups and organizations and among agricultural development professionals

Numerous threads can be identified running through this literature. Three have been selected as particularly relevant for the purposes of this paper: (i) changing emphases within a widening array of aims and challenges; (ii) increasing diversity and differentiation in

[18] This literature stretches beyond material that explicitly focuses on the characteristics of these innovation processes. It also includes the scientific and technical literature that notes aspects of participatory processes only as incidental features of reporting on scientific and technical issues. For example Kongo et al. (2010) briefly comment on aspects of the "participatory approach" that was used in a hydrological monitoring study in South Africa – incidentally in the same village area as the case studies reported later.

[19] We do not claim either that these compilations are systematically representative of the wide body of literature on grassroots/participatory innovation or that the experiences they review about 120 illustrative cases) are representative of the even wider range of practice in this area. Nor do the selective comments here constitute a systematic review of even this body of work.

analytical perspectives and approaches to practice; and (iii) the limited development and use of STI indicators for analytical and policy purposes.

(i) Changing emphases, aims and challenges

Until the early 1980s the primary aims pursued by advocates of participatory approaches to innovation were concerned with two outcomes: (i) increasing the *rate* of implemented innovation and (ii) shifting its *direction* to be more aligned with meeting the needs of disadvantaged farmers, primarily in smallholder contexts. The impacts of such approaches were seen mainly in terms of more frequent implementation of technological changes that were more 'relevant' to resource-poor/small-holder farmers – with the greater relevance contributing to the increased frequency of implemented innovation. But other kinds of impact were also envisaged at that time, and these were extended and given greater emphasis over later years.

- The early aims about poverty reduction were later reinforced as this issue rose to a dominant position in the development agenda, becoming embedded at the top of the Millennium Development Goals in 2000.
- Rather than merely focusing on the implementation of individual steps of innovation, more explicit emphasis was given to the aim of strengthening farmers' own innovation capabilities – often explicitly seen as a means of fostering more continuous and cumulative processes of grassroots innovation.
- The early studies typically referred to gender-undifferentiated categories of farmers (e.g. 'resource-poor farmers'), but increasing emphasis came to be given to aims concerned specifically with the positions of women as both participants in agricultural (and other) technology development and as potential beneficiaries from associated innovation.[20]
- Although some of the early interest in 'informal' innovation included views that it was likely to contribute to more environmentally sustainable agriculture (see especially Richards, 1985), the pursuit of sustainable forms of agriculture became an increasingly explicit aim of grassroots/participatory modes of innovation.
- In recent years a further dimension has been added to that sustainability aim by emphasis on the importance of grassroots/participatory innovation as a basis for adaptive and resilient responses to climate change – a necessary complement to the contributions of more centralized and formally organized research and development that will be inherently unable on their own to meet the scale and diversity of the expected needs for innovation.

This widening range of aims and expectations about the potential impacts from, grassroots/participatory innovation processes raised the significance of two challenges facing practitioners and analysts in this field: one about the overall scale of efforts to implement grassroots/participatory forms of technology development, the other about the qualitative characteristics of those efforts

[20] This was reflected for example in the establishment of the Participatory and Gender Analysis Programme by the CGIAR in 1997

First, despite the growing number of projects and programmes, it was increasingly recognized that the overall quantitative significance of participatory technology development was very limited, and that it was usually marginal to the main bodies of agricultural R&D activity in the sense of being funded via short-term projects and programmes by external donors. By the end of the 2000s, the time of the last two compilations in Table 3.1, several observers offered the view that the scale of activity in this area was at best static and limited, and probably even reversing:

- Robert Chambers, one of the leading contributors to opening up the field in the early-1980s, suggested that: "Many of the challenges are still those of 20 years ago. The paradigms of pipeline research and …. of top-down packages of practices passed on to farmers …. is resilient and keeps reasserting itself" (Chambers 2009, p. xxii).
- This was strongly endorsed by Jacqueline Ashby reflecting her own experience in the CGIAR: "The idea of doing research with farmers has gradually dwindled to a few marginalized activities nursed by individuals committed to the concept, but lacking hard-core, institutional support" (Ashby 2009a, p. 42).
- In the case of the Indian agricultural research system, a series of organizational reforms had failed to alter the dominance of the linear process of technological development running from "the science that generates it to the extension effort that disseminates it and the farmer who uses it" (Sulaiman 2009: 182).
- Commenting specifically on Africa, the editors of Sanginga et al. (2009) reported the view that the region was "... currently experiencing the return of the conventional 'diffusion of innovations' model", while a number of large recent initiatives in agricultural research appear to be "reverting to the Green Revolution model". (p.375).

The second challenge, about the qualitative characteristics of participatory innovation projects, centred on the form of the participation involved: within projects labelled as 'participatory', the type of participation frequently seemed very limited. In many cases it seemed to be oriented towards what Bell (1979) had described as 'extractive' arrangements – appearing at best to be designed only to elicit flows of information and understanding from farmers for the purpose of improving centralized R&D, without supporting and strengthening farmers' own innovation activities.

Behind that, as emphasized by Ashby (2009a), there often lay the capture of the participatory agenda by elite groups that shaped the innovation process along conventional supply-driven lines.

> "Increasingly, FPR[21] became perceived as a way to convince farmers (and donors) that the existing supply of agricultural R&D was on track to benefit the poor …..Programme directors used the 'farmer participatory' label as a sales pitch to compete successfully for development … project funding. …. As a result, the notion of conducting research with farmers became steadily diluted. A hybrid approach to FPR was popularized especially at senior management levels ….This involved farmers in validating the supply of technology coming out of the established, pipeline-style of research." (p.41)

[21] Farmer Participatory Research

Thus by the late 1990s it was apparent that the challenge was not simply about how to shift a larger quantity of overall agricultural R&D effort towards modes of technology development that were participatory and farmer-led in significant ways. What was faced was the greater challenge about achieving change in that direction within the wider institutional contexts of agricultural R&D: the interest groups, power relationships, bureaucratic structures and political processes that shape the allocation and use of resources for innovation. For Scoones and Thompson (2009, p.13), reflecting the observations of Ashby (2009), this raised questions not simply about the supply side of the innovation process. At least as important, they argued, were questions about articulating effective demand from poor farmers and about developing governance and political arrangements that would ensure accountability on the part of those who are supposed to respond effectively to that demand – re-emphasising the kinds of institutional issue that had been highlighted nearly thirty years earlier by Biggs and Clay and summarized above as Link (G) in Figure 3.1, Panel 2.

(ii) Increasing diversity and differentiation in practice and analysis

Proliferation and diversity have been striking features of both practice and analysis in this area since the mid-1980s. With respect to practice, there has been a steadily increasing diversity in the actors involved in supporting, promoting and implementing participatory innovation projects and activities: a widening array of donors, NGOs, universities and government agencies. This has been accompanied by a widening range of different approaches to organising participatory innovation, as well as a growing portfolio of more detailed methods and techniques for fostering and implementing those approaches: methods of stimulating the engagement of farmers, techniques of consultation and enquiry, and tools for assisting farmers to enumerate and report observations and assess options. Increasing attention has also been given to an array of personal and micro-organizational characteristics that facilitate or constrain effective participation: personal attitudes and behaviours, personal and professional status perceptions, along with methods for stimulating personal and organizational reflexivity.

The parallel stream of observation and analysis has demonstrated a similarly growing diversity. In part this has been about the institutional context of participatory modes of innovation. This has involved a widening array of both the institutional phenomena examined and the conceptual frameworks used to discuss them (e.g. Thompson and Scoones 1994, Clark 2002, Hall et al. 2003, and Biggs 2008). This diversity is usefully considered at two levels:

- The first might be called 'macro-institutional'. This includes some of the things that have already been noted in this paper: the kinds of socio-political environments within which the innovation process and its participating organizations are embedded, including the mechanisms by which R&D actors are held accountable to different interest groups and to society as a whole, and also the power relations between different groups involved in using, creating and communicating knowledge in connection with agricultural innovation.
- The second includes institutions that are embedded in organizations and communities. In research organizations this might involve such things as the rules and norms governing how research priorities emerge and are promoted, how research performance is evaluated and by whom, or how organizations reflect and learn. In rural communities it might include rules and norms about such things as communal land-use, gender roles, other dimensions of community hierarchy and power, or arrangements for sharing/appropriating knowledge.

But diversity in analysis has been much greater at a third level concerned with organizational aspects of the innovation process itself. This has focused on the structure of relationships through which it takes place, especially different kinds of division of labour and their coordination - differences that have been referred to in this paper as differing 'forms' or 'modes' of innovation.[22]

The case study literature has not only described this rapidly growing diversity of new modes of innovation; it has also actively contributed to it in the form of product differentiating advocacy of apparently novel approaches within the widening proliferation. Sharp contrasts have been drawn between different 'brands' of participatory and grassroots innovation; and even when these have involved what seem be quite minor variations they have been vigorously differentiated and 'marketed' as offering advantages over others. Perhaps not surprisingly the editors of the last compilation of studies listed in Table 3.1 emphasized the need to "move beyond false dichotomies" and associated "unhelpful debates" (Sanginga et al. 2009b: 377).

(iii) The limited development and use of STI indicators

The preoccupation with singular instances and their differences has gone beyond being merely unhelpful. It has contributed to a significant limitation in the literature over this long period: the scant attention given to comparison, aggregation and synthesis. For example, among the 120 or so case-studies compiled in the publications listed in Table 3.1, there is almost no systematic comparison of even small sub-groups of cases. More importantly, the absence of any systematic typological framework and consistent pattern of reporting makes it almost impossible for others to attempt any comparative or aggregated analysis retrospectively.

Consequently it is impossible to draw on this literature to answer two kinds of policy-related question about this approach to innovation. What is the scale of the activity? What is its impact?

There are two aspects to the question about scale. One is about the *overall magnitude of this broad approach to innovation as a whole.* As noted earlier in this paper, this has frequently been seen as an important issue: along with repeated concern about the apparently marginal scale of grassroots/participatory modes of innovation relative to others, there have been frequent calls for scaling up and mainstreaming financial support for these approaches. But over twenty-five years the kind of literature identified in Table 3.1 has not provided empirical evidence about what the scale of these activities actually is, let alone a credible indication of whether and how that might have been changing.

[22] These kinds of change and difference are described variously in the literature as 'organizational' or 'institutional'. In that context it is pertinent to recall the argument of Nelson and Sampat (2001) that "…it is a mistake to try and make the term 'institutions' cover too much conceptual ground. At the least, the term ought to refer to a set of things at the same causal level". (p.39). Indeed it is tempting to adopt here their concept of 'social technology' (see also Nelson 2008). Distinguished from 'physical technology', this refers to the standardised ways in which "knowledgeable people act and interact where the effective coordination of interaction is key to accomplishment". (p. 44). From that perspective, developing new 'social technologies' in the form of new kinds of division of labour and coordination seems to be precisely what has been involved in the development of grassroots/participatory modes of agricultural innovation over the last thirty years or so. However, as we note below, this field is already replete with conceptual and terminological differentiation, and we would not wish to add more at this stage. We therefore continue to use the terms 'mode' or 'form' of innovation to refer to these kinds of change.

A second aspect of the scale issue arises at a more disaggregated level: *what is the relative scale of different modes of grassroots/participatory innovation*? As also noted earlier in this paper, the case-study literature has offered considerable comment on this issue. In particular, a frequent observation has been that some types of participatory innovation have been much more common than others, and there have even been claims that this distribution has changed over time to include greater/smaller proportions of more/less participatory modes of innovation. However, there is virtually no systematic evidence about such magnitudes and their change over time.

With these two kinds of limitation, one of the key planks of empirical support is missing from the policy arguments about increasing the allocation of resources towards non-conventional modes of agricultural innovation in general or to particular kinds of participatory innovation particular.[23] But problem about these limitations is not simply the absence of quantitative estimates of scale. It is more fundamental. There is no accepted conceptual basis for even starting to compile numbers. The case-study literature has continued to produce a proliferation of case descriptions for twenty-five years, but has developed no agreed framework for identifying what this domain consists of, and hence which modes of innovation are to be counted as 'grassroots' and/or 'participatory'. Nor has it pursued the kinds of conceptual consolidation required to combine examples into typologies of different kinds of grassroots/participatory innovation – a precondition for any attempt to assess their relative magnitudes.[24]

In principle one might also expect innovation indicators to have been developed as a basis for addressing questions about the *impacts achieved* by grassroots/participatory innovation. For example, as noted already, there has been a widening range of important claims about ways in which grassroots/participatory modes of innovation will yield significant benefits compared with more conventional approaches. However, while there are plausible illustrations of many of these impacts in individual projects, there has been little aggregation or suitably comparative analysis to provide an adequate basis for demonstrating the extent to which such claims have actually been realized.

Similarly, two other kinds of question about impact have been raised but not answered. Firstly, a large part of the discussion around the diversifying array of different forms of innovation has been about the advantages of particular participatory modes *relative to others*. However, although there have been numerous descriptions of the merits of individual instances of particular ways of doing things, there has been very little analysis to answer this type of comparative question at a more generalizable level. Secondly, there has also been

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[23] This seems to have been the view of a former policy-maker in this field, as a Managing Director of the Rockefeller Foundation. In a Foreword to the last book in the list in Table 3.1, he noted the lack of systematic attention that had been given to these issues about scaling up and financial sustainability, along with the limited impact on policy. He emphasised that "evidence-based guidance on both issues is required urgently so that … greater long-term impact [can be] achieved." (Matlon, 2009, pp. xvi-xvii)

[24] There were some partial exceptions. In particular, as increasing attention was given to 'innovation systems' as a framework for analysing innovation activities, attempts were made to develop frameworks that differentiated this from previous perspectives. For example, in the compilation edited by Scoones and Thompson (2009), Hall (2009) presented a typology that distinguished between (i) Classic National Research Systems, (ii) Classic Agricultural Knowledge and Information Systems, and (iii) Agricultural Innovation Systems. But these were too aggregated and generalised to act as frameworks for analysing the concrete experiences involved in various forms of participatory/grassroots technology development and innovation.

some discussion about the importance of contexts in shaping the impacts of participatory modes of innovation, with questions raised about *whether particular modes 'work' better in some kinds of context than in others*. Answers to such questions are a necessary accompaniment to policy arguments about scaling up resource allocation to participatory approaches. Given the diversity of arrangements falling under the general category of 'participatory', one needs to be able to offer advice about which should be expanded in which kinds of agricultural context - but the accumulated case study observations offer no such guidance.

The paucity of answers to these kinds of question about the outcomes and impacts of participatory modes of innovation does not stem simply from an absence of evaluative analyses in this body of case-study literature.

On the contrary, there has been a considerable amount. But most of it has been of two types: (i) assessments of issues such as participatory methods, procedures and behaviours, designed to provide learning-centred feedback to help improve processes, or (ii) assessments of impacts in order to meet the accountability requirements of individual agencies and donors involved in particular projects and programmes. Thus most of the observations of outcomes and impacts appear to have been 'internal' to particular projects and programmes, rather than being designed to face 'outwards' to influence policy and resource allocation. At the same time, comparison and aggregation across broad bodies of experience has rarely been attempted. But as noted earlier, the necessary conceptual and typological basis for doing so has been more or less absent.

In sustaining these limitations through such a long sequence of published work, this strand of the case-study literature has remained surprisingly disconnected from a smaller and much less publicized second strand that has sought to address issues about typology, comparison and evaluation.

3.3 Steps towards typological, evaluative and comparative analysis

Table 3.2 provides a selective list of contributions to this second stream of studies over the twenty years between 1989 and 2009. As with the previous list in Table 3.1, these are not systematically representative of the whole field of evaluative studies of grassroots and participatory modes of innovation. Nor do the following comments on the work in this list constitute a systematic review. Instead the focus is on only five selected aspects of the work:

- (i) Its development of conceptual and typological frameworks to identify the scope of participatory/grassroots innovation and its different forms;
- (ii) Its assessment and evaluation of the outputs, outcomes and impacts of these modes of innovation;
- (iii) Its examination of inputs and costs;
- (iv) Its assessment of the incidence and scale of these modes of innovation;
- (v) A broad imbalance in its orientation.

A common feature of the three activities under (ii), (iii) and (iv) is that, from the perspective of participants in agricultural innovation, they make important contributions to forms of assessment and evaluation that may be used to support 'external' policy purposes, and not only 'internal' purposes concerned with the management of projects and programmes. They provide important parts of a basis for addressing broad questions about resource allocation to participatory modes of innovation in general and to specific kinds of participatory mode in particular.

Table 3.2 Grassroots/Participatory Innovation: Selected Contributions to Comparative Assessment and Impact Evaluation

Biggs (1989) *Resource-Poor Farmer Participation in Research: A synthesis of experiences from nine national agricultural research systems.*	Probably the first attempt at systematic comparative assessment of participatory research in practice. Developed a typological framework to review more that 20 research programmes, showing most were primarily designed to provide knowledge flows from farmers to inform centralized rsearch – though several changed over time towards more collaborative forms of process.
Okali et al. (1994) *Farmer participatory research: Rhetoric and reality*.	Aiming to assess rapidly expanding participatory practice, modified Biggs' typological framework to review 11 projects with various forms of participatory research. Most involved knowledge flows from farmers to improve centralized research, with limited strengthening of farmer innovation.
Lilja and Ashby (1999). *Types of participatory research based on locus of decision making.*	Developed significantly modified version of the Biggs' typological framework – focusing on decision-making aspects of innovation projects
Johnson, et al. (2001), *Characterising and measuring the effects of incorporating stakeholder participation in natural resource management research…* [See also Johnson, et al., 2003]	A major advance in assessing impacts of participatory innovation. Examines three large projects in Indonesia, Malawi and Honduras, assessing: (i) technologies developed and their adoption, (ii) contributions to strengthening human and social capital, (iii) feedback links to formal research' and (iv) costs of research. Incorporates a gender dimension in the assessments.
Probst and Hagmann (2003) *Understanding participatory research in the context of natural resource management*	Embeds categories of participation in a much broader typological framework of research and innovation projects, and reviews CGIAR practice.
Ceccarelli et al. (2003), *A methodological study on participatory barley breeding II*.	A detailed analysis of the short term (1 year) performance of varieties selected in contrasting participatory and conventional ways. Demonstrates feasibility and significant benefits of decentralized organization for several purposes – especially adaptation to diverse and/or stressed environments.
Ashby and Lilja. (2004) *Participatory Research: Does it work? Evidence from participatory plant breeding*	Preliminary assessment of the impacts of nearly 150 participatory research projects of various types: suggesting participation yields high returns in production and greater efficiencies in the innovation process.
Lilja and Bellon (2006) *Analysis of participatory research projects in the International Maize and Wheat Improvement Center*.	A review of the use of participatory methods in then-current CIMMYT research, based on a questionnaire-based survey of 18 scientists covering 18 projects.
Lilja and Dixon (2008) *Responding to the challenges of impact assessment of participatory research and gender analysis*.	Introduction to journal special issue on impact assessment of agricultural research and innovation. Reviews broad issues relating specifically to participatory approaches.
Ashby (2009b) *The impact of participatory plant breeding*	Important synthesis of key issues and the latest 'state of play' in the evaluation of participatory research and innovation, with a review of impact assessments of experience across fifty projects.

(i) The development of conceptual and typological frameworks

What seems to have been the first step towards empirically based conceptual framing of different modes of participatory innovation was taken in the report by Biggs (1989). This synthesized a set of studies that had been carried out since 1986 covering more than twenty programmes of On-Farm, Client-Oriented Research (OFCOR) in nine countries in Latin America, Africa and Asia. The OFCOR programmes selected for review had been started during the 1970s and early-1980s and had not been designed with explicit 'participatory' aims and organizational arrangements. But they were pre-cursors of such modes of innovation, and a basic typology for the comparative analysis was couched explicitly in terms of different modes of "participation of farmers in research" (p. 4).

By synthesising qualitative differences in detailed distinguishing features of each of six characteristics of the programmes, this framework distinguished between four types of participatory relationship: contractual, consultative, collaborative and collegial - as shown with their summary descriptors in Panel (A) of Table 3.3 below. Two features of the descriptors merit comment. They focus heavily on: (i) differences in the *underlying purpose*: farmers providing services for researchers at the 'contractual' end of the spectrum, and researchers encouraging and strengthening the informal R&D system at the 'collegial' end,[25] and (ii) differences in the innovation *activities undertaken* by farmers and researchers (the division of labour in the innovation process). Less prominent in the summaries, but present in the underlying descriptions of distinguishing features, was an emphasis on *decision-taking roles* – e.g. about who defines and selects the participating farmers.

This exploratory framework was subsequently taken up and modified in the study by Okali and colleagues (1994) - as indicated by Panel B in Table 3.3, [26] which also indicates in Panel (C) roughly how terms use in this paper ('conventional', 'participatory' and 'grassroots') map on to the different modes of innovation in these two frameworks.

One of the modifications to the Biggs categories by Okali and colleagues was to locate them in a more complete framework by extending beyond both ends of the spectrum of participatory relationships to include (i) a purely centralized, non-participatory mode of research, and (ii) a totally decentralized mode of technology development by farmers themselves – the autonomous informal innovation sub-system. A second modification recognized two issues. Firstly, particular innovation projects might involve different modes at different stages of the research process running from the identification of opportunities for innovation (diagnosis), through the identification of ideas and options, to the testing and adaptation of possible innovations. Secondly, the outcomes and impacts of particular modes of innovation might vary depending on the stage in the process at which it occurred. Rows were therefore added to the extended array of column categories in the overall framework in order to incorporate such stages into the basic framework.[27] Thus, as illustrated by the heavier shaded sections in Table 3.3, they suggested that what is referred to here as 'conventional'

[25] The more detailed descriptions underlying this category are more explicit about the nature of the encouragement provided: e.g. "Understanding and strengthening informal R&D".

[26] It had previously been reproduced in an important review of the role of social science analysis in agricultural research for the rural poor, supported by the International Development Research Centre of Canada (Biggs and Farrington 1991),

[27] This elaboration was important, but was still limited by its roots in the analysis of only research (actually research and development) and not innovation. For some purposes therefore it might be important to add a further row – e.g. 'implementation'.

agricultural research commonly involved some degree of farmer participation in one of the three rows, while decentralized, farmer-only research involved none.

Table 3.3 Modes of Participatory Technological Development: Some Initial Steps Towards Conceptual Consolidation

(A) Biggs (1989)		DIFFERENT TYPES OF PARTICIPATORY INNOVATION				
		CONTRACTUAL	CONSULTATIVE	COLLABO-RATIVE	COLLEGIAL	
		Farmers, land and services are hired or borrowed, e.g. the researcher contracts with the farmer to provide specific types of land.	There is a doctor-patient relationship. Researchers consult farmers, diagnose their problems, and try to find solutions	Researchers and farmers are partners in the research process and continuously collaborate in activities	Researchers actively encourage the informal R&D system in rural areas	
(B) Okali et al. (1994, pp. 20 and 95- 96)						
Stages in Research process	CENTRALIZED: RESEARCHERS ONLY	CONTRACTUAL (AS ABOVE)	CONSULTATIVE (AS ABOVE)	COLLABO-RATIVE (AS ABOVE)	COLLEGIAL (AS ABOVE)	DE-CENTRALIZED FARMERS ONLY
Identify Opportunities						
Identify ideas/Options						
Test and Adapt						
(C) This paper	← Conventional →			← Grassroots →		
		← Participatory →				

Source: Adapted in Bell (unpublished) from Biggs (1989) and Okali et al. (1994)

However, the authors of this elaboration of the earlier Biggs framework recognized that this was still only an exploratory further step that required still further elaboration and use in practice before being widely accepted as a basis for analysis, management and indicator development (p.127). But no further steps along these lines appear to have been taken until the conceptual and typological study by Lilja and Ashby (1999) at an early stage in the work of the CGIAR Program on Participatory Research and Gender Analysis (PRGA) located primarily at the Centro Internacional de Agricultura Tropical (CIAT) in Colombia.

This study again took off from the earlier typologies of Biggs (1989) and Okali et al. (1994), using similar categories of participatory modes of R&D,[28] and also differentiating between stages of the innovation process. But beneath these similarities with the earlier approaches there was a significant adaptation. The different modes of research were defined on the basis of a narrower set of process characteristics: focused specifically on the decision-making

[28] A minor adaptation was the consolidation of the 'researchers only' and 'contractual' categories into a single 'conventional' mode.

elements of technology development projects, rather than also incorporating differences in (a) the purposes of participation and (b) the division of labour in actually 'doing' the innovative activities. However, the authors clearly recognized this limitation and envisaged the development of less narrow bases for classification.[29]

With further minor modifications, this typology – as outlined in Table 3.4 below - was applied in an evaluation of three participatory research and innovation projects (Johnson et al. 2001, 2003). But in this and subsequent work by the CIAT-based PRGA group, there was a more important development in the basis for differentiating modes of participatory innovation.

Table 3.4 Modes of Participatory Technological Development: An Emphasis on Decision-Making

Johnson et al. (2003)*				
CONVENTIONAL *(No farmer participation)*	CONSULTATIVE *(Functional participation)*	COLLABORATIVE *(Empowering participation)*	COLLEGIAL *(Empowering participation)*	FARMER EXPERIMENTATION *(No researcher participation)*
Scientists make the decisions alone without organized communication with farmers	Scientists make the *decision* alone, but with organized communication with farmers. Scientists know about farmers' opinions, preferences and priorities through organized one-way communication with them, and may or may not let this information affect their *decisions*	*Decision-making* authority is shared. Scientists and farmers know about one another's opinions, preferences and priorities through organized two-way communication. *Decisions* made jointly and no party has a right to revoke the shared *decisions*	Farmer make the *decisions* collectively or through individual farmers who are in organized communication with scientists. Farmers know about scientists opinions, preferences, proposals and priorities through organized communication, and may or may not let this information affect their *decisions*.	Farmers make the *decisions* individually or in a group without organized communication with scientists

* Some of the descriptors are slightly abbreviated from the original.

This involved widening the primary focus on patterns of decision-making as the basis for the typology by also taking account of a distinction between the broad aims or approaches of a participatory research or innovation project. This involved a simple dichotomy between 'functional' and 'empowering' approaches. As outlined in Johnson et al. (2003), a *functional* approach is concerned with using participation to increase the efficiency and effectiveness of the innovation process – using the knowledge of farmers and stronger communication between researchers and farmers to achieve better technologies and adoption outcomes or the completion of projects faster or at lower costs. *Empowering* approaches aim to enhance rural people's "capacity and tools to innovate and to influence research agendas" and this can "lead to fundamental changes in the nature of the innovation process, bringing in new actors and altering power relationships". (p.289). As indicated in Table 3.4, the authors associated this distinction with the different types of participation based on differences in decision-making:

[29] "There are functions other than decision-making in participatory processes but we are not including these other functions in this tool yet". (p.1)

by definition, functional approaches are identified with consultative modes, whereas empowering approaches are associated with collaborative and collegial modes.

The grassroots innovation projects that are the subject of the case studies later in the paper were designed with explicit objectives about 'empowerment' in the sense discussed here. However, the approach to classification followed here is not that suggested by Johnson and colleagues because there is a difficulty about the way the Functional vs Empowering distinction is identified with the basic Consultative, Collaborative and Collegial categories in the basic typology (as in Table 3.4). B aligning the two kinds of distinction in this way, collaborative and collegial modes of participation are *defined* as not being concerned with functional aims about process effectiveness and efficiency, while consultative modes are *defined* as having no empowerment effects.

Neither association is necessarily the case, and the approach used in this paper will follow more along the lines of the earlier typologies in Biggs (1989) or Okali et al. (1994) in which alternative modes of participatory research and innovation are defined in terms of organizational features reflecting the division of labour and its co-ordination, as well as aspects of the *ex ante* intentions and purposes.[30] This leaves achieved *ex post* consequences such as functional effectiveness and efficiency or empowerment effects to be treated as variable outcomes and impacts of the different modes of innovation – an important variability that is left open as a matter for empirical enquiry, not something that is given in advance by definitional alignment.[31] In effect, this was the approach actually taken in practice in Johnson et al. (2001, 2003), and by other colleagues in the PRGA in their later assessment of outcomes and impacts of participatory projects, as is discussed immediately below.

(ii) Assessing and evaluating outputs, outcomes and impacts

It is in the area of assessing and evaluating outputs, outcomes and impacts that this strand of literature has made its greatest contribution. Studies have sought to go beyond merely describing illustrative examples of apparent consequences of participatory modes of research and innovation by assessing more systematically how such consequences are associated with groups of innovation projects consolidated into different categories along the lines discussed above.

Some of this analysis has been concerned with evaluating various organizational and managerial characteristics of participatory *processes* and, as in the descriptive case study literature, this focus has been intended primarily to serve 'internal' management purposes. This was a major focus, for example, of the early review by Biggs (1989), centred on the role of various kinds of meeting as a means of strengthening farmer participation. It continued as an important element in several later studies – for example in a review of participatory

[30] In principle, of course, it would be good if the development of typologies by 'manual' methods of aligning different dimensions of innovation processes (as in Biggs, 1989; Okali et al. 1994; and Johnson et al. 2001, 2003) could now be augmented by multivariate clustering methods. It is therefore encouraging that exploratory work along these lines using multiple correspondence analysis of data for 49 participatory plant breeding programmes has been undertaken within the CIAT-based PRGA programme (Ashby 2009b: 657).

[31] Also, this approach does not exclude 'conventional' and 'farmer experimentation' modes of innovation from the evaluative scheme by leaving them not associated with either functional or empowerment characteristics. Instead, it allows the possibility that they also may have *ex ante* purposes of those types (perhaps both). It also envisages that it may be useful to assess *ex post* the variable extent to which those categories achieve elements of functional effectiveness and efficiency or dimensions of empowerment.

research in CYMMYT (Lilja and Bellon, 2006) or in the detailed examination of methods of organising participatory processes of variety selection by Ceccarelli and colleagues (2003).

However, the main contribution in this area has been in connection with the wider outcomes and impacts of participatory/grassroots modes of innovation. Not surprisingly, this was not a feature of the earlier studies. It was largely absent from the review by Biggs. Then, although Okali and colleagues (1994) had originally intended to examine these issues, they found that available information about the outcomes and impacts of their selected programmes was very limited, and what existed was inadequately structured to allow impacts to be attributed clearly to alternative modes of R&D.

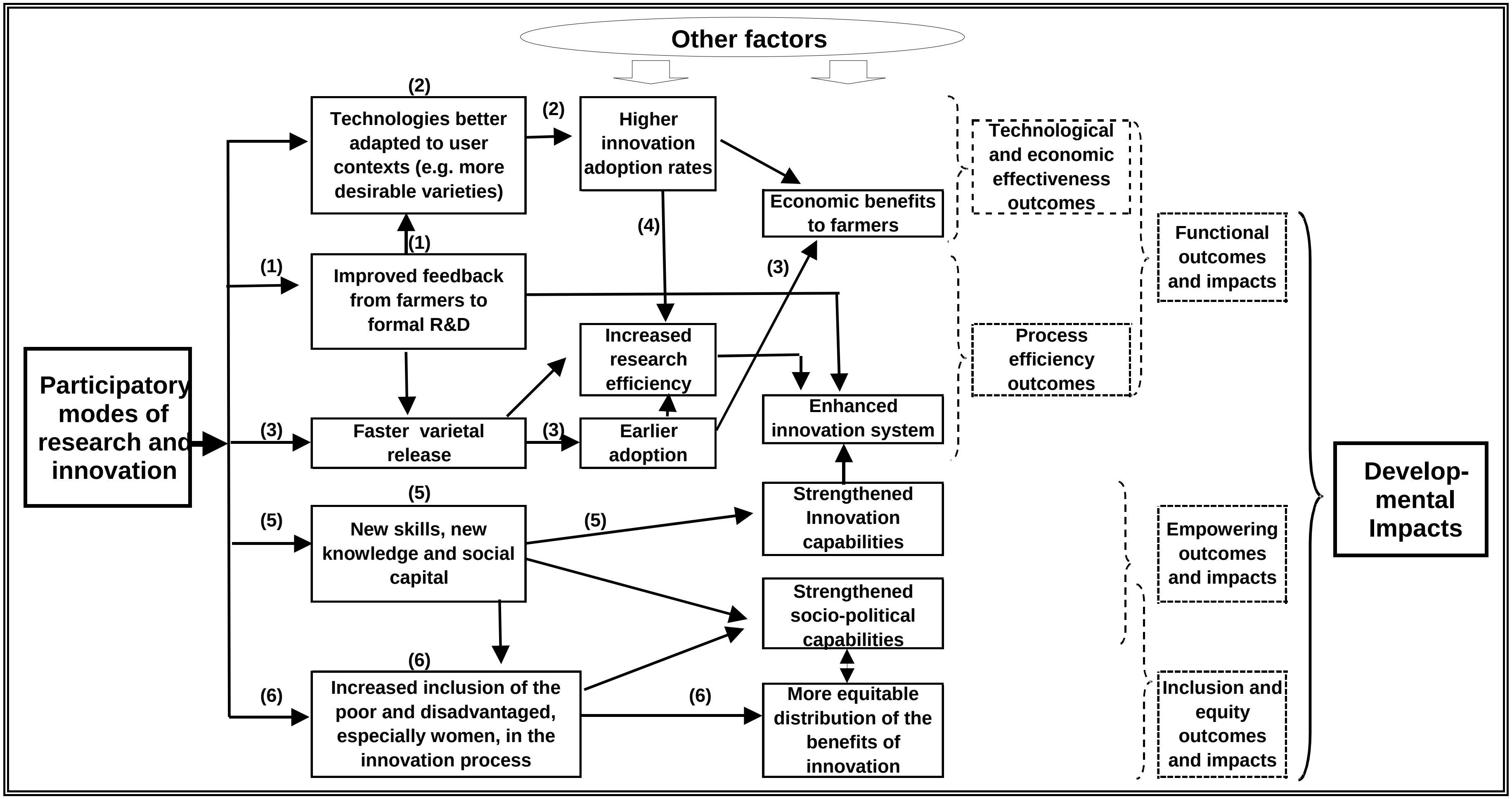
A large part of the contribution has been made in the series of studies by the PRGA programme. An important foundation for this was their emphasis on understanding the complex networks of causal relationships lying between innovation activities and their outcomes and impacts, especially longer term developmental impacts. Without this understanding one cannot reliably attribute observed 'impacts' to research and innovation activities rather than many other factors.[32]

These issues are usually discussed in terms that differentiate between outputs, outcomes and impacts. But there are differences in quite how these distinctions are drawn and used, and the approach followed here is that of Ashby (2009b), who uses the term 'impact pathways' to refer to interacting sequences of causal relationships running from participatory/grassroots modes of research and innovation to developmental impacts. Within these pathways she focuses on specific cause-effect relationships without becoming too bogged down in terminological details (pp. 657-665).

Figure 3.2 outlines *selected parts of* this structure of impact pathways. It also illustrates the kinds of indicator used by Ashby and PRGA colleagues to examine the validity of hypothesized causal relationships within the structure. Some were already commonly used in the evaluation of conventional agricultural R&D. These included indicators of technological and economic effectiveness (e.g. various aspects of the performance of crop varieties, the rate of innovation adoption and the associated benefits for farmers), as well as indicators of efficiency in the research process itself (e.g. the speed to varietal release). Others were indicators reflecting less commonly evaluated aspects of process efficiency (e.g. the extent and form of feedback from farmers to formal R&D activities). Yet others reflected issues that had previously been much less commonly used, in particular, those concerned with: (i) empowerment outcomes and impacts (e.g. the extent and forms of new skills, knowledge and social capital that were created in association with participatory modes of innovation), and (ii) inclusion and equity outcomes (e.g. the extent and ways in which innovation activities included the poor and disadvantaged, in particular women, leading to different directions of innovation and more equitable distribution of its benefits).

[32] This difficulty about attributing observed economic and other events as consequences of research inputs is important not only for assessing the impacts of grassroots-participatory modes of innovation. It is just as important for conventional modes of innovation – for example, in connection with estimating rates of return to agricultural R&D, where some would argue that the problem of is still far from adequately recognised.

Figure 3.2 Selected Pathways from Participatory-Grassroots Modes of Research and Innovation to Longer Term Development Impacts



Source: Adapted in Bell (unpublished) from Ashby (2009b: 657-665)

Three items in the list of literature in Table 3.2 provide overviews of evidence about various causal relationships within the structure of impact pathways: Johnson et al (2001, 2003), Ashby and Lilja (2004) and Ashby's broader review (2009b) of the evidence that was available by the late-2000s. That evidence is drawn on here in order to comment on six particular relationships that are components of the structure of impact pathways shown in Figure 3.2. The evidence relates to participatory research and innovation that was mainly, but not totally, based on plant breeding, and it is derived from studies using a variety of methods ranging across surveys of scientists' opinions, more intensive project analyses and appraisals, detailed experimental trials and wider production surveys.

Pathway Component 1	Participatory/grassroots (P/G) modes of research and innovation improve farmer feedback to formal research, so altering research objectives, priorities and practices in ways that contribute to the development of technologies that are better adapted to user contexts.

All three studies compile extensive evidence to confirm expectations that participation by farmers, especially at early stages of projects, results in more intensive feedback about their preferences and production conditions, and this contributes to shifting the focus and direction of research so that better adapted technologies are made available. Ashby (2009b) summarizes the most recent position as follows.

> "This experience, now so diverse with respect to crops, cultures, and production environments, demonstrates the efficacy of participatory selection in producing varieties for poor farmers who are otherwise excluded by conventional crop improvement programmes" (p. 661)

Pathway Component 2	P/G modes of research and innovation, by producing more desirable varieties, lead to higher rates of adoption. .

Although the number of longer-term adoption studies of technologies developed via participatory/grassroots approaches remains limited, this expectation also seems well founded. For example, these modes of innovation have enabled breeding programmes in several countries to break through adoption bottlenecks and prolonged prior periods of non-adoption of new technologies developed by conventional approaches.

Pathway Component 3	P/G modes of research and innovation also lead to faster varietal release, leading to earlier adoption, so increasing the stream of benefits to farmers.

Several studies have demonstrated that participatory approaches to technology development have substantially reduced the time that would otherwise have been required to release varieties for use – in one case, for example, the technology development process arrived at that point three years earlier than the nine years that would have been involved in more conventional approaches. This acceleration of the innovation process has effects on its efficiency, freeing up resources to undertake additional innovation projects – as discussed later in connection with the costs of participatory/grassroots modes. But it also has a considerable effect on the benefits arising for farmers, primarily as a result of their earlier adoption of beneficial technologies. For example, Ashby and Lilja (2004) report the results of a carefully comparative analysis of the discounted research-induced benefits from different approaches to innovation for barley production in Syria. The benefits from technology development via three different participatory approaches were in a range from twice to five times greater than those from conventional breeding approaches (p.8). Ashby (2009b) explains that most of the difference was attributed to the way P/G modes of innovation "reduced the amount of time it took for improved varieties to get into farmers' fields" (p.663).

Pathway Component 4	By generating more desirable varieties with accelerated adoption paths, P/G modes of research and innovation improve research efficiency.

As well as raising efficiency in the innovation process because of faster progress to varietal release, participatory approaches may also generate another effect on process efficiency. By bringing farmers knowledge and understanding to bear on the research process, efforts to pursue what would later prove to be ineffective directions of technology development seem to be reduced. Such knowledge and understanding helps to bring potentially more desirable technology characteristics *into* the technology development process, while also screening *out* of the process less desirable directions of development, so reducing the probability of going all the way to promoting varieties with poor acceptability - and hence reducing the research resources allocated to such innovatory 'dead ends' (Ashby, 2009b: 663).

Pathway Component 5	P/G modes of research and innovation foster the development of new skills, new knowledge and social capital that enhance innovation capabilities.

Johnson et al. (2001, 2003) indicated that in some of the three participatory projects they studied farmer-researchers "did enhance their experimentation skills" (p.298). To some extent this was a matter of experience accumulation as farmers engaged in R&D activities – relatively passive learning-by-doing. But explicit effort to build substantial training activities and learning opportunities into projects appears to have been more effective in developing technology development competences. In particular, in one case, concerned with developing soil conservation practices in Honduras, the project provided intensive training for a select group of farmers who became 'farmer-promoters' in the project, some of whom later went on to work with other agricultural and development projects.[33] This project also illustrated the longer-term potential of such explicit investment in farmers' capabilities. A substantial proportion of the farmers moved beyond the agronomic practices developed and introduced by the original project. They independently experimented with alternatives and improvements and introduced new practices – so "demonstrating a capacity to innovate beyond the adoption of recommended practices". (p.301). In effect the investment in empowerment components of the project had contributed to creating an autonomous capacity for sustained innovation.

But the evidence was mixed between and within the cases in this study, and in some the increase in capabilities was modest at best. At the same time, evidence of the development of broader social or community capital was scant. Ashby's later review (2009b) suggested that little advance in understanding in this area had been made by the end of the decade. Several studies had shown how farmers in participatory projects might acquire additional research and technology development skills, while research staff in the formal system might also enhance their skills in using participatory approaches. Also as the value of decentralized research being undertaken on-site in low-potential and marginal environments was becoming recognized, so also was the associated need to offset the potentially higher costs of decentralized technology development by strengthening farmers' skills to permit more significant delegation of research tasks. However, Ashby's broad conclusion was that

[33] This is reminiscent of the practice in Japan at the end of the 19th century and early 20th, when the limited resources of the nascent formal agricultural research system were supplemented by the services of experienced or 'veteran' farmers – rono. These were employed as itinerant instructors to assist on branch research stations and more widely as 'informal' extension agents to support localised experimentation and diffusion of improved varieties and agronomic practices. (Hayami and Yamada, 1991)

systematic evidence about these important empowerment-related outcomes and impacts was seriously inadequate.

This is an important limitation because, in principle, a large part of the potential significance of participatory/grassroots modes of innovation does not arise only at the level of individual projects – i.e. in the form of technological and economic gains following from an increased number of participatory projects. It arises also at the system level. It is about structural transformation of significant parts of the agricultural innovation *system* along the lines discussed earlier in connection with the arguments of Biggs and Clay (1981) about effective integration of the informal and formal innovation sub-systems (as illustrated in Figure 3.1). A central part of the argument about such system-level transformation rests on a combination of two of the impact pathways sketched in Figure 3.2: (i) this empowerment-centred Pathway 5 running via the augmentation of skills, knowledge and social capital, and (ii) the long-term institutionalization of Pathway 1 involving improved feedback links between farmers and formal R&D.

Pathway Component 6	P/G modes of research and innovation increase inclusion of the poor and disadvantaged, especially women, in the innovation process, so leading to more equitably distributed benefits.

There are two aspects of this relationship. One, essentially an element of the relationship in Pathway Component 1, is about whether, as a result of participatory modes of research, women and disadvantaged farmers gain any effective traction on the technology development process so as to shift it in directions more consistent with their own interests. The second is about whether, with or without such traction on the technology development process, the distribution of subsequent benefits from the technological results of participatory modes of innovation is shifted towards disadvantaged groups more equitably than would arise under more conventional approaches.

Ashby and Lilja (2004) indicated that there is some evidence of the first effect. For example, in one multi-country project involving consultative participation in the testing stage, the programme researchers considered that:

> "… by consulting women and involving them in varietal evaluation, the programme had included varietal traits that women know about, and especially gender-related varietal preferences, leading to better acceptability and faster adoption of the varieties." (p.8)

Ashby (2009b) reported the existence of other instances, but also noted that the participation of women might also be slight or absent even in more generally participatory projects. In other words, there did not seem to be any necessary connection between generally participatory modes of innovation and the specific inclusion of disadvantaged groups in the process.

She also emphasized that the second aspect of the relationship, namely the distribution of the benefits of implemented innovation, was also not necessarily shaped towards equitable patterns simply as a consequence of generally participatory approaches in the process. She noted in particular an instance where the participants from richer households captured a disproportionate share of the returns, such that the participatory mode of innovation involved in effect "a transfer of wealth to the richer households from the intermediate investors", and this reinforced the gender bias in the distribution of benefits. Her conclusion from the evidence was therefore that:

> "The lesson here is that participation can lead to the exclusion of important groups of beneficiaries, such as women, depending on prevailing customs and norms, especially if participation is based on self-selection." (p.665)

In other words, nearly thirty years later, these conclusions are again in line with the emphasis given by Biggs and Clay (1981) to the powerful role of institutional factors in shaping not only who participates in the innovation process but also who benefits from its implemented results.

(iii) Taking account of inputs and costs

From one perspective the use of participatory approaches appears to involve *adding* elements and activities into the innovation process. Correspondingly the most immediately visible effects can appear to be additional costs, and the evidence from project reviews indicates that such costs do arise. These can include such things as costs for additional communication and coordination; farmers' costs in undertaking research and associated travel; costs for more dispersed fieldwork by formal system research staff; costs for training of researchers – both farmer participants and formal system researchers; costs of greater seed use, and perhaps costs for more complex forms of analysis.

But the costs of such additional inputs to projects account for only a relatively small part of the overall cost picture. Firstly, all these kinds of operational costs are typically a relatively small proportion of total R&D costs. For example, Ashby (2009b) reports that they accounted for only 23 per cent of total budgets in a number of participatory and conventional projects in Syria, and the added costs in the participatory projects amounted to only 3 per cent of the total. (p.663). Secondly, some of these costs may in any case be initial once-off costs, such as training farmers in research-related skills, that would probably fall in subsequent projects.

A more important part of the wider picture seems to be the less immediately visible cost *reductions* that can arise with participatory approaches. Some of these may involve substitution effects as farmer participants undertake research and technology development activities in lieu of (usually much more expensive) formal system staff. Other kinds of reduction may be efficiency effects – e.g. as noted above: (i) accelerating the technology development process so that applicable innovation outputs are made available in shorter times, perhaps cutting several years of expenditure off the costs of achieving those outputs; or (ii) reducing the incidence of technology development efforts committed to unproductive innovation dead-ends.

Within this broader picture the question of financial *sustainability* may sometimes be as significant as the actual level of costs incurred – in particular in cases where costs are initially met by external sources such as NGOs and other donors. Despite the common concern about this issue within discussions about 'mainstreaming' participatory innovation within the established research institutes and budgets, there seems to be only one study of this issue - covering a number of seed diffusion projects to enhance genetic diversity in farmer experimentation in beans, maize and rice in Cuba and Mexico (Labrada 2009). This suggests a positive relationship between the intensity of participation and local financial sustainability: the greater the 'degree' of participation, the greater the extent to which costs were met locally and the lower the dependence on external funding.

But these observations about costs are just fragments, and there is no basis for going beyond the cautious summary offered by Ashby (2009b) with respect to costs and participatory plant breeding (PPB):

> "Clearly more analysis of the way PPB affects costs would help to clarify this debate, but at present we cannot conclude that PPB automatically represents a major increase in cost for a breeding programme." (p.663)

But then the *benefits* from participatory innovation need to be brought alongside the cost picture in order to assess cost *effectiveness*. The necessary evidence is scant, but it is at least illuminating to recall the case reported by Ashby and Lilja (2004) where the discounted present value of benefits from participatory technology development for barley production in Syria were two to five times greater than those from conventional breeding approaches. If benefit streams even at the lower end of this range were more generally associated with participatory modes of innovation, they would more than offset what usually seem to be relatively small increases in costs.

But those results reflect the benefit streams from only a single phase of technology development, and ideally one also needs to take account of the cumulative effects that arise over time. This is potentially important because, scattered through this body of evaluative studies, there are small observations of dynamic learning effects: farmers augment their skills in innovation activities over time; formal system researchers become better at working in participatory modes (as well as learning about the merits of participatory approaches); and links between formal organizations and farmer communities may become more socially embedded.

Such learning processes seem likely to affect both costs and benefits. For example, the relationship between participation and falling external costs in the case of Cuban and Mexican seed projects was not simply cross sectional between different projects. It seems to have reflected dynamic learning effects as projects became more effectively and extensively participative over time (Labrada 2009: 607). With respect to benefits, the case of soil conservation projects in Honduras suggests that cumulative learning by farmers beyond the initial training-intensive project led them into a phase of self-sustained innovative activity yielding considerable further benefits beyond those from the initial phase (Johnson et al. 2003: 294, 301).

However, these observations about benefit streams, even without any consideration of dynamic learning effects, are even more fragmentary than the evidence about costs, and Ashby's cautious generalization about the latter (above) applies even more forcibly here.

(iv) The incidence and scale of grassroots and participatory modes of innovation

A thin thread of observations about the scale or incidence of participatory modes of innovation runs through this body of literature. However this is almost entirely concerned with questions about the relative scale of different modes of participatory/grassroots innovation, not about the scale of these non-conventional approaches to innovation as a whole or relative to conventional modes.

The early study by Biggs (1989) addressed the question of the relative incidence of different modes of participatory innovation in two ways, both based on the number of programmes falling into the different categories of his typology (Panel (A) in Table 3.3). Firstly, it demonstrated the initial distribution of programmes at the time of their inception: largely concentrated in the 'contractual' and 'consultative' categories towards the left of the figure with none in the 'collegiate' category on the right. Secondly, it also examined how that distribution changed over time: many of the programmes changed little and continued in their initial modes, and some shifted leftwards, usually from consultative towards more contractual modes. However a significant number shifted in the opposite direction, mainly from consultative towards collaborative modes, and one from a collaborative to a collegiate form of relationship. Such diversity, including shifts 'to the right', contrast with views expressed in the discursive case-study literature.

Although the study mapped the initial and changing distribution of research activities across the modes of participation only in terms of the number of programmes, information was also available about the size of each of the OFCOR programme - in terms of the number of scientist-years involved (varying between 14 and 104), and also in terms of the number of those person-years as a proportion of the total number in each of the national agricultural research systems responsible for the programmes (varying between 6 per cent in Ecuador and 34 per cent in Guatemala).[34] Thus it would probably have been feasible to map the quantitative features of the participatory projects in terms of these person-year inputs,[35] covering not only their distribution between the different modes of participatory activity, but also their relative significance within the overall agricultural research systems in each country.

But rather than building on the start made in this study, only very fragmentary efforts have subsequently been made to map the scale of participatory/grassroots research. Some studies have offered fairly discursive assessments of the distribution of groups and samples of participatory projects between different participatory modes. For example, Okali et al. (1994) examined the experience of eleven agricultural research programmes in South Asia and Africa that had incorporated participatory elements of organization, and they offered comments about how the distribution of these across different modes of participation seemed to have been changing:

> "… there has been something of a shift from a contractual/consultative relationship. On the other hand, we would argue, there has not been significant progress in creating a 'collegiate interface' between formal research and farmers' own experimental activities" … We believe that this apparent lack of progress reflects the fact that …. despite the rhetoric and several pieces of much-cited literature, few programmes appear to have yet understood how to interact with farmers' own experimental interests and skills". (pp. 94-95)

Subsequent studies have advanced little beyond such discursive comment. In a few instances budget expenditure figures have been used to indicate the scale of particular samples of participatory projects being examined (e.g. Ashby and Lilja 2004: 2). But such magnitudes have not been set in the context of similar figures for 'conventional' modes of research in order to identify the *relative* scale of participatory and conventional modes in particular organizations, regions, fields or national agricultural research systems. Nor have they been broken down by different modes of participatory innovation. Also, there appear to have been

[34] See Table 1 in Biggs (1989: 4)

[35] In the early development of indicators of the scale and composition of R&D in OECD countries and also in the USSR during the 1930s - 1950s, measurement was often based on person-years of researchers, engineers and so forth, rather than on less accessible or reliable financial expenditure data. Such people-based indicators of scale remain important for several types of analysis.

no analyses along the lines in the early Biggs study to assess whether and how the incidence of different modes of innovation has changed over time.

Thus there remains a large gap in understanding about very basic aspects of the scale of participatory innovation, and there has been almost no development of indicators to contribute to policy debates about scaling up and 'mainstreaming' these approaches to innovation. This is a significant gap because, as Ashby (2009b) concludes in her review of the impacts of participatory innovation in the specific area of participatory plant breeding (PPB), active engagement in such 'external' policy debate about scale is important:

> "To realize its full potential on a large scale, PPB requires organizational, policy and legal changes in both international and national plant breeding." (p.666)

Statistical indicators about the scale of participatory modes of agricultural innovation will obviously not achieve such changes on their own, any more than will better indicators of outcomes, impacts and costs. As ever, there remain:

> "…tenacious obstacles to the institutionalization of PPB because science bureaucracies and the political elites that fund them, resist being accountable to poor farmers as clients."

But that seems all the more a reason to develop a much stronger body of evidence and associated indicators to illuminate where, how, why and on what scale participatory approaches to innovation may be effective and preferred ways of undertaking agricultural innovation. But to repeat the basic point about the system-centred framework suggested by Biggs and Clay (1981), that is about strengthening overall innovation systems through stronger and more diverse forms of complementary integration between formal and informal sub-systems. That perspective helps to highlight a substantial imbalance in the orientation of most of the comparative and evaluative literature that has been reviewed here.

(v) A broad imbalance in orientation

Almost all the studies in this strand of literature have focused on projects and activities that have their roots in the formal agricultural R&D system. In effect, the viewpoint has been from the left hand side of the typologies in Tables 3.3 and 3.4. The dominant questions have therefore been about how, how far and with what consequences movements have been made from conventional modes of innovation at that end of the typological spectrum towards less conventional modes at the other end.

Almost totally absent, at least from this body of literature, have been studies with a viewpoint from the right-hand side of the typologies – a viewpoint that *starts* in the domain of decentralized, farmer-only innovation. From that perspective at the grassroots end of the spectrum, initial questions would be about the incidence and characteristics of that mode of innovation on its own, with subsequent questions about how, how far and with what consequences movements have been made *from right to left* across the categories in the typologies. Such questions might include:

- Does there actually exist on a widespread basis a neglected and vibrant informal innovation system supporting smallholder agriculture? In what circumstances does this arise, and what is different about the circumstances where it does not?

- To what extent and how does this innovative activity generate effective demand on the formal component of the innovation system? What happens to this demand, and what kinds of links emerge between the informal and formal system components - and how?
- How far are shifts made into modes of innovation towards the left of the typological spectrum by initiatives starting from the right hand end? How are those steps implemented?
- What is the division of innovative labour between actors in the two components of the system, and how is this coordinated? How do these aspects of the innovation process differ across modes of innovation moving leftwards from farmer-only innovation at the right-hand end of the spectrum?
- What consequences follow from these different approaches to innovation and from shifts between them?
- What constraints impinge on movements from right to left and on the consequences that follow?

The case studies reported in the next sections of the paper take this 'right-to-left' perspective. They are about innovation-centred initiatives that started in smallholder farming, not in the plans or programmes of the formal R&D system in South Africa; and they are about 'grassroots' developments of relationships with that formal system. They do not attempt to address the whole spectrum of questions noted above, but they aim to illuminate at least some aspects of some of the issues involved.

4 THE CONTEXT OF THE CASE-STUDIES

Two cases of grassroots innovation in South African smallholder agriculture were examined. These cover what are probably the two main developmental routes calling for innovation in smallholder agriculture, not only in South Africa but in Africa more generally. The first case, concerned in general terms with improving *highly localized activities* in order to enhance livelihoods and food security *within* the community, centred on developing an alternative method of small-scale potato production. The second, concerned with raising cash incomes by connecting local production more effectively into supply chains *running to markets outside the local area*, centred on initiating the production of a new cash crop (cherry peppers) and on developing a new market outlet. Both were located in Potshini, a village in rural KwaZulu-Natal, and were supported by the PROLINNOVA network and its associated FAIR programme.

This section provides background information about these aspects of the context of the case studies: smallholder production in South Africa, the village of Potshini, and the project-supporting organizations. It also provides brief comment about the approach taken in the case-study research.

4.1 Smallholder agriculture in South Africa

Smallholder production is particularly important in South Africa, not because of the scale of its contribution to overall economic output, which is small, but because of its historical significance, as well as its current centrality to major economic, social and perhaps growing political concerns. The focus of this paper is on the current socio-economic issues, but since these cannot be disconnected from the history and politics, a brief glimpse of those might be useful for non-South African readers.

Since at least the mid-twentieth century smallholder agriculture in South Africa has been more or less synonymous with the agriculture of black farmers. But that has not always been the case, and the history of the sector has been simply described by Vink and van Zyl (1999) as a long process of disempowerment of this part of the black population, running from the early decades of the last century. They summarize the process as follows.

> "African family farming was relatively viable in the latter half of the 19th century, and in some areas well into the 20th century. African owner operated and tenant farming proved to be as efficient as the large-scale settler farming of that time. African farmers adopted new technologies, entered new industries and out-competed large-scale settler farmers in many of the emerging agricultural markets. At present, however, African agriculture is largely associated with the economy of the former Homelands, where it contributes little to household income and generally fails to provide even basic subsistence needs." (p. 61)

The connection between those two situations was a long series of policy measures that progressively suppressed small-scale, black agriculture, allocated the most productive agricultural land to white, large-scale farming, and restricted black agriculture to a set of scheduled 'Native Reserves', later 'Homelands', located for the most part in areas of relatively marginal land. As a matter of intended policy, household income in these areas became heavily dependent on income from agricultural labour on large-scale farms or from migrant labour in mines and urban industry or services. In contrast and in parallel, a wide range of policy measures were put in place to subsidize and protect large-scale white commercial farming.

The result was not merely a highly skewed distribution of farms, with a very small proportion generating a very large share of output and income - a common feature of agricultural sectors, especially in developing economies. Instead there was a sharply differentiated bi-modal distribution – an extreme form of dual structure. But one should not be too statistically precise about the situation because one feature of the smallholder component of that structure was that it was almost entirely unmeasured during the apartheid era. With the homelands covered inadequately, or not at all, in statistical surveys until 1994 (Kirsten and Moldenhauer, 2006), the smallholder sector was statistically excluded as well as being every other kind of excluded.[36]

Nevertheless, rudimentary information is available about the late-1980s when, as summarized by Vink and van Zyl (1999: 67), nearly 90 per cent of actively farmed agricultural land was in white areas. It supported a rural population of 5.3 million, more than 90 per cent of whom were African wage labourers on larger-scale, commercial farms. In contrast, the remaining agricultural land in the homelands supported over 13 million people on the basis of average individual land holdings of about one hectare. In effect, the African family farming sector had been all but eliminated and African peasants had been transformed into wage workers, a large proportion of whom (especially of the adult male population) were absent from their rural communities for long periods. Agricultural capital for farming in this context was at very low levels and human capital in the form of skills and experience had been substantially eroded.

[36] Detailed analyses by Liebenberg (2011) have thrown light on aspects of this statistical exclusion and its implications for understanding even the quite recent economic history of South African agriculture. [Not referenced unless it is 2011]

At the same time, access to agricultural services was very limited and supported by levels of public expenditure that were much lower than those provided for the already knowledge-rich large-scale sector.

After 1994 the framework of discriminatory legislation was dismantled; measures to introduce several types of land reform were introduced, though implemented very slowly; and the research and extension services were reorganized in ways intended to provide greater support to smallholder agriculture, though the total number of agricultural research scientists has fallen (Sandrey and Vink 2008, Vink and van Rooyen 2009). However, a number of surveys since the mid-1990s appear to leave the magnitude and composition of the smallholder/small-scale agriculture sub-sector still unclear (Kirsten and Moldenhauer 2006, Pauw 2007, Aliber and Hart 2009, Drimie et al. 2009). This lack of clarity largely reflects the great complexity of what is bundled together under the general heading of 'smallholder' farming. At the heart of this complexity are widely differing degrees to which rural households engage in agriculture, combined with the different ways they do so and the different purposes they have. Moreover, individuals and households may move in and out of agriculture from year to year.

The counterpart to that is that households draw on multiple sources of income, among which farm income often plays a relatively small role among wage income, pensions and grants, remittances and others – only 23 per cent on average in former homelands households in 2000 (Kirsten and Moldenhauer 2006: 67). The extent to which food security depends on subsistence agriculture also varies widely. But even when agricultural production is relatively small, it can play an important supplementary role, and one estimate of a core group for whom agricultural activity provides a significant basis for their food security is that "some 4 million people from over 2.5 million households, mostly residing in the former homelands … are engaged in agriculture as a means of supplementing household food supplies" (Aliber and Hart 2009: 454). All that complexity varies across geographical areas, and those areas involve varying degrees and types of stressed agricultural conditions, with access to input and product markets also highly variable – though usually poor and often absent.

Perhaps not surprisingly, views about broad policy responses to this complexity vary widely. But, cutting across that diversity, views about the specific role of agricultural research and innovation, seem to differ between two kinds of analysis: (i) those that focus specifically on aspects of smallholder agriculture and 'work back' from there to raise questions about research and innovation, and (ii) those that focus primarily on characteristics of the research and innovation system and 'work forward' from there to consider its role in South African agriculture.

Among studies that focus specifically on the smallholder sector, there is general agreement about five innovation-related issues: (i) the disparity in innovation capabilities between its two components is a critically important factor underpinning the dual structure; (ii) successful innovations in smallholder agriculture have typically involved significant new knowledge inputs such as farming experience, extension visits and increased training; (iii). since the 1990s there has been a significant effort to reorient the provision of inputs by research and extension services towards smallholder farming; but (iv) these services have not been able to support an adequately rapid or widespread development of either market-linked agricultural production or improvement in the supplement to food security provided by small-scale subsistence farming – and the total scale of research and extension services has been falling. Finally however, those limitations are far from being the only obstacles to achieving such impacts because other, often more binding constraints are set by adverse agronomic conditions (with these being exacerbated by climate change), by limited physical infrastructure such as transport access to product markets; and by institutional constraints such as insecure land tenure and access to credit.

Most of the comment about addressing the constrained impact achieved by research and extension services has centred on orienting a larger scale of research and extension resources towards the smallholder sector and developing a stronger system of linkages to *deliver* new technologies to smallholder farmers. However, in some instances, it is recognized that the particular characteristics of agriculture in those contexts may require different kinds of innovation process: types of innovation that would, for example, give greater attention to "villagers' indigenous agricultural practices" (Aliber and Hart 2009: 454) or that would involve "participatory research, information dissemination and capacity building …" (Ortmann and King 2011: 406). That perspective is treated more extensively by Botha (1999)

However, a different perspective seems to be offered by studies that have focused primarily on the country's agricultural research and innovation system and moved from there to address questions about its role in contributing to change in the agriculture. Here the existence of the deeply dual structure of the agricultural economy is commonly almost invisible. So also are explicit discussions about whether or how the formal R&D and innovation system might need to develop distinctly different ways of achieving innovation in order to respond to that duality.

For example, a review of agricultural research between the early 1970s and the late 1990s (Liebenberg, et al. 2004) made almost no reference to the dual structure of the agricultural sector that faced the research system. It did include very brief comment about refocusing research towards small-scale farming and the needs of poor farmers in disadvantaged communities (p.2), but the analysis concentrated almost entirely on broad trends and developments in research activities at the level of the overall national system . Even the disaggregation of that analysis under a heading of *Research Orientation* dealt with only two kinds of orientation: the allocation of resources between (i) different commodities and (ii) different thematic foci (e.g. crop research; livestock, pest and disease control; or post-harvest technologies). A third kind of orientation – between the two sharply different agricultural sub-sectors – was not discussed. Some years later a very similar perspective was taken in an immensely thorough and longer-term review of the sources, structure and trends in South African agricultural R&D between 1910 and 2007 (Liebenberg et al. 2011). Again, even with reference to the 1960s - 1980s period, the discussion was entirely about R&D in relation to a unitary South African agriculture. This broad perspective carried through to the analysis of more detailed aspects of the R&D system. For example, using eleven annual estimates over the period 1910 to 2007, details about research and extension intensities were examined with reference to only the national entity and without any comment about whether or how there might have existed disparities in the intensities between different parts of the dual structure.[37]

[37] In any case, the underlying data relating to the smallholder sector are inadequate to provide a satisfactory picture of even the national aggregate, let alone of any disparities between the components of its dual structure. These intensity indicators measured R&D and extension expenditure as a proportion of farm value added, agricultural GDP, the total number of farms, the total population, the farm worker population and the total farm area; but the data about the smallholder components of these are either inadequate or absent (Liebenberg 2011 and personal communication).

These kinds of analysis perhaps help to reinforce, and certainly do not challenge, perceptions agricultural research and innovation constitute a singular *type* (or mode) of activity. Changes in the scale of this activity may be examined (e.g. in terms of expenditure or personnel), and changes in the system's broad organizational and governance arrangements may also be identified. But essentially the key structural characteristics of the innovation *process* are taken as given. Thus any questions about how the system might better address smallholder agriculture tend to concentrate on re-orienting greater quantities of R&D resources towards smallholder farming and on strengthening the links needed to deliver new technologies to it.

This kind of perspective also dominates policy documents. For example, *The Strategic Plan for South African Agriculture* of 2001 noted "the legacy of exclusion and discrimination in South African agriculture", but its section about research, education and extension said nothing about current imbalances and focused only on expanding the aggregate scale of expenditure these activities – planning to raise it as a proportion of agricultural GNP from 1.4 per cent to 3 per cent. Also, although it highlighted that the research system had in the past a "bias in favour of large-scale farmers", no specific element of strategy was proposed to redress that bias in future.

The later *National Agricultural Research and Development Strategy* (Department of Agriculture, 2008) was a little less narrowly focused. It noted, albeit briefly, the importance of such issues as: broadening access and participation (p.3), articulating the needs of the Second Economy (p. 4), and strengthening the demand side of agricultural research (p.5). However the broad overall concern was about the scale of the research system and its staffing, and its ability to contribute to aggregate growth in the economy. Neither the *Objectives* nor the *Guiding Principles* of the strategy identified issues specifically related to smallholder farming within the dual structure of agriculture.

However, there was one small exception to this overall emphasis. The *Strategy* was set in a perspective about delivering technologies to their users ("One of the greatest challenges in the research fraternity is getting the technologies to the farmers who need these most."- p iii). But there was also an explicit recognition that, if innovation was to contribute to sustained and equitable development, there would need to be different modes of innovation that depended much less on such delivery-focused processes:

> "The traditional linear approach of researcher-extension agent-farmer or end user is limiting in the current South African farming system. *Other approaches, such as participatory action research and farmer-to-farmer learning are more appropriate*". (p.12, emphasis added)

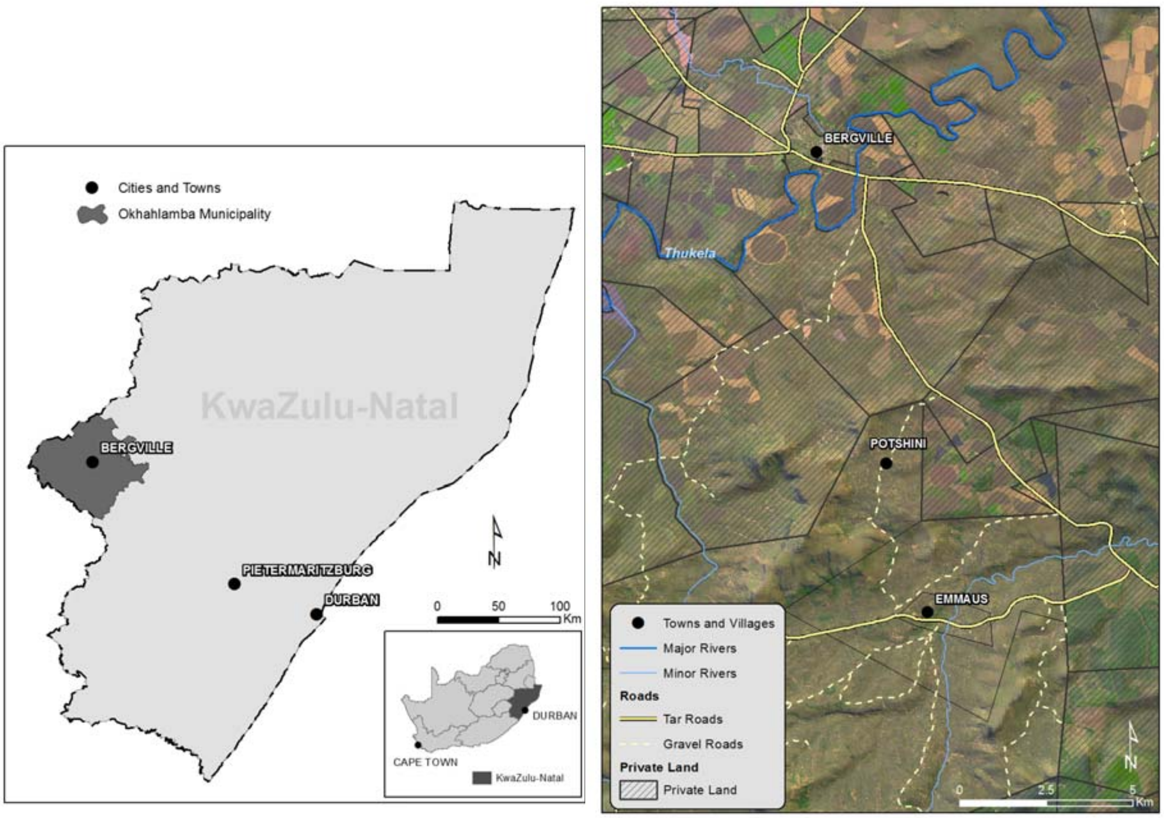
The case studies in this paper explore that claim, and also aspects of the kinds of analysis and indicator development that might be needed to examine it more thoroughly and more extensively.

4.2 The Village Context: Potshini

Potshini, which falls within the Okhahlamba Local Municipality is a rural village situated approximately 25km from the closest town, Bergville (See Figure 4.1). It falls under the Greater Emmaus area, which was previously a Catholic mission and has a large government hospital. The area is characterized by high household densities, which in turn has resulted in small land allocations per household for cropping purposes. Livestock ownership includes cattle, goats and horses. Livestock graze on open access communal grazing areas, which are perceived by the local community to be too limited for the number of households, although stocking densities are lower than in nearby former homeland areas (areas designated for settlement of black communities during apartheid).

Potshini is just one of four closely associated villages (the others are Nokopela, Mlimeleni and Nyonyana), which are bounded by commercial farms. These are large-scale operations that focus on wheat and maize in winter under irrigation, potatoes and maize in summer as well as sheep production.

Figure 4.1: Maps showing the location of the study site



Members of households living at Potshini rely on a range of sources of income, the largest of which is generally the government social grants which include old age pensions, child support grants and disability pensions. In addition, remittances from family members working in the large urban centres, casual (*togt*) work within the rural community and on the surrounding commercial farms, as well as formal employment as farm labourers on the commercial farms also contribute to sustaining households. Returns from agricultural activities in reality make a smaller contribution than other sources to the economic wellbeing of these rural households, though they do contribute to household food security and livestock plays an important role in dealing with unforeseen expenses such as funerals or medical needs.

Underlying these complex livelihoods, the population of Potshini faces the same dual challenge as most other smallholder communities in South Africa: HIV/AIDS and the migration of adults, especially adult males, to employment in distant urban areas. Consequently these communities demonstrate the paradox of shortages of important kinds of labour in a society with very high aggregate levels of unemployment. Typically, therefore, this leaves older women having to carry a very large part of the agricultural (and other) labour burden required to sustain the family and its food security.

Agricultural activities within Potshini mainly include dryland maize and drybean production in the summer months when the majority of the rainfall is received. Some vegetable production takes place in home gardens, mainly for household needs, with small surpluses sold locally.

Before the initiatives examined in these case-studies, smallholder farmers in Potshini had already been involved with a number of different organizations and projects concerned with research and innovation activities. For example between 2000 and 2004 the Agricultural Research Council implemented a 'Landcare' project to introduce a range of practices and cropping patterns oriented towards soil conservation. In addition to this, at least two projects involving explicit 'participatory' approaches to changes in water use and management have been implemented. One was a water management monitoring project undertaken in the mid-2000s. This had involved a range of local stakeholders in the research, with considerable involvement by the Sivusimpilo Farmers Forum covering the Emmaus area (Rockström et al. 2004; Kongo et al. 2010). The other was concerned with developing and applying water use practices (e.g. in small gardens). This also appears to have engaged widespread involvement in the Potshini community (Sturdy et al. 2008).

4.3 The organizational context: PROLINNOVA and FAIR

The two cases examined in this paper are both associated with wider initiatives supported through a network called PROLINNOVA[38] - an international network of organizations that is active in some 20 countries throughout the developing world. The network promotes innovation processes and appreciates the role that local innovativeness can play in overcoming challenges faced by smallholder farmers and rural communities (Wettasinha and Waters-Bayer 2010).

PROLINNOVA has recognized that farmers have the capacities to conduct their own experiments and investigations, but also recognizes that these processes can be strengthened through creating linkages with other actors who can bring knowledge, new ideas or access to markets. PROLINNOVA-South Africa, the local arm of the network, has participated in a sub-programme of PROLINNOVA called FAIR ('Farmer access to Innovation Resources). FAIR is an action research initiative that has piloted the concept of local innovation support funds (LISFs) as vehicles for facilitating access to resources for supporting farmer experimentation. The initiative has been focused in the Okhahlamba District of KwaZulu-Natal. The two main support organizations involved with the FAIR project are Farmer Support Group (FSG), which is an outreach arm of the University of KwaZulu-Natal and SaveAct, a non-governmental organization that supports savings and credit-related initiatives. SaveAct and FSG have worked together to support technical, financial and institutional aspects of FAIR.

LISFs have been conceptualized as locally managed funds that community members can approach for support of local innovation processes. Thus they put funds in the hands of farmers or structures that directly represent farmers, so that they can support farmer experimentation not only with funds, but by establishing linkages with other actors such as markets, researchers and input suppliers. LISFs are a means of allowing farmers to define the

[38] PROLINNOVA is an acronym for 'promoting local innovation in ecologically oriented agriculture and natural resource management',

research agenda more effectively and participate in the development of improved technologies or systems of organization.

The FAIR project recognized the need to establish a local structure to manage the funds and also the need to strengthen the institutional environment/context in which innovation takes place. This led to the establishment of the Hlahlindlela Trust, which is the legal entity that manages the funds, and support to the Sivusimpilo Okhahlamba Farmers Forum (SOFF), which is a platform representing farmers from a number of different communities including those where FAIR is active. The SOFF had already been established in the area prior to the FAIR initiative.

The SOFF supports farmer-to-farmer sharing and encourages innovative behaviour. It has been effective in stimulating farmer experimentation as well as allowing for dissemination of the outcomes of the innovation / experimentation processes. Farmers with ideas for which they planned to apply to Hlahlindlela Trust for support are encouraged to first share their ideas at the SOFF meetings. The Hlahlindlela Trust members then facilitate discussions regarding compliance with criteria for receiving funding and if the idea is found to be satisfactory, then the innovator is encouraged to fill in an application form for submission to the Trust's screening sub-committee. The Hlahlindlela Trust has a number of sub-committees responsible for tasks such as screening applications (according to a set of criteria) and monitoring experimentation and other activities such as cross-visits, which are funded in order to encourage innovation.

The criteria for selecting innovations / experiments to be supported by the LISF include:

- Innovator has prior record of experience with food production, agriculture and/or natural resource management.
- Preferably innovator has some prior experience of innovation.
- The idea is technically, economically and institutionally feasible / acceptable.
- The idea is replicable amongst the poor and vulnerable.
- The innovator is able to meet the requirements for own contribution.
- The innovator is willing to share the results with others.

The team responsible for monitoring and evaluation not only monitors the experimentation processes, but also evaluates the outcomes of other activities (or learning events) The committee then provides feedback on progress at the HT meetings. FSG and other players have been supporting the M&E committee to conduct participatory evaluation. Generally experiments are monitored against the original objective, such as the performance of the crop or livestock. The level of commitment of the innovator is also assessed. The M&E team has also been provided with a digital camera to assist with monitoring the experimentation process. Photography is a method used in the community to document innovations, particularly relevant given the limited levels of literacy.

Though the functions of the HT are currently limited to implementation of the FAIR project, it is envisaged that it could fundraise for other community development activities and create an opportunity for community members to participate in buying of inputs in bulk. The Trust is not yet fully functional and still needs to improve a number of its roles such as reporting of meetings and monitoring of project activities.

4.4 The approach to the case-study research

FAIR supported a total of six innovation projects in 2009/10 (see Table 4.1). As indicated, these were individually quite small projects. The total cost of support for each was around R10,000 – R16,000 (E1000 – E1,600). Within this, the direct, project-specific costs were a small part of the total, except in the Cherry peppers case. These included inputs (such as seedlings and fertilizer) and some support in terms of transportation required, for example, for learning and exchange visits. The supplementary and indirect cost component, the last column in the table, was much more substantial. This covered the general facilitation and advice that FSG and other collaborating actors provided, and also the costs of supplementary experimentation directly related to the innovation.

Table 4.1 Grassroots innovation supported by fair in 2009/10

Innovator(s)	Description of the innovation supported	Direct Cost of support (Rands)	Supplementary/ Indirect Support (Rands)
1. Phuthumani and Walani Farmer Groups	Cherry pepper trial: Testing of a new cash crop, exploration of marketing opportunities and strengthening of relationship with neighbouring commercial farmer.	6,000.00	10,125
2. Sicelumusa Farmer Learning Group	Green manure/cover crops: Testing of different types of legumes (i.e. velvet beans, sun hemp, clover, cowpeas) as crops to be incorporated into the soil, and allowed to decompose for a given period before planting of the following crops.	1,468	11,400
3. Elakho-Ithuba Farmer Learning Group	Livestock fodder supplements: Testing the performance of various fodder species (lucerne, turnip and cocksfoot) for feeding milk cows in winter	834	9,351
4. Thabani Madondo	Potato mulching practice: Testing of a new method of planting potatoes under a layer of mulch against conventional tillage.	808	13,680
5. Khethiwe Hlongwane	Planting vegetables in bags: Test the performance of spinach grown in bags containing either compost or manure	975	12,375
6. Ellen Moloi	Mole prevention in potatoes: Investigating the use of corrugated iron to prevent mole damage by burying the iron and planting on top of it.	408.00	15,290

The two case studies explored here were selected from the group of six and were undertaken as small studies at a relatively early stage in the two innovation processes. Given the fairly limited steps into implementation of both cases at the time of the research, they were not intended as detailed evaluations but instead the aims of the research were more exploratory -

in two respects in particular: (i) to outline broad characteristics of innovative activities at the grassroots end of the typological spectrum discussed earlier, and (ii) to consider issues about policy-related evaluation and indicators that might be important both for this type of innovation and more generally for evaluation of participatory/grassroots modes of innovation at this stage in their development in South Africa.

Previous research by the authors provided considerable background information about the cases. In addition, interviews took place with the farmer innovators involved in both cases. In order to better understand the type of support required for these projects, interviews were held with members of the institutions that have been involved in the implementation of the FAIR programme, namely the Hlahlindlela Trust, which manages the funds, and the SOFF, which supports farmer-to-farmer sharing and encourages innovation.

The discussions with the smallholder farmers involved in each of the cases followed a common framework designed to trace, and elicit information about, the development of the projects through a sequence of phases: pre-existing conditions, origins and initial triggers, activities and linkages, commercialization (where relevant, outcomes and dissemination). Due to the informal nature of local innovation and joint experimentation, it was not easy to track the innovation processes, but the authors believe the information obtained provides an adequately accurate record of the main aspects in each case.

The discussions also helped in identifying indicators that could be used for two more detailed purposes: to measure the impact of grassroots innovation on livelihoods as well as indicators to quantify the extent to which farmer experimentation and local innovation was taking place in the community.

5 THE CASE STUDIES: MAIN FINDINGS

The main characteristics of each of the case studies are described here, but the discussion starts with comments on a set of circumstances that were common to both.

5.1 The demand for innovation support

An initial expectation underlying the FAIR initiative was that there would be a significant demand for funding and other support for autonomous, or at least farmer-led, projects in the community. To date, however, as reflected in the number of applications funded, the demand for support has been much lower than those expectations, despite the fact that the fund has been openly available to anyone within the community as long as the proposed idea is innovative enough to meet the criteria for support.

It is not clear why this has been so. On the one hand, the relatively low demand for support may stem from a relatively low incidence of autonomous innovative activity in the community, and hence a low demand for funding to support it. It is certainly the case that autonomous innovation by smallholder farmers is not a concept that has previously received much attention in South Africa in general; and in the specific context of Potshini one respondent - Thabani Madondo, a local farmer innovator – suggested that the pursuit of innovative solutions is not the most common response to problems: “Many people when faced with a problem just stop their production”. Consequently, those who were applying were only people who had an understanding of what constitutes innovative behaviour and, in Mr Madondo’ words: “those who have their own ideas about ways to solve problems they are facing". The limited demand for support might suggest that such people were relatively few and perhaps also that many previous research initiatives in the area were researcher-driven rather than farmer-led.

On the other hand, it may be that the issue was not about the low incidence of autonomous innovation *per se*, but about the demand specifically for *funding support* for such innovation. People are not accustomed to accessing funds for the sort of activities supported through LISF. They are familiar with applying for funds for items that they need for production (for example a pump or fencing), but not with funding instruments that assist with materials or support for experimentation or innovation. In addition, as suggested by Mr Madondo, there may be people with potentially eligible projects who do not apply because they do not want to share their ideas with the rest of the community.

Whatever the underlying reasons may have been, the limited demand for support for innovation (so far) highlights the importance of systems or platforms that are able to stimulate farmer experimentation. The SOFF, which was established with support from FSG to facilitate sharing between farmers, has proved valuable as such a mechanism. It has also allowed for effective sharing of the outcomes of joint experimentation processes supported by FAIR. Besides the cases that are presented to the SOFF by farmer innovators seeking funding support, the forum also provides an opportunity for sharing knowledge about innovations that do not require support from the LISF. This sharing of innovations appears to help farmers understand and develop solutions to their problems.

5.2 Case 1: Innovation in potato production

The innovator

Thabani Madondo is an active community member and farmer in Potshini. He is one of three leaders of SOFF and is also a member of HT. He has been experimenting with conservation agriculture and sustainable farming techniques and processes for nearly six years. Together with other farmers, he has worked with a number of organizations involved in several agricultural and community-based natural resource management activities, including those of the University of KwaZulu-Natal and the Agricultural Research Council. It appears that the cumulative learning and empowering effects of his involvement in other research initiatives, which have to some extent been of a participatory nature, may have played a role in Mr Madondo's innovative nature. Alternatively, it could be that he has in fact become involved in these initiatives because he has an 'enquiring mind' and an interest in research.

Project origins and the triggers for innovation

During a visit from a pastor that took place during the earlier conservation agriculture initiative, Mr Madondo came across an idea of growing potatoes under mulch rather than using the conventional method of planting them in the soil. He was motivated to experiment with this method because he saw the challenges being experienced in his community because of the loss of the economically active sector of the population through HIV/AIDS or migration to the urban areas. In particular the trigger for pursuing the idea was the difficulties encountered by older women in ploughing the soil, managing the crop and digging to harvest it. In addition, women and children in rural areas often have to juggle a number of different chores and responsibilities. Freeing up time by making use of labour-saving technologies means that this time can be used for other household chores or for education-related activities such as studying or homework. Consequently he saw the alternative mulch-based method not as a way of transforming all potato production in the area but as a way of reducing the labour requirements for growing potatoes in people's home gardens as a means of improving their food security.

Apart from the prospect of reducing labour requirement in this focused way, there were other potential benefits from the new technique. It offered a potential to build soil structure and improve soil fertility. Also, directly after plots have been harvested, they can be used to grow another type of crop, which also saves time. In addition, even without considering the impact of HIV/AIDS, women and children in rural areas often have to juggle a number of different chores and responsibilities. Freeing up time by making use of labour-saving technologies means that this time can be used for other household chores or for education-related activities such as studying or homework.

The research and experimentation

Mr Madondo conducted a small experiment on his own and concluded that the technique had much potential. Through another PROLINNOVA-South Africa initiative aimed at piloting joint experimentation processes, he developed a proposal to support this experiment. He then worked on the experiment with staff from another organization working in the area, Mahlathini Organics (see below) and FSG. The experiment compared the performance of potatoes grown using the two techniques, i.e. conventional planting and planting under a layer of grass mulch. Joint planning was done for experimentation and the innovator led the experimentation process. Mr Madondo had ideas about different depths of mulch and different materials to use for mulching. As described below, these plans and ideas evolved into a phase of experimental activities both within the village and in collaboration with a wider range of organizations. Beyond that initial phase, Mr Madondo has continued with a second phase of experimentation supported by FAIR. He is considering different planting times as well as different mulching materials.

The intention underlying this experimentation was obviously not initiated by the farmer to develop a radically novel type of innovation. Nor was it about developing an innovation that would be 'new-to the-market' in South Africa. The idea was prompted by experience with this production method in Lesotho, but instead of 'adopting' a ready-made technology off the shelf, Mr Madondo decided to try the idea within the local context. He also had to do some 'guess work' as he had only received some fairly sketchy information about the production practice and had not seen it for himself. Moreover those gaps in knowledge do not seem to have been unknown only to the inhabitants of Potshini. The pattern of collaborative research with other actors outside the village, in particular researchers from the research station, suggests that the required knowledge for implementing this new practice was not readily available to others either. In other words this seems to have been something like a 'new-to-the-local-area' innovation that called for creating a significant amount of locally novel knowledge.

The development of links to complementary knowledge sources

Once Mr Madondo's own experimentation with the mulching practice was under way, a number of other actors were drawn in to contributing to the innovation process. The diversity of these contributors was striking. As noted above, Mahlathini organics became involved. This privately run organization, which provide rural development expertise, was already involved in water harvesting activities with Mr Madondo and other farmers in Potshini. Erna Kruger, a researcher from Mahlathini Organics, who supports farmers with technical knowledge related to crop production, provided technical support to the initiative and gave advice to the innovator regarding experimental design, data collection, record keeping and monitoring. FSG facilitated linkages and collaboration in two broad ways. At the village level it facilitated the joint experimentation process and the sharing of experiences through the farmers' forum. At a wider level it also supported the development of links with knowledge sources outside the village. It facilitated the involvement of the researchers from the Provincial Department of Agriculture who are responsible for on-station and on-farm experimentation. As a result, the researchers replicated the experiment on the research station. Thereafter, FSG facilitated a cross visit to CEDARA, the research station of the KwaZulu-Natal Department of Agriculture, where the experiment was replicated on-station with additional treatments. This allowed for sharing of ideas and experiences which informed the farmer experimentation being undertaken in Potshini.

Outcomes of the innovation process

The first year of experimentation in 2008 revealed some interesting results, which would need to be confirmed by subsequent cropping seasons. In terms of productivity, the mulching practice resulted in a 26.7% reduction in yield, when compared with conventional production. The experiment showed that germination rates were lower with the mulched plots, which was thought to be responsible for the total weight of potatoes produced under mulch in October 2008 being 184.6kg, versus 252kg for those grown conventionally on a similar sized plot (Malinga et al. 2010). Mr Madondo believed this poor result was largely the result of the material used for mulching, which inhibited germination. He still believed that the benefit of the reduced labour requirement outweighed the reduction in yield and undertook to continue experimenting.

An effort was made to quantify the labour saving benefit of the mulching technique compared against conventional production (See Table 5.1). The comparison was based on a limited area as might be planted within a household garden (Approximately 48m^2 in area). Mr Madondo's estimate of labour requirements revealed that the mulching technique resulted in a 72.1% reduction in labour. In an effort to quantify these impacts, the reduction in yield and the reduction in labour were also expressed in monetary terms based on the area that was used to estimate labour requirements. Based on the proportional reduction in yield, a loss of 51kg (valued at some R179), would be almost offset by the reduction in labour, valued at R176 (at a rate of R8/hour – the current minimum wage). From this one starts to recognize that less conventional measures of 'success', such as the extent to which they reduce labour requirements may, under certain circumstances, be just as important to people as the issue of yield. The new method might well be preferable in the light of local priorities – something that might not have been apparent from simply examining yield changes with respect to general agricultural production.

Dissemination of the findings

Despite fact that the yield results were not as favourable as had been expected, Mr Madondo organized an information day to share the progress on the experiment with SOFF members who participated in the planting of the experiment. Having heard about the outcomes of Mr Madondo's experiment, four small-scale farmers from other locations went on to replicate the experiment, while another farmer innovator, Mr Mcijeni Mbhele, investigated ways to improve the system by making more efficient use of the mulch. In addition, after Cedara had conducted its on-station replications of the earlier village trials, it held an open day March 2009 to share the results with farmers from all over KwaZulu-Natal.

Table 5.1: Comparison of labour required for 48m^2 of potatoes

Conventional practice	Timeframe	Mulching practice	Time-frame
Manual 'ploughing'	8 hours	*Assume that the farmer has a source of dry bean residue for mulching* Collect the mulch	1 hour
Open furrows	2 hours	Lay the potatoes, Water the soil, Place the mulch (15cm), Water the mulch, Cover with a second layer of mulch (15cm), Water the mulch. *Assume no fertilizer is applied*	4 hours
Apply fertilizer / manure	20 minutes		
Cover with soil	5 minutes		
Place seed potato	5 minutes		
Cover seed potatoes	30 minutes		
Hand-weeding	2 hours	No weeding	0
Watering (if no rain)	1.5 hours every two weeks	Watering (if no use)	1.5 hours every two weeks
Ridge I	1 hour	No ridging	0
Weed (hand-hoe)	2 hours	No weeding	0
Ridge II	1 hour	No ridging	0
Hand-weed	4 hours	No weeding	0
Harvesting	8 hours	Harvesting	2 hours
TOTAL TIME	**30.5 hours**	**TOTAL TIME**	**8.5 hours**

5.3 Case 2: Introducing a new cash crop and a new marketing arrangement

The Innovators

In 2009, farmers who participate in the SOFF started discussions about the possibilities of growing new high value cash-crops rather than the more conventional crops such as maize and cabbages. One of the groups represented by the forum, the Walani Group, took the initiative forward by taking a field trip, funded by FAIR, to the Mkondeni Fresh Produce Market in Pietermaritzburg to get an idea of possible crops. Walani is a group of 9 smallholder farmers from Potshini that engage collectively in agricultural production. The Walani Group was formed by a group of farmers that had initially come together in 2001 to form a group called *Isixaxambiji* (which means 'pulling together'). Their main objective was to assist the community with farming activities, but ploughing in particular. They brought together their oxen and were thus able to help each other with draught power to till the land, moving the combined team of oxen from one farmer's field to the next on a rotational basis.

In this case there appears to be a direct connection between the collaborative activities of innovation process and the pre-existing form of collaboration. It seems likely that the prior experience played a role in how the innovation project developed.

Project origins and the triggers for innovation

Following the initial discussion and market visit, the more specific focus of the project was shaped by a discussion between one of the leaders of the farmers' forum and a commercial farmer whose land borders the community of Potshini. The commercial farmer suggested that the smallholders at Potshini should grow 'cherry peppers' (capsicums) that would be supplied to his processing facility - 'Natal Peppers', located at the town of Ladysmith about 100km away. Beyond the general incentive for diversifying into cash crops to generate higher income in a more reliable market than was achievable with conventional crops, the key trigger for the Walani group was the insight and potential opportunity provided by this discussion with the neighbouring commercial farmer.

It was, however, probably also important that this idea of cherry peppers was not a total novelty for Potshini because some of the smallholder farmers in the village had previously worked as seasonal labourers on the farmer's property and had been involved in the production of the cherry peppers. One of them had even grown a few at home and brought a sample of the fruit to a meeting of the SOFF to share with other farmers. Following the interaction with the commercial farmer, the farmers at the forum then discussed how to explore the opportunity further and undertook to try out the production of the cherry peppers.

The research and experimentation

The Walani group wanted to experiment with the crop under their own circumstances to see whether it could be grown in their area. More specifically, they had three main objectives: (1) to test the performance and survival of the new crop under local conditions, (2) to explore marketing opportunities, and (3) to establish a positive working relationship with the neighbouring commercial farmer and thus to move beyond the 'employer-labourer relationship' that had previously existed (Also much of the interaction in the past had been confined to conflict over the illegal movement of animals from the community onto the commercial farm to find grazing). Thus the innovation process had two kinds of elements – not only technical, but also socio-organizational. Drawing on knowledge provided by the commercial farmer, field staff from FSG assisted the group with planting the crop and applying the fertilizer. While the Walani members managed the crop, for example applying topdressing fertilizer once the crop started fruiting and keeping the crop free of weeds, they were also involved in some adaptation of the planting practices. For example, they incorporated a change in row spacing in order to address the challenge of crop loss resulting from the fact that green peppers were knocked from the bushes during the harvesting process. They felt that by widening the inter-row space, this loss could be minimized. They have also lengthened the inter-row space (the space between plants within a row) as they believe that the initial spacing resulted into interference between plants at the fruiting stage.

Thus, as with the research involved in Case 1, this case was again not simply about adopting a fully 'ready-made' technology. The local experimentation involved more than just feasibility testing to raise confidence in the production technology itself, it also involved the exploration of several technical details that were thought important. In terms of the technical aspects, the experimentation seemed to involve developing understanding about a more limited range of 'unknowns' than in Case 1.

The development of links to complementary knowledge sources

External links to complementary knowledge sources were limited to interactions with the commercial farmer who assisted with the production aspects (technical expertise as well as physical inputs for the trials – such as containers for harvesting) and ultimately provided a market for the crop. Facilitated by the FAIR coordinator, Nomaphelo Shezi, the Walani members had access to the commercial farmer's expertise and markets. They also had an informal arrangement with an employee on the commercial farm who provided the farmers with cheap transportation for collection and delivery of the crop during the experimentation period. Although they did not expect it to be a major difficulty to make alternative arrangements if necessary, once commercial production started, this assistance was a useful contribution during the testing phase when the farmers were unsure of how the new arrangement would work out.

Commercialization of R&D Results

The Walani group moved beyond the R&D phase and entered the market in the 2009/2010 season. They continued to grow cherry peppers in the 2010/2011 season at an increased scale of production, and with no further support from FAIR. In addition, a number of other farmers groups have also planted cherry peppers to supply to the factory in Ladysmith. In addition, some of the Walani members have extended the initiative further by collecting seed from their crop to produce their own seedlings at home and add a further income stream.

Outcomes of the innovation process

In summary, the innovation process has had three strands: (i) the introduction of a new crop (product innovation), (ii) the establishment of an improved relationship with the commercial farmer (socio-institutional innovation), and (iii) entry into a new supply chain (a marketing innovation). An effort was made to quantify the income generating potential of these linked innovations.

Discussion with the members of the group indicated that during the 2009/2010 growing season, they had supplied approximately 180 lugboxes (each holding some 12kg of fruit) from their 0.25 ha area. Taking costs into account they had made a profit of some R7,500 (approximately 750 Euro). Scaled up to a per-hectare basis, this translates into a gross margin of approximately R30,000 per hectare (approximately 3000 Euro). This is a substantially higher return than could be expected from maize or cabbage production - for example, it is more than twice as high as the standard gross margin (R13,436/ha) for cabbages in 2009/2010 (DAEARD 2010).

Dissemination of findings

Throughout the growing season, other farmer groups came to observe the development of the crop at various stages, while some assisted during the planting of the crop. Farmer-led field days, an innovation market and feedback provided at the SOFF meeting also allowed other farmers to share in the knowledge and experience generated by the experiment. This inspired other groups from different locations to replicate the experiment with technical assistance from the Walani farmers and the FSG team. In addition, a cherry pepper production manual has been compiled and translated into local language and will be shared with the SOFF members. Other Farmer Learning Groups have expressed an interest in growing the crop, which is likely to lead to wider spread of technology and sharing of experiences from the respective communities.

6 DISCUSSION: FROM CASE STUDIES TOWARDS POLICY ANALYSIS

6.1 Summary: The case-study observations

The case studies have described two examples of empowerment-oriented projects designed to foster grassroots innovation – a mode of innovation that has been much less commonly examined than other more functionally oriented types of participatory innovation. While the latter draw farmers into closer interaction with the formal research and extension system, primarily to increase its effectiveness, the two empowerment-oriented projects aimed to strengthen the informal innovation system and to develop its demand-driven knowledge-sourcing links with the formal. The two studies illuminate five main aspects of the innovation activities in these projects.

- Together with the four associated projects in Potshini that were not examined, the two cases demonstrate that it was possible to identify a number of people in the Potshini community with interests in pursuing their own innovative activities and with latent capabilities to do so. Although the number who initially came forward to obtain support for such activities was unexpectedly low, the existence of these latent interests and capabilities seems consistent with arguments about the potential importance of projects that seek to empower and mobilize such untapped innovation resources.
- With facilitation and funding support, these interests in innovation led into significant experimentation and testing designed to generate not only technical understanding about potentially applicable technologies but also, in one case, to assess new marketing routes and develop new socio-institutional relationships. In the process of undertaking these kinds of experimentation, demand-led links to other sources of knowledge outside the community were developed.
- These activities addressed two kinds of challenge that are important not only in the Potshini community but more widely across other smallholder contexts: (a) the need to develop new income streams based on new market opportunities (the cherry peppers case), and (b) significant socio-economic problems associated with the livelihoods and food security of poor and disadvantaged groups (the potatoes case).
- In both cases the innovation activities led to outcomes with potentially significant beneficial consequences. These seem to have been clear in the cherry pepper case where substantial new income streams were generated as a result of introducing a new crop/product and developing supply links to new markets some distance from the village. In the other case, the positive outcomes were less clear in measurable economic terms (though there are prospects that they can be improved by continuing experimentation); but they also appear to include potentially significant benefits in terms of less visible impacts on family livelihoods and food security, especially for women and children.
- Beyond those fairly immediate benefits from the individual innovation *projects*, there were a few signs of incipient longer term transitions towards more continuous and cumulative innovation processes – though the short time-horizon of the study precludes clear comment on these empowerment effects at this stage.

These few observations obviously provide no basis for generalization about the effectiveness of this empowerment-oriented approach as a means of fostering innovation in smallholder settings. Nor is it possible to develop such a broad view of this approach by linking the observations reported in this paper to those in other reports about similarly empowerment-oriented projects. This is not because other observations are absent. There are quite a number in the literature that was reviewed in Section 3.2.[39] However, the heterogeneity of these studies, including this one, precludes meaningful synthesis to create a more aggregate and generalizable picture of the characteristics of these empowerment-oriented forms of grassroots innovation.

[39] For example there are several in Reij and Waters-Bayer (2001), especially in Part 5 (Stimulating and Supporting Joint Experimentation), and also in Sanginga et al. (2009a), especially in Parts IV (Local Innovation Processes) and V (Building Capacity for Joint Innovation).

It is even less possible to draw any *comparative* conclusions about the effectiveness of these kinds of empowerment-centred approach *relative to* either more conventional modes or more functional forms of participatory innovation, such those examined in the evaluative literature reviewed earlier in Section 3.3. Although that literature provides more systematic and comparable evidence about impacts, together with a typological framework within which to make such comparisons, and although the observations from this study can be located reasonably well within that typological framework, the limited extent of the analysis of impacts in this study precludes even a small-scale exploratory comparison.

So, in contrast to quite a lot of the disparate case study literature that was reviewed in Section 3.2, this study does not jump from its individual case observations to an argument for scaling up and mainstreaming support for grassroots-participatory innovation. Instead, taking into account the insights provided by the two kinds of literature reviewed in Section 3, as well as these case studies, it is argued that *questions* about scaling up and mainstreaming appear to deserve more serious attention than they have so far received. There *does* seem to be a case for much more systematic analysis of whether, how and in what circumstances greater resources should be allocated to foster forms of grassroots-participatory innovation. That question has implicitly been on the table for more than thirty years. But, the evidence and analysis needed to answer it has so far been inadequate, even in the case of the evaluative studies reviewed in Section 3.3.

Moving beyond those limitations will require new approaches in all three kinds of analysis and indicator development that have contributed to innovation-related policy analysis in other areas, as discussed earlier in Section 2. Possible steps in that direction are outlined later in the concluding Section 7. That follows a discussion of more detailed issues about policy analysis and indicator development that emerge from the case studies.

6.2 The Case Studies: Some more detailed implications

(i) Mapping the innovation process: types of innovation outputs

As discussed earlier in Section 2, the analysis of innovation in industrial contexts has long recognized the importance of differences in the 'significance' of innovations. This has led to various classification schemes, one of the most widely used of which is the Oslo Manual distinction between innovations that are new-to-the-world, new-to-the-market and new-to-the-firm. Distinctions along these lines have, however, been much less commonly used in analyses of innovation in agriculture – though, as noted earlier, the importance of this issue was recently recognized by one of the contributors to the emerging debate about widening the range of agricultural innovation indicators.

This issue matters because policy debate about the role of grassroots-participatory innovation should not be about alternatives to conventional modes of innovation that are generally applicable across all circumstances. It should be about different modes of innovation that are likely to have *complementary* roles to play in achieving *different kinds of innovation*, often in different kinds of context - as demonstrated by Biggs and Clay's (1981) analysis of complementary formal and informal R&D systems, and also by experience in the industrial and service sectors of advanced economies.

The research in the two case studies therefore sought to identify the degree of novelty involved in the two innovations, and efforts were made to apply the Oslo manual distinctions about new-to-market and new-to-firm. But this raised two kinds of problem that would need to be explored further before an Oslo-type approach could be applied in this type of research.

- It was not clear what should be taken as the relevant innovating entity. In principle, the ‘new-to-*firm’* concept might be translated across to this context as ‘new-to-*farm’*. But in neither of the Potshini cases was a clearly identifiable farm the primary innovating actor. The notion of ‘new-to-*village’* might instead have been used, but it was not entirely clear that this was the relevant entity either.

- Even though the innovations in both projects might be similarly classified as, say, ‘new to the local area’, there seemed to be a significant difference between them in the ‘degree of novelty’ they involved - as reflected in the wider range of new knowledge that had to be created as a basis for implementing the potato-mulch innovation compared to the cherry peppers case.

In other words, it may be important to develop for studies of grassroots-participatory innovation a more fine-grained set of distinctions around an agricultural equivalent of the new-to-firm/farm category.

(ii) Mapping the innovation process: Network links to knowledge sources

Over the last two or three decades growing recognition of the networked nature of the innovation process in industry and services has contributed to a shift in policy and management perspectives away from oversimplified linear models of knowledge flow running ‘from-R&D-to-application’. Underlying this general shift, extensive survey and case study data have shown that: (i) diverse kinds of sources are used, (ii) knowledge sources in centralized public organizations such as research institutes and universities are used much less frequently than previously thought, while other kinds of source, especially business enterprises, are drawn on much more frequently; and (iii) these patterns vary across different types of innovation.

However, questions about knowledge networks have been given much less attention in connection with agricultural innovation. This has been especially the case in developing country contexts where attention has focused heavily on the role of centralized organizations such as research institutes and university departments, and where the presumption has been that knowledge links in innovation run in a direct, innovation-delivering line from those organizations to supposedly non-innovating adopters of ready-to-use technologies.

That was not the picture in the two cases examined in this study. Although both of them involved links to sources of knowledge other than the Postshini actors directly involved in the innovation projects, two other features of the knowledge networks did not conform to the commonly expected pattern.

Firstly, there was significant diversity in the knowledge sources and only some were in the formal agricultural research and extension system, and then in only the potatoes case. Others included the pepper-processing firm (Natal Peppers) and a private sector rural development organization (Mahlathini Organics). This has implications for how one might develop more systematic understanding about such networks. In particular, types of survey that are designed to focus only on links with formal research and extension actors would not capture the role played by other kinds of actor in the types of innovation network involved in these two cases. A more open-ended approach would be necessary to map this knowledge-sourcing dimension of the innovation process.

Second, in both cases the links were demand-driven in the sense that they emerged as a result of (often facilitator-supported) 'pull' by the prospective knowledge users. Moreover, the nature of this 'user-pull' took a particular form that does not match either of two commonly discussed kinds of farmer 'demand' for technology'.

- On the one hand, the pull did not consist merely of demand for a solution to a very broadly defined problem – for example for 'labour-saving technology to enhance the livelihoods and food security of households headed by (older) women'. A technology had already been identified in the village as potentially relevant for playing such a role, and what was needed was something more specific.

- But on the other hand, the pull was not so specific that it constituted a demand for a ready-made package of immediately usable instructions (e.g. a recipe for growing potatoes in mulch). The viability of such a recipe in the specific context of the village remained much too uncertain for that – at least as far as the potential innovation implementers were concerned. Instead, the demand was for additional knowledge to resolve uncertainties about what would be viable in the local context, and then to *create* the needed recipe. Even in the cherry peppers case where a well-established technology was already in use in the region, additional knowledge and learning about the technology and market was needed, and this required local experimentation based in part on knowledge inputs from external sources.

In other words it was *the process of innovation itself* that generated the 'pull' on external sources of complementary knowledge inputs. Thus it was the fostering of innovation that led to links, not the fostering of links that led to innovation.

(iii) Assessing Impacts: Cumulative transformation

Assessing the impact of empowerment-focused innovation projects presents considerable difficulties beyond those associated with assessing the impact of projects involving functional modes of participatory innovation. This is because of the difference in emphasis on the impacts aimed for.

- On the one hand, a large part of the argument for shifting towards increased use of functional modes of innovation centres on the impact of *individual innovation projects or steps.* The underlying proposition is that, in comparison with more conventional modes, functional forms of participatory innovation are likely to result in technologies that are better adapted to, and hence more likely to be adopted in, smallholder-type contexts. Evaluative studies can legitimately focus on those kinds of impact and, as shown earlier in Section 5.3, such studies have provided growing empirical support for this proposition about impacts.

- On the other hand, as discussed earlier in this paper, an important thread in the argument about undertaking 'empowering' modes of innovation goes beyond this focus on the gains from individual innovation steps. It is about stimulating a broader and cumulative intensification of innovative activity within smallholder production. This is about increasing the likelihood that individual instances of innovation will be linked into cumulative trajectories of successive innovation steps.

Neither of the case studies sheds much light on these longer term issues – though there was perhaps a glimpse of such a cumulative thread emerging in the step from producing and marketing cherry peppers themselves to the production of cherry pepper seedlings that could potentially reduce reliance on the external source of planting material. This gap is not surprising given the very short time scope of the study running forwards from the concept initiation and R&D phases of the innovation projects. But the case studies do prompt *questions* about this issue – in two groups.

- One group relates *prospectively* to planning and managing empowerment-focused projects. For example: what can one realistically expect by way of cumulative transformation - what kinds of change over what timescales? How do these cumulative transformations evolve and what factors seem to influence them? Hence, what might be done within empowerment-centred projects to increase the probability of more positive trajectories of change?

- The other is more concerned with the *retrospective* evaluation of impacts - for example: what dimensions of cumulative transformation of innovative activity would reflect this kind of empowerment impact? How would one recognize, classify and 'measure' them? How would one attribute them to inputs into particular empowerment-focused activities?

The importance of understanding these issues then prompts questions about how to design the necessary research. This is a significant problem because, as in the case studies reported here, analysis of the impacts of innovation projects and programmes is usually set within time boundaries that preclude the observation of long-term cumulative transformations. Consequently, different kinds of organizational and funding arrangements for longer term monitoring of impacts is likely to be needed if understanding about these issues is to be generated.

(iv) Assessing inputs: Initiation and facilitation

The analysis of inputs to innovation has come to rest overwhelmingly on data about inputs to knowledge-creation activities that are summarized as technological R&D (usually measured in terms of expenditure, but sometimes also in terms of the number of people involved). This focus has been widely accepted for analysis across the industrial, services and agricultural sectors.

However, as discussed earlier in Section 2, it has become increasingly well recognized over the last two decades, at least with reference to innovation in industry and services, that this is an excessively narrow perspective and that there is a much wider range of important inputs to innovation. In part these include institutional and organizational inputs, rather than those focused on the technology itself. But also, even with respect to specifically technological inputs, conventionally measured R&D covers only a fraction of what is involved. Omissions include activities lying 'downstream' from R&D that act either as a critically important link to the implementation of R&D-based innovation or as the originating source of knowledge for innovations that do not draw on any inputs from R&D.

However, in the domain of agricultural innovation, the inadequacy of measured R&D as an indicator of the technology-related inputs to innovation has been less well recognized. That raises similar problems to those in the industrial domain. In particular, although activities lying downstream from R&D (e.g. formally organized extension) are often taken into account, informally organized activities providing inputs to innovation are not – in particular knowledge-creation activities undertaken as 'informal R&D' by farmers themselves, especially resource-poor smallholder farmers. Consequently, where such unmeasured informal R&D has been important, as in the case studies reported here and in all the other studies of farmers' innovative activities, analyses of the gains from innovation would be attributed as returns to only the formal R&D component of total R&D – so inflating the apparent returns to that kind of R&D and obscuring the returns to other kinds.

The case studies discussed here also raise questions about another kind of input that may be particularly important in empowerment-type modes of innovation. This is about the initiation and facilitation activities needed to mobilize and strengthen latent innovation interests and capabilities for innovation. In part this may take the form of facilitating support *during* the course of farmers' R&D activities - in principle a measurable cost of carrying out the R&D. But it may also be an input to innovation that lies *'upstream'* from R&D as normally defined and measured – a prior empowerment investment that creates the conditions for local R&D. Both forms were significant in the Potshini cases:

- *During* the innovation projects, the Local Innovation Support Fund (LISF) and the Farmer Support Group (FSG) facilitated the farmers' interactions with other actors and their exposure to more structured innovation processes.

- But also, with the low initial demand for innovation funding, a *prior phase* of support was important. The FSG played a substantial role in establishing the farmers' forum (SOFF) and facilitating other activities that seem to have been necessary to stimulate innovative activity and assist in formulating proposals submitted to the LISF.

Thus simply providing funding for farmers' innovation activities themselves (e.g. to cover costs of purchasing inputs and materials required for experimentation and testing) would almost certainly not have led to the course of events that was observed. But it seems very unlikely that the costs of these types of activity, especially the up-front mobilising and facilitating type, would be captured in conventional R&D surveys. Yet they would need to be accounted for in assessing the costs of such projects, and their reduction over time might be an important reflection of the extent to which projects of this type contribute to sustained trajectories of cumulatively 'self-starting' innovation.

Given their apparent importance, it may be useful to reflect further on the costs of the up-front mobilising- and facilitating-type activities that contributed to creating a conducive environment for R&D on Potshini. In some respects these appear to be very similar to the training, human capital development, and social capital building that have been discussed in the evaluation studies of participatory modes of innovation.[40] However the intensity and cost of these activities may have to be greater in the type of empowerment-centred projects examined here. Then, it may also be thought that the intensity of such *empowerment*-centred projects, and hence their overall cost, may have to be greater in contexts like South African

[40] They are also similar in principle to the facilitation roles that are widely discussed in the innovation system literature in connection with the importance and theoretical 'legitimacy' of policy measures to overcome 'system failures' (and not just market failures) in the innovation process.

where, as expressed by Vink and van Zyl (1999), smallholder agriculture has been subject to a long, cumulative process of *<u>dis</u>empowerment* - a multi-dimensional process that encompassed the human, physical and social capital components of innovation capability.

<u>(v) The roots of grassroots innovation: 'Initial conditions' and their history</u>

Most of the case study literature about grassroots-participatory innovation has given scant analytical attention to the issue of initial conditions and their influence on innovation activities. But, alongside intra-project issues such as the participatory methods used or the behaviours of individual participants, initial conditions are likely to play a major role in shaping both the way innovation projects develop and the nature of their outcomes and impacts.

That was probably relevant in the cases examined here where the course of events may have been influenced by the fact that, when the PROLINNOVA/FAIR project started in Potshini, the village already had a considerable stock of experience of innovation projects involving local experimentation, with some of these explicitly organized in 'participatory' modes. One might speculate therefore that Potshini was significantly atypical in this respect: how many other rural communities of about 650 smallholder households in South Africa have experienced a decade of continuous involvement in such innovation or experimentation schemes? Correspondingly, how likely is it that the events reported about these two projects would be replicated in similar projects extended more widely?

This study alone does not provide a basis to answer those questions. But it does provide a stimulus to reflect on the importance of understanding initial conditions and their history in the development of future case-study research in this area. Such understanding may be valuable in at least two ways.

- Understanding longer-term cumulative transformations in innovative activities does not depend solely on monitoring changes over sufficiently long periods *after* the implementation of empowerment-centred projects. Valuable insights may also be generated by looking back to periods *before* such projects in order to examine the origins of their initial conditions. For example, with reference to the Potshini potato-growing case, it would be illuminating to know whether and how Mr Madondo's previous involvement with ARC-led research into no-till crop production had not only stimulated his interest in the alternative potato production method but also helped to build his capacity to engage in informal experimentation?

- Understanding about the history of innovation activities that precede innovation projects is also important for interpreting the results from evaluation studies of the impacts of those projects because it is necessary to establish the counterfactual basis for evaluation – the path that would have been followed without the empowerment project. In the case studies reported here it was not possible to develop that basis very clearly, and it is correspondingly unclear whether the observed innovation activities constituted the continuation of a past trajectory or a substantial departure from it. Given Mr Madondo's previously established personal learning trajectory, the former is quite possible. But the latter seems more likely in the light of the initially limited demand for innovation support, combined with the substantial scale of facilitation support that was needed to stimulate the activities.

While much is unclear about the initial conditions and history underlying these cases, the importance of the issues involved seem clear enough to warrant one general conclusion about the future development of case-study research in this area. Even if the observations from such research continue to be stacked up for another thirty years, they will contribute little to understanding about either the process or the impacts of non-conventional modes of innovation unless much more attention is given to questions about the initial conditions underlying the observations. And that attention will need to be systematic in developing compatible information and standardized indicators in ways that permit cumulative comparison.

7 CONCLUSIONS AND NEXT STEPS

7.1 Conclusions

The combination of case studies and literature reviews in this paper permits three broad conclusions about grassroots-participatory innovation in smallholder farming contexts.

1, There is inadequate evidence to provide support for policy and management decisions about the allocation of resources to these modes of innovation – either collectively as a group of closely related ‘non-conventional’ ways of innovating, or more narrowly with respect to particular functional or empowerment modes within that group.

2. However, there is enough evidence to suggest that much more serious attention should be given to addressing policy- and management-oriented questions about those resource allocation decisions - in particular: should these ways of achieving agricultural innovation in smallholder contexts be supported by more ‘mainstreamed’ and increased resource allocation? If so, which modes of innovation are likely to prove most effective in achieving which kinds of outcome in which kinds of context?

3. A necessary part of the “serious attention” that should be given to such questions is the development of a much better base of analysis and indicators designed to inform and influence policy and management decisions about resource allocation to support grassroots-participatory modes of innovation.

The second of those conclusions merits a little elaboration in order to clarify the basis for moving to the third - in particular: what is the evidence about? That can be summarized under three headings.

(i) *Effectiveness in research and innovation.* There appear to be prospects that, compared with more conventional approaches, these modes of innovation (in some kinds of context and with respect to some types of innovation) might generate technologies that are better adapted to local agronomic/ecological conditions and more closely matched to social and economic needs and demands - and hence more likely to be adopted more rapidly. Depending on circumstances and on other factors impinging on the relevant impact pathways, these innovation outcomes could contribute to higher income growth and poverty reduction, greater food security, and increased environmental sustainability.

(ii) *Efficiency in the use of research and innovation resources*. There also appear to be prospects that, in the same kind of comparison and subject to the same qualifications, these grassroots-participatory approaches, rather than adding to the existing costs of equivalent kinds of research and innovation, might reduce them by (i) accelerating the process of innovation and hence shortening the duration of projects, (ii) reducing the incidence of unproductive research routes into 'dead ends' with non-adoptable outputs, and (iii) substituting at the margin other contributors to the innovation process (e.g. farmers) for scarce and expensive research scientists and extension agents.

(iii) *Overall innovation system strengths*. Beyond those prospects of increased effectiveness and efficiency at the level of individual projects, programmes and organizations, there are also longer-term prospects that increased use of these modes of innovation would strengthen broader innovation systems. That is: with (i) a greater diversity of modes of innovation, (ii) a shifted balance towards more decentralized and more autonomous innovation activity at farmer/community level, and (iii) a wider portfolio of stronger links between different system actors and different complementary modes of innovation, it is likely that innovation systems would have more robust and flexible capabilities to address the innovation-demanding challenges and opportunities associated with achieving socio-economic change in contexts of rising environmental stress and global technological developments.

The quality of evidence underlying the first two of these arguments falls along a spectrum from 'marginally convincing' to 'pretty thin', and in the case of the third it might be described as 'largely theoretical'. But that does not mean the arguments have no basis at all and should be ignored. That would be too cavalier in a world that is looking for research and innovation to contribute more effectively to meeting the needs of smallholder agricultural communities on the basis of formally organized research and innovation resources that are already scarce in most contexts and becoming scarcer in many.

Instead, the arguments deserve to be more closely examined. That then focuses attention on the third conclusion – about taking steps to strengthen the base of knowledge needed to inform policy and management in this area. Before turning to discuss in the next section what some of those steps might be, two points of general clarifications may be useful.

The first centres on the notion of 'knowledge needed to inform policy and management'. The emphasis here is on policy and management concerned with broad aspects of resource allocation to these modes of innovation, both in general and with reference to specific types of grassroots-participatory innovation in particular kinds of smallholder context. Consequently, no comment is made here about important types of analysis and indicator development required to inform more detailed aspects of 'management' – e.g. about organizational arrangements and methods used in implementing grassroots-participatory activities. The kinds of analysis needed there were described earlier as 'internally' oriented, especially towards feedback and learning within implementing organizations, and they would include the kinds of evaluation that are designed to inform decision making that is 'internal' to those organizations. This kind of analysis remains important, and a considerable amount of it already takes place – for example within the case-study literature reviewed earlier in Section 3.2. That should continue, preferably being extended, refined and made more comparable across organizations and situations. The point made here is that it needs to be supplemented by a substantial body of work that is 'externally' oriented to inform and influence 'mainstream' decisions about resource allocation to areas and types of research and innovation, and those are usually made 'outside' the project/programme implementing organizations.[41]

The second point is about the role of analysis in informing such decisions. It is certainly important to bear in mind the literature that urges caution in expecting policy-oriented analyses to lead directly to impacts on policy. For example, one study of the role of ex-post impact assessments has suggested they have limited direct effects on donors' decisions about resource allocation to international agricultural research (Raitzer and Kelley 2008). However that study also drew attention to the more indirect ways in which evaluation studies appear to influence policy decisions and the conceptual frameworks within which they are taken:

> "… the primary pathways of influence are indirect and involve incremental improvement to the general understanding of programme functions and as justification for decisions taken on the basis of a range of considerations. Such conceptual influence usually involves combining evaluation findings with other forms of relevant information." (p.198

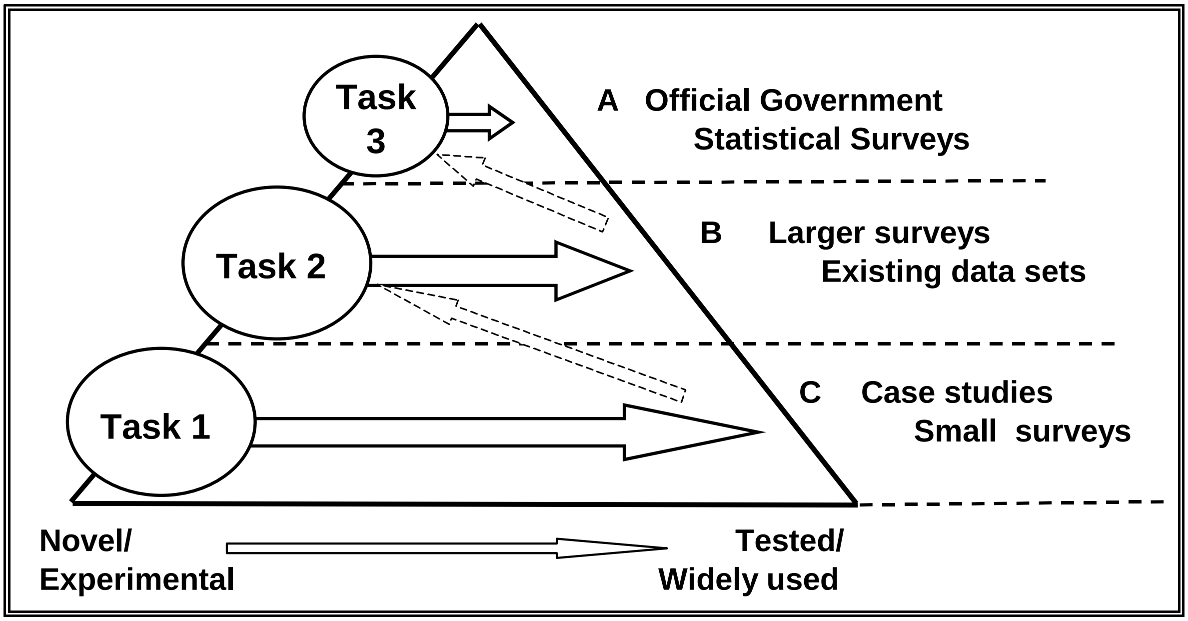
That kind of broader and incremental influence on policy-makers' perceptions, achieved by a mixture of evaluative and other information, seems particularly pertinent. Given the scant consideration currently given to grassroots-participatory innovation in the policy domain, the issue to be addressed is not about influencing decisions that are already highly placed on decision-making agendas. It is much more about shifting questions about these modes of innovation on to policy makers' radar screens, and then about moving their visibility upwards on decision agendas.

7.2 Some next steps

An important component of analysis in this area would involve developing a body of accepted indicators about aspects of grassroots-participatory innovation. But that does *not* mean that a first step, or even a particularly important step in the near future, should be about developing indicators based on data collected in large-scale surveys by or for government agencies. There is very little basis for such 'Level A'-type indicator development, even if there existed a convincing argument for it. Instead, as illustrated in Figure 7.1, the main tasks are concerned with building up through Levels C and B in the iceberg structure discussed earlier in Section 2. That involves dealing with indicator development as an integral part of undertaking various kinds of case-study and survey analysis. Within that the initial primary challenge is probably at the case study level – Level C.

[41] In very large organizations (for example the CGIAR as a whole or its larger associated institutes) the inside/outside distinction may not be clearly linked to the distinction between resource allocation and the management of organizational arrangements and methods.

Figure 7.1 Grassroots-Participatory Innovation in Agriculture: Some Steps in the Further development of Innovation Indicators



Source: Bell (unpublished)

<u>Task 1</u> – Case studies and small surveys (Level C)
The main requirement here is to develop ways of undertaking these kinds of study so that their results are much more consistent and comparable than in the past, and hence capable of being cumulated and aggregated to allow increasingly generalizable observations and understanding. Moving horizontally to the right across the iceberg in Figure 7.1, work could then be undertaken to develop sets of indicators to reflect important features of grassroots-participatory innovation activities. That horizontal path across Figure 7.1 has conceptual and organizational dimensions.

The conceptual dimension is concerned with developing a consensus around core frameworks or models that capture what are thought to be the more important features of grassroots-participatory modes of innovation. These frameworks would need to be extended to include impact pathways within which evaluative studies could be focused along common lines. At the most basic level, a framework for case studies might be no more than a list of topics along the lines of, but probably not the same as, the headings used earlier in the case study descriptions in Section 5. More usefully, that would be developed to provide a basis for exploration and experiments with different forms of indicators. In principle it would probably be important to build up a portfolio of indicators that are consistent with the basic components of indicator systems already used elsewhere for other kinds of innovation in other contexts – e.g. along the lines of the categories used earlier in Table 2.1: *inputs* to innovation, the *actors* involved, the innovation *process*, the *outputs* from that process, and the wider *impacts and consequences;* and perhaps adding *initial conditions* and their *history*.

The organizational dimension is concerned with how one would arrive at consensus around such frameworks, models, categories and specific indicators. These need not constitute restrictive straightjackets.[42] But to be useful they do need to be reasonably widely accepted as minimum cores for a substantial body of case study work, with variations *around* them being not merely possible but desirable as a necessary part of continuing experimentation. Arriving at such accepted cores requires at an early stage some kind of forum within which as many as possible of the main current funders, implementers and analytical observers of grassroots-participatory modes of innovation can work to build a consensus.

Questions about organization, and also about research design, are raised by two of the large gaps in the current body of case-study work in this area. One of these gaps arises because some of the important impacts of grassroots-participatory innovation, especially the more empowerment-centred approaches, only evolve over relatively long periods of time, requiring impacts to be observed over correspondingly long periods. That in turn requires ways of designing, organising and funding studies that differ from most of the arrangements currently used. For example, aspects of the methodology of cohort studies used in other fields might be useful – involving intermittent (rather than continuous) longitudinal studies of the same subjects over long time periods.

The second gap has been left by the dominant (or exclusive) focus of past studies on grassroots-participatory innovation activities that have been embedded in projects undertaken by research institutes, NGOs and other bodies. This leaves a gap in understanding about the characteristics of innovation at the right hand end of the typological framework discussed earlier in Section 3 – the fully decentralized 'farmer only' type of innovation. Case studies of innovation in such situations will be invaluable in understanding the potential and the 'added value' of projects designed to move to the left across the typology towards empowerment-centred grassroots modes of innovation – and also about the constraints they face. Again, discontinuous longitudinal (cohort) study designs might be invaluable in this area.

Task 2 – Larger surveys (Level B)

It will also be important to develop surveys designed to illuminate general features of grassroots-participatory innovation on the basis of much simpler and selective sets of variables. These are likely to be particularly useful in two areas. The first is about mapping the resource *inputs* to these modes of innovation more extensively than can be achieved by the accumulation of case studies - even if these are designed to be much more compatible and comparable than in the past. This mapping would be a supplement to existing surveys of 'formal' R&D (and extension) inputs to 'conventional' modes of innovation. In effect the aim would be to bring resource inputs to 'informal' innovation (both grassroots-participatory and 'farmer-only') within the same kind of framework as the Frascati Manual has provided for 'formal' agricultural R&D. This should then allow the relatives scales of resource allocation to 'conventional' and 'non-conventional' modes to be identified and publicized.

[42] Also, the development of common frameworks does not imply homogeneity in the purposes and scope of studies. For example, not all case-study work will be designed to address the whole spectrum of issues at similar depths, or even at any depth – for example, covering *initial conditions*, *inputs*, *actors*, innovation *processes*, *outputs*, and wider *impacts and consequences*. In particular, it is likely that evaluation and impact assessing types of study are likely to deal with outputs and impacts in much more detail than other kinds of case study.

But, although that kind of comparative aim would be important, such surveys could not conceivably be conducted initially on anything like the same scale as conventional R&D surveys. There are considerable difficulties about definitions and operational feasibility to be resolved before anything like that that can be considered. The requirements are consequently for small–scale exploratory and experimental surveys; and these might focus, for example, on particular agricultural R&D organizations, particular programmes. One might then move on to examine more comprehensive R&D and extension systems, not at the national level but at the level, for instance, of individual provinces.

The second possible area for survey-centred work within Task 2 would be about aspects of the innovation *process* – in particular on the innovators, their knowledge sources and their innovation outputs. These are the main types of data collected under the Oslo Manual framework for surveys of innovation in manufacturing and service industries, and would therefore be able to serve similar purposes. For example, they could shed light on the incidence of different kinds of innovators and different types of innovation, and their distribution across different contexts; and they could illuminate the types of knowledge sources and networks used in innovation in different situations. In principle also, in the same way that Oslo-type data have been used to distinguish different modes of innovation and situations where they appear to be more and less effective in industry and services, data about these characteristics of grassroots-participatory and also conventional modes of innovation could be synthesized and grouped to discriminate broadly between different modes of agricultural innovation and the circumstances in which they appear to be more and less effective – either individually or in playing complementary roles.

In other words, just as the first type of survey work would seek to bring ‘informal’ agricultural *R&D* within a Frascati-type framework, so this second type would seek to bring informal agricultural *innovation* within an Oslo-type framework. But again, this second type of survey work could not conceivably be conducted initially on anything like the same scale as conventional Oslo-type innovation surveys. Explorations and experiments focused on samples of much smaller populations of farming ‘entities’ would be needed – not least to identify what kind of farming entity would be the most appropriate survey unit.

Task 3 - Official government surveys (level C)
As suggested above, before any activity can usefully be developed at this level, it will be necessary to build a solid base of understanding and tested practice at Levels B and C in the iceberg structure. Nevertheless there is perhaps one area of experiment and exploration that might be opened up. This starts from a view that it may never be feasible to conduct Oslo-type surveys systematically across total national populations of farming ‘entities’. The costs might be prohibitive until farming has been consolidated into a very much smaller number of larger enterprises. Reliance would therefore have to be placed on surveys of samples of selected sub-national populations (e.g. in districts or different agro-ecological zones).

It might therefore be worth exploring whether *highly simplified* mini-surveys of agricultural innovation could be added to existing widespread surveys such as Household or Labour Force surveys. Aspects of the feasibility of such ‘piggy-back’ approaches could be explored and tested on a standalone basis in *very* small experiments – very small in both sample sizes and numbers of questions.

While, of course, questions arise about funding and organizational support for pursuing these three kinds of tasks, attempting to answer them lies beyond the scope of this paper. However, there are several reasons for thinking that such an approach should be pursued in South Africa: the key one is perhaps the social, economic and political significance of the smallholder sector in the country, and the need to find effective ways to improve the livelihoods of rural communities, which can be achieved at least partially through participatory-grassroots innovation processes.

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