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ASARECA
Transforming Agriculture for Improved Livelihoods

ANNEXES TO MAIN TECHNICAL REPORT

Making Agri-Food Systems Work for the Rural Poor

in Eastern & Southern Africa

IDRC PROJECT NUMBER	105790-001
RESEARCH ORGANIZATION	ASSOCIATION FOR STRENGTHENING AGRICULTURAL RESEARCH IN EASTERN AND CENTRAL AFRICA (ASARECA)
LOCATION OF STUDY	KENYA, MALAWI AND UGANDA
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REPORT TYPE	FINAL TECHNICAL REPORT
PERIOD COVERED	JANUARY 2010 – MARCH 2014
SUBMISSION DATE	10 DECEMBER 2014
RESUBMISSION DATE	JANUARY 2019

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Annex I

Making agri-food systems work for the poor

Synthesis, lessons and new research agenda for Eastern and Central Africa

Insights from IDRC/ASARECA Side Event at the 2nd ASARECA General Assembly

By Hezron Mogaka & Washington Ochola

Background

The survival of many households in Africa is based food production from peasantry. The production, processing, distribution and marketing of food should be done in a system that contributes to the wellbeing of the poor. The inter-linkages and increasingly globalised networks of food production, on- and off-farm technologies, consumption and regulatory systems are bound together at local, national or transnational levels. Agri-food systems also focus on the natural resource base and complexity of food production in ways that define the realities of the poor. In this regard rural people's economic behaviour is embedded in a complex web of social relations and issues of cultural identity, social capital, gender, and locality. Effective agri-food systems research must generate technologies and affect poor people lives by directly improving livelihoods at the individual and household levels. Such research must also strengthen productivity as a measure of sectoral performance and socio-economic status of communities while promoting conservation and unlocking genetic diversity and natural resources for future generations.

Africa's population is projected to continue its upward trend and even double by 2050. This may constrain the desire to move masses out of poverty, mostly in the rural areas, as a goal for agricultural development under the Comprehensive Africa Agricultural Development Programme (CAADP). Research and development efforts in the region must remain focused on pro-poor approaches, technology development, dissemination, use and scaling up. Investment in research and development is increasingly focusing on developing and nurturing the capacity for technology development, dissemination and adoption. Prop-poor research and development efforts are also aimed at market-driven gains which have to be consolidated by maximizing the number of the poorest of the poor smallholder farmers who access and use the technologies. The International Development Research Centre (IDRC) continues to work with the national research and academic institutions and their partners in Eastern and Southern Africa to implement research and development (R&D) projects with a focus on research that fosters sound environmental management policies and long-term economic development. This research and development initiatives are focused particularly on helping vulnerable communities, smallholders, women and the youth in rural areas overcome their context specific challenges that confine them to poverty. The immediate outcome of this therefore is to counter the effects of chronic and acute food and nutrition insecurity problems in the region. Food and nutrition insecurity in the region is caused by a complex combination of factors including declining soil fertility, degradation of natural resources, inefficient markets, weak institutions and ineffective policies.

The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) held its 2nd General Assembly and Scientific Conference from 9th to 13th December 2013 in Bujumbura, Burundi. The theme of the high level regional gathering was "Transforming Agriculture for Economic Growth in Eastern and Central Africa". The IDRC supported side event was convened under the sub-theme "Making Agri-Food Systems Work for the Poor in Sub-Saharan Africa". At the event 16 different research teams shared their lessons, challenges, and recommendations from on-going and recently concluded IDRC-funded projects. Lessons were shared under broad thematic areas of project overview, technology and dissemination, going to scale and natural resources governance. This synthesis paper summarizes the highlights, lessons and recommendations for new design, programming, investment and implementation of pro-poor agri-food systems research.

Session Outputs and Main Findings

This synthesis report recognizes varied outputs from the AFS research projects presented during the side event and proposes a generic framework as well as specific directions for enhancing AFS research through pro-poor targeting and going to scale with technologies and approaches that work for poor smallholder farmers. The following papers were presented:

Project Overview and Design:

1. Upgrading Women's food Value Chains in Tigrey Region, Ethiopia, *Lemlem. S Mekonnen*
2. Scaling Sustainable Land management Innovations: The African Highland Initiative (AHI) Devolution Model. *Dr Joy. Tukahirwa,*
3. Integrated management of wetland resources for improved food security and enhanced livelihoods: Overview of the project, by *Dr. Nelson Turyahabwe*
4. Bonne Gouvernance des ressources naturelles collectives by *Sylvain Mapatano* et *Déo Niyunkuru*

Technologies for Productivity and Resilience:

1. Déterminants de la pérennité des systèmes antiérosifs au Burundi, *Deo Niyunkuru*
2. Impact des technologies de gestion de l'eau et de fertilité des sols sur le rendement du maïs dans les régions semi-aride : cas de la plaine de la Ruzizi. *E. Bagula*
3. Financial losses due to soil erosion in the Mt. Elgon hillsides, Uganda: a need for action. *Onesmus Semalulu*
4. Rice cultivation practices by smallholder farmers in rain fed lowland ecologies of Eastern Uganda – areas for potential intervention by *David Nanfumba N. Turyahabwe, J. Ssebuliba and W. Kakuru*

Value Chains:

1. Understanding pro-poor market dynamics of a traditional crop within a resource poor producer community- *E.M Kihoro, I.Maina, Q. Diba, E. Chelimo , K. Mutea and F. Murithi.*
2. Value chain analysis for enhanced commercialization of neglected minor crops among rural poor farmers- *K. Odongkara, B. Mbilingi and A. Nasuuna*
3. Analysis of Sorghum Value Chain in Chikhwawa, Lilongwe and Kasungu Districts in Malawi- *Joseph Djanja*

4. The marketability of bag silage among smallholder farmers in Zimbabwe- ***Nyashanu, R; Mugabe P***
5. Enhancing adoption of technological innovations for orphan crops among rural poor farmers- ***Omadi J.***

Going to Scale:

1. Processus d'évaluation des incidences de la gouvernance des ressources naturelles par la méthode « matrice d'influence » au Burundi et sud Kivu. ***Serge Ngendakumana***
2. Devolution- A mechanism for scaling adoption of sustainable land management in Eastern Africa highlands. ***J. Nakanwagi,***
3. Innovation platforms for the establishment and management of community nurseries in the central highlands of Ethiopia ***Yosef Ameha, Kassahun Bekele, Mehari Alebachew***
4. Trade-offs to Wetlands Control and Management in Uganda: a Multi-Objective Decision Analysis Approach- ***Willy Kakuru***
5. Farmer perspectives on scaling up orphan crops in Malawi Farmer perspectives on scaling up orphan crops in Malawi- ***Frank Tchuwa***, ***Lilongwe University of Agriculture and Natural Resources (Bunda Campus)***
6. Determinants of Wide Adoption of SLM Technologies on the slopes of Mt. Elgon – ***J. Bushoborozi***
7. Drivers of the Agricultural Systems of the Rural Poor: A Synthesis of Lessons from Malawi- ***Daimon Kambewa and Mayamiko N. Kakwera***
8. Enhancing adoption of technological innovations for orphan crops among rural poor farmers- ***Omadi J. R***

Natural Resource Governance:

1. Community participatory sustainable land management bylaw formulation in the Highlands of central Ethiopia ***Chilot- Yiga***
2. Land care by laws can increase adoption of soil erosion control technologies: evidence from Mt Elgon highlands in eastern Uganda
3. La dynamique de gouvernance des ressources naturelles collectives au Burundi. ***Astère Bararwandika***
4. La dynamique de la gouvernance des ressources naturelles dans la région des grands lacs- ***Paulin Polepole***
5. Enhancing coping and adaptation to food insecurity among Small Scale Rural Farmers in Uganda- ***Bwambale Mbilingi, Odongkara K, Omadi R, Nasuuna A, Mutenyo H, Mugimbi A***
6. Trade-offs to Wetland Control & Management in Uganda: a Multi-objective Decision Analysis Approach- ***Willy Kakuru and Mwrifsteam***
7. Implications of market access on soil and water conservation investment in the highlands of eastern Uganda- ***R. Gidoi, Dr. F. Mugagga, Prof. M. Buyinza, Dr. W. Wagoire***
8. The Users' Led Process: a brokerage mechanism to build multi-stakeholder partnerships in ARD – ***Jonas Mugabe***

The lessons obtained from the side event in turn are useful in defining impact pathways and intermediate research and development outcomes for poor smallholder farmers. The synthesis report identifies five main findings, from which it derives specific and corresponding recommendations for individual researchers, research organizations, ASARECA, IDRC, other finding agencies and players in the AFS research and development arena. Examples are also listed from some of the research projects. These findings are highlighted below.

Main Finding 1: Understanding and Actualizing Agricultural Research for Development

In order for Agricultural Research for Development (AR4D) to be closer to smallholder farmers, it must be conceived as a system comprised of not only the research protocols and also socio-economic and ecological elements prevailing at the community level and beyond. This is principally because research must provide solutions tor challenges of poverty and hunger. Transforming agri-food systems will thus require a transformation of agricultural research to deal with the complexity of the challenges facing farming systems. The side event appreciated that:

- Agri-food systems research must allow solving a specific problem in a given area. *"Research should not be for the purpose of research or for publication" and also* not only be content to bring new technologies to farmers, it must also support and promote local innovations since the complexity of the challenges requires multiple responses based on an integrated and participatory approach.

- It makes sense to involve the farmers as they are continuously engaged in unique local and independent research process that have safeguarded crop species, preserved and enhanced hybrid vigor and performance of crop varieties and animal breeds through selection and management

- Information flow is best facilitated between research and farmer and other actors in agricultural value chains.

The papers presented, to varied degrees, capture some aspects of integrated agricultural research for development. In particular the lessons indicated that projects were designed to integrate the perspectives, knowledge and actions of different stakeholders around the common theme of pro-poor agri-food systems. Most projects used a broad working alliance to enhance chances of influencing poverty and food security desire by stakeholders. The projects were also conceived to allow learning that stakeholders by working together. There remain difficulties in project coordination to achieve a realistic social learning process. The learning has remained at the level of partners working together rather than on tangible solutions to the research and development challenge targeting the poor which is easily scalable. There also exist unclear procedures of instigating and monitoring learning at various levels- individual, organizational and institutional levels. Even weaker are the mechanisms that researchers put for learning by communities or farmers.

It emerged in discussion sessions that research tailored to the needs of poor households and self-motivated farmers groups has the highest probability of success in terms of real change in food security and income

status, uptake by other farmers and access to markets. For AFS research to deliver tangible outputs leading to adoption of improved technologies and policies in the region, the design and implementation modalities should be assessed against the alternatives for achieving broad development. Research that also supports broadening poor farmers' asset base as a predicate of livelihood support and provides access to market is key to achieving rural poverty alleviation. This will in turn stimulate demand for and adoption of new agricultural technologies, in[puts and advisory services. Investment in this kind of research is viable even for governments and private sector. The sessions had discussions on where ASARECA, NARIs and IDRC focus in research investment for maximum pro-poor benefits and development outcomes. The discussions concluded that tracking change among the poor will be gauged well if there is an research assessment if informed by the collection and analysis of up-to-date and contextual datasets on key variables for socio-economic profiling of the poor living in specific agro- ecological/geographic areas, knowledge about the agricultural value chains and farming systems as well as other household livelihood activities. There is also need to capture infrastructure and market information coupled with the realistic prospects for the research raising agricultural productivity under these conditions.

Main Finding 2: Project Design

To make research significant, researchers must identify specific outcomes that their research has influenced in order to map variables and dynamics that are significant in the outcome- impact pathway. By so doing, the research will capture succinct quantitative and qualitative data to support documentation of outcomes to build a dataset over time in a way that represents the broader emerging pattern analytically and encourages researchers to consider how they can intentionally contribute to the most profound transformation possible including addressing the pervading issue of food security. Projects must be designed to achieve integration and broaden opportunities for target groups to realize development aims. Specifically the design issues include:

- Adapt approaches to diverse contexts for ease of going to scale.
- Building institutions and empowering stakeholders.
- Supporting pro-poor local, national and international actions by policy makers, private sector, researchers, academic institutions and other service providers.
- Fostering farmer-led partnerships at different levels

The lessons also revealed that AFS research will not work for the poor unless they promote household level agricultural productivity and market opportunities as well as diversified livelihoods on and off the farm and reduce risk and vulnerability.

The design of research projects supported under AFS program, on paper had intention to address the main constraints to pro-poor growth. The designs of most projects however – failed to bridge the persistent gap between poor rural households and public and private institutions for research, extension, marketing and finance. Better designs are needed for effective roles to be played by value chain actors and address weaknesses in institutional arrangements that continue to limit the extent to which poor people can be

engaged in AFS. Also evident is the inappropriateness of research designs whose development outcomes depend on agricultural service locations (finance, information, markets, inputs) and stakeholder capabilities not resident in lead institutions or research teams. Working partnerships should be deployed to create opportunity to leverage capacities and linkages within projects to address these shortcomings.

IDRC and ASARECA should create capacities and support research programming that address these weaknesses through fundamental realignment of the institutions that support and conduct AFS research related to services to poor rural households. More innovative institutional arrangements are needed, including partnerships among public, private and civil society organisations within the research set-up. The arrangement should be matched with research processes and tools that encourage practitioners and researchers of those organisations to work with poor households and to build their capacities to do adopt and continuously use the technologies generated while supported doing to scale.

AFS research designers must be cognizant of the fact that poor rural households are further constrained by the degraded natural resources that they depend on. Research should ensure productivity gains alongside adaptive capacities to stall further degradation. Therefore AFS must, of necessity, pay greater attention to sound stewardship of environmental goods and services.

Main Finding 3: Pro-poor Technology generation, dissemination and use

Discussions around the studies and related AFS projects revealed some critical elements that should be addressed for pro-poor AFS and technology generation, dissemination and wider uptake. There are:

1. Careful and context – based definition of target group (the poor) as a pre-requisite for AFS research projects and programmes that hope to benefit the poor and alleviate poverty. A clear differentiation and characterization of the poor should embedded in the research design to allow even more subtle targeting so that research addresses their specific needs, involves special groups in research activities and adequately meets their dissemination requirements.

2. Appropriate mainstreaming of gender through more explicit address to gender inequality in design, implementation and dissemination of AFS research and development initiatives.

3. Scaling up the involvement of the poor in AFS research project design. Relevant stakeholders (including the poor) should take part in research design to stimulate participatory technology generation. By introducing mechanisms that allow small holder (poor) farmers to influence AFS research via channels like organised consultations, representation of the poor in research groups and dissemination fora and introduction of research funds that specifically target and involve the poor.

4. Improving access by the poor to AFS research results in terms of information, knowledge, skills, materials, facilities, infrastructure, markets and finance.

The technology generation and use aspects of the side event papers did indicate the goal of most research projects was clear on pro-poor outcomes but the above elements for pro-poor AFS research were only addressed to a limited extent and not fully translated into the implementation and communication strategies. Only a few countries included comprehensive components that relate to targeting the poor, gender inequality, involvement of the poor and access to information and technologies.

The session discussion generated suggestions for transforming the plight of the poor via agri-food systems research. The generation, dissemination and use of such technologies is critical in this regard. The technology generation process in agri-food systems research should, according to Spielman (2007), at the very least:

- Build platforms to identify opportunities, assign roles and responsibilities.
- Commit resources to both, the project activities and coordination efforts.
- Create formal and informal strategies to manage and mitigate project risks.
- Design mechanisms to facilitate knowledge exchanges and resolve conflicts.
- Develop benchmarks and decision-points to evaluate progress and choose to continue or terminate.
- Ensuring Impact and Going to Scale
- Explicit analysis of the impact pathways through which projects affect poverty.

In conducting research with technologies generated targeting the poor, it is important to consider how the technologies will be adopted. Whether poor households benefit from research outputs depends on many underlying socioeconomic conditions that should be factored in research and other technology developed processes. Such enabling conditions include an equitable distribution of land and income, secure ownership and tenancy rights, efficient input and output markets that serve all farmers, research and extension systems that are geared toward small and large farms, and scale-neutral technologies (Collier and Dercon, 2009). Although AFS cannot research directly influence this strategies for supporting action by relevant actors should consideration in the research design, implementation processes, partnership arrangement, communication and dissemination efforts.

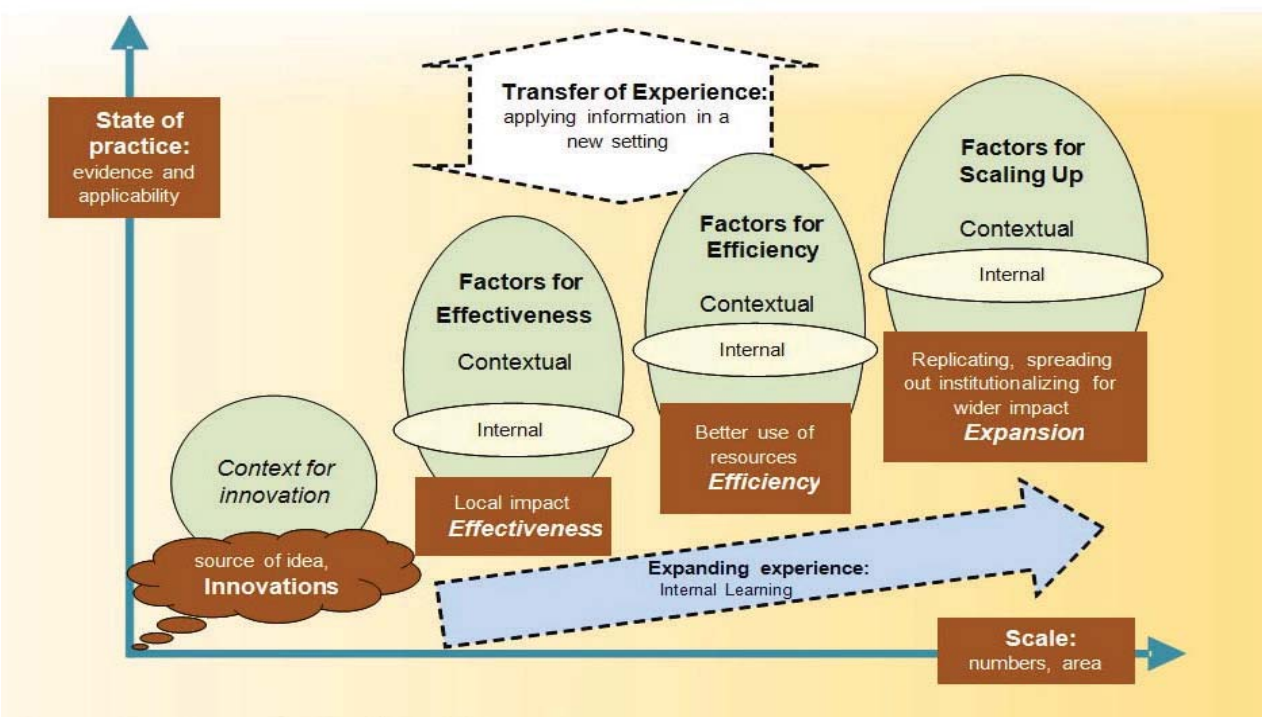
Main Finding 4: Going to Scale with AFS Research and Development

The side event gathered many lessons that explain why many research projects fail to go to scale. Impacts of present research efforts remain isolated and far-between due mainly to lack of purposeful design and implementation strategy that directs efforts toward going beyond piloting. There is an urgent and critical growing need for up/out-scaling based on increasing understanding of models and concepts. As discussed in the side event scaling up should be understood to a collection of strategies and plans for wider dissemination of a new techniques, prototype product, practices or processes; “growing” of results from small to bigger and new levels; and translating a small scale initiative into a spatially expansive scale and wider government policy. Important in this regard is for Agri-food systems research to be clear on: the model, innovation or project to be scaled up – what is being scaled up; the methods of going to scale – the how of scaling up; the organizational roles involved in scaling up – the who of scaling up; the dimension(s) along which scaling up occurs –the “where” of scaling up.

IDRC has been funding a wider array of research and development. The main components of research and development projects funded by IDRC and other donors in their category include – pilot (or R&D) projects, demonstration projects, capacity building projects, and campaigns. It should be a requirement to have in the design of the project strategies, plans and budget for going to scale with the research findings regardless of its type.

The elements of successful scaling up were noted in the discussions including the length and planning during lead-up time during which locally effective and appropriate technologies and processes are refined. Other factors relevant to the success of scaling-up efforts include determined efforts at simplification and documentation of lessons in order to demonstrate the project's effectiveness as a "best practice". The approaches to mapping the progress of going to scale in different dimensions are based on documented evidence and application (Figure 1).

Figure 1: Factors influencing technology scaling



Source: *Jim Hancock (2012)*

Lessons from presented papers indicate narrow understanding and application of going to scale for wider impact. The main dimension of scaling up prominent in the papers is expansion geographically. Scaling up, however, goes beyond the geographical scope. Research should be designed and implemented in such a way that lessons are gathered to scale it out to othe geographical areas as well as other dimensions including: extending services and technologies to more farmers within the original community

(breadth of coverage); sharing detailed agri-food systems knowledge and information (depth of services); widening the target population to include, for instance, all vulnerable groups living in water stressed ecosystems (client type); or applying the approach to address other issues other than the original problem (problem definition).

The design of scaling up models should bear in mind the following issues:

- Ability to replicate and expand the institutional characteristics that were key to the outcomes achieved
- Acceptance and realization of the need for the up-scaling model by the relevant stakeholders, potential partners, and intended target group
- Clarity of inherent and apparent economies or diseconomies of scale
- Documentation of the model, including the process component, and assessment of its cost-effectiveness
- Does needed funding exist for replicating the model on a large scale?
- Understanding of the prevailing special or unique social or political context or general circumstances of the research project including cultural, ethnic, or religious values/ characteristics; distribution of power; homogeneity; economic conditions that would catalyze the replication.

Main Finding 5: Governance of AFS

Governance remains a critical issue in AFS research in so far as it influences value of research. Governance dictates the interceding influence of enabling conditions for poor farmers to access and use agricultural research technologies and the natural resource base. Agri-food systems research should also provide answers to governance questions and especially guide decision making at all levels. Lessons on natural resource governance must be intentionally captured in AFS research owing to the importance of natural assets and their management to the poor. It is imperative to address any gaps in policy frameworks and institutional arrangements for natural resource governance even as agri-food systems research is designed and implemented. The use of natural resources as basis for agricultural production demand a clear strategies within the research and out-scaling models that address issues of governance of natural resources. This should be in order to promote cooperative solutions for efficient management and equity with respect to socio-economic benefits over scale, time and space as well as covering vulnerable and poor people.

Future research should be designed to address current shortcomings in inclusion of natural basis to ensure more lessons are compiled on what dictates who accesses to and use of household and community water, land, forests and other resources. Integration of governance studies and development influence in future research must be a seamless coupling not through current isolated approach by “governance experts and organization”. Further research and support is also necessary on the role of non-local decision making entities as well as processes and power structures in relation to different political, social, economic and administrative systems that affect poor farmers need for accountability of for the sake of food security and other outcomes of

research. These governance issues play out as context factors that usually trigger or deter wider adoption and sustainable utilization of resource management.

Moving Forward

Innovating AFS Research

Pertinent and persistent issues for making AFS research work for the poor still remain and should be addressed by researchers, research organizations at national and regional levels and by research funders/ partners like IDRC. The issues if well integrated in design, implementation, funding and monitoring of AFS research procedures will undoubtedly improve research quality for impact and ease of going to scale with projects that directly benefit the poor in terms of food security improvement and wealth creation. The issues include capacity building, approaches to scaling up, out-come-output orientation and models for research management, business promotion, scaling up and general agricultural transformation.

A couple of critical emerging research foci and issues for investment emerged:

a. Research, capacity building and development initiatives to continue to promote the understanding of and increase in labour productivity through mechanized and ICT-propelled agriculture at all levels with special focus on engaging the youth and women in agriculture

b. Determination of appropriate business model that can attract the youth to profitably and competitive engage in agriculture value chain learning from successful models such as the expansion and proliferation of the ***boda boda***, cell phone and other emerging models

c. Scaling up and increasing the wider commercialization of under-utilized crops through innovative ways that incentivise small scale farmers' engagement

d. Impact orientation, understanding the missing links, identify specific innovations to make a difference, how the results will be used, project should have clear partnerships across sector and disciplines, clear graduated outcomes, learn from models that have worked to learn how to scale up, sustainability as part of project design – environmental and implementation sustainability.

It also emerged that innovation is not necessarily what is new but that which presents new opportunities for pro-poor prospects through the 3 I's: Ideas, Innovations and Impacts. There is need for, where resources allow, project PIs to conduct quick survey to assess outcome and impact level results. This should be factored in the research design and budget. Researchers should design simple tracking tools to ensure continued monitoring and enable the results and outcomes from the projects to be shared widely to influence policy and practice. Sustainable transformation is hinged on institutional aspects such as local value system, markets, policy, social capital and stakeholder capacity to adapt technologies. Projects should innovatively incorporate transformational channels in the conduct and dissemination of research for development. At the regional level there is need for bringing to scale emerging positive results, the need to take seriously some of the emerging terminologies – innovations, up-scaling to regional research issues.

Other issues to address include:

- Action-oriented research – going to scale
- How to address external supply of more preferred foods which may be a driver to undermining some of the local foods.
- Research on institutional frameworks that create a market-oriented small-scale holders taking into consideration environmental sustainable basis, nutrition, involvement of youth, creation of jobs for the youth, business incubation perhaps to be conducted in the same sphere – youth engagement, business incubation, wealth creation, involvement of the rural poor.
- Research that is regional in nature, defined landscape, based on clear value chain
- Seed system focused on underutilized high value crops, linking farmers to the markets, promote diversified food reserves – going beyond maize

A number of strategies can be deployed to realize innovative research: these include interrogating new approaches and best practices for integrated sustainable intensification. The use of market-oriented productivity-improvement research and value chain models will strengthen the competitive ability of smallholder farmers in general and the poor in particular. Land as the basis of agricultural production should be factored in pro-poor AFS research. This will continue to require integration of research and communication strategies that reduction land degradation replenish soil fertility and also address land tenure and related socio-economic issues like gender. The use of integrated catchment strategies for natural resource management in research design, implementation and scaling up is equally instrumental and can be integrated in research processes. The application of mechanical power, and embracing information and communication technology at all levels especially if the largely underutilized youth population in the region is to be deployed.

Ideas for IDRC Programming and Support

Research funding by IDRC should continue the focus on "useful research for development" by ensuring and supporting the design, implementation and communicating in ways that heightens the reach to those who can use (farmers, service providers and policy makers) and other stakeholders. Support should also be given to ensure researcher design for procedures to track and evaluate the extent of research influence. As partnerships are designed and research usefulness for development is planned quality aspects should not the lost. This is with respect to the scientific process including research design, methodology for data collection, analysis and presentation. AT the same time the IDRC supported research should further continue to emphasize the impact and relevance of research beyond ordinary outputs and consider outcomes. Special attention and components of the research should be paid to how research influence or changes practice and policy as well as continues to socio-economic and ecological changes. Participants were however concerned with the over-emphasis of impact at the "expense of research quality". This was concluded to be non-issue as there exist sound research pathways that can indicate contribution to impact on poor farmers while still maintaining scientific rigour.

The model used by IDRC to support research in the region still remains relevant. Its focus on food security and pro-poor research for development will continue to be vital for the socio-economic transformation of the region. While agriculture will for some time the main window for poverty eradication and food security enhancement, emerging and new research agenda should be considered for an even more engaging IDRC support. The approach used by IDRC of constant engagement and direct partnership with scientists and research organizations should be maintained and strengthened by lessons gathered from the side event and other follow-up activities.

There are however many missing links in the research-impact pathway. More support and capacity building should target the efforts to realize the impact contribution of AFS research. This includes research design, partnership composition and management, communication strategies and research outcome monitoring. The inclusion of baseline setting and appropriate reviews and evaluation systems will become more useful. Efforts need to be made to adopt a phased approach to action research, impact orientation and scaling up.

Failure to go to scale and demonstrate impact remains a major area of concern. The deployment of appropriate models (this was not apparent in all research papers) will ensure research findings are brought to scale. Past, current and future success cases and their findings can be modelled to trigger action by wider communities, private sector and other actors to multiply the benefits and even commercialize to scale.

Particular attention should be paid to the transformation of agriculture via youth involvement in taking up results of studies through incubation approaches and other models, partnerships and ICT driven innovations should be supported as well. As part of scaling out, research for development could embody models to target the masses (youth, women, poor, people living in fragile ecosystems, vulnerable communities across state boundaries, small farms and others through research and development interventions that also have education, food security, market access and other challenges as entry points for going to scale. Despite the much needed divestiture into new research and development frontiers, concentration on crops, livestock, agro-food systems and commodities and technologies that have quick fix returns to investment and benefits to poor households should be maintained. All in all research supported must demonstrate in both design and implementation conscious stimulation of maximization of farmers' benefits and natural resource protection in the value addition processes. Other key areas for which innovative research should be targeted and supported include:

a. Mechanization to increased labour productivity at all stages
b. Business model to get the youth to be involved in agriculture to actualize transition and impact on smallholder farmers
c. Nutrition as an entry point for promotion of research and productivity in underutilized crops
d. Documentation of working models for scaling up

It should remain a major requirement that new research initiatives must demonstrate the difference they will make in terms of propelling the transformation of the region's agriculture and its drivers. There must also be a demonstration of equitable, environmentally sensitive productivity/food security results. In future, projects

have to address the missing links that constrain agricultural transformation and innovations in ways that are practical for the farmers' context.

Conclusions and Recommendations

Although the research projects under the IDRC support targeted the poor as beneficiaries, the presentations did not explicitly demonstrate that this was realized. The design of projects should directly target the poor (by ensuring that ARD results are relevant for and applicable to their specific requirements), or by using ARD to benefit other target groups, but with secondary benefits to the poor (such as reduced food prices and increased food availability).

IDRC should work with partner institutions and their researchers to ensure they are more explicit in their choice of strategy and systematically monitor whether the desired prop-poor outcomes are achieved. Whenever agri-food systems research targets the poor directly, their agro-ecological, socio-economic and geo-political contexts should be considered in designing their participation and outcomes. This works best by involving the poor in research priority setting, design, implementation and monitoring so that research outputs become relevant to the poor. The configuration of the poor should also be considered with special reference to gender and vulnerability to climate change and other socio-economic changes. Women and youth involvement in agri-food systems research processes is particularly important to this end in order to improve accountability of research programmes to the poor.

It is also critical to make research outputs available to the poor through accessible dissemination channels. The poor are less able to access and use research findings due to poor connectivity (by road, media or inter-personal contact with intermediaries such as extension agents and traders) and resource endowment. They also have limited access to modern ICT platforms increasingly used by researchers. Special efforts should be made to ensure that the channels for research dissemination and uptake environment are conducive to the poor. This requires appropriate infrastructure and policies that enhance the utility of dissemination mechanisms by catering for the specific needs of the poor.

For future research programming and funding, the following are recommended:

- Identifying more explicit IAR4D agenda and funding modalities that accommodate strategies and interventions that are directed at the poor. This should include an operational definition of the poor.
- Ensuring that including and tackling food systems challenges of women and the youth become a core part of AFS research.
- Ensuring that research targets the poor much more specifically in the dissemination of results with messages, media, materials, inputs and services that are tailored to their specific needs. ICTs can specifically very attractive to the rural your.
- Development aspects of iAR4D should include capacity building for the poor to organise themselves and actively take part in agricultural value chains as well as in platforms that shape the AFS research agenda.

- As a requirement research proposals must include ex-ante analysis of expected impact on poverty, and independent ex-post analysis of whether this has been achieved through broad-based analysis of social, economic, political and technical context in which the project is to operate, and influence impact on poverty and food security.

Over and above these recommendations, the mind sets of researchers must be shifted by raising awareness about demand-led and pro-poor research approaches and the development of "soft skills" (communication, negotiation, facilitation) and capacity building on the use of qualitative research methods that complement other research techniques for addressing needs of the poor. There may be a need to design good practice guidelines for making AFS research results work for the poor. Specific attention should be paid to supporting learning among researchers and other AFS actors as well as other involved in planning and implementing pro-poor AFS research and development programmes to share experience from clear field examples, where emphasis is given to the "how to", in terms of approaches and tools used against the prevailing context and costs.

In responding to the need for AFS research to work for the poor, IDRC funding should target programmes that specifically enhance research utility by the poor and other agri-food systems actors. This should involve any new areas of new research and scaling up of current and past research findings. The merit of AFS research should be gauged by extent of reaching diverse users including the poor and policy/decision makers. The side event provided some directions for making AFS work for the poor: a) Making existing information more accessible to the poor; b) Analysing and synthesising research to provide tailored information services; and c) More harmonised and effective communication of research. There is also a need to track outcomes and learn lessons from AFS research conduct and communications activities. Adequate support should target mainstream research communication work or mainstreaming of communications and scaling up within other R&D initiatives.

References

Collier, P. and S. Dercon (2009). African Agriculture in 50 years: Smallholders in a rapidly changing world? Proceedings of the Expert Meeting on How to Feed the World in 2050. FAO. Rome.

EC (2008). EC Guidelines on Agricultural Research for Development. http://ec.europa.eu/development/icenter/repository/B2_EC_Guidelines_ARD_june08.pdf

Hazell, P. B. R. (2012). Options for African agriculture in an era of high food and energy prices. Elmhirst Lecture, 27th International Conference of Agricultural Economists, August 2012. Foz do Iguaco, Brazil

McCullough, E., P. L. Pingali and K. G. Stamoulis (2008). Small farms and the transformation of food systems: an overview. The Transformation of Agri-Food Systems: Globalization, Supply Chains and Smallholder Farms. E. McCullough, P. L. Pingali and K. G. Stamoulis. London, Earthscan: 3-46.

Reardon, T. (2007). Global food industry consolidation and rural agro-industrialization in developing economies. Transforming the Rural Nonfarm Economy, opportunities and threats in the developing world.

Spielman, von Grebmer 2007

Wiggins, S. (2009). Can the smallholder model deliver poverty reduction and food security for a rapidly growing population in Africa? Proceedings of the Expert Meeting on How to Feed the World in 2050. FAO Headquarters. Rome.

2nd ASARECA GENERAL ASSEMBLY

Theme: "Transforming agriculture for economic growth in Eastern and Central Africa"

SIDE EVENT: "*Making Agri-Food Systems Work for the Poor in Sub-Saharan Africa***"**

10th- 12th December 2013 – HALL 1

DAY/DATE	08:30 – 10:30		11:00-13:00		14:00-16:00		16:15-1800
Day 1: Monday 9 Dec 2013	**ASARECA General Assembly (Main Plenary)**		**ASARECA General Assembly** **(Main Plenary)**		**ASARECA General Assembly (Main Plenary)**		**ASARECA General Assembly** **(Main Plenary)**
Day 2: Tuesday 10 Dec 2013	**Session 1:** Opening and Stage Setting Chair: **Déo NIYUNKURU** ■ Introductions and objectives-Hezron Mogaka, ASARECA ■ Food Security: Making a Difference Through Research Excellence- Pascal Sanginga, IDRC ■ Discussions and Preparing for Paper Presentations and Synthesis Washington Ochola	**BREAK *** BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Session 2:** Project Overview Presentations Chair: **Festus MURHETI** ■ Making Agricultural Systems Work for the Rural Poor – Immaculate, M. ■ Upgrading Women's food Value Chains in Ethiopia, Lemlem ■ Scaling Sustainable Land management Innovations: The African Highland Initiative (AHI) Devolution Model. J. Tukahirwa, ■ Integrated management of wetland resources for improved food security and enhanced livelihoods: Overview of the project, by Dr. Nelson Turyahabwe ■ Bonne Gouvernance des ressources naturelles collectives. Sylvain MAPATANO ■ Burundi-DRC : Video and Deo/ Mapatano	**BREAK *** BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Session 3:** Technologies for productivity and Resilience Chair: **Innocent BUTARE** ■ Déterminants de la pérennité des systèmes antiérosifs au Burundi, Deo NIYUNKURU ■ Impact des technologies de gestion de l'eau et de fertilité des sols sur le rendement du maïs dans les régions semi-aride : cas de la plaine de la Ruzizi. ■ BAGULA E1,* ■ Financial losses due to soil erosion in the Mt. Elgon hillsides, Uganda: a need for action. Onesmus Semalulu ■ Rice cultivation practices by smallholder farmers in rain fed lowland ecologies of Eastern Uganda – areas for potential intervention by Mr. David Nanfumba ■ The response of soil nitrogen dynamics under sorghum and cowpea productivity in Kirinyaga west sub-county, central Kenya – Peterson N.	**BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Poster session** **Book launch**

DAY/DATE	08:30 – 10:30		11:00-13:00		14:00-16:00		16:15-1800
Day 3: Wednesday 11 Dec 2013	**ASARECA General Assembly** **(Main Plenary)**	BREAK *** BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Value chain Papers** Chair: **Prisca MUGABE** ■ Understanding pro-poor market dynamics of a traditional crop within a resource poor producer community. Kihoro, Esther M. ■ Value chain analysis for enhanced commercialization of neglected minor crops among rural poor farmers. K. Odongkara ■ Analysis of Sorghum Value Chain in Chikhwawa, Lilongwe and Kasungu Districts in Malawi Joseph Djanja ■ The marketability of bag silage among smallholder farmers in Zimbabwe Nyashanu, R. ■ Enhancing adoption of technological innovations for orphan crops among rural poor farmers OMADI J.	BREAK *** BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Session 6:** Going to Scale Chair: **Dr. Nelson T.** ■ Devolution- A mechanism for scaling adoption of sustainable land management in ■ Eastern Africa highlands. J. Nakanwagi, ■ Innovation platforms for the establishment and management of community nurseries in the central highlands of Ethiopia Dr. Yosef Ameha ■ Trade-offs to Wetlands Control and Management in Uganda: a Multi-Objective Decision Analysis Approach- Willy Kakuru ■ Farmer perspectives on scaling up orphan crops in Malawi Farmer perspectives on scaling up orphan crops in Malawi – Frank T. ■ Innovation systems in agricultural research – J. Mugabe	BREAK *** BREAK *** BREAK *** BREAK *** BREAK *** BREAK ***	**Session 7:** NRM Governance Chair: **Sylvain MAPATANO** ■ Landcare bylaws can increase adoption of soil erosion control technologies: evidence from Mt Elgon highlands in eastern Uganda – Mildred B. ■ La dynamique de gouvernance des ressources naturelles collectives au Burundi, Astère Bararwandika ■ Coping mechanisms and adaptation strategies to food insecurity among small scale rural farmers in Uganda – Bwambale, M ■ Discussions and Synthesis
Day 4: Thursday 12 Dec 2013	**Panel Discussion** Chairs: **Pascal Sanginga and Innocent Butare** **Regional Synthesis Facilitator: Washington**		**Country synthesis working groups** Facilitator: **Washington Ochola**		**Country synthesis Report to Plenary** Facilitator: **Washington O.** **Side Event Closure**		**FREE**
Day 5: Friday 13 Dec 2013	**DEPARTURES/ASARECA General Assembly** (Main Plenary)						

Annex II

Empowering small scale farmers through participatory market development: The case of Kiriogo location, Nyandarua North District, Kenya

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Abstract

Markets play a significant role in reducing rural poverty. However markets fail the rural small-scale farmer where the risks of participation and the related costs are high, or where social and economic barriers abound. This study carried out in Kiriogo Location in Nyandarua County, Kenya, sought to empower farmers to participate in both the local and external markets. A Farmer Participatory Market Development (FPMD) approach was designed to help the farmers overcome the constraints of inadequate markets and poor market infrastructure, and to support farmers to learn how to interact and bargain more confidently. The FPMD approach aimed at reducing farmers' vulnerability by ensuring that they integrate marketing in their production plans. The paper presents a retrospective assessment of the application of the FPMD approach within one of the project sites of the Kenya Agricultural Research Institute (KARI), International Development Research Centre (IDRC) funded project "Making agri-food systems work for the rural poor in Eastern and Southern Africa." The paper discusses the innovative six-step FPMD approach: formation of umbrella CBO from independent farmer groups; participatory, gender-sensitive choice of priority value chains; formation of marketing committees; market opportunities identification; enterprise design and business planning; collective marketing; and continuous partnership building. The key findings are also presented. Experiences with application of the FPMD approach indicate that building marketing infrastructure from the grassroots lays a strong base for building resilience in rural communities and it enhances farmers' ability to overcome the challenge of inadequate markets and marketing infrastructure that commonly face the Kenyan farmer. The FPMD approach holds great potential for farmers when they learn and implement that which they perceive is beneficial and which could bring profit to them. The approach increases farmers' appreciation of market dynamics and of buyers' preferences and the need to produce for the market.

Key words: markets, farmer participatory market development, agri-food systems

Introduction

This study was carried out in Kiriogo Location of Nyandarua North Sub-County, one of the project sites of the Kenya Agricultural Research Institute (KARI), International Development Research Centre (IDRC) funded project "Making agri-food systems work for the rural poor in Eastern and Southern Africa." The activities in Kiriogo Location contributed to the project objective "*t*o test, adapt and scale up technology and market innovations for promoting orphan crops that enhance food security, increase incomes and ecosystem integrity." The activity was informed by the fact that poor markets and market linkages hinder the functioning of the linkages that enhance adoption of agricultural technologies and constrain scaling-out and scaling-up . Nationally, inadequate markets and marketing infrastructure have been listed as challenges facing the Kenyan farmer today (GOK, 2011). Markets are important for rural transformation and poverty alleviation. They provide the direct means through which the poor farmer can participate in economic activity as a producer, labor provider and as a consumer of goods and services. This farmer is however, often constrained by lack of agro-entrepreneurial skills, poor understanding of market dynamics, limited business and negotiating skills, and lack of the necessary business group organizational skills that could give them the bargaining power they require to interact on equal terms with other, larger and stronger market actors.

Farmer Participatory Market Development (FPMD) approach was therefore designed to empower the farmers to overcome the aforementioned constraints so that they can learn how to interact and bargain more confidently in both the local and external markets. The approach as preferred because pparticipatory approaches increase the level of farmer ownership in the process and enables producers and Service providers to develop new types of relationships. The process involves a step by step participatory and practical training process along the marketing segment of the APVC aimed at reducing farmers' vulnerability by ensuring that they integrate marketing in their production plans. Farmer Participatory Market Development (FPMD) is an innovation that enables farmers to adopt a market-oriented agricultural approach. It is a guided practical approach to development of agro-entrepreneurial skills and agri-food market development. Farmers are trained on how to link up their produce with markets for their produce. The farmer learns to produce what the market demands and in the desired quantity, quality and packages.

Many authors have cited lack of markets as one of the key draw-backs in adopting would be lucrative agro-enterprises among resource poor farmers. The lack of interventions or policy changes geared towards increasing female farmers' access to productive resources has also been highlighted (Quisumbing and Pandolfelli, 2010). Markets have been shown to interface positively with human capital, gender issues and investment in natural resource management (Kaaria et al., 2008). State interventions in supporting agricultural market development have also been discussed (Dorward, et al., 2004). The agricultural development policy of Kenya is designed to support market-led agricultural development, competitiveness of smallholder producers and commercialization of small-scale production (GoK, 2011). Farmers' aspirations, research outputs and policy inform the development of viable and remunerative market linkages. Indeed, the underlying factors for the development of the Farmer Participatory Market Development in the Agri-food Systems Project, arose mainly out of three concurrent situations; farmers' demand, current research outputs and policy dispensation.

Justification

During stakeholders meetings held in the beginning of the Agrifood Systems Project and also during subsequent planting seasons, marketing was cited as a major draw back in agricultural production in the study site. Farmers sought to be helped to overcome this problem and subsequently the project team adopted market oriented approaches in their programming. Building marketing infrastructure from the grassroots lays a strong base for building resilience in rural communities and it enhances farmers' ability to overcome the challenge of inadequate markets and marketing infrastructure that commonly face the Kenyan farmer.

Objective of the Study

The aim of engaging in Farmer Participatory Market Development (FPMD) was to reduce farmers' vulnerability by ensuring that they integrate marketing in their production plans. The specific objective were to:

a. Use the seven steps in FPMD in equipping the Kiriogo farmer with marketing skills.
b. Build ownership by involving the farmer in developing their own marketing strategies through FPMD
c. Empower the farmer in generating knowledge and making decisions based on market Demand.

Participatory approaches increase the level of farmer ownership in the process and enables producers and Service providers to develop new types of relationships, FACILITATION

Research Questions

The questions the study addressed were:

a. Can the farmers in Kiriogo join together for profitable agricultural production and marketing?
b. Can application of FPMD as a marketing strategy build ownership in the farmer in Kiriogo Location?
c. Can application of FPMD equip small-scale farmers in Kiriogo with the necessary marketing skills?
d. Can application of FPMD to the farmers in Kiriogo create empowerment in generating knowledge and making decisions based on market Demand.

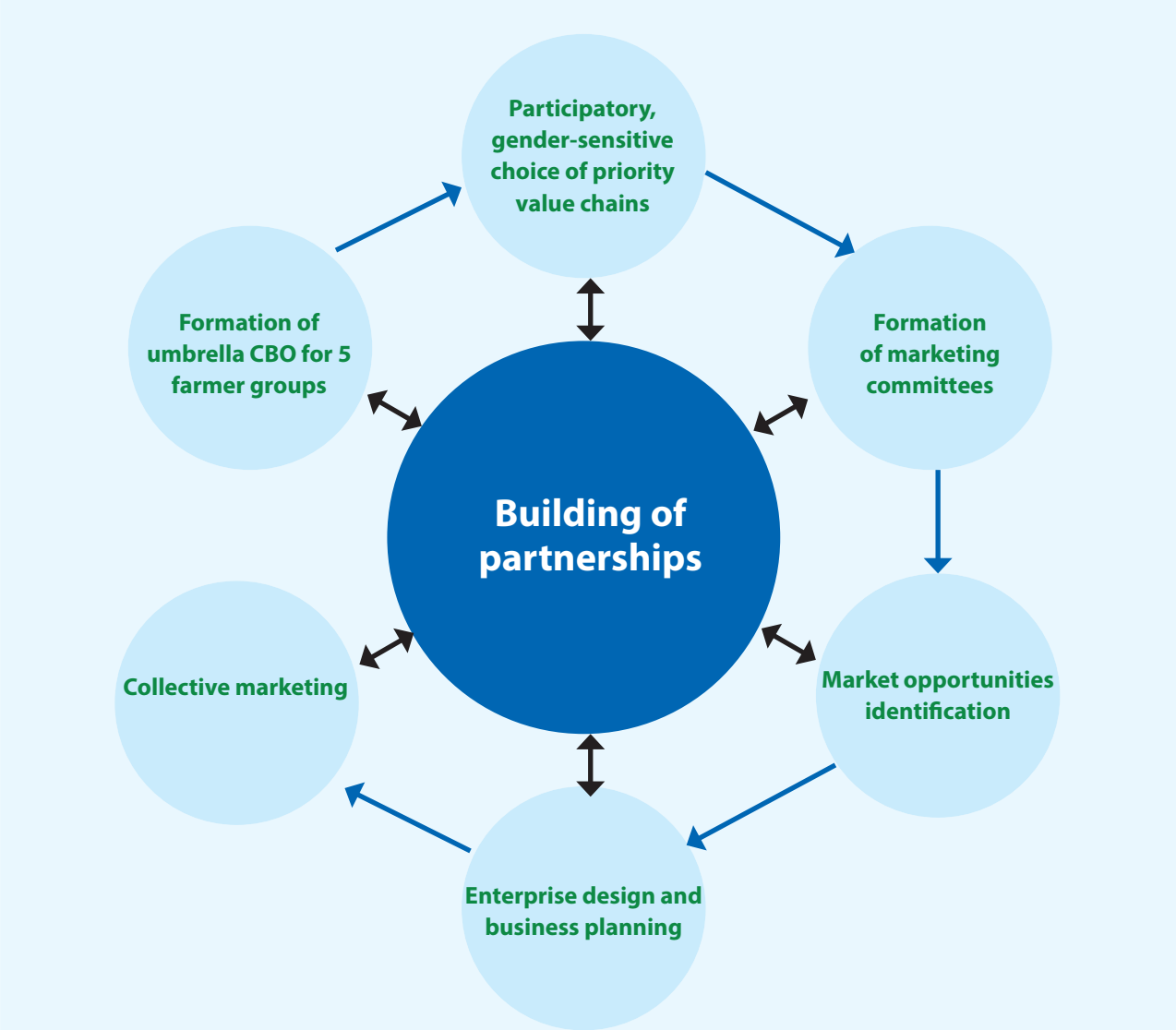


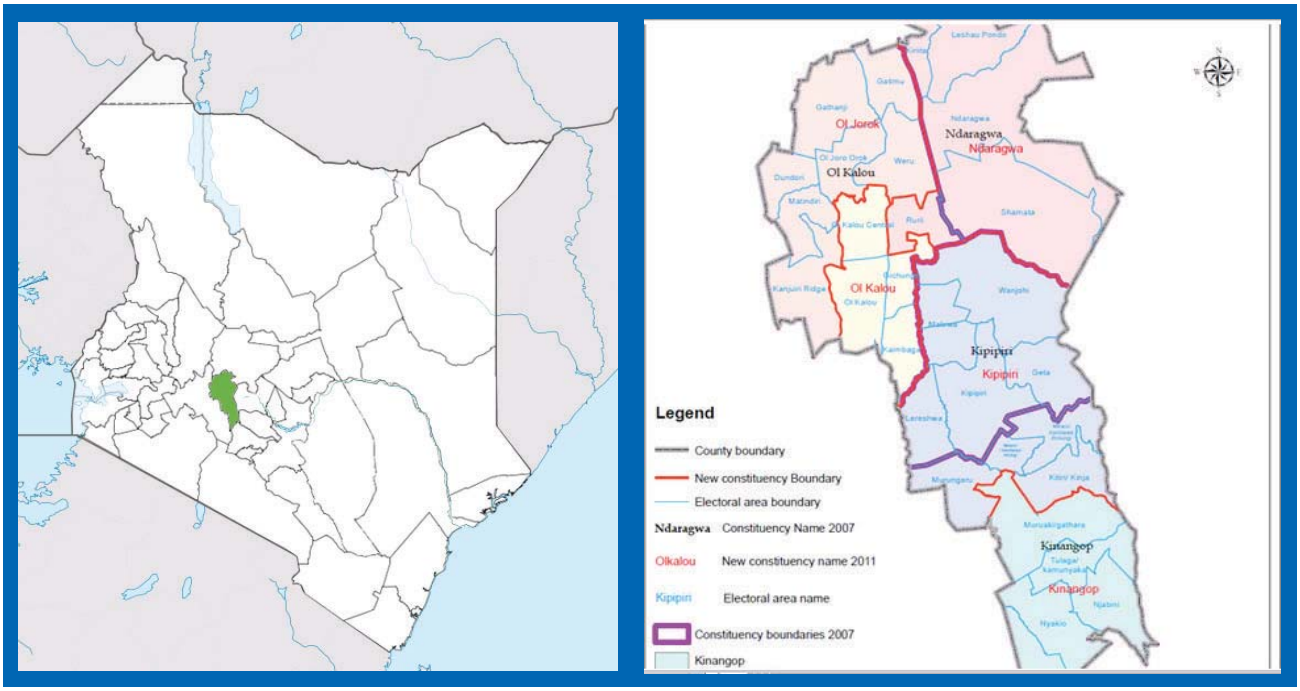
Figure 1. Conceptual framework of the Farmer Participatory Market Development (FPMD)

Materials and Method

Study Site

This study was carried out in a project site, Kiriogo Location, Ndaragwa Division, Nyandarua North sub-County of Kenya. Nyandarua North Sub-County falls in the highland savannah zone with expansive grasslands but in elevated areas there are thick forests and thick undergrowth. Most of the vegetation has been cleared giving way to man made environmental hazards hence presenting a crisis to natural resources management. Rainfall in the district ranges from a high of 1620mm to a low of 968mm per annum, with an annual average rainfall of 979mm. The land potential is classified into three zones depending on general fertility and use. These zones are high, medium and low potential areas. Out of the total district population of 485,457 individuals, 27% live in absolute poverty and 44.2% are considered as food poor (GOK, 2007). Thus, this district has an

unexploited potential for agricultural productivity and represents an area that is generally considered as food secure but with low resilience. There is potential in promoting high value horticultural crops, encouraging farm agro-forestry-fodder tree species as well as in facilitating marketing structures for agricultural produce. The question is how to unlock this potential. The target farmer groups identified oil crop production as a value chain with great potential.



Map of Nyandarua County (http://en.wikipedia.org/wiki/File:Nyandarua_location_map.png/ http://farm8.static.flickr.com/7145/6671943583_99ca53e885.jpg)

Methodology

The paper presents a retrospective assessment of the application of the FPMD approach. The following six steps describe the Farmer Participatory Market Development approach as it was applied in Agri-Food Systems Project.

Step I: Formation of CBO from independent farmer groups

The initial step involved support to five independent farmer groups to come together as one Community Based Organization (CBO) for effective group collective marketing. The researchers in the company of the Ministry of Agriculture Field Extension Officers met with individual groups for a series of discussions on the option of joining the five groups into one CBO. In these consultative forums, advantages and disadvantages of forming one bigger group were outlined and discussed. All this pointed to collective production and marketing. The groups were able to envision market opportunities available to the CBO.

Step II: Participatory, gender-sensitive choice of priority value chains

The marketing activities began with meetings with the members of the CBO to strategize for marketing. Pair wise ranking was used to prioritize the marketing potential of the crops and livestock on their farms. During the exercise gender separation was done to allow freedom of choice.

Plate 1: Women Farmers prioritize use bean seeds to prioritize their enterprises

Step III: Formation of marketing committees

A marketing committee was then constituted through elections. Their roles, responsibilities and rules of engagement were also agreed upon at CBO level.

Plate 2: The Marketing committee secretary records the results of prioritization

Step IV: Market Opportunities Identification

Market Opportunity Identification is a process of generating knowledge and making decisions based on Demand. Taking clients to the market is often a real "eye opener" In this step of the FMD approach farmers made visits to different potential markets to gain hands-on experience and understanding of market dynamics. Prior arrangements were made with the traders. The researcher trained the farmers on how to carry out the exercise before they went out to the market. The role of the researcher was to facilitate the farmers step by step through the marketing process. The researcher accompanied the farmers to the market and monitored the process from aside.

The traders visited consisted of those in the county council and municipal markets, supermarkets, and the National Cereals and Produce Board (NCPB). The farmers dialogued with these traders seeking to understand the way the market operated and identifying potential linkages for sale of their produce within the respective markets (see Plates 3, 4,5,6,7, and 8).

Plate 3: Pre-testing the questionnaire at Wiyumiririe market: One of the marketing committee members (Middle) interviews a trader (extreme left) as the extension and research officers watch form the side (extreme right)

Plate 4: The team receives a lecture from the manager of cereals and produce board, Nyahururu branch

Plate 5: The team learns the value of attractive branding and packaging in the market from the manager of Spear Supermarket Nyahururu

Plate 6: The team observes the different branding and packaging at the Supermarket in Nyeri

Plate 7: Farmers listen to the trader as she explains where and how she sources of her cereals in Nyahururu market

Plate 8: Farmers listen keenly as the trader explains the need for quality in the market in Nyeri

Step V: Enterprise design and business planning

Discussion sessions were held with members of the CBO and the selected marketing committees where farmers were guided in developing their own business plan The business plan outlines the following key sections:

1. Introduction:- Who they are, intended products, vision , production cycle, physical and contact address,
2. Business organization:- Membership, description of group in purpose, age of group, values of group, gender, leadership, legal status,
3. Product- What do farmers want to produce or what are they services they want to provide
4. Market strategy – Intended customers, marketing channels, customer relationships,
5. and expected income.

6. Market risks- key challenges and possible mitigation
7. Business Operation Plan-The flow of operations
8. Production Costs-Labor and materials cost
9. Marketing Costs- planned sales cost or profit and loss accounting
10. Profit and Loss-Gross margin.
11. Financial requirements- Capital funds available

Step VI: Collective marketing

A Field day was organized where the farmers displayed their skills in marketing, processing and packaging to the participants. During the field day a machine from the neighboring Leshau location was borrowed from one innovative farmer for demonstration purposes.

Partnerships Building

Partnerships' building is the central principle in the FPMD process and it involves identification of the roles and responsibilities of all those players in the marketing chain and particularly those that directly affect the farmers' produce.

These stakeholders were invited to participate in the inception workshop at the beginning of the project and were also invited to stakeholder meetings that preceded the implementation of the market development strategy as project implementation progressed.

Continuous engagement with the partners in the project including KARI researchers, the project donors, local administration, officials of the Ministry of Agriculture, local opinion makers, the farmer groups was encouraged throughout the implementation process.

Results and Discussions

These are the results of applying the Farmer Participatory Marketing Development (FPMD) approach in Kiriogo Location of Nyandarua North Sub-County.

Step I: Formation of CBO from independent farmer groups

The Kiriogo Farmers Federation was born out of joint efforts and planning of the following previously independent farmer groups: Human Effort Women Group, Kionereria Self Help Group, Kahigaini Self Help Group, Mugomoini Self Help Group and Kirioka Farmers' group.

Step II: Participatory, gender-sensitive choice of priority value chains

The priority setting activities were carried out in a meeting with the members of the CBO. Pair wise ranking was used to prioritize the market potential of crops and livestock on their farms. During the exercise gender separation was done to allow freedom of choice. The enterprises fell under the categories listed below.

Table 1: Priority crops by Males

Food Crops	Cash Crops	Food/Cash Crop	Livestock
Maize	Sunflower	Cabbages	Cow's milk
Potatoes	Snow peas	Runner beans	Cattle
Beans	Tobacco	Garden peas	Chicken

Table 2: Priority Crops by Females

Food crop	Cash crop	Food/cash crop	Livestock
Carrots	Sunflower	Runner beans	Cow's milk
Kales	Tobacco	wheat	Chicken
Sorghum	Pyrethrum	Maize	Eggs

Table 3: Priority Crops by Males and Females

Gender	Food crop	Cash crop	Food crop/cash crop	Livestock product
Female	Carrots	Sunflower	Runner beans	Milk
Males	Maize	Snow peas	Runner Bean	Milk

The farmers gave sunflower and runner beans first priority for commercial enterprises.

Step III: Formation of marketing committees

The marketing committee was constituted through elections. The officials took up their roles and responsibilities as given by the CBO and undertook the market survey. After finishing the market identification survey they presented their findings to a plenary sessions of all other members of the constituent CBO farmer groups. Some of the important findings were that:-

- There was a ready market for runner beans in the local market
- Local traders are not ready to enter into contractual supply due to the risk of buyers taking advantage of market fluctuations to fleece farmers
- Product preferences differ from place to place. In Nyeri consumers preferred beans of mixed varieties since they were less costly while consumers in Nyahururu preferred pure varieties even though they went at a higher price. The consumers in Nyeri argued that once beans were cooked they looked more or less the same and they were all beans anyway.

Step IV: Market opportunities identification

The findings of the farmers visits to two potential open air markets are given in Table 4 below.

Table 4: Information collected by farmers from the open markets

Item Observed	Nyahururu	Nyeri
1. What the trader had in display The packaging material Cleanliness of product Quantities of package Variety of goods Do they have what you want to sell?	No packaging. All goods were displayed from open gunny bags Polishing was done on request when trader was free. This was on customer relationship and not at any fee. Goods were displayed from open gunny bags and quantity generally depended on how much had been sold from the bag At the wholesale shops traders specialized in one kind of goods e.g legumes alone. While the retailers had a variety of legumes at one side and a variety of green vegetables on another side Nearly all the agrifoods produced at Kiriogo were in the market and they were in demand	As in Nyahururu As in Nyahururu As in Nyahururu Market setting had areas with both wholesalers and retailers. This made it easier for the retailers and also for the consumer who could also easily access both traders. As in Nyahururu
2. Where traders get their runner bean from a) How far is it from the market?	Around Nyahururu Meru Wholesalers travel in teams to areas of production like Meru about 200 kms or the surrounds of different distances of up to 50kms. They go up to Busia for cooking beans, over 400kms	Meru Endarasha, Kimahuri Wholesalers travel in teams to areas of production like Nyandarua 100kms, Meru 200 kms Kimahuri, 50kms They go up to Busia for cooking beans, over 400kms
3. By whom does the bean get to the market?	Usually wholesalers go for the goods, but even at the points of collection they at times deal with brokers	As in Nyahururu
4. By what does the bean get to the market?	They at times travel by bus but they also higher lorries depending on size of luggage	Lorries, Matatus, Buses and Boda Bodas for short distances
5. In what packages does the bean get to the market?	Gunny bags	As in Nyahururu
6. In what quantities is the bean packed to the market?	Grains are usually in 90kgs bags	As in Nyahururu

Item Observed	Nyahururu	Nyeri
7. Who are the target consumers?	For the wholesaler retailers and institutions are the target. Retailers sell mostly to women for feeding their families.	As in Nyahururu
8. What time of the year does the bean fetch the highest prices?	During the planting season farmers also buy for seed.	As in Nyahururu
9. What is the price of the bean ?	Prices increase as we move out of the harvest time and peaking up at planting time. Wholesalers sell at about Kes. 80-100 per kg, and retailers at Kes.120-150kgs depending on season	As in Nyahururu The price was more or less the same in both markets, Nyeri tending to be slightly more expensive
10. Does the trader have sufficient supply of the bean?	There is usually never too much of runner bean for the wholesalers and retailers may miss the supply depending on season	They are in high demand
11. Would the trader be willing to buy runner beans from your CBO? What varieties would they prefer? What quality and what prices would they offer? How often	Definitely. Purchases are per kg. The speckled varieties are most common but white ones are becoming rare. Those interested in planting seem to prefer the shorter types and the price depends on current market price Cannot be able to give definite times because they can predict the consumption	Definitely. Purchases are per kg. Both white and speckled are liked as long as they are clean Clean ones and disease free Price depends on current market price All the time
12. What business terms would the trader prefer?	Contracting is not practiced at local markets. Whoever comes with clean goods when needed is taken	Contracting is not practiced at local markets. Whoever comes with clean goods when needed is taken
13. Which grade of runner bean would you prefer	They are not aware of any grade but the product must be free from diseases and chaff	As in Nyahururu
15. What other farm products might your CBO be able to sell to the trader?	Carrots, maize, kales, beans, soybeans, pumpkins, dolichos, peas beetroots and many more. Terms and conditions are as those of runner beans	As in Nyahururu

In the supermarkets the farmer representatives observed cooking oil displays and learnt the dynamics of packaging and branding. They were also able to see packaging and display of the runner beans. In Nyahururu the farmers learnt about the dynamics of purchasing, processing and storage of grain.

Step V: Enterprise design and business planning

After several enterprise design and business development sessions, the Kiriogo Farmers Federation Business plan was drafted.

Table 5: Business Information

Item	Explanation	Detail
Organization	Kiriogo farmers Federation	A Community Based Organization (CBO).
Type of Entreprise	Production Processing and Marketing	Growers and processors of Sunflower and Runner beans
Production Cycle	Main season Short season	April –September October-February
Address	Post Office Box	Kiriogo Farmers Federation, P.O. Box 120, Ndaragwa.
Contact	Mobile Number	Mary Warutumo-0726790239, Chairperson Stephen Kihato-0703359394, Secretary

Step VI: Collective marketing

A Field day was held on 19th July 2013. The total attendance was 185, consisting of 129 farmers (50 females and 76 males and 59 agriculture students (18 males and 41 females from the hosting school. The farmers displayed their skills in marketing, processing and packaging to the participants. The farmer from Leshau demonstrated a simple oil filter made from locally available plastic water jars and sleeves made with cloth material from the shops. This innovative effort was lauded and could be scaled up to other groups interested in processing.

Building Partnerships

Partnerships' building is an important aspect in the FPMD process and it involves identification of the roles and responsibilities of all those players in the marketing chain and particularly those that directly affect the farmers' produce. The Ministry of Agriculture played the role of linking the researchers to the farmers. The Ministry of Culture and Social Services guided farmers on registration procedures for farmer groups. Their community officer also taught about the importance and advantages of collective activity. The local government officials helped improve structures like roads in the area, and the local traders at Wiyumiririe

trading Centre, the nearest market stocked the farmers' produce in their stores. Traders in Nyahururu town, the nearest town council headquarters and those in Nyeri town provided potential external outlets. Their involvement in the marketing process led to its success. Egerton University strengthened the market development process through the Graduate Opportunity for Innovations and Transformation (GO4IT) that trained the researcher on how to apply innovations through the PMSD process. These stakeholders were invited to participate in the inception workshop at the beginning of the project and were also invited to stakeholder meetings that preceded the implementation of the market development strategy as project implementation progressed.

Conclusions

The Farmer Participatory Market Development process supported capacity development of human capital as shown by farmers' administration of questionnaires and collecting of information gathered as well as reporting back to their peers. With the questionnaires, the CBO members now have the skills and capacity to undertake a market survey without assistance. They have the confidence to approach potential buyers of produce and make contacts with persons with the potential to add value to their farming. Farmers' now appreciate market dynamics and buyers' preferences and the need to produce with the market in mind. A case in point is where they learnt that the preferences of buyers from different localities differ totally. For example in Nyahururu (40km away), the consumer preferred the pure varieties of beans for their domestic consumption, implying a higher cost while the consumers in Nyeri (80kms) preferred the mixed varieties because it was less costly and would not show much difference once cooked anyway.

Through the Farmer Participatory Market Development process, the farmers in Kiriogo were able to build confidence and bring out potential from within them. This empowerment allowed farmers to express themselves effectively in the market, make contacts with potential buyers and to seek services from pertinent offices. Since they were able to compare different prospective buyers, the farmers are now able get the best market for their products and therefore are fetching better prices. For example the farm-gate price of runner beans is currently Kes.70; however, when the farmer packages and delivers to the supermarket they will be selling it at double the farm gate price.

The farmers were also able to quickly and effectively build a research-development link. Out of this, there are three distinct outcomes.

i) The farmers negotiated for an oil pressing machine from their local Member of Parliament within a season of the training. This was a very crucial stakeholder that came out as a result of the farmers' initiative. This equipment is now in the process of installation.

Plate 9: Supervisors from Go4It Initiative of Egerton University(4th right & squatting) join the CBO Officials as they show off their Oil press.

Plate 10: A Farmer, Mr. Karuri joyfully explains his experiences in growing sunflower

Plate 11:. Dr Elizabeth Kamau, Mrs Violet Kahiga &Charity Ngari listen as the farmer tells his experiences

ii) Through this process other partners were incorporated for capacity building that had trickle down effect. In one such case we see Mr. Karuri a farmer confidently taking the GO4IT evaluation team through his sunflower plots explaining the farming systems he had in place. One of the things he demonstrated was the difference made in bird damage with and without maize intercrop.

PMSD created a forum for farmers to interact with the university, exchanging views with the lectures helped build linkage between the community and the university. This created a great impact on the attitudes of the farmers.

iii) Skills gained through the FPMD led the Community Based Organization (CBO) to negotiate for the building of a local market. at their local Assistant Chiefs' camp. This may not have been possible when each group operated alone. It is easier to attract funding as a bigger group

The local market will not only enable farmers make more profitable bargains with external traders but will also enable better local level trade of their different farm products.

REFERENCES

Dorward, A., Kydd, J., Morrison, J., Urey, I. (2004). A Policy Agenda for Pro-Poor Agricultural Growth. ***World Development,*** Volume 32, Issue 1: Pp. 73–89. Imperial College London, UK. ***http://dx.doi.org/10.1016/j.worlddev.2003.06.012***

Government of Kenya (2011). Agricultural Sector Development Support Programme. Ministry of Agriculture, Kilimo House. www.kilimo.go.ke

Government of Kenya (2007). National Development plan. Ministry of Finance. Government Printers. Nairobi

Kaaria, s., Njuki, j., Abenakyo, A., Delve, R., and Sanginga, P. (2008). Assessment of the Enabling Rural Innovation (ERI) approach: Case studies from Malawi and Uganda. ***Natural Resources Forum*** 32 Pp.53–63 Blackwell Publishing Ltd.

Quisumbing A.R. and Pandolfelli, L. (2010). Promising Approaches to Address the Needs of Poor Female Farmers: Resources, Constraints, and Interventions. ***World Development,*** Volume 38, Issue 4: Pp. 581–592. State University of New York at Stony Brook, Stony Brook, NY, USA. ***http://dx.doi.org/10.1016/j.worlddev.2009.10.006***

Enhancing adoption of technological innovations for orphan crops among rural poor farmers

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Abstract

Researchers have developed a number improved varieties as well as appropriate management practices for the orphan crops, but only a handful of farmers ably have access to and use these technologies. In order to introduce and promote orphan crops' improved technologies adaptation trials were conducted from second cropping seasons of 2010 to first season of 2012 with farmers groups. 120 trials were established in the target districts at the start of the study in Tororo (60), Mukono (30) and Ntungamo (30). In the first season of 2013, tracking of adoption was carried out where 300 farmers were interviewed in the project parishes. Despite the randomization, majority of the interviewed farmers (71.3%) were those who participated in the trial phase of the study compared to only 28.7% who were non-members; implying that there was high adoption and some spill over. There was high level of adoption of technologies for the selected orphan crops in the study area, implying that the methods used to introduce the technologies were effective and could be considered for increasing of adoption of other technologies.

Key words: Adoption, technologies, food security, poor farmer

Introduction

Background

One of the global challenges in Sub-Saharan Africa is ensuring food and nutritional security and sustainable livelihoods for an increasing population. In Uganda, about 6.3% of households are food insecure and 21.3% are at risk of becoming food insecure (World Food Program, 2009). These characterize the extent of poverty in the country, which is still severe, especially in rural areas closely linked to marketing problems and low productivity in the agricultural sector (Appleton, 2001; MFPED[1], 2002). Empowering rural small scale farmers to improve agricultural productivity and increasing access to markets for their produce could be a major

1 MFPED – Ministry of Finance Planning and Economic Development

milestone towards fighting poverty in country (MAAIF[2] and MFPED, 2000). This is possible through promotion and diffusion of high quality seeds of improved crop varieties and their management practices. A wide range of crops are cultivated in Uganda yet most households depend on a few traditional crops for food and income (Nzuma ***et al***, 2008). This is likely to jeopardize food and nutritional security for many households. Crops such as cowpeas, yams, sweet potatoes, among others that are often categorised as orphan crops have potential to enhance food and nutritional security for rural poor households in the country (Rubaihayo, 2002), if appropriate technology is availed to farmers. They are valued culturally, adapt well over wide range of adverse conditions such as low soil fertility, low rainfall and are important for the subsistence of local communities (Naylor ***et al***, 2004). The role of orphan crops in food systems cannot be ignored if Uganda is to realise the contribution of agriculture in achieving vision 2040. In addition, these crops are major source of income to the resource poor farmers attributed to equally high rates of returns from sales (Akibode and Maredia, 2011). Researchers have developed a number improved varieties as well as appropriate management practices for the orphan crops, but only a handful of farmers ably have access to these technologies including access to quality seed (Agri food systems Baseline survey report (2009/10). This is because seed sector in Uganda is largely private and the policies remain unsupportive to minor crops as the seed companies prefer to deal with staple or major food crops like maize (MAAIF 2009, 2010). Other constraints such as inadequate land area for cultivation, environmental hazards, low income, labour shortage, degraded soil condition, among others were identified. It was against this background that this project was established with the purpose of increasing productivity of the orphan crops that will translate into increased access to food and incomes, hence contributing food security among rural small scale farmers.

Objectives

The study objectives included; 1) improving farmers' access to improved technologies for the selected orphan crops; 2) strengthening capacity of farmer groups and individual farmers to manage agricultural activities and 3) track the level of adoption of introduced technologies.

Materials And Methods

Project location and materials

The study was conducted in two phases (adaptation phase and adoption phase) in three sub-counties per districts of Mukono, Ntungamo and Tororo located in the central, western and eastern part of Uganda, respectively. Based on the order of importance, challenges faced and farmers' interests (yield, taste, colour, grain size, and maturity period), one to three varieties of five (5) crops were selected for the study (Table 1). Two orphan crops were studied per district, namely cowpea and sorghum for Tororo, groundnut and yam for Mukono, and groundnut and sweet potato for Ntungamo.

Host farmer selection and establishment of trials

Host farmers were selected by members of each farmer group using the criteria: amount of land availability, willingness to host and manage the trial; willingness to allow access to trial gardens by other farmers to learn and acquire skills, proximity access road; membership to a farmer group and level of involvement in the group. A total 120 host farmers were chosen to host trials for the adaptation phase of the study. Trials

2 MAAIF – Ministry of Agriculture Animal Industry and Fisheries

were planted in host farmer's garden in a non-replicated plot for two seasons during which the technologies were introduced and adapted. The size of the plots depended on the land availed for the study, which ranged from 30 to 400 Square Metres. Two to three improved varieties of each crop were evaluated against the local varieties at each trial site following recommended crop management practices. The local varieties were used as controls. Planting was done jointly by farmer group members, extension workers and researchers. With the exception of sweet potato which was planted in mounts, row planting was used for the crops.

Farmer training

Farmers were trained on a wide range of topics including production and management of selected orphan crops; participatory local monitoring and evaluation of farmer trials; food security for rural farmer households (definition, indicators of food insecurity and possible interventions); strengthening farmer groups through simplified project planning monitoring and evaluation training and market access for orphan crops. Classroom approach and field practicals were used to conduct the training.

Local participatory monitoring and evaluation

Local participatory monitoring and evaluation committee members were selected by farmers from their groups in order to monitor project activities at grassroots/farmer level and as such agreed on activities that needed to be monitored, indicators of progress and monitoring timelines. Each of the 15 groups in the project implementing sub counties elected a monitoring committee member to monitor group members' activities in line with the required agricultural practices.

Tracking of adoption of technologies for orphan crops

Tracking of adoption of technologies was carried out in the second phase of study with individual farmers in the study area from the time introduction. A tracking tool, unit questionnaire, was designed pretested and administered. As in the pre-testing, face to face interview with a larger number of randomly selected farmers was used to administer the questionnaire. Information captured included farmer bio-data, farming experience, engagement in farming groups, participation in Agri-food system project activities, production and marketing of orphan crops, and access to services such as extension and financial services. Data generated was analyzed using SPSS and MS Excel computer statistical packages.

Results and discussions

Introduction of improved technologies for the selected orphan crops

Farmers actively participated in the trials as well as the training sessions with enthusiasm. During the trial phase, four training sessions were conducted for average of 299 farmers per district. At the end of each training session, trainees identified key areas of the training they have understood and were willing to apply. Of the farmers who participated in the training, 89.6% liked crop production and management skills session followed by accessing markets (86.6%), household food security (86.3%) and strengthening farming groups (84.9%).

A participatory preference assessment was also conducted at the close of the trial phase and based on

knowledge and skills acquired the following varieties were farmers' preferences; SECOW 2W, Sekedo, Serenut 1 & 3, and Naspot 8 & 11 for cowpea; sorghum; groundnut and for sweet potato, respectively. No preference could be made for yam because only the local variety was planted. This information was later used to design adoption tracking tool.

Tracking of adoption of technologies for orphan crops

This phase of the study was meant to assess the adoption of the introduced technologies and relate it to possible factors that could have influenced the adoption. Three hundred sixty (360) farmers were interviewed during the survey carried out to determine the proportion of farmers who have adopted the improved technologies after introduction in the Study target districts. The interview was conducted randomly so that both farmers who directly or indirectly benefited from the trial phase of the study were captured. Despite the randomization, majority of the interviewed farmers (71.3%) were those who participated in the trial phase of the study compared to only 28.7% who were non-members. This is an indication that the initial trial phase, where improved technologies were introduced, was extensively done in the study area and majority of the farmers in the study area benefited.

Participating farmers in the adoption study were also asked about utilization of the orphan crops/varieties they have cultivated and the results showed that majority of farmers used the crops (varieties) both for consumption and commercialization (Figure 1). This clearly shows the potential of these crops to meet food/nutritional needs and income of rural poor farming households in the country (MAAIF, 2010; UBOS, 2010).

The percentage proportion of farmers using the introduced technologies and their perception was used to measure the level of adoption. These approaches were successfully used by Kebede, Gunjal and Coffin (1990), Adesiina and Baidu-Forson, (1995) and Tjornhom, (1995). A significant variation in level of adoption of the technologies was observed with most of the farmers, averaging at 76.4%, who participated in the trial phase having adopted at least one of the improved technologies (Figure 2.).

The results also showed that there was spill over in adoption as farmers who did not participate in the trial phase were found to have taken up the new technologies implying that the farmers liked the technologies that have been introduced and the method used to introduce the technologies (participatory adaptation trials) was effective and could be considered for increasing of adoption of other technologies. Farmers growing cowpea and groundnuts were the most adopters as over 60% of those interviewed adopted the improved varieties as well as crop management practices such as planting line, appropriate plant spacing, and spraying to control pests.

Most of the farmers who adopted the technologies were found to have participated in the trial phase (Group members) and received the advisory services. For example, for those who adopted cowpea technologies 79.7%, 89.5% and 42.7% of the farmers (group members) received the extension services, participated in the M & E, and accessed financial services, respectively (Table 3). Meaning that participation in trial phase, trainings, and receiving extension and financial service were influential on adoption of the technologies

Table 4). This is in agreement with Obuo et al (2004) report where farmers operating in groups learn and adopt faster as they support each other by sharing knowledge and skills acquired. Other factors which had some influence included membership to a farmer group, access to market and farmer perception. Besides external factors, characteristics of the technologies such as compatibility with the existing values and norms, complexity, observability, trialability, and relative advantage is also at play in influencing adoption by farmers (Rogers, 1995).

In addition, mechanisms for small farmers to oversee their food security interventions were established. For examples, a structure (Local M & E committees), tool and capacity for farmers to monitor and evaluate their projects were established. This initiative was observed to be helpful in promotion of improved varieties and crop management packages. Results of local monitoring and evaluation committee members are presented in figure 3.

Socio-economic characteristic of the sampled farmers such as age, sex, marital status, size of household, level of education, residency in the study area, ownership of land for agriculture, period of practicing farming especially the study crops, and membership to a farming group were collected and analysed. Though not significantly different as compared to farmer participation in trial phase and training received, these socio-economic characteristics of the farmers were found to affect the level of adoption of the introduced technologies. Most of the practicing interviewed farmers who adopted the technologies were aged between 30 and 56 years and married with average of 5 people per household. Most of them have practiced farming for over 10 years and the study crops have been used as staple though local varieties were most cultivated. Majority of the farmers were residents and therefore owned the land used for farming averaging from less than half an acre (< 0.5 acres) to over three acres (> 3 acres). However, younger farmers appeared to have adopted the technologies that required energy such as line planting and spraying than older farmers. In their study, contribution of Uganda Cooperative Alliance to farmers' adoption of improved agricultural technologies (Mugisha ***et al.,*** 2004a), Mugisha and the colleagues reported that younger farmers were more dynamic in the adoption of new farming techniques, while older ones are more experienced and skilful but less energetic. The older farmers tend to avoid technologies that demand for energy. In this study as reported earlier (Mugisha ***et al.,*** 2012; Mugisha ***et al.,*** 2004a), the more educated the farmers the easier to learn and adopt new technologies. This was clearly explained by Lin, (1991) that the educated farmers easily synthesize information availed and apply them to the farming situation.

Conclusion

There was high level of adoption of technologies for the selected orphan crops in the study area. Some adoption was noted among farmers who did not participate in trial phase. However, participation in farmer group trials, training, participatory monitoring and evaluation at the adaptation phase were observed to be crucial in determining adoption of the innovations. Other factors which had some influence included membership of a farmer group, access to market, advisory and financial service. Implying that the method used to introduce the technologies, participatory adaptation trial, was effective and could be considered for increasing of adoption of other technologies. In addition, mechanisms for small farmers to oversee their

food security interventions were established. Local monitoring and evaluation committees of five members per sub-county were formed that ensured regular monitoring and evaluation. This helped in promotion of improved technologies and could be adopted.

Acknowledgements

We would like to thank the International Development Research Centre (IDRC) for funding this research, and Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and National Agricultural Research Organization (NARO) for the collaboration and coordination.

Refferences

WFP[3]. Food security Analysis. Comprehensive food security and vulnerability analysis, Uganda, 2009.

Appleton, S. Poverty Reduction during Growth: The Case of Uganda. Centre for African Studies, Oxford University, Oxford, Mimeo. 2001.

MFPED. Uganda Participatory Poverty Assessment Process (UPPAP). Republic of Uganda, Ministry of Finance, Planning and Economic Development, Kampala, Uganda, 2002.

MAAIF and MFPED. Plan for Modernization of Agriculture: Eradicating Poverty in Uganda, Government Strategy and Operational Framework. Kampala, the Republic of Uganda, 2000.

Nzuma, J., Machana, E., SikaGbegbelegbe and Karugia, J. ESA Orphan Crop Prices Rise in Tandem with Staple Food Prices. Transforming agriculture for improved livelihoods, ASARECA. Regional Strategic Analysis and Knowledge Support Systems, 2008.

Rubaihayo E.B. The Contribution of Indigenous Vegetables to Household Food Security, 2002.

Naylor, R. L., Falcon, W. P., Goodman R.M., Jahn M.M., Sengoba T., Tefera H., Nelson J.R. Biotechnology in the developing world: a case for increased investment in orphan crops. Food Policy, 2004; (29) 15- 44

Akibode, C.S. and M. Maredia. Global and Regional Trends in Production, Trade and Consumption of Food Legume Crops. Report submitted to the Standing Panel on Impact Assessment (SPIA) of the CGIAR Science Council, FAO, Rome, March 2011.

MAAIF. The Draft National Seed Policy. The Republic of Uganda Ministry of Agriculture, Animal Industry and Fisheries, 2009.

MAAIF. Agriculture for food and income security, Agriculture Sector Development Strategy and Investment Plan –DSIP 2010/11-2014-15, Republic of Uganda, 2010.

Uganda Bureau of Statistics (UBOS). Uganda National Household Survey 2009/10: Socio-Economic Module Abridged Report, Kampala: Uganda Bureau of Statistics, 2010.

Kebede, Y., K, Gunjal and G. Coffin. Adoption of new technologies in Ethiopian agriculture: The case of Tegulet-Bulga District, Shoa Province". Agricultural Economics. 1990; 4:27-43.

Adesiina, A.A. and J. Baidu-Forson. Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence From Analysis in Burkina Faso and Guinea, West Africa. Journal of Agricultural Economics. 1995; 13:1-9.

Tjornhom, J.D. Assessment of Policies and Socio-Economic Factors Affecting Pesticide Use in the Philippines. MS. Thesis, Virginia Polytechnic Institute and State University, 1995.

Obuo J. E. P, Omadi J. R., Okwang D. and Okurut- Akol H. Pigeonpea seed production and delivery system: Experience from the Lango Farming systems. Uganda Journal of Agricultural Sciences, 2004; 9, 656- 658

3 WFP – World Food Program

Rogers, E.M. Diffusion of Innovations.3rd Edition. New York: The Free Press, 1983. 4th Edition. New York: The Free Press, 1995.

Mugisha, J., O.R. Ogwal, W. Ekere and V. Ekiyar. Adoption of IPM groundnut production technologies in Eastern Uganda. African Crop Sci. J., 2004a;12: 383–391

Mugisha, J., B. Ajar and G. Elepu. Contribution of Uganda cooperative alliance to farmers' adoption of improved agricultural technologies. J. Agric. Soc. Sci., 2012; 8: 1–9

Lin, J.Y. Education and innovation adoption in agriculture: Evidence from hybrid rice in China. American J. Agric. Econo., 1991; 73: 713–722

Tables and Figures

Table 1: Varieties used, plot size and spacing for the crop trials

Crop	Varieties	Spacing
Cowpea	Secow 1T, Secow 2W & Local variety (*Ebelat*)	60x30cm
Sorghum	Sekedo, Epuripur and Local variety	60x30cm
Yam (*Dioscorea* spp)	Nigeria yellow and Local variety (*Balugu)*	150x150cm
Groundnut	Serenuts 1, 3, 4 and Red beauty	60x15cm
Sweet potato	(Naspot1, Naspot8, Naspot11 and local variety	3 vines per mound

Adopted from Agri food systems Baseline survey report 2009/10

Table 2: Distribution of project trials in the three districts in the cropping seasons of 2010-2011

District	Cowpea	Sorghum	Groundnut	Yam	Sweet potato	Total
Mukono			15	15		30
Tororo	30	30				60
Ntungamo			15		15	30
Total	**30**	**30**	**30**	**15**	**15**	**120**

Figure 1: Utilization of crops/ varieties by farmers in study area

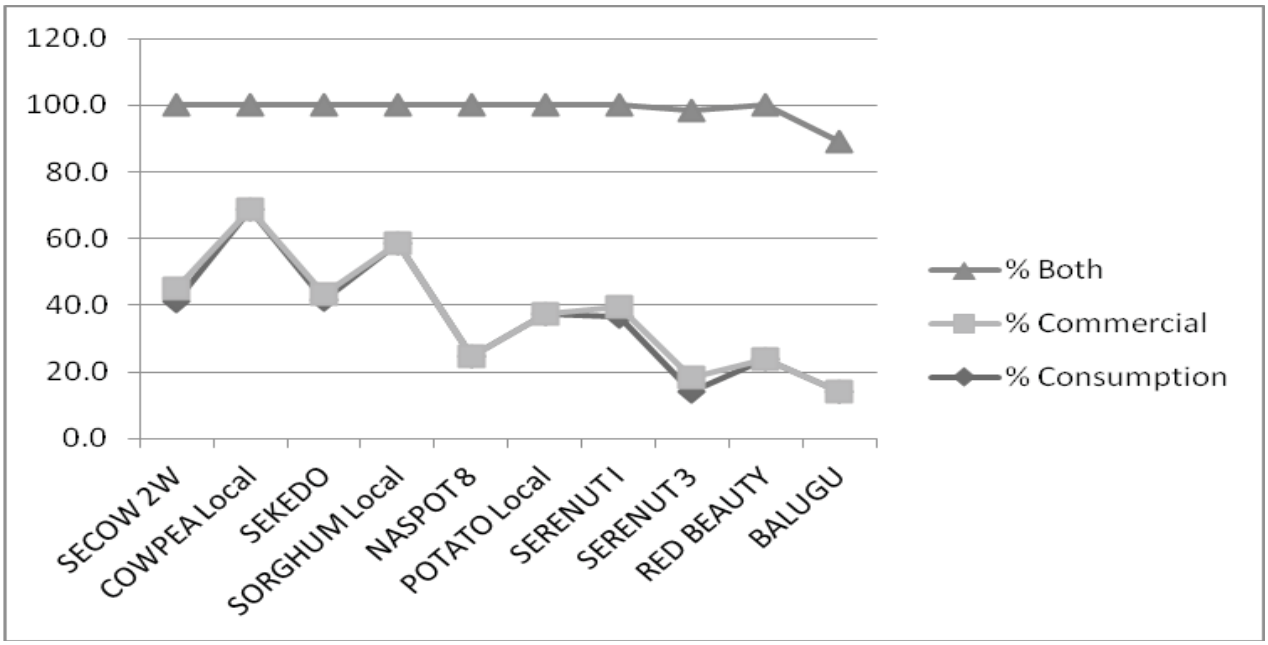

Figure 2: Rate of adoption of improved crop varieties and their management packages by members and non group members where yes = member and no = non members.

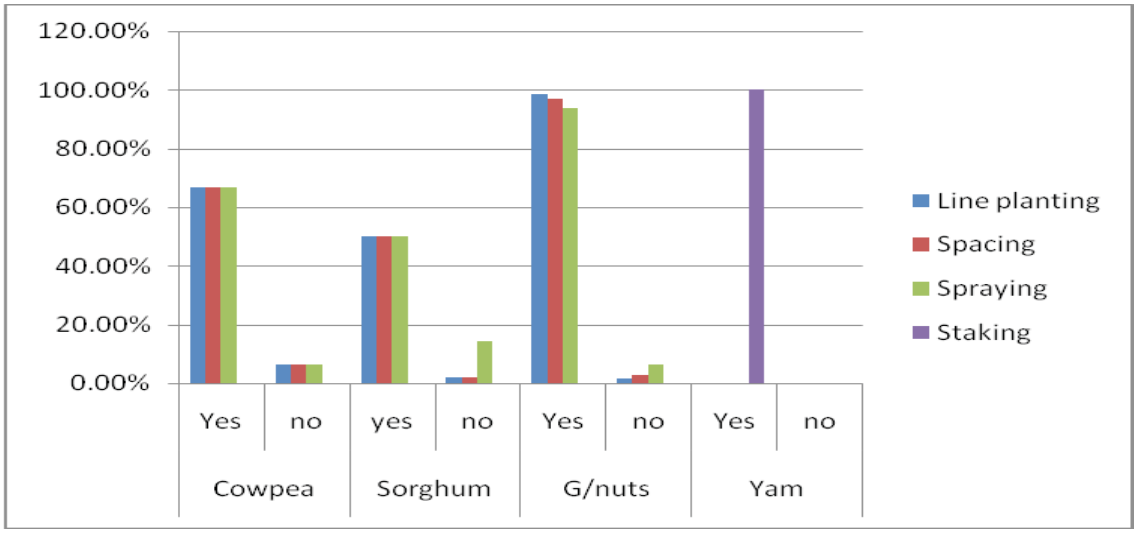

Table 3: Percentages of farmer per crop either in a group or not that received services

Crop	Farmer category	Percentage farmers per Services Received					
		Extension		PM&E		SACCO	
		Yes	No	Yes	No	Yes	No
Cowpea	Group Members	79.7	20.3	89.5	10.5	42.7	57.3
	Non-group members	6.7	93.3	7.1	92.9	38.5	61.5
Sorghum	Group Members	79.5	20.5	88.4	11.6	46.0	54.0
	Non-group members	6.3	93.8	12.5	87.5	46.7	53.3
Sweet Potato	Group Members	72.1	27.9	81.8	18.2	45.8	54.2
	Non-group members	33.3	66.7	43.8	56.3	30.0	70.0
Yam	Group Members	68.1	31.9	73.9	26.1	27.3	72.7
	Non-group members	0.0	100.0	0.0	100.0	0.0	100.0
Groundnuts	Group Members	74.1	25.9	83.9	16.1	55.5	44.5
	Non-group members	23.1	76.9	42.9	57.1	50.0	50.0
Average	Group Members	74.7	25.3	83.5	16.5	43.4	56.6
	Non-group members	13.9	86.1	21.3	78.8	33.0	67.0

Fig 3: Farmers performance according to the results generated from Local Monitoring and Evalution committee monitoring

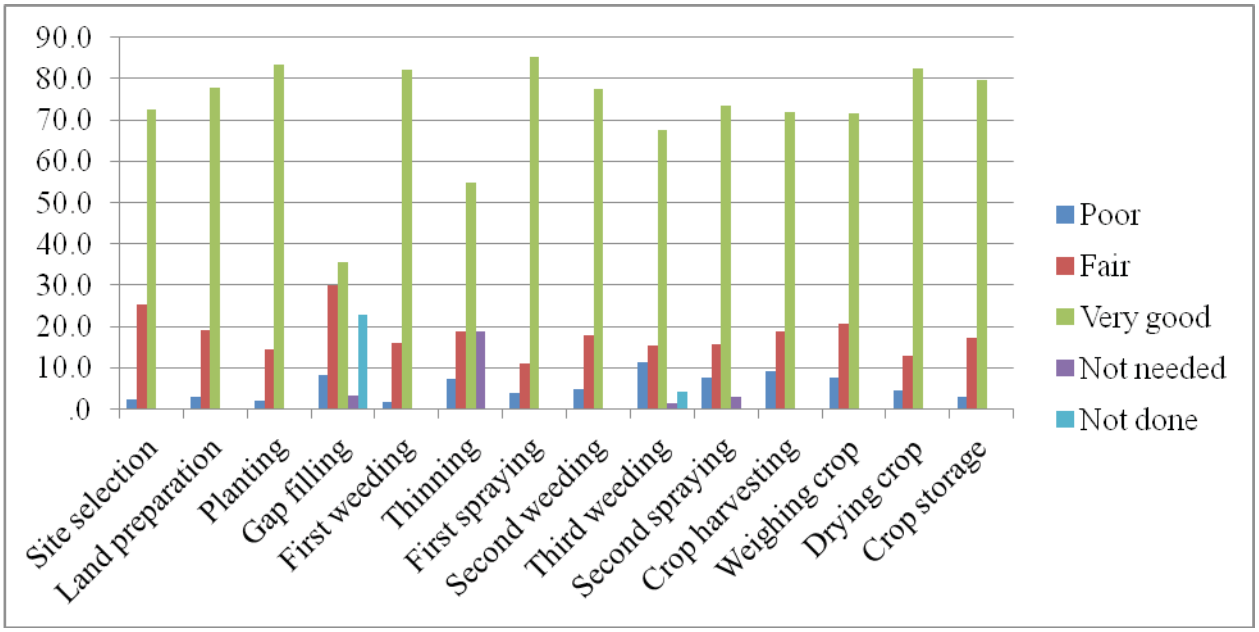

Table 4: Respondents who adopted technologies

Technologies adopted				
		Improved variety	Line planting	Recommended spacing
Project group member	SECOW2W	93.2%	93.2%	93.2%
	SEKEDO	97.9%	97.9%	89.4%
	NASPOT8	97.6%	92.7%	68.3%
	SERENUT3	98.0%	98.0%	89.6%
	YAM	100.0%	100.0%	37.5%
	Average	97.3%	96.4%	75.6%
Attended training	SECOW2W	95.5%	95.5%	97.7%
	SEKEDO	98.1%	98.1%	84.6%
	NASPOT8	97.8%	93.5%	63.0%
	SERENUT3	98.5%	97.1%	89.4%
	YAM	100.0%	100.0%	33.3%
	Average	98.0%	96.8%	73.6%
Access to seed market	SECOW2W	88.9%	88.9%	88.9%
	SEKEDO	100.0%	100.0%	75.0%
	NASPOT8	100.0%	100.0%	0%
	SERENUT3	100.0%	93.8%	75.0%
	YAM	100.0%	100.0%	100.0%
	Average	97.8%	96.5%	67.8%
Access to market	SECOW2W	92.3%	92.3%	100.0%
	SEKEDO	100.0%	100.0%	82.4%
	NASPOT8	100.0%	92.6%	70.4%
	SERENUT3	100.0%	100.0%	85.3%
	YAM	100.0%	100.0%	33.3%
	Average	98.5%	97.0%	74.3%
Access to seed supply	SECOW2W	97.6%	97.6%	100.0%
	SEKEDO	100.0%	100.0%	86.0%
	NASPOT8	96.8%	90.3%	71.0%
	SERENUT3	98.2%	98.2%	94.4%
	YAM	100.0%	100.0%	33.3%
	Average	98.5%	97.2%	76.9%
Guided by extension worker	SECOW2W	97.6%	97.6%	100.0%
	SEKEDO	100.0%	100.0%	86.0%
	NASPOT8	96.8%	90.3%	71.0%
	SERENUT3	98.2%	98.2%	94.4%
	YAM	100.0%	100.0%	33.3%
	Average	98.5%	97.2%	76.9%

Technologies adopted				
		Improved variety	Line planting	Recommended spacing
Guided by PM&E committee	SECOW2W	100.0%	100.0%	97.7%
	SEKEDO	100.0%	100.0%	88.0%
	NASPOT8	97.8%	93.3%	60.0%
	SERENUT3	98.4%	98.4%	93.4%
	YAM	100.0%	100.0%	25.0%
	Average	99.2%	98.3%	72.8%
Access to financial services	SECOW2W	100.0%	100.0%	90.9%
	SEKEDO	100.0%	100.0%	93.9%
	NASPOT8	100.0%	100.0%	66.7%
	SERENUT3	100.0%	97.4%	86.8%
	YAM	100.0%	100.0%	33.3%
	Average	100.0%	99.5%	74.3%

Farmer perspectives on scaling up orphan crops in Malawi

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Abstract

Recently development practitioners have focussed on interventions that aim at scaling up orphan crops such as bambara nuts, pumpkins, okra and amaranthus. These crops have been neglected by research, extension, policy and development programs yet they play a significant role in livelihoods of smallholder farmers in terms of nutrition, food security and incomes. This paper provides findings on farmer perspective on scaling up orphan crops in Malawi. Particularly, it focuses on types of orphan crops preferred by farmers as well as opportunities and challenges that need critical consideration when scaling up orphan crops. Data was collected from leaders and members of 10 farmer groups producing orphan crops through focus group discussions using a checklist in Chikhwawa, Kasungu and Lilongwe districts. The study reveal diverse and site specific farmer preferences on orphan crops influenced by biological, physical and social economic factors such as agro ecological suitability; resilience to climatic shocks; availability of inputs; existence of indigenous knowledge; and availability of markets. The opportunities existing for scaling up orphan crops include availability of natural resources, farmer' indigenous knowledge and social capital. However, farmers lack

capacity to fully utilise these opportunities. Existence of diverse and dynamic challenges such as unavailability of inputs and farm tools, lack of knowledge on modern practices and poor market infrastructure are barriers to scaling up orphan crops. The paper concludes that if orphan crops are to be scaled up into the mainstream agriculture, farmer involvement is critical. This will only be possible if a local innovation platform for orphan crops is established through which farmer preferences are taken on board. Further, farmer capacity building that focuses on social mobilisation, pre and post harvest handling training and extension as well as marketing is essential to enable farmers utilise existing opportunities for scaling up orphan crops.

Key words: *Orphan crops, scaling up, farmer preferences, opportunities, challenges.*

1.0 Introduction

The term ***Orphan crop***s synonymously used with terms such as ***minor, underutilised*** or ***neglected species*** refers to crops that barely receive institutional support in terms of research and extension. They are not produced widely around the world; they are not traded to any significant extent in international markets and hardly earn recognition in international investments (International Development Research Centre [IDRC], 2009; Naylor and Manning, 2005). Most of these crops are indigenous and include crops such as sesame ***(Sesamum indicum)***, bambara nut ***(Vigna subterranean)***, yam ***(Dioscorea)***, pumpkin ***(Cucurbita)*** and amaranthus ***(Amaranthus cruentus)***.

Just as at the global level, in Malawi orphan crops bare the low status among crops considered as major in the mainstream agriculture such as tobacco, tea, sugar, cotton, maize and rice. They have been denied adequate attention with respect to research, extension and marketing by existing agricultural institutions and barely receive recognition in national agricultural policies and development strategies (Government of Malawi [GoM], 2009).

Despite being neglected, orphan crops are critical for feeding the world's most disadvantaged regions including Malawi. They are valued culturally, often adapted to harsh environments, nutritious and diverse in terms of their genetic, agro climatic and economic niches (Naylor and Manning, 2005). It is further argued that orphan crops are important for the most vulnerable rural households; particularly women as regards to food security and income generation (IDRC, 2009).

The Making ***Agri-Food Systems Work for Rural Poor in Eastern and Southern Africa*** is an IDRC funded project that aims at scaling up orphan crops into the mainstream agriculture in Malawi. It is being implemented in Chapananga, Simulemba and Malingunde areas of Chikhwawa, Kasungu and Lilongwe districts respectively. The implementing institutions of the project include Bunda Campus of the Lilongwe University of Agriculture and Natural Resources (LUANAR), the Malawi Enterprise Zone Association (MALEZA) and the Association for Strengthening Agriculture Research in Eastern and Central Africa (ASARECA).

The project recognises the importance of actively involving smallholder farmers at grass root level in promoting orphan crops (IDRC, 2009). This is based on the fact that smallholder farmers are the custodians of indigenous knowledge on orphan crops. They have also preserved the orphan crops from one generation to another. Involving the smallholder farmers at grass root level would therefore ensure sustainability of the initiatives to scaling up orphan crops in Malawi.

This paper presents farmer perspective on scaling up orphan crops in Malawi. It specifically focuses on the types of orphan crops preferred by farmers and then identifies the opportunities and challenges encountered in the process of scaling up orphan crops into the mainstream agriculture.

2.0 Methodology

2.1 Study areas

This study was conducted in Chapananga, Simulemba and Malingunde areas of Chikhwawa Kasungu and Lilongwe districts respectively. The study involved farmer groups that produced at least one of the orphan crops as indicated by Tadele (2009), IDRC (2009) as well as Naylor and Manning (2005).

2.2 Sampling of study units

The farmer groups existing in the study areas were divided into 3 clusters. The first cluster had farmer groups that belonged to an association, the second with farmer groups that belonged to a cooperative while the third cluster had farmer groups that did not belong to any larger organisational body. The groups in the third cluster were named *individual farmer groups* in this study.

Using simple random sampling 2 farmer groups were selected from the cluster with groups belonging to the association. From the cluster with groups belonging to the cooperative, 3 groups were selected. From the cluster with individual groups, 5 groups were selected. This resulted to a total of 10 farmer groups. This number of farmer groups was chosen in order to make possible an in depth analysis of the groups.

2.3 Data collection

Data was collected through focus group discussions conducted with the sampled farmer groups. A total of 10 focus group discussions with the leaders and again 10 focus group discussions with the ordinary members were conducted using a checklist.

To address the question on types of orphan crops preferred by farmers, the leaders and members of the farmer groups were provided with a list of orphan grains, tubers, fruit and vegetables developed by the researchers. This list was further improved by the local participants by adding names of orphan crops existing in communities that were missed on the researchers' list. The leaders and members were then asked to rank the orphan crops from the most preferred to the list preferred. Table 1below shows the list of orphan crops that were subjected to farmer ranking.

Table 1: List of orphan crops subjected to farmer ranking

Common name	Scientific name	Common name	Scientific name
Sorghum	(Sorghum bicolour)	Yam	Dioscorea
Peal millet	(Pennisetum glaucum)	Pumpkin	Cucurbita
Finger millet	(Eleusine coracana)	Amaranthus	Amaranthus cruentus
Pigeon pea	(Cajanus cajan)	Cat's whiskers	Cleome gynandra
Sesame	Sesamum indicum	Black jack	Bidens pillosa
Bambara nut	Vigna subterranea	Roselle	Hibiscus sabdarrifa
Sweet potato	Ipomea batatas	Okra	Abelmoschus esculentus

To address the question on existing opportunities and challenges for scaling up orphan crops in their communities, the leaders and members of the farmer groups were asked to indicate the opportunities and challenges they face or would potentially face when working with orphan crops in their groups.

2.4 Data analysis

Analysis of qualitative data was done by generating narrative cases following the procedure highlighted by Yin (2003). The classical content analysis was then used to analyse each narrative case as advocated by Leech ***et al.*** (2007). Analysis of quantitative data such as preference scores involved generating descriptive statistics. The descriptive statistics included frequencies, percentages and means. To test statistical differences within variables and between groups, a One- Way ANOVA was used. To separate means, the Duncan Multiple Comparison Test was used (Duncan, 1955). The quantitative data was entered, managed and analysed in the Statistical Package for Social Sciences (SPSS).

3.0 Results

3.1 Farmer preferences on types of orphan crops to scale up

Prior to farmer ranking, the orphan crops under study were categorised into 4 crop categories; grains, tubers, fruits and vegetables. Table 2 below shows farmer' preference scores on orphan grains, tubers and fruits. Results show that while in general terms, farmers assigned high preference scores to sweet potato (2.9), sorghum (3.4), bambara nut (3.7) and pumpkin (4.1), there were variations in scores assigned to orphan crops across districts. Farmers in Kasungu assigned high preference scores to finger millet (1.8) and bambara nut (1.8); in Lilongwe pumpkin (2.3) and sweet potato (2.3) and in Chikwawa they assigned the highest score to Sorghum (1.5) and sweet potato (1.5).

Table 2: Farmer preference scores on orphan grains, tubers and fruits

Orphan crop		All districts (n= 10)	Kasungu (n=4)	Lilongwe (n=4)	Chikwawa (n=2)
		Average preference scores			
Grains	Sorghum	3.4^{a}	3.8^{b}	4.0^{ab}	1.5^{a}
	Peal millet	6.4^{bc}	8.0^{c}	6.3^{bc}	3.5^{ab}
	Finger millet	4.7^{ab}	1.8^{a}	6.0^{bc}	8.0^{c}
	Pigeon pea	4.7^{ab}	4.8^{b}	5.3^{ab}	3.5^{ab}
	Sesame	7.3^{c}	7.5^{c}	7.8^{c}	6.0^{bc}
	Bambara nut	3.7^{a}	1.8^{a}	3.5^{ab}	8.0^{c}
Tubers	Sweet potato	2.9^{a}	4.3^{b}	2.3^{a}	1.5^{a}
	Yams	7.8^{c}	8.3^{c}	7.8^{c}	7.0^{c}
Fruit	Pumpkin	4.1^{a}	5.0^{b}	2.3^{a}	6.0^{bc}
F value		7.10***	15.24***	5.10***	8.51***

****= significant at 1%: Values with different superscripts are significantly different at 5%*

Results in table 3 below show that there were no variations on the types of orphan vegetables that farmers assigned high preference scores in all districts. The orphan vegetables that were assigned high preference scores included okra (1) and amaranthus (2).

Table 3: Farmer preferences on orphan vegetables

Orphan crop	All districts (n= 10)	Kasungu (n=4)	Lilongwe (n=4)	Chikwawa (n=2)
	Average preference scores			
Okra	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}
Amaranthus	2.0^{b}	2.0^{b}	2.0^{b}	2.0^{ab}
Cat's whiskers	3.2^{c}	3.5^{c}	3.0^{c}	3.0^{b}
Black jack	4.1^{d}	3.5^{c}	4.5^{d}	4.5^{c}
Rosalle	4.7e	5.0^{d}	4.5^{d}	4.5^{c}
F value	119.6***	71.3***	71.3***	23.8***

****= significant at 1%: Values with different superscripts are significantly different at 5%*

From the discussions with farmers, it was learnt that farmers preferred orphan crops that satisfied the following characteristics; were agro ecologically suitable in their area; were resilient to harsh climatic conditions such as dry spells and erratic rainfall; planting materials were locally available; farmers had indigenous knowledge and skills on field husbandry, processing and preparation for household consumption; and demand on local markets was available to enable farmers earn income.

3.2 The opportunities and challenges to scaling up orphan crops

The leaders and members of the groups were asked to indicate the opportunities and challenges to scaling up orphan crops in their communities. Table 4 below shows that the opportunities existing in communities were mainly related to availability of natural resources, farmer' indigenous knowledge, social capital and to a lesser extent existence of markets for some of the orphan crops.

The leaders and members of the groups indicated that land was available for cultivation of orphan crops. In addition, some of the orphan cops adapted well in intercropping systems. For example a field of maize was intercropped with pumpkin and okra. Wet lands ***(dimba)*** with adequate water also existed in communities. This would enable them to extend the season for orphan crops to dry periods when there are no rains by using irrigation. The farmers also expressed their vast indigenous knowledge on cultivation and utilisation of some of the orphan crops. They acquired this knowledge from their parents and were in the process of passing this knowledge to their children as well.

The members from Kasungu and Chikwawa indicated that some orphan crops especially sorghum were good for them since they are tolerant to drought or erratic rainfall. This means that they could grow these crops even if their areas experienced such climatic hazards. The members and leaders of the groups also recognised the roles that their farmer groups could play in working with orphan crops. They highlighted that their groups had already started producing some of the orphan crops such as sweet potato and finger millet. Through these groups farmers shared knowledge and experiences as well as planting materials for orphan crop production. The market opportunity was not common and was only perceived by farmers in Lilongwe. These farmers indicated that markets for orphan crops were available in their areas especially at Chigwirizano trading centre which is close to the city of Lilongwe.

Table 4: Opportunities perceived by farmers for promoting orphan crops

District	Opportunities
Kasungu	-Land is available
	-Indigenous knowledge on cultivating orphan crops
	-Tolerance of orphan crops to erratic rainfall
	-Water for irrigation is available
	-existence of farmer groups working with farmer groups
Lilongwe	-Markets available
	-Land is available
	-Water for irrigation is available
	- Indigenous knowledge on cultivating orphan crops
	-existence of farmer groups working with farmer groups

Chikhwawa	-Land is available
	- Indigenous knowledge on cultivating orphan crops
	-Water for irrigation is available -existence of farmer groups working with farmer groups

The results in table 5 below show that farmers perceived a number of challenges to scaling up orphan crops. These challenges were related to unavailability of adequate inputs and farm tools, lack of modern and technical knowledge and skills for managing orphan crops both in the field and post harvest stages as well as unavailability of markets.

In all the study areas the members of the farmer groups indicated that they had insufficient access to inputs such as seed for bambara nut and sweet potato; Pesticides for vegetables such as okra and amaranthus which are heavily attacked by both pests and diseases in the field; storage pesticides for grains like bambara which is attacked by weevils in storage ***(sitophilus spp.)***. They also lacked farm tools such as sprayers for spraying pesticides, watering canes as well as equipments such as treadle pumps for irrigation in winter season which is a dry season in Malawi.

The members also indicated that they had insufficient modern and technical knowledge and skills for improved husbandry of orphan crops such as plant spacing, nutrient management, pests and disease control. They also did not know how to store some of the orphan crops such as sweet potato for a longer period. Unavailability of reliable markets was another challenge highlighted by the farmers. The farmers explained that some orphan crops like okra are cultivated by almost every household in the rain season, and therefore reducing market demand within the community. At the same time some areas like Simulemeba in Kasungu district are very far (not less than 30km) from main markets and have poor transport infrastructures which make it difficult for farmers to access markets with high demand for orphan crops.

Table 5: Challenges perceived by farmers to promoting orphan crops

District	Challenges
Kasungu	-Insufficient access to improved seed especially for Bambara
	-Unavailability of reliable markets especially for Okra
	-Insufficient technical knowledge and skill to increase production
	-Field pests infesting on vegetables especially Amaranthus
	-Birds eating sorghum in the field
Lilongwe	-Field pests infesting on vegetables especially Amaranthus
	-Insufficient irrigation equipment for vegetable production in winter
	-Insufficient spraying equipment for pest control in vegetable fields
	-Insufficient knowledge on storage of Sweet potato

District	Challenges
	-Insufficient technical knowledge and skill to cultivate some orphan crops
	-Storage pests for Bambara
	-Insufficient access to seed for Sweet potato
	-Unavailability of reliable markets for crops like Pumpkins
Chikhwawa	-Field pests infesting on vegetables especially Amaranthus
	-Unavailability of reliable markets

4.0 Discussion

The findings of this study reveal that farmer preferences on orphan crops are site specific. These preferences are mainly based on the suitability of the orphan crop to the agro-ecological conditions of the site, how the crop would be utilised in terms of food and income generation as well as knowledge on husbandry of the crop. This calls for a crop diversification approach in the process of promoting orphan crops. No single crop can be effectively promoted across sites. It also calls for the need to actively involve famers in identification of target orphan crops in development projects that aim at promoting orphan crops. This opposes the practice of development practitioners who without farmer involvement introduce crops in a community under a project on the basis that the introduced crop has good traits and performed wonders elsewhere. The findings in this study further imply that for orphan crops to be successfully promoted at smallholder level there is need of utilising the indigenous knowledge that farmers have generated from their forefathers. However this has to be enriched by making available scientific knowledge to farmers, improving their access to inputs as well as linking them to reliable markets.

The findings also show that opportunities for scaling up orphan crops do exist in communities and that the farmers are aware of these opportunities. To a certain extent farmers are already utilising these opportunities. For example farmers are able to find land for cultivating orphan crops by integrating them into the existing intercropping systems. With this practice farmers do not always need to acquire extra land for production of orphan crops. The increasing intensity and occurrences of the impacts of climate change also provide an opportunity for scaling up orphan crops. Farmers will be opting for crops that are resilient to the impacts of climate change and most of these crops are orphan crops such as sorghum, millet and sweet potato. The increasing number of interventions aimed at promoting irrigation farming is also an opportunity to scaling up orphan crops. The results in this study reveal that even farmers now realise that irrigation is not only for mainstream crops such as maize, but also orphan crops such as okra and amaranthus. The increasing demand for indigenous food in growing urban areas is also another opportunity. This emanates from increasing health campaigns for consumption of indigenous food. There is a wide perception especially in urban areas that indigenous foods are less hazardous to health and can increase one's life span. Farmers have to therefore respond to this market demand by growing more of the orphan crops. The fact that the farmers are mobilised in groups is also another important opportunity. Through the farmer groups farmers would mobilise inputs for production of orphan crops, provide quality extension and market services, invest in processing and value

addition as well as advocate for orphan crops on national policy agenda. While these opportunities offer a window to scaling up orphan crops in Malawi, there is a need to facilitate farmers' capacity building so that they fully utilise these opportunities and enhance their livelihoods.

The study also reveals that even from the farmers' perspective, there are diverse and dynamic challenges in all the relevant stages of the orphan crops' value chain. As such no one solution is in a position to address the dynamic challenges to scaling up orphan crops. This calls for an integrated approach that incorporates all actors in the value chain of each orphan crop if orphan crops are to be promoted into the mainstream agriculture. At the same time, for such diverse challenges to be fully addressed, an innovation platform for orphan crops that include stakeholders such as farmer organisations, private sector, NGOs and public sector is unavoidable. This innovation platform would be involved in identifying and understanding the emerging challenges to promoting orphan crops; generating solutions for addressing the challenges; and experimenting and evaluation of the generated solutions.

5.0 Conclusion

This study finds that farmer preferences on orphan crops are diverse and site specific. Farmer preferences on orphan crops to cultivate are influenced by biological, physical and social economic factors such as suitability of the crop to the agro ecological zone; crop resilience to harsh climatic conditions such as dry spells and erratic rainfall; availability of inputs for the crop; existence of indigenous knowledge and skills on field husbandry and processing of the crop; and existence of demand on local markets for the crop. The diverse and site specific farmer preferences, entails that there is need to actively involve farmers in the process of indentifying orphan crops to be targeted in any research and development intervention. In this participative process of identifying target orphan crops, attention should be paid to existing biological, physical and social economic factors that influence farmers preferences on orphan crops.

The study also finds that farmers are aware of the existing opportunities for scaling up orphan crops in their communities. Such opportunities are related to availability of natural resources, farmer' indigenous knowledge, social capital and to a lesser extent existence of markets for some of the orphan crops. Despite their awareness on existing opportunities, farmers lack capacity to fully utilise these opportunities for enhancement of their livelihoods. This calls for facilitating capacity building of farmers especially the farmer groups to enable them efficiently utilise the existing opportunities.

From the farmers' perspective, scaling up of orphan crops into the mainstream agriculture is hindered by diverse and dynamic challenges existing in all the stages of the orphan crops' value chain. These challenges are related to unavailability of adequate inputs and farm tools, lack of pre and post harvest modern and technical knowledge and skills for handling orphan crops as well as unavailability of reliable markets. Setting up local innovation platforms that should be addressing these diverse and dynamic challenges is an essential step to scaling up orphan crops. Such an innovation platform should embrace a holistic and integrated approach to problem identification, experimentation and evaluation of solutions for addressing challenges. Further, it should be comprised of multidisciplinary stakeholders including farmer organisations, NGOs, private and public sectors.

References

Abell, P. (2006). ***Organisation Theory: An Interdisciplinary Approach.*** London: London School of Economics and Political Sciences.

Ahmed, A. U., Vargas, R. H., Smith, L. C., Wiesmann, D. M., & Frankenberger, T. (2007). ***The World's most Deprived:Characteristics and Causes of Extreme Poverty and Hunger.*** International Food Policy Research institute.

CAADP. (2010). ***COMESA Regional CAADP Compact.*** Pretoria: FANRPAN.

Casley, D. J., & Kumar, K. (1988). ***The Collection, Analysis, and Use of Monitoring and Evaluation Data.*** London: John Hopkins University Press.

Coleman, J. S. (1988). Social Capital in the Creation of Human Capital. ***The American Journal of Sociology, Vol. 94,***, 95-120.

Collion, M., & Rondot, P. (1999). Agricultural Producer Organisations: Their Contribution to Rural Capacity Building and Poverty Reduction. ***Summary of a workshop*** (pp. 951-970). Washington DC: Rural Development Department, World Bank.

Cragan, J. F., & Wright, D. W. (1986). ***Communication in Small Groups Discussions .*** USA: West Publishing Company.

Duncan, D. B. (1955). ***Multiple Range and Multiple F Tests***. Biometrics, 11, 1-42.

Edriss, A. K. (2001). ***A Passport to Research Methods: Manual.*** Lilongwe: University of Malawi.

Government of Malawi [GoM]. (2006). ***Farmer Organisation Development Guidelines.*** Lilongwe: Ministry of Agriculture and Food Security.

GoM. (2009). ***Project Indicator Manual: Impact and Output Indicators for Agriculture, Food Security, Nutrition, Natural Resources and Fisheries/Aquaculture Projects/Programmes in Malawi.*** Government of Malawi.

Handy, C. (1999). ***Understanding Organizations.*** Pengiun Books.

International Development Research Centre [IDRC]. (2009). ***MakingAgri-Food Systems Work for the Rural Poor in Eastern and Southern Africa: A Proposal Submitted to the Rural Poverty and Environment Programme Innitiative.*** Nairobi.

INTRAC. (1999). ***NGO Management.*** London: University of London.

Korten, D. C. (1980). Community Organisations and Rural Development. ***Public Administration Review*** , 480-511.

Leech, N. L., & Onwuegbuzie, A. J. (2007). An Array of Qualitative Data Analysis Tools:A Call for Data Analysis Triangulation. ***School Psychology Quarterly, Vol. 22, No. 4*** , 557–584.

Naylor, R., & Manning, R. (2005). Unleashing the Genius of the Genome to Feed the Developing World. ***Proceedings of the American Philosophical Society VOL. 149, NO. 4,***, (pp. 515-528).

Nyariki, D., Sanginga, P., Yemshaw, Y., & Kakuru, W. (2010). Policy and Governance in Natural Resources Management. In W. Ochola, P. Sanginga, & I. Bekalo, ***Managing Natural Resources for Development in Africa: A Resource Book*** (pp. 391-448). Nairobi: University of Nairobi Press.

Ostrom, E. (1990). ***Governing the Commons: The evolution of Institutions for Collective Action.*** Cambridge: Cambrdge University Press.

Putnam (1995). Making Democracy Work: Bowling alone: America' Declining Social Capital. Journal of Democracy. Vol. 6-1.

Shiferaw, B., Obare, G., & Muricho, G. (2009). Leveraging Institutions for Collective Action to Improve Markets for Smallholder Producers in Less-Favored Areas. ***Afjare Vol 3 No 1*** .

Shiferaw, B., Obare, G., & Muricho, G. (2006). Rural Institutions and Producer Organizations in Imperfect Markets: Experiences from Producer Marketing Groups in Semi-Arid Eastern Kenya. ***Research Workshop on Collective Action and Market Access for Smallholders.*** Cali, Colombia: Collective Action and Property Rights (CAPRI).

Shiferaw, B., Obare, G., & Muricho, G. (2008). Rural Markets Imperfections and the Role of Institutions in Collective Action to Improve Markets for the Poor. ***Natural Resources Forum 32 (1)*** , 25-38.

Stockbridge, M., Dorward, A., & Kydd, J. (2003, june 12). Farmer Organisations for Market Access. ***Briefing Paper*** .

Stockbridge, M., Dorward, A., Kydd, J., Morrison, J., & Poole, N. (2003). ***Farmer Organisations for Market Access; Issues from a Literature Review on Global Experience and Theoretical analysis.*** London: Department of Agricultural Sciences, Imperial College.

Stringfellow, R., Coulter, J., Lucey, T., Mckone, C., & Hussain, A. (1997). ***Improving the Access of Smallholder to Agricultural Services in Sub-Saharan Africa: Farmer cooperation and the Role of Donor Community.*** London: Natural Resources Perspective 20 ODI.

Tadele, Z. (2009). ***Role of Orphan Crops in Enhancing and Diversifying Food Production in Africa.*** http://www.atdforum.org/journal/html.

Von Braun, J., & Pandya-Lorch, R. (2007). ***Taking Action for World's Poor and Hungry People.*** International Food Policy Research Institute.

World Bank. (2008). World Development Report: Agriculture for Development. Washington,D.C: World Bank.

Yin, R. (2003). ***Case Study Research Design: Design and Methods.*** USA: SAGE Publications.

Coping mechanisms and adaptation strategies to food insecurity among small scale rural farmers in Uganda

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Abstract

Reducing food insecurity in Sub-Saharan Africa can be done through increasing agricultural productivity of smallholder farmers and creating rural off-farm employment opportunities. The Agri-food systems project was part of such interventions and was implemented in Tororo, Ntungamo and Mukono. Project baseline results that involved sample survey questionnaires with 360 farmers and FGDs with up to 14 participants indicated that only 44.4% of the respondents had enough to eat but not always the kinds of food they wanted. Food insecurity was as a result of inadequate land holdings, declining soil productivity, climate change effects, big family sizes, continued use of old faming technologies as well as the effects of pests and diseases. To enhance food security, some farmers applied recommended soil and water management practices, such as crop rotation and mulching. Growing quick maturing crops and selling house hold assets to buy food were some adaptation strategies used. In order to enhance their adaptive capacities, some farmers were trained on the application of improved agricultural technologies, household food security.

Key words: Food insecurity, coping mechanisms, adaptation strategies, rural farmers, interventions

Introduction

For too long the face of Sub-Saharan Africa has been one of dehumanizing hunger. More than one in four Africans is undernourished, and food insecurity is pervasive yet Sub-Saharan Africa has ample agricultural land, plenty of water and a generally favourable climate for growing food (UNDP, 2012). The causes of chronic food

insecurity include: poverty, insufficient access to health and education services, as well as poor governance, environmental damage, climate change and the mismanagement of natural resources (EC, 2009).

In Uganda the proportion of the population that is food insecure reduced from 83 percent in 1992/93 to 59 percent by 1999/2000, before rising back to 63 percent and 66 percent in 2002/03 and 2005/06 (UBOS, 2007). It is argued that more productive agriculture will build food security by increasing food availability and lowering food prices, improving incomes and improving access. (DSIP, 2010)

In order to contribute to reducing food insecurity, the Agri-food systems project was implemented in three districts of Ntungamo, Tororo and Mukono. The overall goal of this project was to stimulate the adaptation of pro-poor Agri-food systems innovations as a contribution to improving food security, incomes and sustainable natural resource management in Uganda. The project focused on "orphan crops" or "minor crops" which are believed to be locally important for food and household nutrition, and provide income opportunities for the most vulnerable and women in particular. This was because most food security interventions tend to focus on promoting technologies for a limited number of major crops.

Materials and methods

Sample survey questionnaires were enlisted with a total of 360 respondents (50.5% males and 49.5% females). Clustered sample survey, where three clusters, namely Tororo, Mukono and Ntungamo districts were used to represent the food insecure, moderately food insecure and food secure districts of Uganda was used. A combination of purposive and random sampling techniques were used, whereby the 3 districts, 9 sub-counties and 18 parishes were chosen purposively for the survey while the respondents were randomly selected except for the female respondents. In addition, Focus Group Discussions (FGDs) were also carried out with up to 14 farmers including females in each project sub county. The FGD results helped to elucidate some of the quantitative data results. Quantitative data was entered into Statistical Package for Social Scientists (SPSS) where frequencies, percentages and means were generated. Some of the generated data was input into EXCEL where graphs were generated. Content analysis was used in qualitative data analysis.

Results and discussions

Status of food security

The food security status of the respondents was examined with respect to food availability, utilization and access.

Food availability

Availability was analysed in terms of sufficiency of quantities of food for a household. Respondents were given four statements and asked to select what best described the food eaten in their households in the last 12 months and results are summarized in table 1. Overall, most respondents in Mukono (56.9%) and Ntungamo (52.5%) indicated that although they had food most times, it was not always the kinds of food that they wanted to eat. Tororo respondents were worse off as 60.5% reported that they sometimes did not have enough to eat. The most common reason why some respondents did not always have enough to eat

was that the harvests were too little to last the season (75.0%), followed by insufficient money to buy food from the market (20.8%).

Food Access

This involves stable markets, affordable prices for local populations, decent incomes and adequate purchasing power, thus enabling households to cover their food needs (EC, 2009).

Respondents were asked to respond to food access statements that based described their food situation and results are summarized in table 2. Overall, over 54% of the respondents indicated that their household's sometimes lacked enough money to buy the necessary food items and sometimes relied on low cost food items. According to AHDR (2012), although the poorest households in Sub-Saharan Africa spend 54%-90% of their income on food, the cost of an adequate diet exceeds the household income.

Food utilization

This involves supplying an adequate and balanced diet in a way that satisfies the physiological needs (nutrition) of populations and enables people to lead healthy and active lives (EC, 2009).

In order to get some indications of the diversity in their diet, respondents were asked to recall if they or someone in their households consumed the different types of food the previous day or night. The results of the main foods eaten are summarized in table 3. Overall, the foods consumed by the majority included grains, roots, tubers and vegetables. The least consumed foods were eggs, meats, fish and vitamin A-rich fruits. This implies that they did not balance their diets which could result into malnutrition which according to AHDR (2012) is an obstacle to human development and may cause irreversible damages on individuals.

Causes of food insecurity

FGDs gave the following as the causes of food insecurity: (a) Inadequate land and inappropriate rights over land, (b) use of poor farming methods (c) laziness, especially among the youth and men (d) crop and livestock pests and diseases (e) effects of climate change (g) selling off all or most household produce and (i) high prices of food stuffs in the local shops/markets. It is important that interventions aim at addressing some of these challenges in order to enhance food security. The National Development Plan for Uganda recognises some of the above causes and indicates that efforts will be made to address them (NDP, 2010).

Groups of people who were prone to food insecurity

FGDs revealed the following as the groups that were more prone to food insecurity in the project areas: (a) The poor (b) the youth due to laziness (c) the elderly because they were less energetic (d) people with big families with majority being elderly, children and youth (e) the sick and (f) people living with disabilities.

Coping and adaptation strategies to food insecurity

seeking extension services: In order to improve production, most respondents, that is, 78.1% and 61.2% for crops and livestock respectively sought extension services. Figure 1 shows that extension services were

mainly provided in areas of: mulching, crop rotation, minimum tillage and terracing whereas fig 2 shows that areas where they received extension were the ones which were most carried out. Failure to apply after seeking the services was due to inability to afford (28.7%), recommendations not being new (19.4%) and lack of interest (18.5%). NDP (2010) indicates that improving extension services leads to better production and will be a major focus under Uganda's National Development Plan for 2010/11-2014/205.

Livestock diversification: In order to widen incomes and enhance food access, most respondents (82.8%) kept some livestock which were mainly cattle, chicken, goats and pigs. The other advantage of keeping livestock was that their wastes were used as manure. NDP, (2010) attributes failures in sustaining soil productivity partly to the high cost and limited availability fertilizers so the use livestock manure helped to provide a cheap source. The use of such household-made manure helped to reduce expenses that would have otherwise been spent on buying manure/fertilizers. Such savings would cater for food items among other things.

Alternative employment: alternative employment mainly in formal, informal and off-farm helped to generate incomes to buy food. The main activities were farm laboring (21%), trading farm produce (15.4%), formal salary earning (9.2%) and wage earning (8.7%). Other activities were: brewing, brick making, tailoring and construction among others. It was however noted that involvement in alternative employment was minimal as it was practiced by less than 30% of the respondents.

Utilising benefits from group membership: Belonging to groups also helped to downplay food insecurity. Generally, over 70% of the respondents belonged to groups. A series of food security programmes including the National Agriculture Advisory Services (NAADS) which provided seeds and agriculture trainings made interventions through groups which forced many to join. Over 90% of the respondents who belonged to groups indicated that the organizations were active. FGDs also revealed that belonging to groups helped to fight food insecurity through sharing knowledge (both new and indigenous) and acquisition of skills that helped them boost agricultural productivity. They also indicated that group members sometimes pooled labour and helped to solve the problem of labour shortages. Some group members who sold their produce in bulk had the advantage of having better bargaining power that would result into better prices and incomes which they would use to buy other food items. Belonging to groups has been indicated to offer a cost-effective vehicle for service delivery (Heather and Ann, 2001).

Management of seed sources*:* One of the ways of ensuring food security was to ensure that one does not miss out on every planting season. In order to fulfil this, farmers had to ensure that they had seed. To preserve seed for the season, FGDs revealed that the following were done: selecting good quality seed from previous harvest and hanging it either in the roof or at the fire place in order to protect from pests or keeping seed normally in sacks but periodically displaying it on the sun especially every fort night to reduce the moisture content. The other methods revealed through FGDs were mixing seeds with goat's droppings, Lantana camara and ash as preservatives. For vegetative propagated crops like cassava and sweet potatoes, small portion gardens would be maintained for purposes of getting planting materials. It was however indicated

that over 75% of the farmers had not adopted the use of improved seeds. This was partly contributed to failure to combat food insecurity. FGDs also revealed that some farmers who did not want to go through huddles of preserving seed for the next season and who were interested in growing improved seeds opted to sell and keep the money for buying seed when the season started.

Coping and adapting to climate change effects: Farmers indicated through FGDs that since the formerly known seasonal patterns had changed, they also had changed their way of operating for example: waiting and therefore planting only when there was rain or planting in anticipation of rain after receiving weather forecast information mainly on radio. The National Development Plan for Uganda has plans of automating the meteorological instruments in order to enhance the predictability of the weather and climate parameters and increase reliability of forecasts (NDP, 2010). The FGDs also revealed that due to prevalence of more prolonged droughts, some farmers had switched to growing more of drought resistant and quick maturing crops which also they planted in variety in order to spread risks. Planting fruit trees to regulate the climate but also provide fruits was another practice.

Interventions

Based on some of the above research findings, the project made interventions by training 225 farmers in areas of: Crop production with the aim of improving production and food security with the aim of enhancing the understanding of food security dynamics. Others trainings held were: farmer group management with the aim of improving group benefits that can promote food security and orphan crop marketing with the aim of enhancing market access. Training notes for all the trainings were given to farmers in form of bronchures in local languages and english for those who were able to read it for referrence. In addtion, 225 farmers were also supplied with at least two or more varieties of improved seed varieties as a way of enahcning multiplication, adoption and uptake. It is expected that the trainings provided coupled with the varieties of seed provided will help to improve production and marketing but above all improve the food security situation.

Acknowledgements

The Research Team would like to thank National Agriculture Research Organisation (NARO) and National Fisheries Resources Research Institute (NaFIRRI) for the support provided during implementation of the survey. Thanks go to International Development Research Centre (IDRC) for the project financial support and the Tororo, Ntungamo and Mukono District staff who supported the project in different ways.

References

Africa Human Development Report (AHDR). Development Nutrition Policies for a Food Secure Future. 2012.

Agriculture Sector Development Strategy and Investment Plan (DSIP) for 2010/11-2014/15. Ministry of Agriculture, animal Industry and Fisheries. 2010.

Donald R. Nelson. Adaptation and resilience: responding to a changing climate. 2011.

European Commission (EC). Food security: Understanding and meeting the challenge of poverty. 2009.

Heather Kindness and Ann Gordon. Agricultural Marketing in Developing Countries: The Role of NGOs and CBOs. The University of Greenwich, Natural Resources Institute. 2001.

Mark Davies, Bruce Guenther, Jennifer Leavy, Tom Mitchell and Thomas Tanner. Climate Change Adaptation, Disaster Risk Reduction and Social Protection: Complementary Roles in Agriculture and Rural Growth? Centre for Social Protection and Climate Change and Development Centre . 2009; IDS working paper 320

National Development Plan (NDP) policy document Ministry of Finance Planning and Economic Development. 2010.

Uganda Bureau of Statistics (UBOS) .Statistical Abstracts. 2012.

Tables

Table 1: Statements that describe the food eaten in the households in the last one year

	Mukono	Tororo	Ntungamo	All
We always have enough to eat and the kinds of food we want	27.7%	15.1%	4.2%	16.1%
We have enough to eat but not always the kinds of food we want	56.9%	22.7%	52.5%	44.4%
Sometimes we don't have enough to eat	12.3%	60.5%	36.4%	35.7%
Often we don't have enough to eat	3.1%	1.7%	6.8%	3.8%

Table 2: Responses to food situation statements

Statement	Often true	Sometimes true	Never true
"I am worried whether our food would run out before we got money to buy more."	19.4%	60.7%	19.9%
"The food that we bought just didn't last, and we didn't have money to get more."	17.5%	54.3%	28.3%
"We couldn't afford to eat balanced meals."	22.4%	63.2%	14.4%
"We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food."	17.8%	59.3%	22.8%
We couldn't feed the children a balanced meal because we couldn't afford that."	19.6%	61.7%	18.7%
"The children were not eating enough because we just couldn't afford enough food."	14.3%	56.9%	28.9%

Table 3: Types of foods that respondent/anyone else in household ate the previous day or night

Food types	No one	Someone
Millet, sorghum, maize, rice, wheat, or any other locally available grain	29.6%	70.4%
Pumpkin, carrots, sweet potatoes that are yellow or orange inside	52.0%	48.0%
White potatoes, white yams, cassava or any other foods made from roots or tubers	42.3%	57.7%
Dark, green, leafy vegetables such as cassava leaves, bean leaves, spinach, pepper leaves and amaranth leaves	47.6%	52.4%
Ripe mangoes, ripe pawpaws or any other locally available vitamin A-rich fruits	72.2%	27.8%
Beef, pork, lamb, goat, rabbit, chicken, duck, or other birds, liver, kidney, heart, or other organ meats	77.3%	22.7%
Eggs	86.5%	13.5%
Fresh or dried fish or shellfish	72.9%	27.1%
Foods made from beans, peas, or lentils	45.2%	54.8%
Cheese, yogurt, milk or other milk products	62.4%	37.6%
Foods made with oil, fat, or butter	63.0%	37.0%

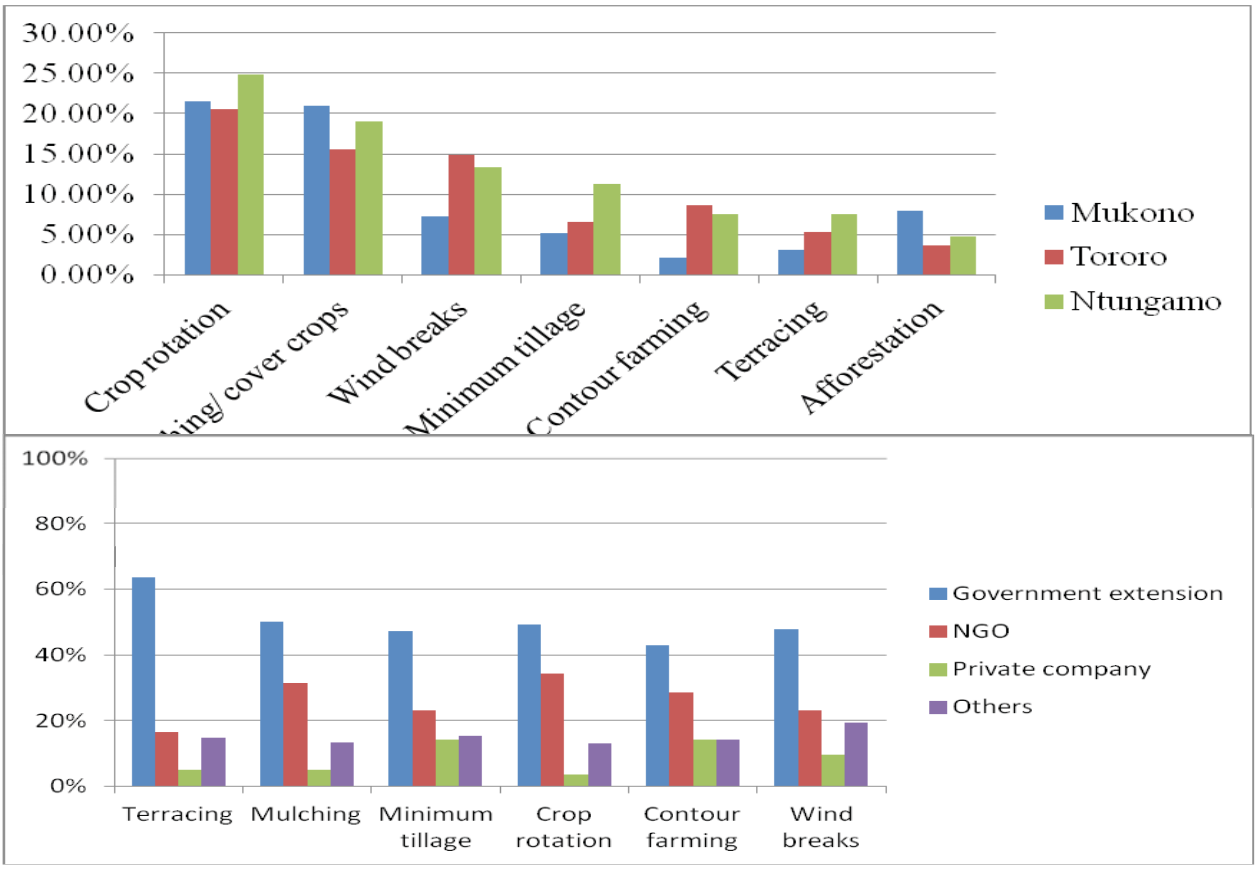

Figure 2: Main recommendations received from the agencies in the last one year

Making agricultural systems work for the rural poor

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Abstract

The work upon which this paper is based aimed at identifying the major drivers and dynamics that make the farming systems work for the smallholder rural poor farmers in Malawi. The smallholder farming sector in Malawi and developing countries, especially in sub-Sahara region are characterized by high poverty and high population. The sector account for over 70 percent of national populations and it contributes about 80 percent to the total agricultural production.

Using the agri-food systems framework, the paper synthesizes the data gathered by the IDRC funded Agri-Food Systems Project and the McKnight Foundation funded Scaling Project implemented by Bunda College of Agriculture in Malawi to identify the drivers and dynamics of the agricultural food systems. The results show that smallholder farming systems consist of a variety of technologies, which are based on farmers' local practices and knowledge. Farmers combine the local knowledge and practices with modern technologies as a response to inadequate inputs. But these systems do not operate to their potential. Generally, the smallholder farming system lacks services such as extension, research and markets.

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It is concluded that it is the combination of modern and local knowledge and practices that drives smallholder farming systems. One cannot therefore 'box' smallholder farmers into either modern or local knowledge or practices, a typical case of "no knowledge is above the other". Holding this conclusion as true, it is argued that smallholder agricultural systems will only work for the poor if they are built on a 'combined technologies approach' as practiced by the farmers. Any support in form of markets, extension and research would make the systems operate to their potential.

Key words: Smallholder farming systems, 'combined technology', agricultural productivity

Background

Agricultural productivity in the eastern and southern Africa region is impaired by declining soil fertility, degradation of natural resources, inefficient markets and weak institutions and policies. This decline is mostly manifested in deteriorating food security situation. Crucial in addressing this situation is the agricultural productivity of the rural poor in the smallholder farming system as they constitutes the larger population and play a significant role in the agriculture sector. The rural poor in Malawi and most developing countries are characterized by high poverty and high population. The farmers account for over 70 percent of national populations. They contribute over 80 percent of total agricultural production. Most of the agricultural work is done by women as they provide over 70 percent of the labour force.

Despite this significant role the rural poor are poor and vulnerable and they mostly rely on safety nets. A major reason for this status is that food security research and extension rarely reaches these poor farmers with technologies and practices that would improve productivity of their farming system.

In an effort to stimulate the adaptation of pro-poor agricultural food systems innovations two projects have been implemented by Bunda College of Agriculture in Malawi from 2008 to 2012. One project was funded by the IDRC and it was titled Agri-Food Systems and the other one was funded by the McKnight Foundation and it was titled Scaling Project. Some specific objectives of these projects included: (1) to identify and promote local innovations and adaptation strategies that work for the poor rural men and women to cope with food security vulnerabilities; and (2) to adapt and scale up sustainable innovations for promoting orphan or traditional high value crops that enhance food security, increased incomes and ecosystem integrity in selected areas.

Methodology

The projects upon which this paper is based adopted an agri-food system framework (Figure 1) to examine the inter-linkages between productivity, farmer practices, efficient markets and policies and their long- and short-term developmental impacts. Agri-food systems refers to the network of economic and non-economic actors, and the linkages amongst these actors that enable technological, organizational and social learning of the kind needed to devise agriculture context specific solutions (UNCTAD, 2010).

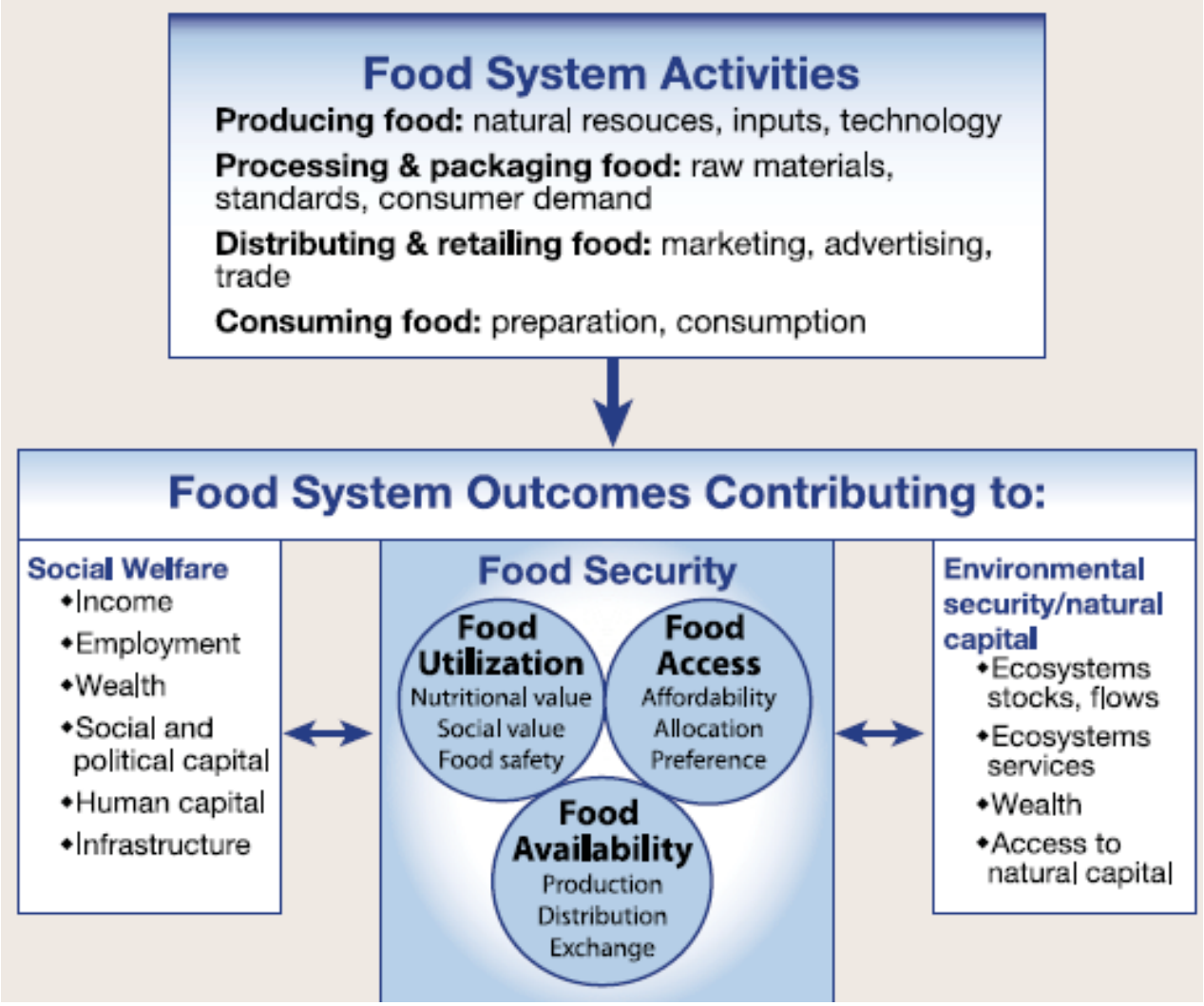

Figure 1: Agri-food systems framework. Adapted from GECAFS (2006)

Through repeated cycles of action research, the projects facilitated farmer experimentation to test, adapt and scale up a range of technologies and innovations for improving agricultural productivity and marketability of orphan or minor crops. These crops have the potential to enhance food security, promote nutrition

security, provide income opportunities and diversify farming systems to become more resilient to climatic vulnerabilities.

The projects were implemented by a multi-disciplinary team of researchers and development professionals in selected sites of Chikhwawa, Lilongwe and Kasungu in Malawi. The sites were selected based on food security situation, agricultural potential and vulnerability level. Lilongwe represented food secure areas, while Kasungu was considered to be border line food insecure and Chikhwawa represented areas with acute food shortage and livelihood crisis.

A variety of methods such as observations, questionnaire surveys as well as focus group discussions and key informant interviews were used to collect the data on the drivers and dynamics of the smallholder farming systems in the project sites. An extensive literature search was also used to understand the drivers and dynamics.

Results

Agricultural production in Malawi

A review of existing literature shows that agriculture remains important to Malawi's economy, accounting for over 35% of national income, 80% of the labour force and 80% of export earnings (GoM, 2011). Within the recent past the country has experienced surplus maize production and food security. Generally, millions of Malawians have been lifted out of poverty and the children described as underweight has fallen from 24.4 to 15.5% (van Gresmer, ***et al.***, 2009). This impressive production is in part due to good rains over most seasons, although some areas such as the lower Shire and some districts in the Southern and Northern Regions experience early cessation of rains. Some areas have also experienced highly intensive rain showers which have affected crops in the field.

Besides weather related factors, Government policies have played a major role in Malawi's shift from a 'maize consuming, importing country' to a 'producing, exporting one'. The Malawi Growth and Development Strategy (GoM, 2011) and the Agricultural Sector Wide Approach (GoM, 2011) both target agriculture as the driver of economic growth and poverty alleviation. The Agricultural Development Program also guides development activities and investment programs in the agricultural sector (GoM, 2008). All the policies aim at food security and food self-sufficiency which is deemed to be achieved by increasing maize productivity, reducing post-harvest loses, diversifying food production and managing risks through national food reserves.

A program supported by policies and politicians is the national agricultural farm input subsidy program (FISP) by the Malawi Government. This program has overshadowed other agricultural sector policies and it has caught the attention of policy-markers and donors at home and abroad. The program has increased access by smallholders to purchase inputs to increase incomes and achieve self-food sufficiency. Generally, the program has increased availability of inorganic fertilizers, hybrid and OPV maize seed to smallholder farmers. Undoubtedly, the subsidy program has made huge contribution to agricultural production harvest over the years. Targeted at small-scale farmers, the program has resulted in increase in maize production from 1.2 million metric tonnes in 2004/05 up to 3.4 million metric tonnes in 2009/10 (GoM, 2011).

Whilst the agricultural input subsidy program has undoubtedly made great contribution to the overall food security in Malawi, it presents considerable economic, social and environmental sustainability challenges for police-makers. The financial cost of the FISP is now over 40 billion Kwacha due to price hikes and program expansion. The program actually takes more than two thirds of the agricultural budget allocation. Since the Government is heavily aid-dependent the FISP relies heavily on the donor support, which is subject heavily to policy shifts.

Dualism in the smallholder farming system

The situation described above is an example of typical situation where government is 'boxing' farmers into technologies such as hybrids and chemical fertilizers. As expected only few farmers who can afford or access these technologies participate in this farming system. But literature on agricultural systems in Malawi indicates that the agriculture sector is divided into commercial and smallholder sectors. With this picture both sectors are treated as homogeneous. While this might be true for commercial sector, it may not apply to the smallholder sector, which is heterogeneous and dualistic. The smallholder farming system is dualistic in the sense that on the one hand there are those farmers who have access while on the other hand there are those who do not have access to modern technologies.

This dualism has to be recognized in order to avoid boxing farmers into technologies that are beyond their reach. In other words, failure to appreciate dualism has made researchers, development practitioners and extensionists unable to come up with a menu of technologies from which farmers can choose according to their capacity and capability. Such is the case in Malawi where the majority of farmers (about 60 percent) in the smallholder sector is poor and incapable to use modern technologies such as chemical fertilizer and hybrid seed unless it is subsidized. These farmers live in remote areas. Researchers find it difficult to reach these areas. Development programs easily justify projects but rarely work in these areas. Agricultural production in these areas is highly diversified with local livestock breeds and underutilized or neglected or orphan crops such as millet, sorghum. Some crops and livestock are mostly said to be for women due to cultural position and also the fact that crops are considered "low value or less important".

Drivers of the smallholder farming systems

Despite poor access to modern technologies life still continues for the rural poor. This section presents living experiences on how the rural poor run agriculture using their own practices and knowledge. As indicated earlier, these practices are a response to situations when farmer do not have access to chemical fertilizers and hybrid seeds or when inputs are inadequate. These practices define the type of farming system that would work for the rural poor in Malawi, here called the 'combined technology'.

The first case of a 'combined technology' comes from an observation that in the smallholder farming systems the rural poor indulge in integrated soil fertility management and practices (ISFM). An integrated soil fertility management is a set of soil fertility management practices that include the use of fertilizer, organic inputs and improved germplasm combined with the knowledge of how to adapt these practices to local conditions, aiming at optimizing agronomic use efficiency of applied nutrients and improving crop productivity (Fairhurst *et al.*, 2013). The ISFM practice is common among the rural poor farmers in Kasungu and Lilongwe. Farmers mix 20kgs of compost manure with 20kgs of cattle or chicken manure and 5kgs of chemical fertilizer (Urea)

and apply this as basal dressing and top dressing on a 400 square meters plot.

Five farmers who followed the ISFM practice in 2012/13 season indicated that they harvested between 3 and 5 50kg bags of maize, which is equivalent to 150 to 250kgs. This harvest was much higher compared to less than 1 50kg bag they would have harvested if they had not mix the inputs. In Karonga one farmer mixed 5 kg of Urea fertilizer with 20 kg of maize bran and 20 kg of bokash manure and applied to a 100 square meters plot and harvested 3 by 50kg bags of maize (Kambewa, 24th June, 2013, personal communication).

The farmers reported that they mixed compost and livestock manure together with Urea fertilizer because they did not receive adequate fertilizer under the subsidy program. In fact one bag of fertilizer under the subsidy program was being shared among 2 or 3 farmers. Sharing is common as it is a solution to situations when there is inadequate fertilizer. The farmers share because they feel it is not good for members of the same village to have fertilizer when others do not have anything. After sharing, the little fertilizer available is not enough to cover a larger area, hence mixing the inputs is the only way to spread the fertilizer on a larger area.

Besides combining chemical fertilizer and manure, farmers are aware of the need to enrich soils with combine organic soil fertility measures, including manures and compost, biomass transfers and green manures. In Kasungu, farmers opt for basal micro-dosing with compost, incorporating groundnuts residues, planting legumes, using chemical fertilizer as a top dressing (Wellard and Kambewa, 2009). In Kenya and Malawi research has shown that adequate soil organic matter can improve the efficiency of fertilizer from 20 kg of grain per kg of nitrogen fertilizer applied to double or triple this response (Place ***et. al***., 2003).

Research has also shown that specific multipurpose legumes such as pigeon peas offer the opportunity to improve both soil fertility and family nutrition, and have been widely adopted in the Southern region of Malawi. Learning from the farmers that have adopted multipurpose legumes a 'double up grain legume technology' has been developed and tried by farmers in Kasungu and Mzimba districts in Malawi. The technology involves rotating maize with a 'double up grain legume' system, where pigeon peas are intercropped with groundnuts or soyabeans in year one. In year two, maize is grown and benefits from the dual legumes residues that have been incorporated (Snapp ***et al***., 2002). This technology has been tried and Table 1 shows results of a doubled up legume and continuous fertilized maize trial in five villages in Kasungu.

Table 1: Maize grain yield (Kgs) following legume systems in five villages, Mkanakhoti EPA. Kasungu

Treatment	Chaguma	Chisazima	Kaunda	Ndaya	Tchezo
Maize + 0N	1490	690	965	953	877
Maize + Urea	2236	1190	1710	1393	1622
PP + GN	2246	1201	1721	1708	1633
PP + SB	2143	1097	1617	2176	1529

Key; pp= pigeon pea, GN= groundnuts, SB= soya bean

Source:Kanyama-Phiri et al., (2013)

The results show that there were no significant differences in maize yield following doubled up legumes and continuous fertilized maize (+46 N ha^{-1}). The average yield was 1.5 ton ha^{-1}. This yield might be lower due the sporadic rains in the areas that might have affected availability of N to plant as there was not enough moisture to make the applied nitrogen available for plant use. Yield of unfertilized maize averaged 0.85 ton ha^{-1}, much lower than in doubled up legumes.

The second case of a 'combined technology' comes from an observation that the smallholder farming system is highly agro- bio diversified. Agro- bio diversity refers to the variety and variability of animals, plants and micro-organisms used directly or indirectly for food and agriculture (FAO, 1999). This is the case with the smallholder farming systems where cropping systems enable farmers continue to grow a variety of local crops in form of mixed cropping and keep a variety of local livestock as the case of mixed farming despite these crops and livestock registering lower production compared to hybrids and the improved ones. These local crops are now referred to as orphan crops because they do not receive attention from policy, research and extension such that their potentials are not known (Tchuwa 2012). Some of the notable orphan crops include millet, sorghum, Bambara nuts and most indigenous vegetables.

The reasons why farmers diversify are vast and they include unaffordability of hybrid seed, local preferences, resilience to climatic variability, good storage characteristics and easy to recycle (Tchale, 2011). However, this diversity is getting eroded as research, development programs and extension services tend to encourage farmers to specialize in hybrids and improved livestock. The evidence on this is the proliferation of technologies that encourage mono cropping such as the Sasakawa planting method instead of mixed cropping. There is also a growing presence of sole farming systems. Already seeds for most of local crops such as local sweet potatoes are becoming scarce. If the erosion is left unchecked it might create more hunger in the smallholder farming system as the important characteristics such as resilience to climatic variability, good storage characteristics and recyclability get lost.

Discussion

It appears what is working for the rural poor is the 'combined technology', thus a combination of approaches and a combination of technologies. The combination of technologies exploits the advantages and overcome the constraints of both the one that is technologically fixed and the one that is diverse. However, the 'combined technology' has not received the attention it deserves from the development programs such as FISP, research and extension agendas. These agendas focus on either increasing availability and use and accessibility of inorganic fertilizers or organic or sustainable agriculture technologies. As it is, these programs and agendas tend to box farmers into one approach where they have to use chemical fertilizer or not. They have to use improved seeds or not. They have to use organic or sustainable agriculture technologies or not. Contrary to these programs and agendas farmers obtain economic returns from chemical fertilizer and improved seeds if combined with organic matter improving technologies, such as grain legume rotation, compost and green manures.

Elements of 'combined technology' are already being practiced in the smallholder farming system. But a

successful 'combined technology' requires more support from research and extension to generate and disseminate knowledge on those technologies and practices that work and improve those that seem not to work to help them do it better. Policy and political will also need to be revisited. For example, instead of putting all the money into the FISP to buy fertilizer and improved seed for smallholder farmers, some of the budget would be used to support research and extension on technologies that are necessary to have a meaningful 'combined technology model'. Some important issues and challenges to be considered in the 'combined technology' approach include the following:

1. How to increase crop response to inorganic fertilizer. For example crop diversification that improves soil structure and biological fertility of the soil, micro-dosing, residue and compost management.

2. Making biological soil fertility options as well as orphan crops more attractive to smallholder farmers. For example, through composting in-field, multipurpose legumes, output markets for improved grain legume and orphan crops.

3. Providing a range of biological and inorganic fertilizer options, together with ways of adapting these to individual farm situation. For example, large scale on –farm testing of technology, provision of extension materials.

4. Increasing nutrition of the poor people and vulnerable groups at the same time increasing soil fertility and overall food availability. For example, through double-legume technologies, recipe testing and nutrition groups.

5. Increasing resilience of smallholder farmers to external shocks such as climate variability through knowledge enhancement and promoting crop diversification systems.

6. Developing markets for orphan crops through value chain and market studies.

7. With farmers, testing, adapting and developing husbandry practices for orphan crops through agronomic trials and entomological studies.

Conclusion

In conclusion Malawi has made advances in food security in times of good and favourable climatic conditions and the FISP. However, "there is no one shoe that fits all", hence not all farmers should be considered worthy the FISP. Elements of 'combined technology' are already being practiced in the smallholder farming system. Adoption of technologies to sustain the 'combined technology' approach is low. This requires prioritization of research, extension and development programs towards a 'combined technology' model as this is an alternative to make smallholder farming system to be more self-reliant for the poor.

References

FAO (1999). Women: Users, preservers and managers of agro-biodiversity. (www.fao.org/FOCUS/E/Women/Biodiv-e.htm).

George Kanyama-Phiri., Sieglinde Snapp., Wezi Mhango., Annily Msukwa., Lizzie Shumba., Brian Kunkwezu., Joseph Kalasa., Kate Wellard Dyer., Anne Ferguson, and Patson Nalivata (2013). Legume Best Bets for a Changing World Annual Report 2012-13, McKnight Foundation

Government of Malawi (2008). The Agricultural Development Program, 2008-2011. Ministry of Agriculture and Food Security, Lilongwe, Malawi.

Government of Malawi (2011a), Malawi Growth and Development Strategy II: Draft 2011-2016, Ministry of Development Planning and Cooperation, Lilongwe, Malawi.

Kambewa D, personal communication with farmers in Karonga, 24th June, 2013

Place F., Barret C., Freeman H., Ramish J. and Vanlauwe B (2003). Prospects for integrated soil fertility management using organic and inorganic inputs: evidence from smallholder African agricultural systems. Food Policy 28 (4) 365-378.

Republic of Malawi (2011). Malawi Agricultural Sector Wide Approach: A prioritized and harmonized Agricultural Development Agenda: 2011 – 2015, Ministry of Agriculture and Food Security, Lilongwe, Malawi.

Snapp S.S., Kanyama-Phiri G., Kamanga B, Gilbert R and Wellard K (2002). Farmer and researcher partnerships in Malawi: developing soil fertility technologies for the near-term and far-term Experimental Agriculture. 38:411-431

Snapp S.S., Blackie M.J, Donovan C. (2003). Realining research and extension services: experiences from southern Africa. Food Policy 28 (4) 349-363.

van Gresmer K., Nestorova B., Quisumbing A., Fertziger., Fritschel H., Pandya-Lorch R and Yahannes Y. (2009). Global Hunger Index and the challenge of world hunger: Focus on financial crisis and gender inequity. IFPRI, Bonn, Washington DC.

Tchale, M. S. C. (2012) The Role of 'Orphan' crops among Smallholder Farmers in Simulemba, Malingunde and Chapananga areas. MSc Degree Thesis, University of Malawi, Lilongwe.

Tchuwa F (2012). Capacity of Smallholder Farmer Organizationsnin Promoting Orphan Crops in Chikhwawa, Kasungu and Lilongwe Districts of Malawi. MSc Thesis in Rural Development and Extension. University of Malawi, Bunda College of Agriculture.

UNCTAD. 2010. Technology and Innovation Report 2010: Enhancing food security in Africa through science, technology and innovation. United Nations Conference on Trade and Development, Geneva, Switzerland. USA

Wellard Kate and Kambewa Daimon (2009). Policy Context for Scaling-up ISFM and seed supply in Malawi. In Integrated Soil Fertility Management and Seed Systems in Malawi. 1st Consultative Policy Workshop, Lilongwe 2009. 18:22

Value chain analysis for enhanced commercialization of neglected minor crops among rural poor farmers

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Abstract

Several indigenous minor crops are often neglected under development and research programmes and by farmers themselves due to the limited economic impacts associated with them, despite their role in household food and nutrition security and income and resilience to climatic variations and climate change. Value chain analysis approach was applied to identify investment and market opportunities for the neglected minor crops to enhance their commercialization among rural poor farmers. The methodology involved surveys and focus group discussions focusing on cow pea, sorghum and groundnut as the target crops in Tororo, Mukono and Ntungamo Districts in Uganda. Results revealed a simple value chain structure for the neglected minor crops, with producers, traders and processors being the key players, supported by service providers and regulatory agents. The largest proportion of value went to the producers (75.2%), because of the cost and price structures. Different key players had influence on price determination and producers did not consider themselves to be disadvantaged. Contractual sales were also observed, involving credit and pre-harvest buying of crops. Quality assurance remained a concern, due to lack of knowledge, facilities and incentive for its implementation and ineffective regulatory framework. Value addition was practiced by a few (26.0%), involving milling, shelling or packaging, due to lack of investment resources and facilities. Limited market information and technical advice was provided by public extension agents (30.5%) and preference was for messages to be delivered verbally at community meetings in vernacular. Backward and forward linkages were identified, which represented investment opportunities.

Key words: neglected minor crops; value chains; commercialisation; linkages; economic opportunities

Introduction

Background

The Sub-saharan Africa (SSA) region has often experienced pockets of acute food insecurity, attributed to inadequate adoption of productivity innovations, degradation of natural resources, inefficient markets, weak institutions and policies. In order to contribute to alleviating these challenges, the project "Making agri-food systems work for the rural poor in Eastern and Southern Africa" was implemented in Uganda, Kenya and Malawi. Its overall goal was to stimulate the adaptation of innovations for the pro-poor agri-food systems as a contribution to improving food security and sustainable natural resource management. It focused on the rural poor, with emphasis on promotion of "neglected" minor crops. These were considered important for household food and nutrition security and income, particularly for the vulnerable groups such as the women, elderly and the youth. They had the potential to diversify the farming systems, could be adapted to spread risks and were resilient to climatic variations and climate change.

The paper applied value chain analysis to identify investment and market opportunities to enhance commercialization of orphan crops. Value chain refers to the range of activities that brings a product or a service from its conception to end use, changing hands in the process (Campbell 2011). The value chain players produce, transform, store, transfer or market the product, adding to its value at each step in the process.

The focus of the paper has been on three of the neglected minor crops promoted under the project, namely cow pea, sorghum and groundnut. The results would promote the entry of neglected minor crops into the market systems and help in identifying economic linkages of the value chain players internally and externally, for improved economic opportunities.

Objectives

The overall objective e of the paper was to contribute towards commecialisation of the neglected minor crops among rural poor farmers by identifying the critical bottlenecks, opportunities and incentives along the value chains. The specific objectives were as follows:

a. Identify the key market players along the value chains
b. Assess the distribution of values along the value chains
c. Examine price determination
d. Assess quality assurance and value addition.
e. Establish mechanisms for market information and technical advice
f. Assess economic linkages
g. Identify measures for improving commercialization.

Justification

Agriculture continued to be the dominant sector in Uganda's economy, although its contribution to Gross Domestic Product (GDP) declined over the years to 21 percent of the total GDP in 2009 at current prices and

accounted for 90 percent of the total export earnings (UBOS 2010). It also provided approximately 80 percent of the employment and supplied raw materials to most industries and services in the country. Furthermore, about 85 percent of the population, equivalent to 27 million people, derived their livelihoods from the sector. However, Uganda continued to experience persistent food challenges, with 4 million people reported to be malnourished (McKinney 2009). In 2007, food insecure people increased from 12 to 17.7 million from the previous year and 50 of the 80 Districts required food relief for their residents. In 2008, agricultural growth rate declined to 2.6%, from 7.9% in 2000. There had also been persistent decline in quality of soils, wetlands, forests and fisheries (NEMA 2010). In 2011, inflation in food prices hit a record high of 42% with major food consequences for the people.

It was, therefore, the objective of Uganda's agriculture sector development strategy and investment plan to focus on increasing rural incomes and livelihoods and improving food and nutritional security (MAAIF 2010). In order to achieve this, players along agriculture commodity value chains needed to identify market opportunities, quality assurance mechanisms and ensure value addition for their produce. The paper would, therefore, provide the necessary information basis on the value chains, necessary for identifying the economic opportunities for rural poor farmers.

Methodology

The study was carried out in Tororo, Ntungamo and Mukono Districts of Uganda during the months of July to September, 2012. The data collection methods included secondary data search to establish existing knowledge and identify gaps to be addressed by the study. A sample survey, using a semi-structured questionnaire, was enlisted with 1,146 respondents consisting of input dealers, producers, commodity traders and consumers. Focus Group Discussions (FGDs) were held with 18 groups of 10 to 14 persons to obtain their views on how to improve market access and increase the bargaining power of the rural poor farmers.

Data analysis involved value chain analysis to identify the key market players and distribution of values along the value chains. Descriptive analysis, using SPSS and Excel software, was done to generate frequencies, means and variances, checked using Chi-square test and Standard Deviation. Content Analysis was used for the FGD data, displayed using matrices and synthesized to obtain summary results.

Results and discussion

Key players along the value chain

The key players along the value chain were identified as the produces, traders and processors. Other players on the market included the input suppliers and consumers at the upstream and downstream ends respectively. There were also other service providers as shown in Fig.1.they included the farmer groups which provided social support, financial services as well as fora for provision of technical advice by the extension agents. financial organiisatons, including savings and credit co-operative organisations (SACCO), micro-finance institutions (MFI) and banks were there to provide financial services. Extension agents, both public and non-governmental, provided technical advice. Government institutions, namely the Agriculture Department and Administration, carried out policy and regulatory functions

The socio-demographic characteristics of the key players revealed that the input supplies, producers and commodity traders involved were middle aged persons whose average age was 39.1 years, more of females (57.7%) and of different ethnic groups. The majority were married (83.1%) but some of them were single, separated, widows and divorcees. Their educational achievement was mostly incomplete primary school (30.6%) but they also included person with no schooling (13.5%), a condition that hindered their ability to adapt productivity and marketing innovations, thus limiting commercialisation of the neglected minor crops. They had been in the business for 14.6 years on average (Table 1).

Input suppliers consisted of both retailers and wholesalers and their operations went beyond the inputs of neglected minor crops and included the major commercial crops. They dealt in seeds, farming implements such as hoes, pangas, slashers, ox-ploughs, agricultural chemicals namely pesticides, herbicides and fertilizers and packaging materials. They obtained their seed supplies from farmers (42.9%), followed by seed companies (34.0%) while the implements and chemicals were obtained from bigger companies, manufacturers or imported. The major expenses incurred weekly were on transport (Shs 111,261), storage (Shs 69,100, skilled labour (Shs 49,000) and unskilled labour (Shs 35,063) averages per respondent.

Producers cultivated neglected minor crops on small gardens of average size of 0.4 acres on land owned, rented or borrowed. Respondents carried out land preparation mostly manually (55.0%) but, where feasible, oxen and ox-plough were used (45%) while the use of tractor was negligible. Due to inadequate land preparation, some of the producers were not able to get the best results from their gardens. They obtained their local seed varieties mostly from fellow farmers, while the limited improved varieties were bought from farm supply shops. Only 37.9% of producers among the respondents sold some of their harvests of neglected minor crops and on average, 61.1% of the quantities harvested were sold, mostly to small traders (50.6%) and direct consumers (20.8%). Although the neglected minor crops were being promoted primarily for food security, farmers were advised to produce quantities with surplus for sale. The key external factors which respondents regarded as affecting their operations were the seasons (76.4%), long distances to the market and service centres (63.3%) and the poor road types (58.1%).

Traders obtained their supplies from farmers (63.2%) or from fellow traders (30.1%) while a few also traded their own harvests, especially of local groundnut variety (12.7%). There were limited supplies from the open market or farm supply shops, indicating that trading in these crops was low and the necessary trade facilities not well developed. They bought and sold in different units but the majority used Kg (63.6%), the unit preferred for serving the numerous small consumers to whom they sold the commodities. Larger packages like 50kg and 100 kg bags were taken by the large traders for re-sale to smaller traders and retailers.

Distribution of values

In order to gain appreciation of the economic importance of the different players, the proportions of value along the value chain were estimated, based on the prices received less prices paid, prior to considering costs and volumes. The results revealed that the highest proportions of value went to producers, followed by traders and retailers. Taking the three crops together, the estimates were 75.2%, 15.4% and 9.4% for

producers, traders and retailers respectively (Table 2).

Factors that influenced proportions of value were the production costs, market structures and demand. Total costs of the operations at each stage affected the proportion of value along the value chain. With respect to market structures and the resulting competition, lower prices were received on a competitive than a monopolistic market for the commodity. Large numbers of producers, traders and retailers dealing in small quantities made the neglected minor crop markets fairly competitive. Lastly, higher value was realised where there was higher demand for the commodity. In this respect, producers, traders and retailers all regarded demand for their commodities to be high.

Price determination

Most producers believed that the prices for their neglected minor crops were determined by themselves (61.4%), by the traders (34.0%), by their groups (3.0%) and by others such as large customers (1.6%). Producers set prices whenever they took the commodities to the open markets and sold directly to consumers or small traders in small quantities in kilograms, tins or cups.

Traders set the prices when producers delivered the commodities to their stores. Similarly, processors such as flour millers and large consumers such as schools also set the prices. In almost all cases, however, there was bargaining within a small margin to arrive at the prices actually paid.

Collective marketing, common for major crops, was still under consideration by the producers. Under the arrangement, producer groups would agree on prices to charge and the commodities would be sold by brokers on behalf of the members for their convenience and to ensure compliance with the agreed prices.

Seasons were a major factor for prices of the neglected minor crops. Prices were at their lowest after harvest and gradually rose as harvests became used up and supply dwindled. The period before planting was usually the highest price period because of the additional demand for seed for planting for the new season.

Some producers obtained credit from processors or traders which were recovered from sale of the commodities after harvest. These were in the forms of seeds, chemicals, implements and even cash to pay labour. The farmers' commitment was to sell to the credit provider. There was, however, no evidence that the credits affected the prices at which the farmers sold the commodities to credit providers. However, only about 10% of respondents acknowledged involvement and this was attributed to the small scale of operations on these crops. Similarly, traders had little incentives to lend to farmers for these crops, with preference for more important crops.

Some traders booked or even bought gardens of the neglected minor crops prior to harvesting. It was believed that farmers obtained the advantage of quick revenue but the buyers from gardens could have realised financial gains from this arrangement, in form of lower prices. Prices along the value chains are given in Table 2.

Gross margins

Gross margins for the neglected minor crops were defined as the differences between selling and buying price as percentages of buying prices. They were important pointers to commercialization because a commodity would enter the market if there was profit to be made out of it and commodities with low gross margins would not be traded.

Gross margin were generally higher for input suppliers (46.3%) than for the commodity traders (30.3%) (Table 3). This was because input suppliers sold mostly during planting seasons when supply on the market was low and were also expected to deal in high quality seed. among the input suppliers, the seeds with highest gross margins were sorghum local (70.0%) and cowpea local (66.7%), attributed to the high demand for these seeds. Among commodity traders, the highest gross margins were for sorghum improved and local (50.0%) and groundnut (25.0%)., which were also in high demand.

Quality control and value addition

Due to the marginalized nature of the neglected minor crops, limited resources and attention were put into quality control. Few farmers acquired improved seed varieties with higher commodity attributes, reported at 6% for cow pea, 8% for sorghum and 18% for groundnut. This was attributed to lack of knowledge of improved varieties, poor accessibility and high costs compared to local varieties. Other challenges included the substandard seed quality on the market and the failure of farmers to realize higher prices for improved variety commodities.

Site selection, whereby gardens with suitable soil fertility and drainage, was often not made in favour of the neglected minor crops but the best gardens went to the priority household crops. Timely planting, recommended for disease and pest minimization, was not possible due to demand on household. Even when pests were detected, the crops were not sprayed due to resource constraint. Harvest immediately after maturing was often not possible due to labor constraint. The crops were not well winnowed before marketing. Different varieties were often mixed up in the consignments. Stores were not available, not clean or bags were not placed on raised platforms. Furthermore, the regulatory framework was unclear and its implementation weak.

Limited value addition was observed, applied mostly for groundnut but least for cow pea (Table 4). The value added products were targeted at middle income consumers, prompted by the nutritional values of the commodities and the quality assurance associated with them. They were conveniently packaged and could be easily transported and stored.

However, challenges affecting value addition were that many farmers did not produce specially for value addition, hence did not meet the standards required in production and handling. There was little investment in the value addition due to the limited and irregular supply of the input commodities. Availability of other inputs such as power, skilled labour, packaging materials and transport were limited. There was low demand for value added products due to the small middle class in the country. Prices of the products were significantly

high compared to the fresh or processed products. The products also faced competition from imported products which were cheaper or of higher quality.

Market information and technical advice

Agricultural information flow along the value chains revealed that the majority of respondents sought advice on production (78.1%) while only 21.9% went in for marketing advice. The main sources of information included public extension agents (30.5% of respondents), neighbours and fellow farmers (22.8%) and NGO agents (16.9%) and others (29.8%).

The main attributes why respondents choose to use these particular information sources were accessibility to the people (41.9%) and reliability (22.2%) (Table 5).

Majority of respondents were satisfied with the performance of various agricultural extension services (68.0%) while some were neutral (24.0%) and others dissatisfied (8.0%). However, only 43.2% reportedly applied them and those who did not apply them attributed this to inability to afford them (28.7%), recommendations not being new (19.4%) and the benefits not being clear (18.5%). Other concerns were that the delivery of was not timely; messages were repetitive and agents were not knowledgeable about the information they were disseminating. The mean distance from respondents' homes to extension centres was 5.6 kilometers, close to the walking distance of 5 kilometers recommended for rural service locations.

Respondents preferred the information to be disseminated on radio (51.5%), print media such as brochures, pamphlets, leaflets (41.2%) and others such as television and internet (7.2%). The language most preferred was vernacular (88.9%), with low preferences for Kiswahili (6.1%) and English (5.0%).

Economic linkages

The study examined economic backward and forward linkages of the value chains and their potential for creating development opportunities. Internally, the different components along the value chains were linked through flow of the commodities from producers through processors and traders to the consumers and export markets (Fig. 1). Cash, on the other hand, flowed in the opposite direction. A significant feature of economic linkages within the value chains was that vertical integration was common. This was exhibited by producers who also traded their produce by taking to the market place. Many traders were also farmers and part of the commodities they traded were own harvests.

Externally, the value chain players had backward linkages in obtaining supplies of implements and chemicals from large input suppliers in towns (75.0%) and ox-ploughs from local manufacturers (33.3%). They were also linked with service provides for energy, transportation, communications and packaging materials. Their forward linkages were with large traders, institutions and exporters who bought their processed or value added products.

Conclusion

Value chain analysis approach was applied to identify investment and market opportunities for the neglected minor crops to enhance their commercialization among rural poor farmers. The indigenous minor crops, often neglected under development and research programmes and by farmers themselves, had important role in household food and nutrition security and income and resilience to climatic variations and climate change. A sample survey and focus group discussions were conducted, focusing on cow pea, sorghum and groundnut as the target crops in Tororo, Mukono and Ntungamo Districts in Uganda. Results revealed a simple value chain structure for the neglected minor crops, with producers, traders and processors being the key players, supported by service providers and regulatory agents. The largest proportion of value went to the producers, because of the cost and price structures. Different key players had influence on price determination and producers did not consider themselves to be disadvantaged. Contractual sales were also observed, involving credit and pre-harvest buying of crops. Gross margins were higher among input suppliers than commodity traders for these crops and sufficient to provide incentive for commercialization of the minor crops, Quality assurance remained a concern, due to lack of knowledge, facilities and incentive for its implementation and ineffective regulatory framework. Value addition was limited to milling, shelling or packaging, due to lack of investment resources and facilities. Limited market information and technical advice was provided by public extension agents and preference among farmers was for messages to be delivered verbally at community meetings in vernacular. Backward and forward linkages were identified, which represented investment opportunities that could be exploited. To promote commercialisaton, therefore, there is need to invest in value addition, improve information and technical advice services and strengthen regulatory framework for quality assurance.

References

Campbell R., 2011: Strengthening value chains to promote economic opportunities. ACDI/VOCA.

MAAIF (Ministry of Agriculture, Animal Industry and Fisheries), 2010: Agriculture for Food and Income Security. Agriculture Sector Development Strategy and Investment Plan: 2010/11 – 2014/15.

McKinney, P., 2009: Comprehensive food security & vulnerability analysis, Uganda. United Nations World Food Programme.

MFPED (Ministry of Finance, Planning and Economic Development), 2009: National Development Plan, 2010-2014.

National Environment Management Authority, 2009: Sate of Environment Report Uganda, 2008.

Uganda Bureau of Statistics, 2010: Statistical Abstract, 2010.

Acknowledgements

The authors would like to acknowledge the funding support of the International Development Research Centre (IDRC) for the research and the administrative support provided by the National Agricultural Research Organisation (NARO).

Tables

Table 1: Social characteristics of respondents

		Input supplier	Farmer	Commodity trader	Consumer	All
Average age (years)		38.2	41.5	38	36.9	39.1
Sex	Male	77.4%	38.4%	59.2%	39.0%	42.3%
	Female	22.6%	61.6%	40.8%	61.0%	57.7%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%
Tribe	Muganda	29.0%	19.3%	13.5%	20.0%	19.2%
	Japadhola	12.9%	12.3%	15.6%	13.4%	13.2%
	Munyankole	35.5%	31.9%	36.2%	34.1%	33.3%
	Itesot	12.9%	20.2%	25.5%	20.7%	20.9%
	Others	9.7%	16.3%	9.2%	11.8%	13.4%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%
Marital status	Married	96.8%	83.6%	87.9%	80.4%	83.1%
	Single	3.2%	3.5%	4.3%	9.1%	5.9%
	Separated		2.4%	2.8%	3.6%	2.9%
	Widowed		9.3%	4.3%	4.9%	6.6%
	Divorced		1.2%	0.7%	2.1%	1.5%
	Total	100.0%	100.0%	100.0%	100.1%	100.0%
Education	No schooling	3.2%	16.7%	5.0%	13.2%	13.5%
	Incomplete primary	3.2%	36.7%	22.7%	28.4%	30.6%
Education	Complete primary	12.9%	17.8%	22.7%	16.5%	17.7%
	Secondary	45.1%	26.2%	41.9%	32.7%	31.3%
	Tertiary	25.8%	2.2%	3.5%	7.7%	5.3%
	University	9.8%	0.4%	4.2%	1.5%	1.6%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%
Years of operation		7.9	17.2	7.2		14.6

Table 2: Prices and share of values along the value chains for selected neglected minor crops

	Cow pea		Sorghum		Groundnut		All
	Price	Share of value	Price	Share of value	Price	Share of value	Share of value
Producers	1,500	79.0%	1,400	66.7%	2,800	80.0%	75.2%
Traders	1,800	15.8%	1,800	19.1%	3,200	11.4%	15.4%
Retailers	1,900	5.3%	2,100	14.3%	3,500	8.6%	9.4%

Table 3: Gross margins of input suppliers and commodity traders by crop variety

	Quantities (kg)	Cost price (Sh/kg)	Selling price (Sh/kg)	Gross margin
Input dealers				
Cow pea local	360	1,500	2,500	66.7%
Cow pea improved	200	2,000	2,800	40.0%
Sorghum Local	10	1,000	1,700	70.0%
Sorghum improved	25	1,500	2,000	33.3%
Ground nut local	400	2,800	3,500	25.0%
Ground nut improved	115	3,500	5,000	42.9%
All				46.3%
Commodity traders				
Cowpea local	147	1,500	1,800	20.0%
Cowpea improved	233	1,500	1,800	20.0%
Sorghum local	209	1,000	1,500	50.0%
Sorghum improved	93	1,000	1,500	50.0%
Ground nut local	44	2,800	3,500	25.0%
Ground nut improved	223	3,000	3,500	16.7%
All				30.3%

Table 4: Types of products from the neglected minor crops marketed

Crop	Unprocessed	Processed	Value added
Cow pea	Leaves Fresh pods	Seed	--
Sorghum	--	Grains	Flour
Groundnut	Fresh poded Boiled fresh poded Roasted fresh poded	Seed	Roasted seed Pounded flour Paste Oil

Table 5: Attributes why respondents chose the service providers

	Accessible	Reliable	Cost effective	Professional delivery	Usefulness	Other	Total
N	310	164	99	63	60	43	739
Percent	41.9%	22.2%	13.4%	8.5%	8.1%	5.8%	100.0%

Figures

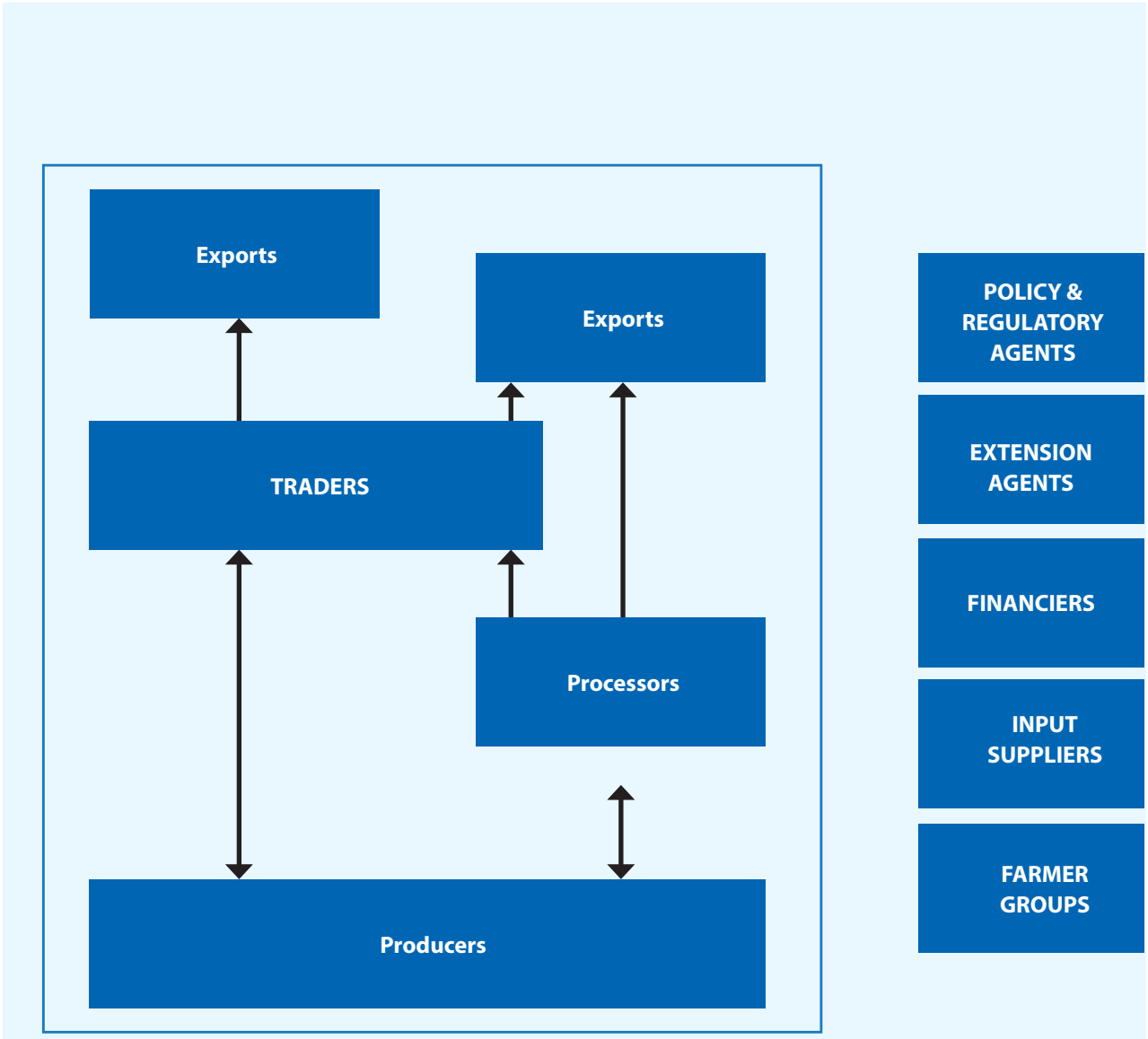

Fig. 1: Value chain for neglected minor crops

Participatory farmer evaluation of pearl millet *(Pennisetum glaucum)* cultivars with improved drought tolerance and enhanced utilization characteristics

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Abstract

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is native to Africa and is a main cereal crop grown in the semi-arid parts of eastern Kenya including Mbeere South district. This crop is principally grown in the sorghum-millet-extensive livestock Land Use System (LUS) located in the Lower Midland (LM) 5 and Inland Lowland (IL) 5 Agro-Ecological Zones (AEZ). The main crop production constraints in these areas are low erratic rainfall, low water holding capacity of the soil, high transpiration and low infiltration of some of the compacted soils. Use of drought tolerant/escaping crops and varieties has previously been identified as one of the farmers' strategy to overcome these constraints. This study was therefore initiated to allow farmers evaluate new pearl millet cultivars with an aim to identify drought tolerant cultivars that posses superior agronomic traits and also meet the farmers' utilization and marketing preferences. The study was conducted in Kiambere location of Mbeere South district. Farmers listed the attributes that they consider important when choosing a pearl millet cultivar over another as; yielding ability, drought tolerance, threshability when dry, threshability when green, taste/palatability and resistance to bird/weevil damage. Using both pairwise as well as matrix ranking, farmers indicated that drought tolerance is the most important varietal attribute for pearl millet in this area. The second and third most important attributes were shown to be the yielding ability and earliness, respectively. Agronomic evaluation showed that the local cultivar, Mugombe, yielded significantly lower ($P<0.05$) grain than Kat/PM-3 but gave a comparable yield to Kat/PM-1. Out of the seven varietal attributes that the farmers listed, Kat/PM-3 out-ranked both Kat/PM-1 and Mugombe in 5 out of 7 attributes.

Key words: *Smallholder farmers; Pearl millet; Varietal attributes; Ranking; Drought tolerance; Enhanced utilization*

Indigenous vegetables and spices their diversity and use in Tigray, Northern Ethiopia

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Abstract

Ethiopia is home to a lot of unique plants which are used by the local communities. Unfortunately due to the fact that they are neither well known nor promoted; and due to environmental degradation these plants are being marginalized, are declining and going toward extinction. National and regional studies indicate that there are a lot of these plants in Tigray. To document and assess the potential of plant species categorized as traditional vegetables, and spices an assessment was done in selected districts of Tigray. Six districts were purposely selected. A total of 120 households were included for this particular study. The study locations were selected purposively based on plant species record and quantitative and qualitative data were collected from randomly selected respondents using a semi-structured questionnaire. 38 different vegetables were found in the study, with Kola Tembien having the highest level of unique vegetables (10 in number. There were 17 spices found, out of which only Raya Azebo had one unique spice. The study revealed that proper utilization of these plants can have a paramount importance on the social and economic welfare of the community.

Introduction

Ethiopia is one of the countries known for their high biodiversity distribution. It is also one of the Vavilovian Centers of origin/diversity for many crop species and their wild relatives (Vavilov, 1951). The flora of Ethiopia is estimated to have between 6500 and 7000 species (Cufodontis, 1953-72). Of these, about 24% of the species are endemic to Ethiopia (Teweldeberhan, 1991). Some of the endemic species yield edible vegetables, spices although of limited commercial value. Despite the fact that the world knows Ethiopia for its recurrent drought resulting in famine.

Several studies of the vegetation in Ethiopia have shown that food domestication happened in Ethiopia with unique crops like 'teff' Eragrostis tef and 'enset' Ensete ventricosum (Edwards, 1991), which are found only in Ethiopia. In addition to this several of the international crops like wheat and barley have also had time and

conditions allowing for their own unique diversity to develop (Harlan, 2001). Like the cereals and legume crop species, Ethiopia is endowed with different types of leafy vegetables, aromatic plants, spices and edible fruits rich in micronutrients. But again, these are not considered important to cultivate and eat- unlike exotic, imported cabbages- so they are slowly becoming endangered from the Ethiopian landscape. Cultivated fields are used for cereals and legume crops. However, some farmers, especially women, have been observed to grow these unique species in a small home garden plots. The wild relatives of these crops are also found in Ethiopia, indicating that it is actually a centre of domestication and diversification of the varied food crops used (Edwards, 1991).

Hence, documenting the ethnobotany and indigenous knowledge of the edible wild plants is vital. Systematic efforts should be done to compile information on lesser known species (traditional crops). Moreover, it is important that greater research focus should be given on: Strengthening capacity of the community to maximize sustainable utilization of diverse plant species. Thus, the study was initiated to document plant species consumed as traditional horticultural plants and to identify and understand better the importance of these plants in the livelihood survival strategies adopted by rural people in food insecure areas of the study region (Tigray). With this the overall objective of the study was to document and promote traditional leafy vegetables, and spices used by women and children.

Materials and Methods

Description of the study area

The study was conducted in six woredas of the Tigray administrative region. The woredas where the study was undertaken are Alage, Raya Azebeo, Gulo Mekeda, Kilte Awlalo and Kolla Tabmien. The study sites were selected based on the representation of the different agro-climatic and cultural context within Tigray. In Tigray there are three major agro-climatic regions, the highlands, mid-altitude and the lowland areas. The rainfall pattern also varies in that it gets drier as one goes eastward, and the eastern escarpment and the Raya Azebo valleys get bi-modal rain. In the cultural setup, the Raya Azebo people have a different culture with respect to fumigation using smoke from selected woody species and aromatic beatification. Taking these facts into account the following sites were selected, to represent the variations within Tigray. The characteristics of the woredas selected is summarised in Table 1.

Table 1. Characteristics of the *woredas* selected

Woredas	Major agro-climatic region	Uniqueness
Alage	Mid altitude	Have a specific culture in aromatic beatification and fumigation
Raya Azebeo	Lowland	Have a specific culture in aromatic beatification and fumigation
Gulo Mekeda	Mid altitude	No culture of fumigation but experience with vegetables
Kilte-Awlalo	Mid altitude	Have a culture in aromatic fumigation and traditional irrigation
Kolla Tabmien	Lowland	No culture of fumigation but known for diverse wild fruits and utilisation of wild vegetables
Atsbi	Highland	Have a culture in aromatic fumigation and traditional irrigation

Sampling and Data collection Procedures

The survey was conducted using household level questionnaires. Prior to household survey PRA tools were applied to understand the contribution of women in vegetable domestication, spices and aromatic plants planted or used. Some plants available during the study were collected, dried, mounted and identified. Key informant interviews and a case study were conducted to document the detail knowledge and management of species that are uniquely grown by few farmers. After the selection of the woredas, in the second stage, one village was randomly selected from each woreda. Once the study sites were selected, a purposive sampling method was used to identify 20 women each in the woredas for the individual interviews, and a small group of 6 to 10 women were selected for the group discussions. The identification of knowledgeable women in the woredas was undertaken with the help of the home agents in the different woredas.

For the vegetables a Multidimensional Unfolding analysis was also undertaken. The interviewees discriminated between the vegetables primarily in terms of their taste, time required for cooking, fuel saving, marketability, multipurpose functions and availability of the vegetables. Women farmers were asked to rate their preferences using 1-9 scale, depending on the number of vegetables listed; where 1 means high preference and the lower value was low preferences. As most of the plants were named only by their English or Tigrigna (the local language) names, scientific names of them were determined according to descriptions provided by Schippers (2002), and Flora of Ethiopia (Edwards, 1997). The quantitative data were analyzed using SPSS statistical package release 20 (SPSS, 2011) and the result was presented with descriptive statistics.

Results and Discussion

The marital status and family size of the women in the interviews are summarised in Table 2 and Table 3

Table 2. Marital status of the women in the interview

Marital status	Frequency	Valid Percent	Cumulative Percent
Married	51	45.9	45.9
Divorced	9	8.1	54.1
Widow	5	4.5	58.6
Single	46	41.4	100.0

As can be seen from the table 2, the highest proportion was made up of married women, followed by single women.

Table 3. Family size of the women in the interview

Woreda	Frequency from	% family size									
		1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
Alage	Within *woreda*	0.0	0.0	9.1	45.5	0.0	18.2	18.2	0.0	0.0	9.1
	Within family	0.0	0.0	6.7	13.9	0.0	11.8	16.7	0.0	0.0	100.0
Kolla Tembien	Within *woreda*	5.0	10.0	10.0	20.0	0.0	30.0	10.0	15.0	0.0	0.0
	Within family	33.3	28.6	13.3	11.1	0.0	35.3	16.7	37.5	0.0	0.0
Kilte-Awlalo	Within *woreda*	10.0	5.0	20.0	25.0	5.0	20.0	5.0	10.0	0.0	0.0
	Within family	66.7	14.3	26.7	13.9	10.0	23.5	8.3	25.0	0.0	0.0
Gulo Mekeda	Within *woreda*	0.0	10.0	20.0	40.0	10.0	5.0	5.0	5.0	5.0	0.0
	Within family	0.0	28.6	26.7	22.2	20.0	5.9	8.3	12.5	50.0	0.0
Atsbi	Within *woreda*	0.0	5.0%	.0%	35.0	25.0	10.0	10.0	10.0	5.0	0.0
	Within family	0.0	14.3	0.0%	19.4	50.0	11.8	16.7	25.0	50.0	0.0
Raya Azebeo	Within *woreda*	0.0	5.0	20.0	35.0	10.0	10.0	20.0	0.0	0.0	0.0
	Within family	0.0	14.3	26.7	19.4	20.0	11.8	33.3	0.0	0.0	0.0

As can be seen from Table 3, the number of families with just one person is less than 41.6%, showing that even unmarried women are supporting more than just themselves. The highest frequency level is found for the family size of 4, followed by 6, 3 and 7 with respective decline.

Availability and use of Vegetables

To start, let us say a quote from a woman: "The cooked grains boast, with the saving grace of vegetables in the rainy season!" 38 different vegetables were listed in the study woredas (Table 4). The frequency distributions of within and across woredas is presented in Table 4.

Table 4. Frequency distribution of traditional vegetables used by women

No	Name of vegetable	Scientific name	Parts used	Number of Responses	Percent of Cases
	Adri	Brassica carinata	Leaves/tender stem/ seeds	95.00	85.59
	Tilian	Amaranthus hybridus	Leaves/tender stem/root	59.00	53.15
	Tetie	Erucastrum abyssinicum	Leaves/tender stem/root	49.00	44.14
	Birniho	Amaranthus graecizans sub sylvestus	Leaves/tender stem	47.00	42.34
	Senafich	Brassica nigra	Leaves/seeds	46.00	41.44
	Asma	Asema myricoides	Leaves/seeds	20.00	18.02
	Abetiye	Cleome gynandra syno (Gynandropsis gynandra)	Leaves	19.00	17.12
	Duba	Cucurbita maxima	Fruit	12.00	10.81
	Misa		Leaves	12.00	10.81
	Shinfafot		Leaves	9.00	8.11
	Shilan	Anethum graveolens	Leaves/tender stem	9.00	8.11
	Girbiya	Hypoestes forskaoli	Leaves	7.00	6.31
	Keretsa	Osyris quadripartite syno (O. Abyssinica)	Leaves	7.00	6.31
	Shinfaie	Lepidium sativum	Seeds	6.00	5.41
	TsebhiAbun	Lycopersicum esculentum	Fruit	6.00	5.41
	Amiee		Leaves	5.00	4.50
	Kulich		Leaves	5.00	4.50
	Kintishara	Boletus edulis	Leaves	5.00	4.50
	Tebeb	Becium grandiflorum	Flower	4.00	3.60
	Kumelni		Leaves	4.00	3.60
	Muguya*	Snowdenia polystachya	Leaves/seeds	4.00	3.60
	Agol	Withania somnifera		4.00	3.60

No	Name of vegetable	Scientific name	Parts used	Number of Responses	Percent of Cases
	Kibie	Chenopodium murale	Leaves & tender stem	4.00	3.60
	Eif	Brassica spp.	Leaves	4.00	3.60
	Alalimo	Solanum sinaicum	Leaves	3.00	2.70
	Gudyibelu	Sisymbrium arvensis	Leaves	3.00	2.70
	Mearkuah	Momordica foetida		3.00	2.70
	Taftafo	Eragrostis cilianensis (and other Eragrostis spp.)	Seeds	2.00	1.80
	Enkeftiha	Malva parviflora	Leaves	2.00	1.80
	ChfriMerat	Commelina subulata		2.00	1.80
	Tsidiet			2.00	1.80
	HariHareao	Cyphia glandulosa	Root	2.00	1.80
	Dikune		Root	2.00	1.80
	Merekuah	Momordica foetida	Leaves, fruit	2.00	1.80
	Tsebadimu	Euphorbia hirta, Kanahia laniflora (given to plants with white latex)	Leaves	1.00	0.90
	MeantaTeli	Evolvulus alsinoides or Convolvulus siculus	Root	1.00	0.90
	Mazile			1.00	0.90
	Fochoka			1.00	0.90
Total				470.00	423.42

**Seeds collected, grounded and mixed with barley flour for consumption*

As can be seen from Table 4 the most commonly used traditional vegetable is the Brassica carinata with 85.59% of the respondents saying they use this vegetable. Next to that Amaranthus hybridus, Erucastrum abyssinicum, Amaranthus graecizans sub sylvestus and Brassica nigra were the most common vegetable with 53.15%, 44.14%, 42.34%, and 41.44% of the respondents respectively saying the used these vegetables. Similarly, the study by Gebremedhin and Mulubrehan (2007), focused on home gardens, and this study looked at domestic, semi-wild and wild vegetables. The respondents of this study had said they sometimes grew Senafich in their home gardens, yet it was not mentioned by the study done. The difference may be due to the fact that the study sites were also different, and goes to show that there may be different levels of domestication of these vegetables in different sites of the region.

Table 5. Frequency distribution of top five mentioned and unique traditional vegetables, as described in the *woreda* and among the *woredas*

Woreda	Vegetable	Adri	Tilian	Tetie	Birniho	Senafich	Shilan	Kulich	Tsebadimu	Misa	Merekuah
Alage	In woreda	63.64	18.18	9.09	9.09	45.45	-	45.45	9.09	-	-
	Overall	7.37	3.39	2.04	2.13	10.87	-	100.00	100.00	-	-
Kolla Tembien	In woreda	100.00	-	-	80.00	5.00	-			60.00	-
	Overall	21.05	-	-	34.04	2.17	-	-	-	100.00	-
Kilte-Awlalo	In woreda	90.00	45.00	55.00	70.00	90.00	45.00	-	-	-	-
	Overall	18.95	15.25	22.45	29.79	39.13	100.00	-	-	-	-
Gulo Mekeda	In woreda	100.00	95.00	100.00	50.00	5.00	-	-	-	-	-
	Overall	21.05	32.20	40.82	21.28	2.17	-	-	-	-	-
Atsbi	In woreda	95.24	90.48	80.95	23.81	19.05	-	-	-	-	14.29
	Overall	21.05	32.20	34.69	10.64	8.70	-	-	-	-	100.00
Raya Azebeo	In woreda	52.63	52.63	-	5.26	89.47	-	-	-	-	-
	Overall	10.53	16.95	-	2.13	36.96	-	-	-	-	-
	Vegetable	ChfriMerat	Keretsa	MeantaTeli	Fochoka	ChfriMerat	Mazile-	Merekuah	Hari Hareao	Dikune	
Alage	In woreda	-	-	-	-	-	-	-	-	-	
	Overall	-	-	-	-	-	-	-	-	-	
Kolla Tembien	In woreda	10.00	35.00	5.00	5.00	10.00	5.00	10.00	10.00	10.00	
	Overall	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Kilte-Awlalo	In woreda	-	-	-	-	-	-	-	-	-	
	Overall	-	-	-	-	-	-	-	-	-	
Gulo Mekeda	In woreda	-	-	-	-	-	-	-	-	-	
	Overall	-	-	-	-	-	-	-	-	-	
Atsbi	In woreda	-	-	-	-	-	-	-	-	-	
	Overall	-	-	-	-	-	-	-	-	-	
Raya Azebeo	In woreda	-	-	-	-	-	-	-	-	-	
	Overall	-	-	-	-	-	-	-	-	-	

As can be seen from Table 5, only Adri, Birniho and Sinafich are known in all six woredas at 85.59%, 42.34%, and 5.41% frequencies respectively.

From the woredas Kollatembin has 10 unique vegetables, Alaje has two, Kilte Awlalo has one, Atsbi womberta has one, and Raya Azebo had no unique vegetables. As can be seen in Figure 1, the distribution of vegetables varied across woredas. Atsbi Wemberta and Gulo Mekeda, and Kilte Awlalo and Kolla Tembien show that clustering meaning that they as groups have more plants in common that the other woredas assessed. Merekuah, Alalimo, Kumelini, Shinfafot and Kumelini are found in Atsbi Wemberta and Gulumekeda; Taftafo Abetiye, Amiee, Girbya in Raya Azebo; Muggia, Kulich and Agula in Alage; Binkuo, Shilan and Gudiberlo in Kilte Awlalo; Chifrimerat, Mentatelli, Mista and Kerets are found in Kolla Tembien; and and Adri, Enkeftha and Tilian are common in all woredas.

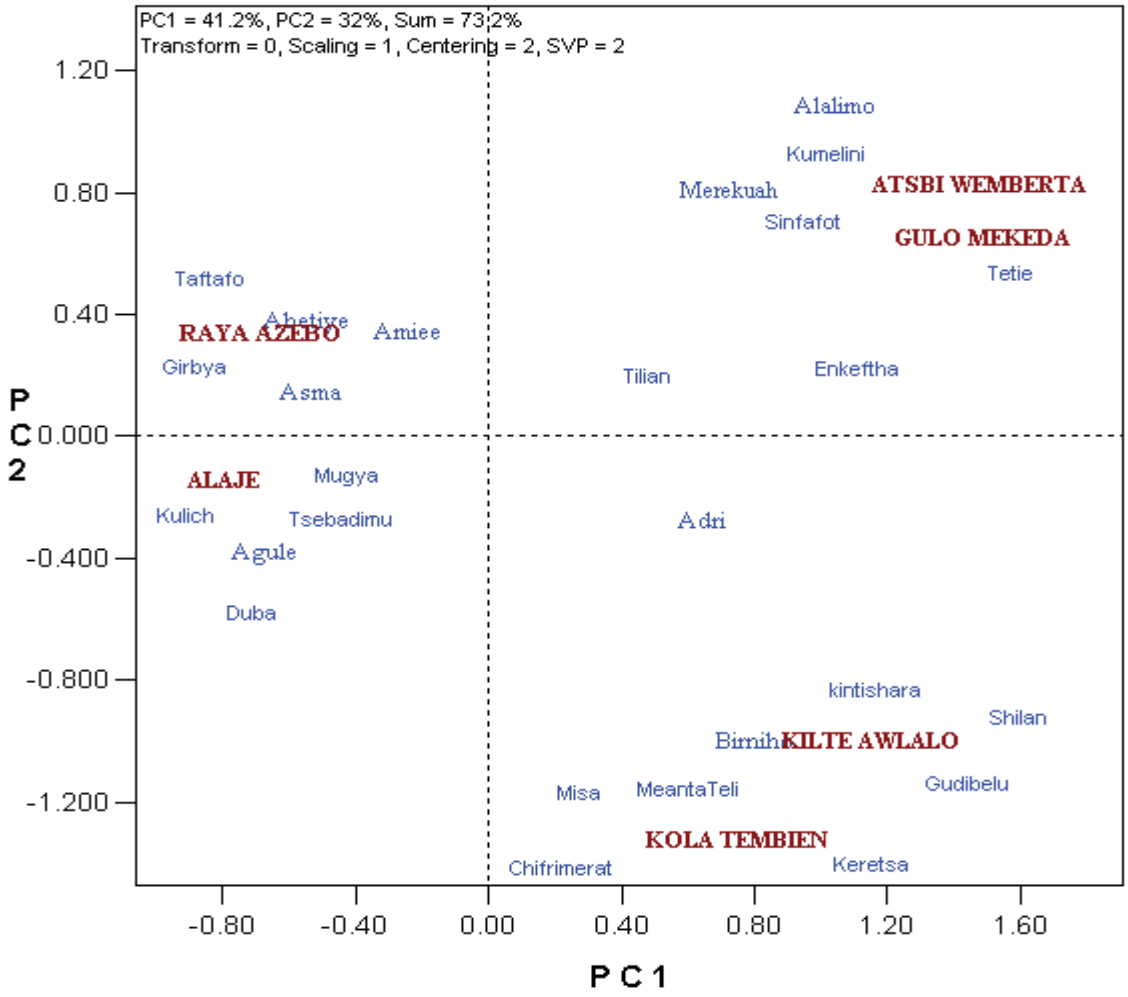

Figure 1. Bi-plot analysis for vegetable distribution by study district

The vegetables used were also ranked by the women interviewed; in Figure 2 is the multidimensional unfolding analysis for the ranking. The algorithm converges after 261 iterations, with a final penalized stress of 0.8606915. The variation coefficients and Shepard's index are sufficiently large, and DeSarbo's indices are

sufficiently low, to suggest that there are no problems with degeneracy. In the joint plot of the common space allows the horizontal dimension, and this appears to discriminate between Adri (a planted vegetable) Tetie, Tilian, Birnihio and other naturally grown vegetables. The vertical dimension (dimension 2) does not have clear discriminations. This creates clusters of popular and less popular types of naturally grown vegetables. For example, Tilian, Tetie and Birnhio are forming a cluster closer to Adri showing they are more popular.

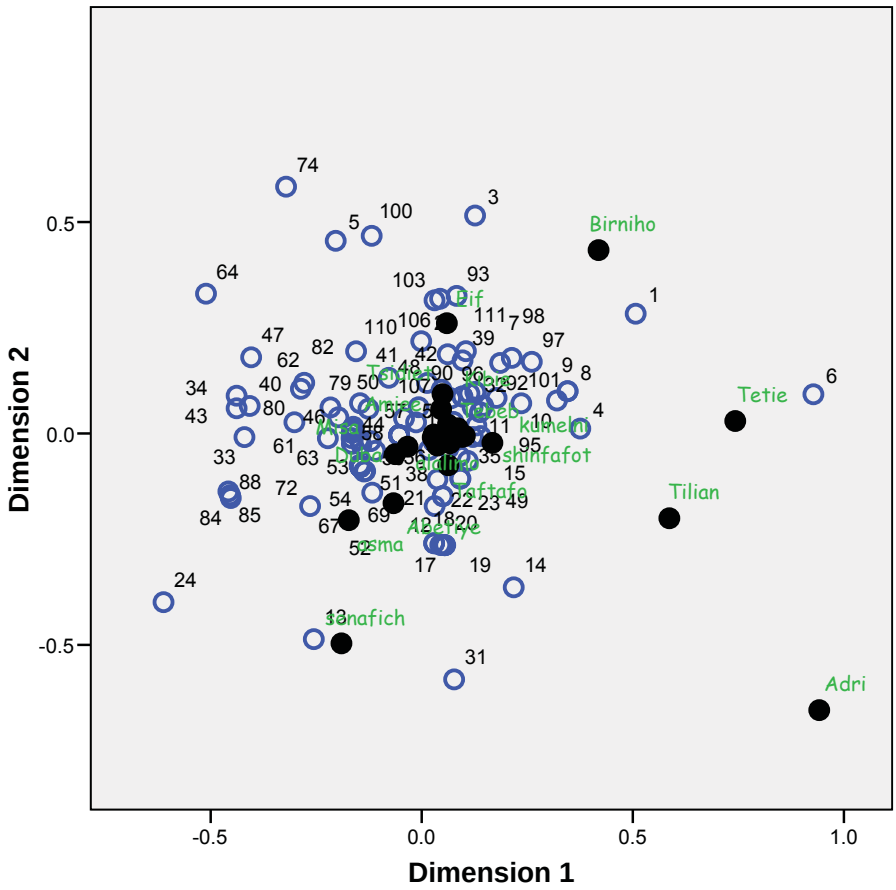

Figure 2. The multidimensional unfolding analysis for the ranked vegetables

In addition to the above information, the women interviewed were asked about their preference of the traditional versus modern vegetables with regards to their taste and marketability. The summary of their responses is presented in Table 6 and Table 7.

Table 6. Vegetable preferences of women to the group modern versus traditional vegetables with respect to taste

Woreda	Frequency calculation for	Traditional	Modern	Total
Alaje	Count	1	10	11
	% within woreda	9.1%	90.9%	100.0%
	% within taste	3.3%	12.3%	9.9%
Atsbi	Count	3	17	20
	% within woreda	15.0%	85.0%	100.0%
	% within taste	10.0%	21.0%	18.0%
G/mekheda	Count	1	19	20
	% within woreda	5.0%	95.0%	100.0%
	% within taste	3.3%	23.5%	18.0%
Kilteawlaelo	Count	7	13	20
	% within woreda	35.0%	65.0%	100.0%
	% within taste	23.3%	16.0%	18.0%
Kolla Temben	Count	13	7	20
	% within woreda	65.0%	35.0%	100.0%
	% within taste	43.3%	8.6%	18.0%
Raya Azebo	Count	5	15	20
	% within woreda	25.0%	75.0%	100.0%
	% within taste	16.7%	18.5%	18.0%
Total	Count	30	81	111
	% within woreda	27.0%	73.0%	100.0%
	% within taste	100.0%	100.0%	100.0%

As can be seen from Table 6, the preferences for modern vegetables are higher in all woredas, except for Kolla Temben where traditional vegetables take up 65% of the preference. One of the reasons may be the fact that Kolla Temben is remote and sheltered from the influences of mainstream foods.

Table 7. Vegetable preferences of women to the group modern versus traditional vegetables with respect to marketability

Woreda	Frequency calculation for	Traditional	Modern	Total
Alaje	Count	3	8	11
	% within woreda	27.3%	72.7%	100.0%
	% within marketing	6.1%	15.1%	10.8%
Atsbi	Count	7	13	20
	% within woreda	35.0%	65.0%	100.0%
	% within marketing	14.3%	24.5%	19.6%
G/mekheda	Count	5	15	20
	% within woreda	25.0%	75.0%	100.0%
	% within marketing	10.2%	28.3%	19.6%
Kilteawlaelo	Count	7	7	14
	% within woreda	50.0%	50.0%	100.0%
	% within marketing	14.3%	13.2%	13.7%
Kolla Temben	Count	11	6	17

Woreda	Frequency calculation for	Traditional	Modern	Total
	% within woreda	64.7%	35.3%	100.0%
	% within marketing	22.4%	11.3%	16.7%
Raya Azebo	Count	16	4	20
	% within woreda	80.0%	20.0%	100.0%
	% within marketing	32.7%	7.5%	19.6%
Total	Count	49	53	102
	% within woreda	48.0%	52.0%	100.0%
	% within marketing	100.0%	100.0%	100.0%

As can be seen from Table 7, the marketability of the products was amazingly similar. It was surprising to see that the traditional vegetables still had a market, despite the fact that most of them have to be collected from the wild and the labour demands for collection are high. If they were to be domesticated and grown, their marketability could improve. The women were also asked if they found that the availability of the vegetables, especially those collected from the wild had declined.

Spices availability

Seventeen different spices used by women were listed in the study *woredas* (Table 8). The frequency distributions of within and across *woredas* is presented in Table 8.

Table 8. Frequency distribution of spices

No	Name of woody plant	Scientific name	Parts used	Number of Responses	Percent of Cases
	Seseg	Ocimum basilicum	Leaves/fruit	82	84.54
	TsaedaShigurti	Allium sativum	Tuber	53	54.64
	Abaekhe	Trigonella foenum	Seeds	48	49.48
	chenaAdam	Ruta graveolens	Leaves/fruit/ flower	41	42.27
	KehihShigurti	Allium cepa	Tuber	36	37.11
	TselimKimem		Seeds	24	24.74
	Awesuda	Nigella sativa	Seeds	16	16.49
	Kamun	Caminun cyminun	Seeds	16	16.49
	Azmud	Trachyspermum copticum	Seeds	11	11.34
	Senafich	Brassica nigra	Leaves/seeds	10	10.31
	Shifnae	Lepidium sativum	Leaves/Seeds	10	10.31
	Tesne	Thymus vulgaris	Leaves	10	10.31
	Mokmoko	Anethum graveolens	Branch	5	5.15
	Tsakda		Fuits	3	3.09
	Zinjibil	Zingiber officinale	Tuber	3	3.09
	Berbere	Capsicum frutescens	Fruit	2	2.06
	Dimblil	Coriandrum sativum	Seeds	1	1.03
				371	382.47

As can be seen from Table 8 the most commonly used spice is the Seseg with 84.54% of the respondents saying they use it. This plant is followed by TsaedaShigurti, Abaekhe, ChenaAdam and KehihShigurti as the most common plants with 54.64%, 49.48%, 42.27%, and 37.11% of the respondents respectively saying they used these plants.

In Gebremedhin, and Mulubrehan (2007)'s study Seseg, Tseada Shigurti, Abaekhe, Chana Adam, Kehih Shigurti, Awasuda (Tselim Awaseda and Tseada Awaseda), Kamun, Tesne, Tsakda, and Berbera are mentioned, while Tselim Kemem, Azmud, Sinafich, Shinfae, Mokmoko, Zinjibil, and Dimbilil are not mentioned. Ades, Awasenti, Hamli Adri and Shirba were also mentioned in the study of (Gebremedhin, and Mulubrehan 2007), that have not been found in this study. This goes to show that a comprehensive study of the whole of Tigray could reveal a more complex and varied assortment of spices grown.

As can be seen in Figure 3 the frequency of distribution of the spices was variable across woredas. The analysis shows most of the spices are commonly used in all woredas. The spices used in Alaje, Kollatemein and Gulo Mekeda are more common than those used in the other woredas, as these three woredas show clustering. Demblil is mentioned only in Raya Azebo and Zinjibil is mentioned only in Kilte Awlalo. The results of this analysis show slight differences from the frequency distribution tables, as it gives a weighted response.

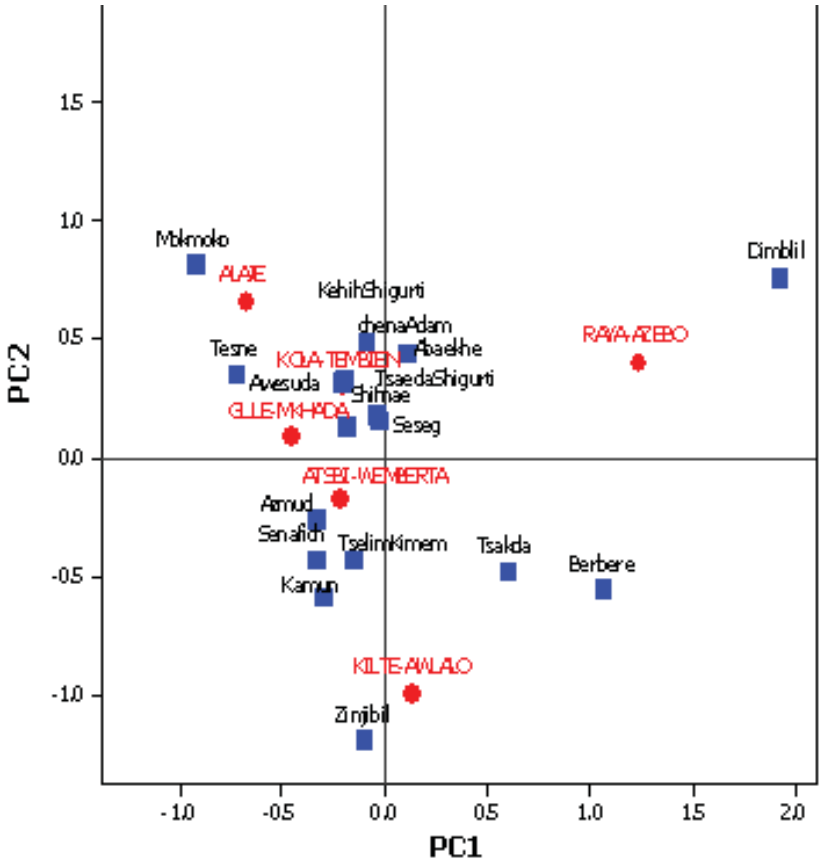

Figure 3. Simple correspondence analysis result for spices used by women

Acceptance quality of the plant species

All the species that are edible are not equally attractive for consumption. Some of the species have recorded as good palatability whiles, the others medium or low. For example, ***Brassica carinata, Cucurbita pepo***, Cherry tomato is good and more frequently used as vegetables. However, Amaranthus spp. is less palatable among the commonly available and selected vegetables.

Among the plants, there were species used for the same and/or different consumed parts and species purposely cultivated for other uses, but also having parts that are sporadically consumed. Although most of the edible plants were safe for consumption, few species that consumed mainly during severe famine (such as leaf and seed of ***Amaranthus spp***), were believed to cause health problems. Some of the respondents indicated plants cause some effect; the symptoms included exhaustion, vomiting, sore throat, stomach ache, abortion etc. The type and severity of health problems depend on which part and how much is consumed.

Socio-Economic Significance

In addition to food value, the identified species are marketable and provide the opportunity to supplement household income. This is indeed observed in the study areas where various wild edible plants were sold at local market. Among the local vegetables the highest market demand attributed to the Ethiopian mustard (two-thirds of produce is sold), followed by ***cucurbita pepo***. Of all edible plants produced, only some reaches the market and the rest is either consumed at home or presented as gift to others. Among the farmers cultivating traditional vegetables, the share of farmers selling in the market is highest in Hawzen (64.5) and lowest in Raya Azebo (22.9%).

Conclusion

The six woredas assessed in Tigray are also endowed with a rich biodiversity with a range of applications as food, flavouring of food and beautification. All woredas have unique plants used by women and children. The high number of diverse plants used shows the presence of high biodiversity. In the interviews all interviewed women stated that the availability of these plant resources has declined. The main reason given by most women is a dryer climate, with a second reason being increased population size with increased demands on the plant resources. One unique reason given was the preparation of compost, which has now resulted in the destruction of seeds found in the dung of browsing cattle. Spreading of dung in the backyard had resulted in the production of these wild plants in the past, with the compost preparation at the current time this has stopped. Overall, the declining availability of the plants shows the need for methods of conserving this rich biodiversity.

References

Cufodontis, G. (1953-72). Enumeratio Plantarum Aethiopiae, Spermatophyta. Bulletin du Jardin Botanique National de Belgique, Bruxelles

Edwards, S.B. 1991. Crops with wild relatives found in Ethiopia. Plant genetic resources of Ethiopia,: p. 42-47.

Edwards,S.Sebsebe Demissew and Hedberg, I (eds.). 1997. Flora of Ethiopia and Eritrea. Volume, 6.

Gebremedhin, T. and H. Mulubrehan. 2007. Women in backyards: root crop production and biodiversity management in backyards–a case study in five selected woredas of Tigray Regional State, Northern Ethiopia, , Drylands Coordination Group Report.

Harlan, J., 1969. Ethiopia: A center of diversity. Economic Botany,. 23(4): p. 309-314.

Schippers, R.R. 2002. African Indigenous Vegetables, An Overview of the Cultivated Species 2002- Revised version on CD-ROM. Natural Resources International Limited, Aylesford, UK.

SPSS. 2011. SPSS statistical package release 20.

Teweldberhan G.E. (1991). Diversity of Ethiopian flora. In: Engles, J.M.M. et al. (eds,). Plant genetic resources of Ethiopia. Cambridge University Presss

Vavilov, N.I. (1951). The Origin, Variation, Immunity and breeding of Cultivated Plants. Chron. Bot. 13:1-366

Acknowledgement

The authors of this study would like to thank IDRC for financial support. They would also like to thank Mekelle University for providing the platform needed for the research.

The evaluation of sorghum and cowpea yield potential in drought prone areas of Embu County, Eastern Kenya

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Abstract

The lower parts of eastern Kenya are characterized by irregular rainfall distribution leading to soil nutrient loss, poor crop yields and increasing poverty levels among smallholder farmers. This has been coupled with inadequate understanding of intra-seasonal rainfall variability, which is necessary to develop an optimal cropping calendar. A study was conducted to evaluate crop yield potential of (***Sorghum bicolor*** (L.) Moench) and cowpea (***Vigna unguiculata*** L.) productivity in the drought prone region of Embu County, Eastern Kenya. The experiment was laid out in Partially Balanced Incomplete Block Design (PBIBD) replicated three times. Treatments included three levels of water harvesting (tied ridges contour furrows and farmers practice, N applied at 0 and 20 and 40 Kg N ha^{-1} with a blanket application of P at 40 Kg P ha^{-1} in all the treatments except experiment controls. Manure was also applied at 0, 2.5 and 5 t ha^{-1}. The test crops were sorghum (Sorghum bicolor (L.) Moench) and cowpea (Vigna unguiculata L.) grown in pure stands or in intercrops. The tie ridges treatments under sole crop plus soil amendment of 40 Kg P /ha + 20 Kg N /ha + manure 2.5 t/ha had the highest grain yield of 3.4 t/ha. The soil fertility management options differed significantly from one another ($p = 0.0001$) in terms of sorghum and cowpea grain yield. There was some significant interactions between water harvesting x cropping systems x soil fertility management options ($p = 0.0001$) and cropping systems x soil fertility management options ($p = 0.0002$). Overall, all experiment 'controls' yielded low amounts of between 0.3 t/ha to 0.5 t/ha. Integrating minimal additions of Nitrogen and organic soil amendment inputs on sorghum under rain-fed agriculture is a crop management option with potential to contribute to food security drought prone areas of Embu County, Eastern Kenya.

Key words: *Eastern Kenya, food security, soil fertility management, rain-fed agriculture and smallholder farmers*

Introduction

Agricultural productivity has been impaired by climate change, declining soil fertility, degradation of natural resources, inefficient markets, weak institutions and policies in semi-arid areas of Kenya. Over 13 million of the 38 million people in Kenya live below the poverty line of less than U.S$1 a day(source). Agriculture is the mainstay of the Kenyan economy contributing approximately 55% of Gross Domestic Production (GDP). The sector further provides 80% employment, accounting for 60% of the exports and 45% of the government revenue [26]. The government in Kenya has put in place the Agricultural Input Subsidy Program (AISP) to support farmers so that they can access inputs such as inorganic fertilizers. In its "Vision 2030", the government also spells out the desire to use agriculture as the vehicle to transform the country to industrialization [1].

Eighty per cent of Kenya's landmass is classified as arid and semi-arid areas characterized by low and erratic waterfall, high evaporation rates and fragile soils that are unsuitable for sustainable rain-fed agriculture in Kenya [16]. The decline in food productivity has been as a result of inadequate understanding of intra-seasonal rainfall variability to develop optimal cropping calendar [30]. Understanding spatio-temporal rainfall patterns rainfall has been directly implicated to combating extreme poverty and hunger through agricultural enhancement [30]. Several recent studies have yielded little evidence on poverty levels and occurrence of dry spells to increase the frequency of rain water use efficiency in semi-arid areas of the whole Africa [28]. This has been contributed by mixed crop-livestock systems being currently projected to see reduction in crop production as a result of drought throughout most East Africa regions due to climate change variability by 2050 [29].

Therefore, semi-arid areas in Kenya continue to experience elevated rainfall onset, variations, length and cessation, persistent dry spells, prolonged droughts and high annual potential evapo-transpiration of 2000 to 2300 mm year^{-1} [14]. There is generally enough water on the total. However, it is poorly re-distributed over time [11] with 25% of the annual rain often falling within a couple of rainstorms, that crops suffer from water stress, often leading to complete crop failure [8]. There exist information gap on inter/intra seasonal variability of rainfall in Embu County despite its critical implication on soil-water distribution, Water Use Efficiency (WUE), Nutrient Use efficiency (NUE) and final crop yield.

This continues to pose a challenge on how to maximize any drop of rain water which falls on the ground to increase agricultural production in these drought prone areas. The food security situation is expected to continue deteriorating and could worsen in future if water harvesting and integrated soil fertility technologies are not adopted by these communities. Along side with soil and water management in these areas, highly valued traditional crops such as sorghum and cowpea should be considered as the 'crop for the future' [3]. However, improving agricultural productivity is crucial for resolving food crises, enhancing food security and accelerating pro-poor growth in these areas.

Most food security research and development programmes tend to focus more in high and medium potential areas by promoting maize and beans, and neglect sorghum and cowpea which are drought tolerant. Yet, these crops are locally important for food and household nutrition, and provide income opportunities to

most vulnerable people and women in particular. However, these premium crops have potential to diversify the farming systems, adapt to spread risks and are more resilient to climatic variability. Therefore, this study assessed crop yield potential of (***Sorghum bicolor*** (L.) Moench) and cowpea (***Vigna unguiculata*** L.) productivity in the drought prone areas of Embu County, Eastern Kenya.

Materials and methods

Study sites location

The figure (1) below shows the map of Kenya and Mbeere South Sub-County showing study area in Embu County.

Site description

The study was conducted in Kiritiri Division, Mbeere south District which lies in the southeastern slopes of Mt. Kenya on latitude of S0.91672 and Longitude 37.47680 to the North and between Latitude S0.47330 degrees and Longitude 37.91238 E to the South at an altitude of 800 m a.s.l . It receives an average rainfall of 700 to 900 mm, temperature of 21.7°C to 22.5°C. The soil type is ferralsols. The study was conducted in agro-ecological zone (LM 5) in Long rains 2011, 2012 and short rains 2012 [6].

Experimental design

The experiment was laid out in a Partially Balanced Incomplete Block Design (PBIBD) with six incomplete blocks per replicate each containing six treatments giving 36 treatments, replicated 3 times making a total of 108 plots. There were 3 levels of water harvesting techniques (Tied Ridges, contour furrows and conventional tillage/farmers Practice), 2 levels of cropping systems (Sole sorghum (Gadam), Sorghum and cowpea (M66) intercrop and 6 levels of soil fertility amendment options (Control, 40 Kg P /ha + 40Kg N /ha, 40 Kg P /ha + 20 Kg N /ha, 40 Kg P /ha + 40Kg N /ha + Manure 5 t/ha, 40 Kg P /ha + 20 Kg N /ha + Manure 2.5 t/ha and manure 5t/ha.. Treatments were assigned to blocks randomly with plot size of 6 m x 4 m.

Data analysis

The biophysical data on crop yield was analyzed using statistical Analysis of Variance (ANOVA) and multiple analysis using SAS version 8. The means were separated using Least Significant Differences (LSD) of means at $p < 0.05$. Differences between treatment effects were declared significant at $P \leq 0.05$.

Field experiment results

The results (Table 1) underscore the scientific crop evaluation from the field experiment during long rains 2011, 2012 and short rain 2011 in Mbeere South Sub-County.

The soil fertility management options differed significantly from one another (p=0.0001) in terms of sorghum and cowpea grain yield. There was some significant interactions between water harvesting x cropping systems x soil fertility management options (p = 0.0001) and cropping systems x soil fertility management options (0.0002). The three levels of water harvesting and the two cropping systems did not differ significantly in terms of grain yield among themselves (p=0.8513) and (p=0.7001) respectively. The total dry matter amount varied

significantly among levels of cropping system and fertilizer application (p= 0.0111 and 0.0001) respectively. However the total dry matter amount did not vary significantly across water harvesting methods (p=0.5333). The sorghum biomass were significantly different among cropping system (p=0.0020) while water harvesting and fertility levels did not differ significantly (p=0.3820 and 0.0854).

Combination Effect

The results further indicated that sorghum without manure application did not differ significantly in yield production with treatments that did not receive fertilizer application. The plots that received fertilizer and no manure gave slightly higher sorghum yield as compared to plots that received manure and no fertilizer (Table 1). The highest sorghum yield (3.4 t/ha) was recorded from tied ridges and contour furrows both under sole sorghum and intercrop cropping system with external nutrient replenishment of 40 Kg P /ha + 20 Kg N /ha + Manure 2.5t/ha. The top eight treatments, yield did not differ significantly from one another ($p<0.05$). The lowest sorghum yield (< 2.0 t/ha) was observed in treatments regarded as 'control' with neither fertilizer nor manure regardless of other intervention (water harvesting methods or cropping systems). The total dry matter and biomass were highest in tied ridges under sole cropping of soil fertility amendment of 40 Kg P/ha +20Kg N/ha +Manure 2.5t/ha (6.4 t/ha) and (3.0 t/ha) respectively.

Discussions

Treatment performance

There is a consistently results (Table 1) on high grain yields, biomass and total dry matter at 3.4 t/ha, 3.0 t/ha and 6.4 t/ha respectively in tied ridges under sorghum alone with a minimum combination of organic and inorganic inputs at half dose application of Nitrogen and manure. There was also significant interactions between water harvesting x cropping systems x soil fertility management options ($p = 0.0001$) and cropping systems x soil fertility management options (0.0002). This is all an indication that soil fertility degradation is one of the major problems facing crop productivity in Eastern Kenya. It is defined by [27] as the loss of soil physical and nutritional qualities over long time in period. It has been an issue of concern that these soils requires minimal nutrient replenishment throughout Eastern Kenya and this cuts across many different soils and crops [24].

Integrated soil fertility management (ISFM) has been cited by many authors, including [24], [5] and [25], as the key approach in raising productivity levels in agricultural systems while maintaining the natural resource base. It is described by [31] as a set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs, and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity in this region. Because of the pressing need for global food security, many articles have been published which relate ISFM to the production of annual food crops like maize [11], and rice [9], giving lesser attention to perennial crops like coffee. It is no longer wondering then that the role of ISFM for sorghum and cowpea in central Kenya and the socio-economic perception of it have not been studied to any significant detail. This was an indication that minimal nutrient replenishment was required in all the season in Mbeere South Sub-County.

Studies by [18, 19] and [4] have also reported that farms in drought prone areas of Embu County require nutrient replenishment every season from manures, fertilizers and from of crop residue return in their farms. It has also been reported by [22, 23] and [13] that soil fertility can be also be accessed through visual observation on crop performance and yield. The results (Table 1) further shown that water harvesting technologies and integrates soil fertility management technologies played a major role in moisture conservation and increased crop productivity. This is in agreement with what [15] and [17] has further found that by incorporation of water harvesting and legumes on-farm the can enhance crop productivity in Eastern Kenya.

The results further shows that the third and the fourth treatments of tied ridges and contour furrow under sorghum and cowpea intercrop with the same soil fertility management options were dominated by their sole cropping systems. This could be as a result of nutrient competition since cowpeas are heavy nutrient miners as they are associated with interspecific competition in mixed stands. The same results have been reported by [10] that crop yield reduction can be experienced in intercrops where they are associated with interspecific competition in mixed stands and the absence of interspecific competition in the monocrops. The results further indicate that probably intercropping sorghum with cowpea depressed sorghum yields and this influenced farmer's decision on crop performance. This outcome for sorghum (Table 1) could be in line with reports for maize from Kenya [21] and in Tanzania [7] where maize grain yields reduction of 46-57% and 9% occurred when maize was intercropped with cowpea due to the competition for moisture between the two crops. Alternatively due to slow mineralization of manure which needed a number of seasons to met the level of nutrient competition [12].

The results by [15] have also shown that cowpea was also a nutrient competitor for maize production in semi-arid areas of eastern Kenya. The experiment control farmers practice under sorghum and cowpea intercrop was the lowest in grain yield. This is in line with continuous cultivation of the same piece of land as this will lead to nutrient depletion and requires nutrient replenishment [20]. This has lead to land degradation contributing to reduced crop production as a result of failure of rainfall distribution in semi-arid areas of Mbeere South Sub-County. However, farmers are discouraged from adopting these water conservation structures as a result of labour shortage and land tenure uncertainty in their farms [2]. Therefore, land productivity can be improved by employing of appropriate agricultural technologies which suit these semi-arid areas of Mbeere south Sub-County, Eastern Kenya.

Conclusion

The results reported in the study demonstrate clear evidence from the study that there is need to incorporate water harvesting and integrated soil fertility management technologies on sorghum and cowpea productivity in drought prone areas of Embu County, Eastern Kenya. This will also suggests that only low-input technologies are currently suitable and need to be adopted through a known crop intensification technologies that could be enhanced in these areas. The results have also demonstrated a very clear message to smallholder farmer, extension services and other stakeholders that there is need for nutrient replenishment on-farm on every season to enhance sorghum and cowpea productivity. Therefore, integration of minimal organic and inorganic inputs under various water harvesting technologies could be considered as an alternative food security initiative towards climate change mitigation for Mbeere South Sub-County, Embu County in Eastern Kenya.

References

CAADP. 2008. Agricultural Policy-Making in Sub Saharan Africa: CAADP Progress in Kenya.

Demelash, M. and Stahr, K. 2010. Assessment of Integrated soil and water conservation measures on key soil properties in south Gonder, North-Western Highlands of Ethiopia. ***Soil Science and Environmental Management*** 1: 164-176.

Fongod, A.G.N., Mih, A.M. and Nkwatoh, T.N. 2012. Morphological and agronomic characterization of different accessions of sweet potatoes (Ipomoea batatas) in Cameroon. ***International Research Journal of Agricultural Science and Soil Science*** 2: 254-245.

Gachimbi, L. N. 2002. Technical report of soil survey and sampling results: Embu-Mbeere Districts, Kenya. LUCID working paper series number: 9. KARI-kabete, Nairobi, Kenya.

Gumbo D (2006). Integrated soil fertility management. Technical Brief, Practical Action Southern Africa, Harare, Zimbabwe. P. 5.

Jaetzold, R., Schmidt, H., Hornet, Z. B. and Shisanya, C. A. 2007. Farm Management Handbook of Kenya. Natural Conditions and Farm Information. 2nd Edition. Vol.11/ C. Eastern Province. Ministry of Agriculture/GTZ, Nairobi, Kenya.

Jensen, J.R., Bernhard, R.H., Hansen, S., McDonagh, J., MØberg, J.P., Nielsen, N.E. and Nordbo, E. 2003. Productivity in maize based cropping systems under various soil-water-nutrient management strategies in semi-arid Alfisol environment in East Africa. ***Agric. Water Management***. 59:217-237.

Jury, M., R. 2002. Economic Impacts of Climate Variability in South Africa and Development of Resource Prediction Models. ***Journal of Applied Meteorology***, 41:46–55.

Kaizzi, C.K., Ssali, H., Nansamba, A. and Vlek, P.L.G. 2007. The potential benefits of Azolla, velvet bean and N fertilizers in rice production under contrasting systems in Eastern Uganda. In: A. Batiano et al (eds). Advances in ISFM in Sub-Saharan Africa: Challenges and Opportunities. Springer. pp. 423-433.

Katsaruware, R.D1. and Manyanhaire, I.O. 2009. Maize-cowpea intercropping and weed Agronomy and Soil Science: Madison, WI, USA. Suppression in leaf stripped and detasselled maize in zimbabwe. ***EJEAFChe***, 8 (11): 1218-1226.

Kimani, S.K., Esilaba, A.O., Odera, M.M., Kimenye, L., Vanlauwe, B. and Bationo, A. 2007. Effects of organic and mineral sources of nutrients on maize yields in three districts of Central Kenya. In: A. Batiano et al (eds). ***Advances in ISFM in Sub-Saharan Africa:*** Challenges and Opportunities. Springer. pp. 353-357.

Lekasi, J. K., Tanner, J. C., Kimani, S. K. and Harris, P. J. C. 2003. Cattle manure quality in Maragwa district, Central Kenya: effect of management practices and development of simple method of assessment. ***Agriculture, ecosystems and environment*** 94: 289-298.

Mairura, F.S., Mugendi, D.N., Mwanje, J.I., Ramisch, J.J., Mbugua, P.K. and Chianu, J.N. 2007. Integrating scientific and farmers' evaluation of soil quality indicators in Central Kenya. ***Geoderma*** 139: 134–143.

Micheni, A. N., Kihanda, F. M., Warren, G. P. and Probert, M. E. 2004. Testing the APSIM Model with Experiment Data from the Long Term Manure Experiment at Machang'a (Embu), Kenya. In Delve, R. J. and Probert, M. E., editors, Modeling Nutrient Management in Tropical Cropping Systems, pages 110–117. ***Canberra, Australian Center for International Agricultural Research (ACIAR)*** No 114.

Miriti, J.M., Kironchi, G., Esilaba A. O., Heng, L.K., Gachene, C.K.K. and Mwangi D.M. 2012. Yield and water use efficiencies of maize and cowpea as affected by tillage and cropping systems in semi-arid Eastern Kenya. ***Agricultural water Management*** 115: 148-155.

Miriti, J.M., Thomas, D.B. and Gachene, C.C.K. 2003. Soil chemical properties, sunflower growth and yields as affected by tillage, compost and mulch application. ***E. Afr. Agric. For. J.*** 68 (3), 159-163.

Mucheru-Muna, M., Pypers. P, Mugendi. D, Kung'u. J, Mugwe. J, Merck. R. and Vanlauwe, B. 2009. A Staggered Maize-Legume Intercrop Arrangement Robustly Increases Crop Yields and Economic Returns in the Highlands of Central Kenya, ***Field Crops Research***. 115, pp. 132–139.

Mugendi, D., Mucheru-Muna M., Mugwe J. and Bationo A. 2003. Enhancement of food productivity using leguminous shrubs in the Eastern highlands of Kenya. ***African Crop Science Conference Proceedings***, 6:581-586.

Mugendi, E., Gitonga, N., Cheruiyot, R. and Maingi, J. 2010.Biological Nitrogen Fixation by Promiscous Sobean (Glycine max L. Merril) in the central Highlands of Kenya: Response to Soil Amendends. ***World Journal of Agricultural sciences*** 6:381-387.

Mugwe, J., Mugendi, D., Mucheru-Muna, M., Merckx, R., Chianu, J. and Vanlauwe, B. 2009. Determinants of the decision to adopt integrated soil fertility management practices by smallholder farmers in the central highlands of Kenya. ***Expl Agric***. 45:61-75.

Nadar, H.M. 1984. Intercropping and intercrop component interaction under varying rainfall conditions in eastern Kenya. II: Maize/cowpea intercrop. ***E. Afri. Agri. For. J.*** 44:176 – 181.

Njeru, P.N.M. 2009. The effect of push-pull management and different fertilisation strategies on maize crop yield in Central Kenya. Msc. Thesis. SLU- Uppsala University , Sweden.

Njeru, P. N.M., Hjalten, J. and Kimani, S. K. 2010. A book on the effect of push-pull management and different fertilization strategies on maize crop yield in central Kenya. ***Lambert Acadamic publishers***, German, SSBN 978-3-8433-6376-1.

Okalebo, J. R., Othieno, C. O., Woomer, P. L., Karanja, N. K., Semoka, J. R. M., Bekunda, M. A., Mugendi, D. N., Muasya, R. M., Bationo, A. and Mukhwana, E. J. 2006. Available technologies to replenish soil fertility in East Africa. ***Nutrient Cycling in Agroecosystems*** 76:153–170.

Raab, RT (2002). Fundamentals of Integrated Soil Fertility Management. IFDC Training materials for the "Training Program on Integrated Soil Fertility Management (ISFM) in the Tropics", Lome, Togo. P. 10.

Ragwa, P.K., Kamau N.R. and Mbatia E.D. 1998. Irrigation and dwaterage Branch position paper. Paper presented during the workshop on promotion of sustainable smallholder irrigation development in Kenya, 16-20 November. 1998. Embu. Kenya.

Stocking M and Murnaghan N (2000). Land degradation: Guidelines for field assessment. Overseas Development Group, University of East Anglia, Norwich, UK. P. 120.

Stroosnijder, L. 2009. Modifying land management in order to improve efficiency of water use in the African highlands. ***Soil & Tillage Research.*** 103:247–256.

Thornton, P.K., Jones, P.G., Alagarswamy, G., Andresen, J and Herrero, M. 2010. Adopting to climate change: Agricultural system and household impact in East Africa. ***Agricultural Systems*** 103:73-82.

Tilahun, K. 2006. Analysis of Rainfall Climate and Evapo-Transpiration in Arid and Semi-Arid Regions of Ethiopia Using Data over the Last Half Century. ***Journal of Arid Environments,*** 64:474–487.

Vanlauwe, B and Zingore, S. 2011. Integrated soil fertility management: An operational definition and consequences for implementation and dissemination. ***Better Crops***. 95(3):4-7.

Acknowledgement

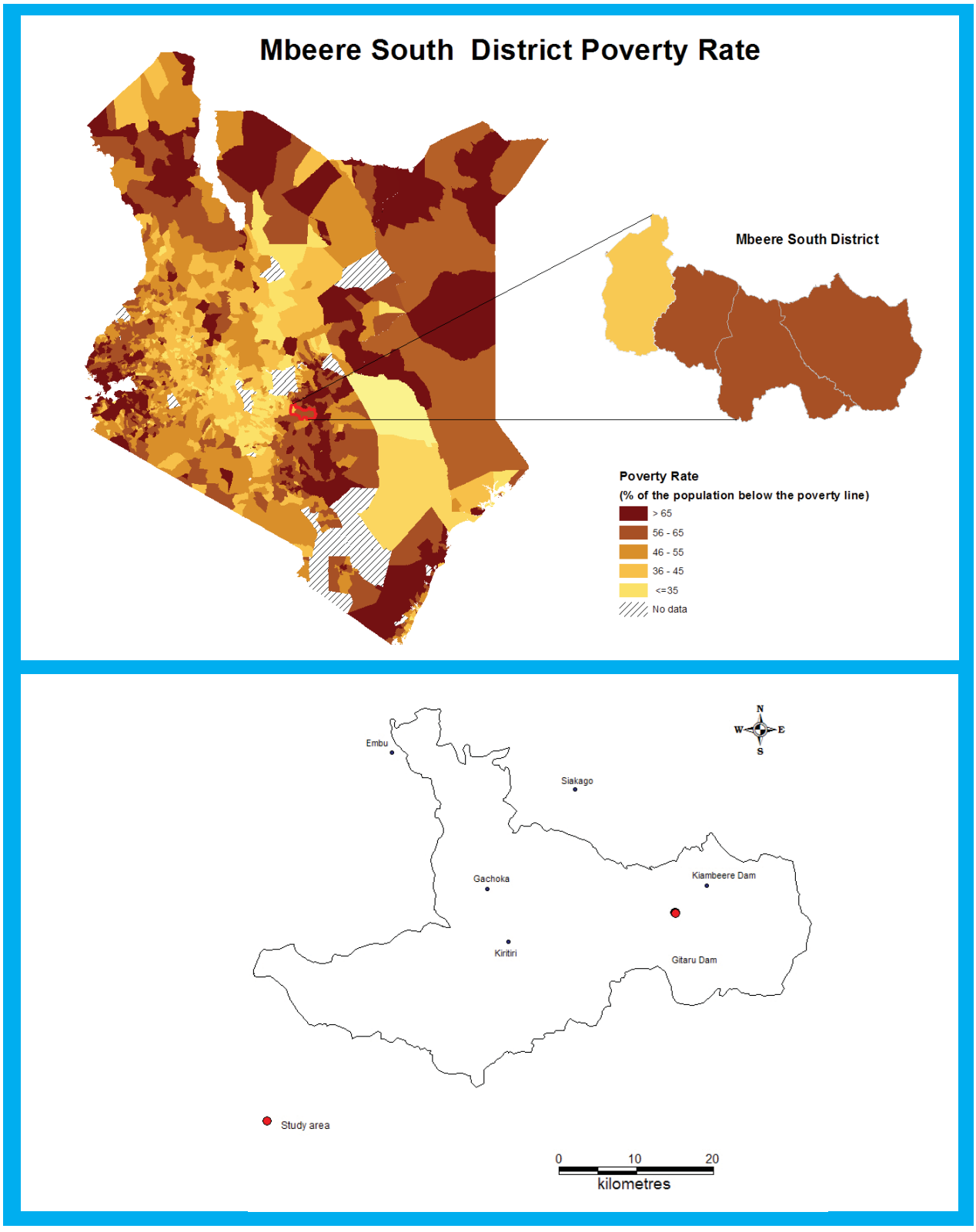
This work was supported by International Development Research Centre (IDRC- Grant Number 105790-003). We would like to acknowledge the Director KARI, Centre Director KARI-Muguga and Kenyatta University supervisors. We are grateful to all the area agricultural extension officers and farmers who participate in this work.

Table 1: The effects of water harvesting, cropping system and soil fertility regimes on sorghum yields in Kiritiri Division

Water Harvesting	Cropping system	Soil fertility management regimes	Total Dry Matter T/Ha	Biomass T/Ha	Grain yield T/ha
Tied Ridges	Sole crop	40 Kg P/ha +20Kg N/ha + Manure 2.5t/ha	6.4	3	3.4
Contour furrows	Sole crop	40Kg P/ha+20Kg N/ha +Manure 2.5t/ha	6.4	3	3.4
Tied Ridges	Intercrop	40Kg P/ha+20Kg N/ha +Manure 2.5t/ha	6.4	3	3.4
Contour furrows	Intercrop	40Kg P/ha+20Kg N/ha+ Manure 2.5t/ha	6.4	3	3.4
Tied Ridges	Sole crop	40Kg P/ha+20Kg N/ha	6.2	2.9	3.3
Contour furrows	Sole crop	Manure 5t/ha	6.1	2.9	3.2
Tied Ridges	Sole crop	40Kg P/ha+40Kg N/ha+ Manure 5t/ha	6.1	2.9	3.2
Tied Ridges	Sole crop	40Kg P/ha+40Kg N/ha	6	2.8	3.2
Contour furrows	Sole crop	40Kg P/ha+40Kg N/ha +Manure 5t/ha	5.8	2.8	3
Tied Ridges	Intercrop	40Kg P/ha+40Kg N/ha +Manure 5t/ha	5.6	2.7	2.9
Contour furrows	Sole crop	40Kg P/ha+40Kg N/ha	5.6	2.7	2.9
Contour furrows	Sole crop	40Kg P/ha+20Kg N/ha	5.4	2.6	2.8
Tied Ridges	Intercrop	40Kg P/ha+40Kg N/ha	5.2	2.5	2.7
Contour furrows	Intercrop	40Kg P/ha+40Kg N/ha	5.1	2.5	2.6
Contour furrows	Intercrop	40Kg P/ha+20Kg N/ha	5	2.4	2.6
Tied Ridges	Sole crop	Manure5t/ha	4.9	2.4	2.5
Contour furrows	Intercrop	Manure 5t/ha	4.8	2.3	2.5
Tied Ridges	Intercrop	Manure 5t/ha	4.8	2.3	2.5

Water Harvesting	Cropping system	Soil fertility management regimes	Total Dry Matter T/Ha	Biomass T/Ha	Grain yield T/ha
Farmers Practice	Intercrop	40Kg P/ha+20Kg N/ha +Manure 2.5t/ha	4.6	2.2	2.4
Farmers Practice	Sole crop	40Kg P/ha+20Kg N/ha	4.6	2.2	2.4
Farmers Practice	Sole crop	40Kg P/ha+40Kg N/ha	4.5	2.2	2.3
Farmers Practice	Sole crop	40Kg P/ha+20Kg N/ha +Manure 2.5t/ha	4.4	2.1	2.3
Farmers Practice	Intercrop	40Kg P/ha+40Kg N/ha	4.3	2.1	2.2
Farmers Practice	Intercrop	40Kg P/ha+20Kg N/ha	4.2	2	2.2
Farmers Practice	Sole crop	40Kg P/ha+40Kg N/ha +Manure 5t/ha	4.1	1.9	2.2
Farmers Practice	Intercrop	40Kg P/ha+40Kg N/ha +Manure 5t/ha	3.9	1.8	2.1
Farmers Practice	Intercrop	Manure 5t/ha	3.9	1.8	2.1
Farmers Practice	Sole crop	Manure 5t/ha	3.7	1.7	2
Tied Ridges	Sole crop	Control	1.7	1.2	0.5
Tied Ridges	Intercrop	Control	1.6	1.1	0.5
Contour furrows	Sole crop	Control	1.5	1.1	0.4
Contour furrows	Intercrop	Control	1.4	1	0.4
Farmers Practice	Sole crop	Control	1.3	1	0.3
Farmers Practice	Intercrop	Control	1.1	0.8	0.3
Means			4.5	2.2	2.3
CV			17	22.8	20.4
LSD			1.92	1.41	0.2
Test statistics			F(10,376)=2.81;p=0.002	F(10,376)=2.89;p=0.002	F(10,376)=2.81;p=0.002

Figure 1: Shows the location of study site in Mbeere South Sub-County in the map of Kenya



Nutritional Status of children aged (0-59 months) and associated factors in Mbeere South District, Kenya

Theme: Enhancing food and nutritional security.

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Abstract

Information on nutritional status of children under five years is a indicator of nutritional situation in society. Identification of core factors influencing nutrition of this population supports plans to alleviate child malnutrition and its consequences. This study sought to determine the nutritional status of children under five years and associated factors in Mbeere South District. This cross-sectional descriptive study used a structured questionnaire and measurements of weight and height. A total of 144 households were randomly sampled. Nutrition status of one child from each of the sampled households was assessed using anthropometric measurements. The World Health Organization (WHO) reference standard was used to interpret the nutrition status. ENA for SMART was used to compute z-scores; and SPSS was used for descriptive and correlation analyses. The results show that 39% of the children were stunted; 7.9% were wasted; and the underweight prevalence was 22.0%. The prevalence of stunting and wasting was significantly higher in boys than in girls (χ =6.765, df =2, p =.034) and (χ= 13.053, df =2, p = .036), respectively. The individual dietary diversity score showed that the most consumed food group was cereals. Eggs and meat were the least consumed foods. Low diversity scores were recorded for 41.9% of the children (< 4 food groups); 35.7% had medium scores (4-5 food groups) while 22.5% had high scores (6- 8 food groups). There was significant association between household size and nutritional status (P=0.047). The findings indicate that malnutrition and dietary diversity are major challenges in Mbeere South District. Future interventions should focus on improving food access and availability for enhanced diet diversification for the rising population.

Keywords: Nutrition status, dietary diversity, associated factors

Background

Nutritional status of children is an indicator of the level of development and future potential of the community. The nutritional status of infants and children under five years of age is of particular concern since the early years of life are crucial for optimal growth and development [1]. Nutritional deficiencies affect long term physical growth and development and may lead to high level of illness and disability in adult life. Moreover high prevalence of malnutrition jeopardizes future economic growth by reducing the intellectual and physical potential of entire population [2]

Undernutrition among children remain common in many part of the world. About 178 million children under five years worldwide are too short for their age group while 115 million are underweight. Stunting rate among children is higher in Africa and Asia [3]. In Kenya, 35 percent of children under five are stunted, while the proportion severely stunted was 14 percent; 16 % are underweight (low weight-for-age) and 4 % are severely underweight. [4].

There has been agreement among researchers on factors contributing to malnutrition. The primary determinants as conceptualized by several authors relate to unsatisfactory food intake, severe and repeated infections, or a combination of the two [5, 6, 7]. The interactions of these conditions with the nutritional status and overall health of the child and by extension of the populations in which the child is raised have been shown in the UNICEF Conceptual framework of child survival [5]. The model characterizes the correlates of malnutrition as factors that impair access to food, maternal and child care, and health care. It is these very factors that impact the growth of children. Consequently, the assessment of children's growth is a suitable indicator for investigating the wellbeing of children, and as well as for examining households' access to food, health and care [8, 5].

Factors associated with malnutrition differ with countries or even regions around the world. The objective of this study is therefore to determine the three common indicators of malnutrition (stunting, wasting and underweight) among children below the age of five in Mbeere South District (MSD) and analyze on some of the demographic and socio-economic factors that others studies suggest are associated with malnutrition. These include characteristic like household size, marital status of household head, level of education of the mother, household income and child dietary diversity.

The result of this study will support the plans to formulate appropriate policies and evidence based intervention aimed at addressing factors affecting malnutrition in MSD. Ultimately, the incidence of child malnutrition and its consequences can be reduced.

Materials and Method

Study site

The study was conducted in Mbeere South District in Eastern province of Kenya. The District lies between latitudes 0° 20′ and 0° 50′ south and longitudes 37° 16′ and 37° 56′ and covers a total area of 2,092.5 km^2 with a population of 219,220 persons [4]

Study design

A cross sectional survey, both descriptive and analytical in nature was carried using structured questionnaire and measuring the height and weight to determine the nutritional status of children aged 0-59 months. It was conducted in Mbeere South District.

Sampling

According to multiple indicator survey (MICS) conducted in Embu District in 2008, proportion of underweight children in the District was 10% [9]. This assumption and confidence interval (CI) of 95 % were taken into consideration to determine sample size for population greater than 10,000 [10]. A total of 144 households with children 0-59 months were randomly selected for the study. Households with a child aged 0-59 months and were permanent residents of the study area were included in the study. Household without a child aged 0-59 months and those with children below 59 months but not permanent resident of the study areas were excluded from the study. A child aged 0-59 months was purposively selected for the study from each of the selected household. Household with more than one child aged 0-59 months, only one child was selected for the assessment randomly by toss of a coin. It was assumed that children in the same household are subjected to the same condition hence any selected child can represent the household.

Data collection method

Research assistants were trained on taking of anthropometric measurements and basic interviewing techniques. The questionnaires and anthropometric tools were pretested for validity. The data collection took two weeks.

Socio-economic and demographic data

The respondents were interviewed to give details on their household profiles like age, sex, education level and occupation of household members, household size and marital status of the household heads. Data on sources of income and dietary diversity were also collected.

Anthropometry

Anthropometric measurements taken for children aged (6-59) months to determine their nutritional status. Standard technique and equipment were employed [11] as follows:

Date of birth: The date of birth for each child was inquired from the care taker/ mother and cross checked from immunization cards and recorded in months.

Length/ height: Length for children (6-24) months was measured lying flat and centrally on measuring boards placed on a hard flat surface on the ground. The length was read to the nearest 0.1 cm (head and feet against the base of the board and foot piece respectively).

Height of children aged above 24 months was measured standing straight on measuring board placed on hard flat surface against a wall with line of sight perpendicular to the horizontal surface. The child's height was measured to the nearest 0.1 cm

Weight: the child was put in the weighing pants and was gently lowered on the standardized Salter scale with the strap of the pant in front. The scale was hanged from a secure position, the child's weight read to the nearest 0.1 Kg after the scale needle stabilizes.

Data analysis

Emergency Nutrition Assessment for Standardized Monitoring and Assessment of Relief and Transition (ENA for SMART) was used to compute Z-score (weight-for-age, height-for-age and weight-for-height) according to WHO reference standard [12], taking-2SD as cut-off points (underweight, stunting and wasting). SPSS version 20 was used to enter and analyze data on demographic and socio-economic data. Data cleaning was done by running and tabulating all variable frequencies.

Frequencies and cross tabulation were used to give frequencies, means, standard deviation in descriptive analysis on socio-demographic characteristics of households and study children.

Measure of dietary diversity score of the children was based on simple counts of number of food groups consumed by the child in the past 24 hour (8 food groups by FAO for individual dietary diversity) [13].

Correlation analysis was conducted in SPSS to establish any association, strength and direction of such association between demographic and socio-economic characteristics and nutritional status of children.

ENA for SMART was used to convert raw anthropometric data (weight, height and Age of the children) into anthropometric Z-score that was used to classify children into levels of nutritional status (stunting H/A, wasting W/H and underweight W/A). The classification of the nutritional status was done according to the WHO,2006 [12] cut-off points recommended by the world Health Organization. For all the condition, children were classified into categories of nutritional status as follows. Below-3 Z-Scores = Severe, Between-3 and <-2 Z-Scores = Moderate , ≥-3 to <-2 Z scores = Global, ≥-2Z-Scores = Normal

Results

Characteristic of study population

The survey was conducted among 144 households from 15 different villages in 2 locations, Kiambere (67 %) and Mutuombare (33 %) of Mbeere South District. The household size ranges from two to eleven people with a mean size of 5 people per household. Age distribution of the household members was highly varied. The proportion of children aged between 6-17 years was comparatively higher (27.8%). The children under five years (target population) comprised 26.9% of the total population**.** The ratio of male to female in the study population was approximately 1: 1.1. The dependency ratio of the population was 0.98. The majority of the study population attended primary school or was in primary school (71%). About 23.5% attended secondary school while only 2.0% attained above this level. The main occupation was farming (43.1%). Only a very small proportion (3.7%) of the study population had salaried employment **(table 1)**

One out of every 10 households was female headed. Majority (89.5%) of the household heads were married. Majority (57.6%) of the household heads were farmers. Only a very small proportion (10.4%) of household heads had salaried employment. About 15.6 % were self employed or engaged in small business and 13.9% were casual laborers. The others were either student (0.7%) or had no employment (1.8%). Although the study shows that all the household heads had some formal education, the highest education level attained by majority of the household heads was 5-8 years of primary education (63.2). Only 4.3% attended college.

The main source of income among the study population was sale of crop (42.7%) followed by sale of livestock (27.1%). The mean monthly household income in the study population was Ksh. 4160.65 (SD= 5581.62). The minimum monthly income among the study population was Ksh. 200 while the highest income was Ksh. 20,000. Majority (52.2%) of the households earn less than Ksh. 2000 per month.

Malnutrition among the children

42 % of the study children were boys and 58 % were girls. The mean age of the sampled children was 28.4 months (SD = 17.7) with the youngest child being 0 months old and the eldest 59 months old. Of the children examined, 61 % had normal height for their age. The prevalence of stunting among the children was 39%. About 28% of these were moderately malnourished while the rest (11%) were severely stunted. 92.1% of the children had normal weight for their height. Prevalence of wasting was 7.9 % ; about 6.3% moderately while 1.6% severely wasted.

Prevalence of underweight was assessed using weight- for- age z-scores for 144 children aged (0-59 months). There was no evidence of prevalence of underweight observed among 17 children below the age of 0-6 months. However, for children aged (6-59 months), the prevalence of underweight was 22.0% of whom 16.5% were moderately underweight while 5.5% were severely **(Table 2).**

The prevalence of wasting and stunting was higher in boys than in girls χ= 13.053, df =1, p = .036) and (χ =6.765, df =2, p =.034) respectively. A chi-square test on the difference in the prevalence of underweight between the difference gender found no significant difference (p>.05). In all the three indicators of nutritional

status, the prevalence in the first year of life was observed to be low. Stunting reaches it's peak in the third year and reduces as age progresses.

Dietary diversity of the children

Individual dietary diversity assessment was carried out for children aged 6-59 months using eight food groups as stipulated by FAO [13]The mean dietary diversity was 4.2 food groups (SD =1.7). The minimum number of foods was 2 food groups while the maximum was 8 food groups. Most (24.2%) of the children consumed 3 food groups while only 4.7% ate foods from the 8 groups. Cereals was the most popular food group consumed by the children, followed by legume, nuts and seeds at 97% and 76.8 % respectively. The eggs and meat group was the least consumed food group at 36 % and 19.2% respectively.

Classifying the number of food groups consumed revealed that majority of the children (41.9%) had low diversity (< 4 food groups). About 35.7% of the children had medium diversity (4-5 food groups) while only 22.5% had high dietary diversity score (6- 8 food groups).

Association of selected variable with child nutrition status

Bi-variate analysis was performed on various selected variables with nutritional indices of the children to determine possible associations. A positive and significant correlation was found to exist between underweight, stunting and wasting. Negative and significant correlation was observed between children's age and nutritional status based on wasting and underweight. A positive and significant relationship was found between household size, stunting and wasting **(table3).**

There was no significant association between the three indicators of nutritional indicators and gender and education level of the household head. There was no direct significant association between household income and nutritional indicators. However $p<0.05$, there was a significant association between number of food groups consumed and household income.

Although poor dietary diversity is evident among the children, at $p>0.05$, there was no statistically significant relationship observed between dietary diversity and the nutritional indicators.

Discussion

Nutritional status of children under five years of age is an outcome of immediate, underlying and basic causes of malnutrition [14]. Analysis of nutrition status in this study is according to the new WHO, 2006 standard.

The finding of this study shows that generally prevalence of stunting was high but lower than that reported by KDHS for Eastern province [4]. Prevalence of wasting was similar, while that of underweight was higher compared to that of Eastern province. Prevalence of all the three indicators were higher in this study as compared to MICS conducted in former Mbeere District [15]. No evidence of overweight was observed in this study.

The observation that the prevalence of stunting in the first year of life is low is similar to finding of a survey conducted in the year 2008 in Mbeere District [9]. Prevalence of stunting is higher among children 12-35 months. This could be attributed to poor weaning, and complementary feeding practices resulting to inadequate energy and protein intake. Negative and significant relationship observed between children's age and nutritional status based on stunting and underweight could be explained by the fact that as the child grow older he/she becomes more dependent and access different food than the younger infant who depend on what is provided by the caregiver/mother [16]. However in this study the prevalence of wasting and underweight seem to increase after the 48 months of age. This is probably due to increased physiological activities of the child at this age which necessitate more nutrient intake to support growth and development. A person activity level will affect their nutritional requirement. High activity level improves metabolic efficiency and increases nutrient requirement. Other factors could be due to the fact that most children at this age are outside homes either in school or playing, failing to feed regularly to replenish their energy. Finding that prevalence of stunting and wasting being higher in male than female concurs with that of national prevalence [4]. Other studies are required to explain the relationship between sex and nutritional status.

Negative significant relationship between household size and stunting and wasting could be explained by the fact that family meal is distributed among large number of people resulting to inadequate diet for an extended period eventually causing chronic malnutrition.

Contrary to other studies [17,18] this study did not find significant association between nutritional status and dietary diversity. Malnutrition may be caused by other factors other than just having a diversified diet. Additional studies are required to explain cooking method and caloric adequacy of the complementary food consumed by children in the study area. The high consumption of food items from mainly cereals observed in this study only confirms that diets of the children are predominantly based on starchy staples. From personal communication, the diet of children below three years mainly comprise of starchy staple (mashed banana and potatoes). While the intake of energy is important in diet, other nutrient such as vitamins, proteins and minerals are also necessary for healthy living. Besides lacking adequate nutrient, it is also possible that the quantity of carbohydrates obtained from these cereals group is still not adequate to meet the macronutrient needs of the children. Moving from a monotonous diet to one containing a more diverse range of foods has been shown to increase intake of energy as well as micronutrients in developing countries [19] The low consumption of egg and meat group confirms that the their diet constitute very little animal protein and thus large number of children are deficient in calcium, iron and vitamin A.

The study found no relationship between the nutritional status and gender of the household head as well as their education level. These could be attributed to the fact that the overwhelming majority of the household head were of the same gender (male) and also similar in their education level (grade 5-8) to impact difference in nutritional status.

Conclusion

In conclusion the result of this study shows that malnutrition rate among the children under five years is high and clearly confirms that malnutrition is still a wide spread health problems. Diversity and quality of the meals of particularly children below 3 yrs is poor. Less than 25% of the children consumed highly diversified while over 40 % consumed poorly diversified. Therefore, findings specify that malnutrition and dietary diversity are major challenges in Mbeere South District. Future interventions should focus on improving food access and availability for enhanced diet diversification for the rising population.

Reference

1. Preschulek H, Aldana JM and N Hassan. Feeding practice and malnutrition in children in rural Bangladesh. Food and Nutr. Bull. 1999; 20 (4): 396-400.

2. Kabubo-Mariara J, Godfrey K. Ndenge and Domisiano M. Kirii. Determinants of Children's Nutritional Status in Kenya: Evidence from Demographic and Health Surveys. Oxford, 2006.

3. WHO. World Health Statistics.World health organization, Geneva 2011

4. Kenya National Bureau of Statistics (KNBS) and ICF Macro. 2010. Kenya Demographic and Health

Survey 2008-09. Calverton, Maryland: KNBS and ICF Macro.

5. UNICEF. The state of the World's children. Oxford University Press, Oxford(1998).

6. Rowland MG, Rowland SG and TJ Cole. The impact of nutrition on the growth of children from 0-2 years in age in an urban West African community. Am. J.Clin. Nutr. 1988; 47:134-48

7. Schroeder DG and KH Brown. Nutritional status as a predictor of child survival:Summarizing the association and quantifying its global impact. Bull. WHO 1994;72:569-79

8. de Onis M, Monteiro C and Akre J et al. The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. In: http://www.who.int/whosis/cgrowth/bulletin.htm (Accessed on 2/09/2013).

9. Kenya National Bureau of Statistics, 2009. Embu district Multiple Indicator Cluster Survey 2008, Kenya: Kenya National Bureau of Statistics.

10. Fisher AA, Laing JA and JW Townsend. Handbook for Family Planning Operations Research, 2nd ed. Population Council. New York, USA 1991: 40-46.

11. Gibson, R.s.. Principles of nutrition assessment 2005.2nd ed. Oxford university Press, New York.

12. WHO. Multicentre Growth Reference Study Group. WHO child growth standards: Length/height-for-age, weight-for-age,weight-for-length,weight, weight-for-height and body mass index-for-age: methods and development 2006.. Geneva. http://www.who.int/childgrowth/standards/ accessed 2/09/2013

13. FAO. Guideline for measuring household and individual dietary diversity, version 4. Nutrition and consumer protection division 2008. Food and Agricultural Organization(FAO). Rome, Italy

14. UNICEF. Strategy for improved nutrition of children and women in developing countries: a UNICEF policy review 1990-91. UNICEF, New York

15. Kenya National Bureau of Statistics, 2009. Mbeere district Multiple Indicator Cluster Survey 2008, Kenya: Kenya National Bureau of Statistics.

16. Meme MM. Nutrient Intake and Nutritional Status of Primary School Children in a School With and Without a Feeding Programme in Nyambene District, Kenya. MSc Thesis, University of Nairobi 1996: 48-71

17. Ruel MT. Is diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. FCND Discussion paper No. 140, International food policy research institute, Washington, DC, USA, 2002.

18. Onyango A, Koski K and K Tucker. Food Diversity Versus Breastfeeding Choice In Determining Anthropometric Status In Rural Kenyan Toddlers. International Journal of Epidemiology, 1998;27:484-489.

19. Gina LK, Maria RP, and Chiara S et al. Dietary Diversity Score Is a Useful Indicator of Micronutrient Intake in Non-Breast-Feeding Filipino Children. The Journal of Nutrition.2007; 137:472-477.

Acknowledgement

We are grateful to the Director Kenya Agricultural Research Institute (KARI) for Supporting this project. We thank the International Development Research Cooperation (IDRC) for funding this project. Special thanks also to community members of Mbeere South district who accepted to participate in this study.

Table 1: Characteristics of study population

Characteristics	Statistics	
	N	%
Total households	144	100
Sex distribution		
Male	320	53
Female	361	47
Sex ratio		
Male to female	1:1.1	
Education level		
University	1	0.2
College	9	1.8
Secondary	114	23.5
Primary	345	71.0
Illiterate	17	3.5
Occupation	N	%(N=459)
Salaried employment	17	3.7
Farmers	198	43.1
Self employment	36	7.8
Student	173	37.7
Unemployed	7	1.5

Age distribution	N	%(N=681)
<5	183	26.9
6-17	189	27.8
18-25	78	11.5
26-35	136	20.0
36-45	76	11.2
46-54	13	1.9
>54	6	0.9
Dependency status		
0-14(dependent population)	342	50.2
15-64(Productive population)	337	49.5
>65(dependent population)	2	0.3
Dependency ratio	0.98	

Selected characteristics of the household heads

Household heads characteristic	% (N=144)
Sex of household head	
Male	90.8
Female	9.2
Marital status of household heads	
Married	89.5
Separated	2.8
Widowed	0.7
Single	6.3
Divorced	0.7
Occupation of household heads	
Salaried employment	10.6
Farmer	57.7
Self employed	15.5
Casual labor	14.1
Student	0.7
Unemployed	1.4

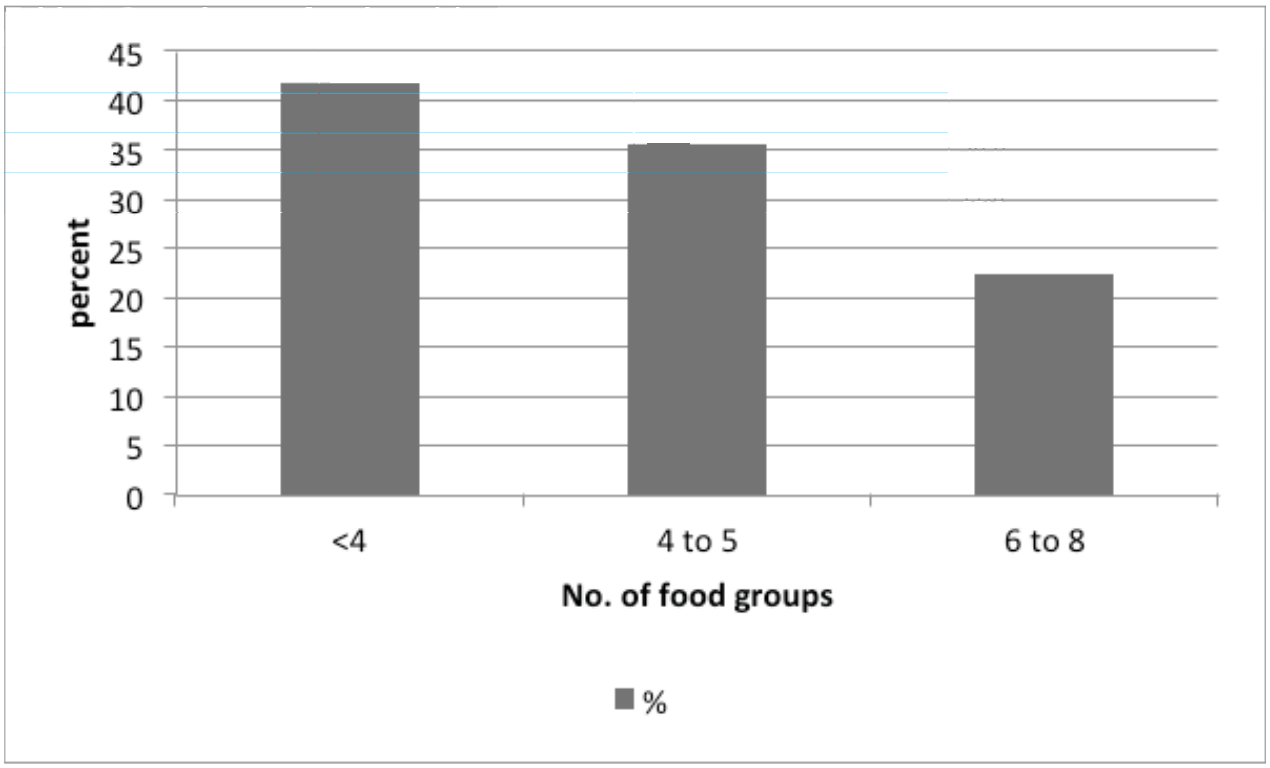

Figure 1: Dietary diversity score

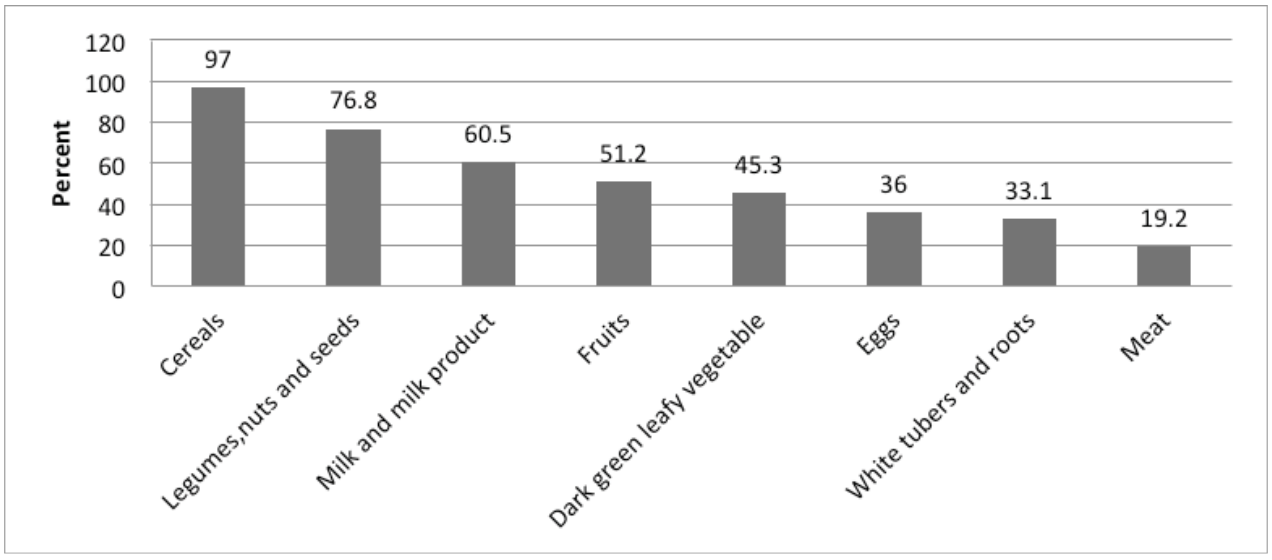

Figure 2: Distribution of children by food group consumed

Table 3: Correlation coefficients of selected socio-economic factors and nutrition status

Variable	WAZ	HAZ	WHZ
	R	r	r
WAZ	1.000	.504*	.828*
HAZ	.504**	1.000	-.047
WHZ	.828**	-.047	1.000
Household size	.611	-.210**	-.202*
Education of household head	-.045	.036	-.052
Gender of household head	-.91	.013	-.013
Age of the child	-.296**	.544*	-.243**
Household income	-.592	-.270	.576
Child dietary diversity	-.346	.312	.224

*** Correlation significant at 0.01 level (2 tailed). *Correlation significant at 0.05 level (2 tailed)*

The marketability of bag silage among smallholder farmers in Zimbabwe

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Abstract

Silage bagging technology is more adapted to smallholder farm conditions compared to bulk silo methods and can also facilitate sale of silage as a commercial product. A survey was carried out in Chikwaka and Mariragwe farming areas to evaluate the marketability of bagged silage in the Zimbabwean smallholder dairy sector. 49 smallholder dairy farmers where purposively sampled and interviewed through semi-structured questionnaires to assess the characteristics of the farmers, needs and perceptions on using bagged silage. The majority of the farmers (59%) owned less than five dairy animals with 96% of them taking dairy as a serious business venture. 89.6% of the farmers are already using silage as a dairy cow feed but the majority make own silage while others buy from neighboring commercial farms. 83.7% of the interviewed farmers are willing to buy bagged silage if available in the market. It was concluded that there is a market opportunity for bagged silage in Chikwaka and Mariragwe area but the product and distribution model must have a competitive advantage over the current silo silage by used by the communities.

Introduction

In developing countries of the tropics and subtropics, livestock production is often restricted by inadequate feed supply during prolonged dry seasons (Reiber et al, 2010). In much of Zimbabwe, livestock keepers face a 4 to7 months dry season in which feed is scarce and expensive. This particularly affects smallholder farmers. About 20 % of smallholder farmers even cease milking during the dry season due to feed shortage (Reiber et al, 2010). According to Njarui et al (2011) maintaining access to adequate quantity and quality of feed resource is crucial for milk production in dairy cattle Forage conservation in the form of silage is an option to increase dry season feed availability. However, in the tropics silage adoption among smallholders in general has been low (Reiber et al, 2010).

Important factors to improve adoption of silage by smallholder farmers in the tropics are low investment costs, low risks and the potential of rapid and significant returns on investment (Machin, 2000). Novel techniques are required so that farmers without access to tractors, forage harvesters or bales can have access to silage (Reiber et al, 2010). Studies have shown that plastic silos can produce silage of acceptable quality from different crops or crop combinations. Such studies suggest that bag silage is a suitable low-cost technology

for smallholder farmers (Titterton et al, 2002) because of its low requirements for initial investment and manpower. Bagged silage would also be flexible in handling and feeding according to individual farmer needs. It also has a great market potential because it is easy to transport. Unlike in pit silos, there is reduced risk of aerobic deterioration during feeding since only a small number of bags are opened (Reiber et al, 2010). It has been reported to be widely used and marketed in smallholder dairy farms in Thailand and but there are no such reports in Zimbabwe and other developing countries in Southern Africa (Reiber et al, 2010). The objective of this study was therefore to evaluate the marketability of bagged silage in the small holder dairy sector of Zimbabwe.

Methodology

The study was conducted in Chikwaka and Marirangwe area of Mashonaland East Province, Zimbabwe. The province is in Natural Region IIb, receiving an average annual rainfall of 750mm to 1 000mm. A total of 49 households were purposively sampled and interviewed through pre-tested semi-structured questionnaires. Data on the characteristics and needs of the market, preferred pricing option, general perceptions on silage usage and willingness to buy bagged silage was collected. The data was analyzed using Statistical Package for Social Sciences Version 17.

Results

Characteristics and needs of the market

All farmers in the population of study were either a member of the Mariragwe or Chikwaka dairy association. The correlations between dairy association and some demographic characteristics were analyzed. For herd size it was found to be 0.128, 0.305 for qualification held and 0.265 for milk produced per day. So there was no strong association between those characteristics and the dairy association the farmer belonged to. Of the 49 farmers interviewed, 53% did not have any form of tertiary education in agriculture or anything else. 46.9% of the farmers had some form tertiary training either through Master Farmer Training (34.7%), Certificate in Agriculture (2%), Diploma in Agriculture (2%) or some non-agriculture training (8.2%). Herd sizes ranged from 1 to 103 animals with a mean value of 9.16±17.1. The majority (59 %) of the famers own five or less animals (Figure 1) with a very small proportion of farmers (4%) having a herd size of more than 20 animals.

The majority (95.9%) of the farmers keeps dairy animals for income generation alone and insists that all the milk is sold with little or no milk saved for household consumption. Only 4.1% of the farmers keep dairy animals for both income and home consumption. This group of farmers shares their milk between household needs and sales, without depriving themselves milk for consumption.

Farmers also characterized a number of production challenges. These included disease outbreak, limited feed availability, poor breeding systems, poor market linkages, lack of extension and insufficient labour (Figure 2). Limited feed availability and lack of extension services were identified as the most outstanding production challenges while labour availability was found to be the least constraining production factor.

General perceptions on silage usage

All famers in the area supplement their animals in times of need and they also know about silage as a conserved feed for dairy animals. Most farmers (89.8%) have used silage in their feeding systems with only 10.2 % depending on the natural veld and other commercial supplements only. Of the 89.8% farmers who use silage as a feeding resource, 53.1% make their own silage, 28.6 % buy from neighboring commercial farms and 8.2% make their own but also buy when they cannot meet own demands. Those who buy silage purchase it in bulk from surrounding large scale farms. The commercial farmers selling silage do so in bulk with a minimum purchasing amount being 1000 kilograms. As such farmers combine their needs and the silage is transported to the milk collection centre in trucks for distribution. At the milk collection center, sharing of the silage is done among farmers who then pack and transport the silage in 50 kilogram bag containers to their homesteads. Only 18.4 % farmers are travelling for more than 10km to silage collection points (Table 1). The majority (63%) of the famers are either with 2km or making silage at ther homesteads.

Willingness to buy bagged silage and preferred bag

Asked whether they would be interested in buying already bagged silage, 83.7 % of the farmers said yes, with only 16.3% not interested as they perceive it as a low value product which should not be bagged. However the demand of silage seems to be seosonal with the majority of consumption being reccorded in the late dry season (Figure 3). Of the farmers who are prepared to buy bagged silage the majority (63.3%) would prefer to buy 50kg units, followed by 28.8% preferring to buy 20 kg units, 14.3% preferring 15kg units and only 6.1% preferring 5kg units (Figure 4). Even though most farmers preferred 50kg units, very few farmers (7.7%) indicated more than 10kg silage consumption per day. Half of the farmers (50%) are using between 4 to 6kg per day, followed by those using 7 to 10 kg (24.9%) and 1-3kg (15.4%).

Preffered pricing options

Currently farmers are purchasing silage from the neighbouring commecial farmers at an average price of $0.058 per kilogram. The farmers were asked to offer prices on the different bag size options given that they know the going price. As shown in Table 2, famers were generally not able to offer prices with no price offers at all for the 2kg and 10kg bags. The few farmers who offered prices for the 5kg, 15kg, 20kg and 50kg bags had price ranges of $0.02-$0.30 per kg. The 50kg bag had better responses in terms of price offer, with only 37% of the responcendes failing to give an offer.

Discussion

The fact that most of famers produce mainly milk for selling means that they view their dairy activities as a business enterprise as opposed to a subsistence activity, creating an opportunity to encourage to buying of silage. With the majority of the famers owning less than five animals, bagged silage becomes more appropriate as farmers can purchase or make bag sizes appropriate to their herd sizes. According to Eyers, (1989) bale silage is especially useful when small quantities of silage are needed, which is usually the situation in smallholder farming situations. Such an intervention will also reduce cost of production in the smallholder sector as bagging silage is said to be of a low cost with flexibility in storage capacity (Bernades and Chizzotti, 2012). This would ensure that the quality is kept and maintained at acceptable level. Currently

most famers using silage as a dairy feed, are depending on buying pit silage from nearby commercial farmers. Given the distribution model, there is a possibility that the quality of silage is compromised before even the initial feeding process. According to Bernades and Chizzotti (2012) quality losses during unloading and feeding depend on the duration of the exposure of the silage to air. The current distribution model exposes silage to oxygen, thus risking deterioration in quality. With such a challenge in the distribution system, it may be appropriate for farmers to use bagged silage as this would help in minimizing exposure of silage to oxygen. According to Driehuis (2013), the most important prevention strategy for silage derived mycotoxins is to restrict exposure of silage to oxygen. As such this creates an opportunity to sell bagged silage to farmers.

Although 53% of the farmers making own silage in pits, forage outsourcing is becoming a more common trend internationally for dairy farmers. Gillespie et al., (2010) states that dairy farmers are better of outsourcing silage because the improved management associated with a specialized milk-producing farm and a second specialized forage-producing farm potentially allows each to produce milk or forage at lower cost per unit than would one farm producing both products. Resistance to buying bagged silage is not likely to be a problem in this community as evidence by willingness to but the product if available. However since the product is already there in the market, bagged silage would have to be competitively priced to enhance profitability of their operations because farm profitability is positively correlated to adoption of any forage technology (Turinawe and Mugisha, 2012). Moreover farmers are not travelling long distances to buy silage and as such the bagged silage would have to be made as close to the targeted buyers as possible. To support adoption of the bagging technology, extension services would have to be available because farmers identified poor extension service as a challenge in their production system. Such services would have to be relevant to the bagging of silage to encourage adoption of the forage technologies. The fact that all the farmers belonged to a dairy association can also facilitate adoption or usage of the bagging technology because Turinawe and Mugisha (2012) observed that membership to farmer groups had a significant and positive influence on use of new technologies.

Famers preferences of bigger packages seem not related to any quality factors but to the current practice of using 50 kilogram bag containers to carry silage home. As such the farmers were better able to offer a price for a 50 kilogram bag than a 10 or 5 kilogram bag which could be more relevant for most of their feeding circumstances. Give that most of the farmer use between 4-6kgs a day, it means farmers are not relating keeping quality and consumption rates. This is not surprising as most of them are not technically qualified and extension services in the areas are poor. There however would need to be a check on the quality of their silage from days of purchase to last day of use as the described distribution channel increases exposure of silage to oxygen. It is not clear how farmers arrived at the prices offered for a kilogram of silage as their offers are not in some cases close to their current purchase price. This gives an impression of farmers who have no decision making criteria as one would have expected offer prices ranging around the current purchase price, regardless of bag sizes. However there is a general decline in the minimum and maximum prices offered with an increase in bag size.

Conclusion

It can be concluded that there is a market opportunity of bagged silage given the herd sizes, the possible silage quality constraints to milk production associated with the current distribution model and the positive attitude of the farmers towards silage in general and willingness to try using bagged silage. However the product must be competitively priced and located given the competing option of buying silo silage from the nearby commercial farms. Introduction of the bagged silage into the communities must however be backed with good extension services to support uptake of the technology and ensure that farmers make informed decision with regard to bag size and their consumption needs.

References

Bernardes T. F and Chizzotti F. H. M (2012). Technological innovations in silage production and utilization. Rev. Bras. Saúde Prod. Anim., Salvador 13 (3) : 629-641 http://www.rbspa.ufba.br ISSN 1519 9940

Driehuis F (2013) Silage and the safety and quality of dairy foods: A review. Agricultural and Food Science. 22: 16-34

EYERS. B., 1989. Place for big bales in current silage scene. Big Bale Silage. Proceedings ofBritish Grassland Society Conference. 1.1- 1.7. NAC Stoneleigh.

Gillispie J, Nehring R, Sandretto C and Hallaham C (2010). Forage outsourcing in the Dairy sector: The extend of use and impact on farm profitability. Agriculture and Resource Economics review. 39 (3): 399-414

Machin, D.H. 2000. The potential use of tropical silage for livestock production, with special reference to smallholders. In silage making in the tropics with particular emphasis on smallholders. FAO Plant Production and Protection Paper No 161, 71-78. Rome (Italy): FAO

Reiber, C., Schultzer-Kraft, R., Peters, M., Lentes, P. and Hoffmann, V. 2010. Promotion and adoption of silage technologies in drought-constrained areas of Honduras. Tropical Grasslands (2010) Volume 44, 231-245.

Titterton, M., Mhere, O., Maasdorp, B.V., Kipnis, T., Ashbell, G., Smith, T. and Weinberg, Z. 2002. Ensiling of tropical forages with particular reference to African Livestock Systems. Forage production and conservation for dry season feeding of smallholder dairy cattle in the semi-arid region of Southern Africa. Paper presented at the XIII International Silage Conference, 11–13 September 2002.

Njarui D M G, Gatheru M, Wambua J M, Nguluu S N, Mwangi D M and Keya G A 2011: Feeding management for dairy cattle in smallholder farming systems of semi-arid tropical Kenya. Livestock Research for Rural Development. Volume 23, Article #111. Retrieved November 7, 2013, from http://www.lrrd.org/lrrd23/5/njar23111.htm

Turinawe A and Mugisha J (2012) Socio-economic evaluation of improved forage technologies in smallholder dairy cattle farming systems in Uganda. Journal of Agricultural Science 4(3)

Acknowledgement

This project was funded by International Development Research Centre, Project Name: 'Developing a livestock Feed Business Incubation Model for Zimbabwe Graduate Youths'; IDRC grant number: 107001-001

Table 1: Frequency of farmers' distance from silage source

Distance travelled to silage source point	Frequency
Less than 2km	63.3
2-5km	10.2
5-10km	6.1
More than 10 km	18.4

Table 2: Price offers by the farmers for the proposed different bag sizes

Bag Size (kgs)	Frequency (%) of Price offers($)										Offer price range per kg($)
	No offer	1	1.50	2	2.25	3	3.50	4	5	8	
2	100%	-	-	-	-	-	-	-	-	-	-
5	93.9%	4.1%	2%	-	-	-	-	-	-	-	0.2- 0.3
10	100%	-	-	-	-	-	-	-	-	-	
15	91.8%	2%	4.1%	-	-	2%	-	-	-	-	0.07-0.2
20	85.7%	2%	2%	10.2%	-	-	-	-	-	-	0.05-0.10
50	36.7%	2%	-	8.2%	2%	10.2%	6.1%	10.2%	22.4%	2%	0.02-0.16

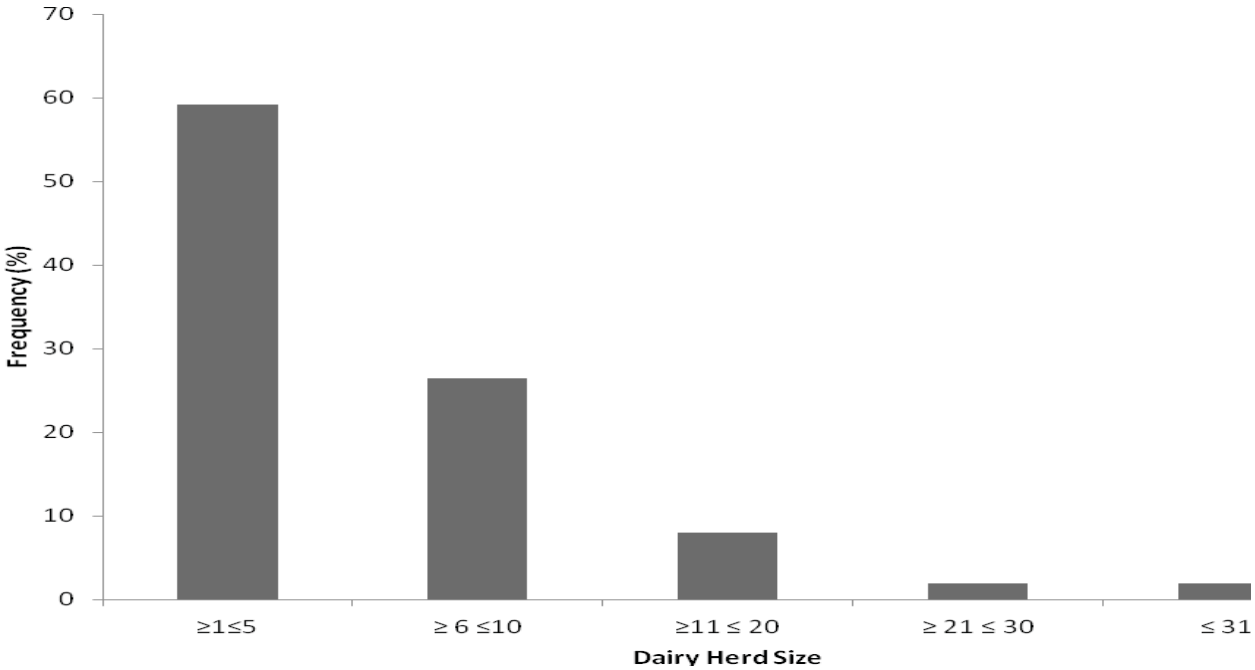

Figure 1: Dairy herd sizes for farmers in the Chikwaka and Marirangwe Dairy schemes

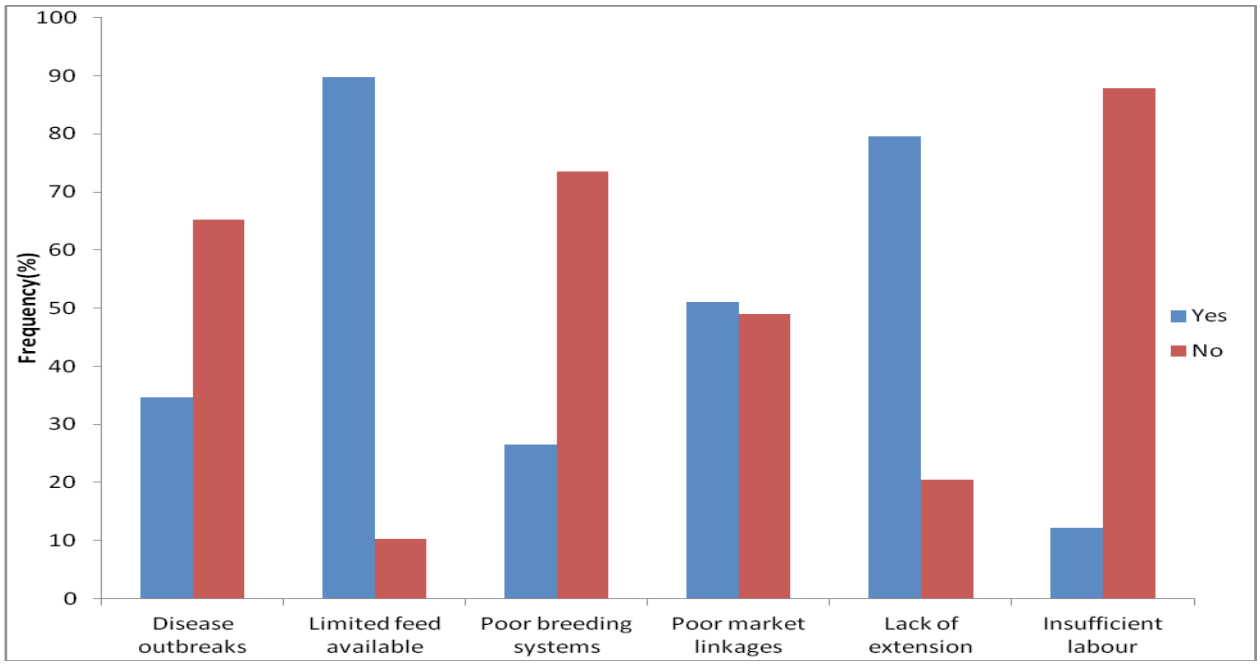

Figure 2: Dairy production challenges encountered by farmers

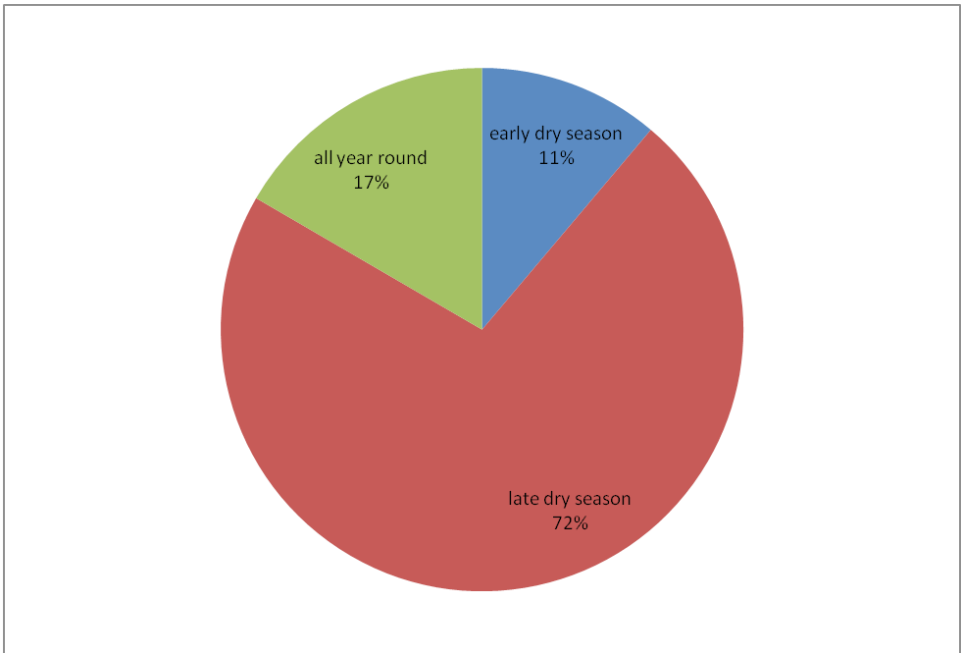

Figure 3: Seasonal demand of silage

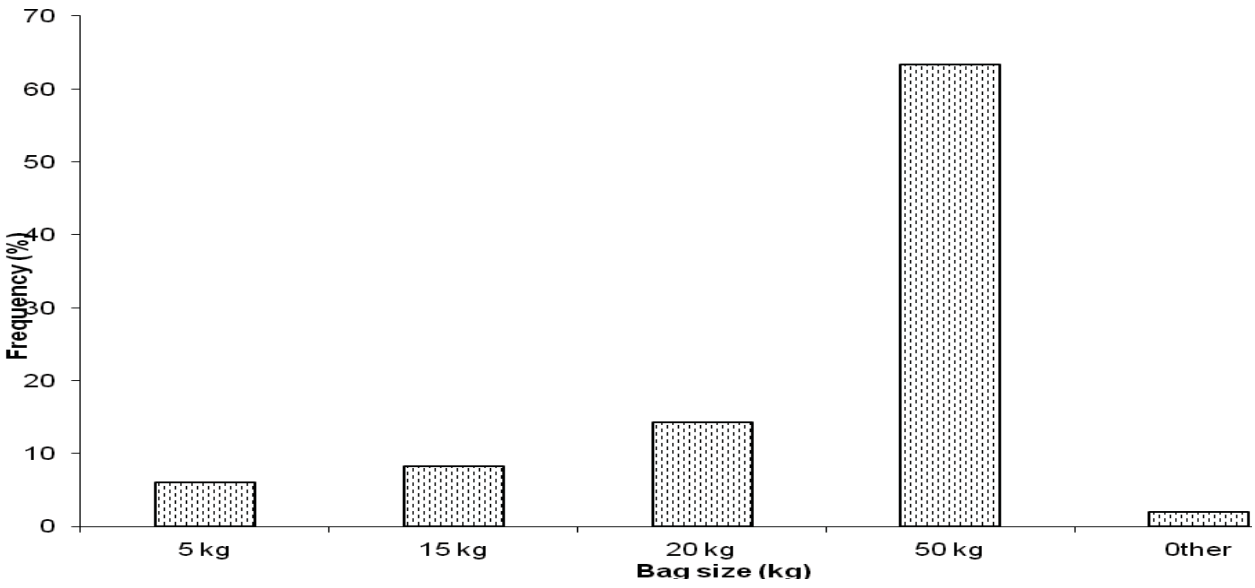

Figure 4: Farmers' preference of bag sizes

Analysis of Sorghum Value Chain in Chikhwawa, Lilongwe and Kasungu Districts in Malawi

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Abstract

This paper presents the results of value chain analysis for sorghum in Malawi. Despite being an important source of food and farm income for smallholder farmers, recent studies have identified the crop as one of the orphan crops in the Malawian food system. The paper was aimed at identifying opportunities for smallholder farmers to diversify into alternative agricultural commodities, such as sorghum as a basis for improving their incomes and food security. The analysis was based on sub-sector data regarding the structure and function of the sorghum value chains. The data were gathered through interviews with farmers and various value-chain players.

The results indicate that there is scope to promote the productivity and competitiveness of sorghum sub-sector. However, the profitability of the crop is being constrained by low productivity at farmers' level and lack of effective structured markets. The mean yield for sorghum across the three districts was 741.85 Kg/ha for Chikhwawa, 116kg/ha for Kasungu and 148.26 Kg/ha for Lilongwe. The mean yield across the three areas was 335.4 kg, which was only 28% of the potential yield for unimproved sorghum varieties. Although, the yield in Chikhwawa is relatively higher than the national average of 600kg per ha, it is far much lower than the potential yield of 1,200 kg per hectare (for unimproved varieties) under good management. Productivity is an issue that needs to be improved if farmers are to realise adequate surpluses for the market. In addition, the sorghum value chain suffers from significant power asymmetry among the value chain players and

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farmers are just price takers with no leverage to negotiate for better output prices.

The study recommends the promotion of the crop by encouraging the adoption of improved varieties for increased productivity and collective marketing to benefit from economies of scale.

Introduction and Background

Sorghum is an important source of food and farm income for smallholder farmers in Malawi, which can be enhanced especially if linked to efficient markets. Recent research (Tchale, 2012) has however identified the crop as one of the orphan crops in the Malawian food system. Orphan crops are defined as crops with a potential, not fully exploited, to contribute to food security and poverty alleviation but have a strong link to cultural heritage and traditional uses. However, they are produced with little or no external inputs, weak or non-existent seed supply systems, poorly documented and researched; even though they are well adapted to specific agro-ecological niches (GFU, 2006).

Sorghum usually has a lot of potential as it thrives in infertile or difficult terrains that are not well suited to large-scale commercial agriculture. Such areas are usually inhabited by poor communities. Hence sorghum, along with other orphan crops provide poor farmers with alternative sources of food and income-paths out of poverty (Hawtin, 2007). The easiness to grow in environmental conditions where major crops such as maize and wheat would not thrive is one factor that influences rural poor communities to continue to grow sorghum and other orphan crops (Esfeld ***et al.,*** 2009). In addition, most orphan crops usually demand reduced labour inputs and are resistant to diseases compared to major crops (Blench, 1997). In this way, sorghum has the potential to support poverty reduction efforts in the developing world, especially in Sub-Saharan Countries of which Malawi is part. Unfortunately, significant productivity enhancements are impeded by low access to improved technologies such as high-yielding seed varieties. Besides, inefficient marketing systems and lack of policy support tend to reduce the financial benefits that farmers could realise. These challenges have pushed the crop into further oblivion and have rendered it almost invisible in the research and policy debate in most of developing world including Malawi.

This research was conducted in the context of the '*Making agri-food systems work for the rural poor in eastern and southern Africa*' regional research project funded by the International Development Research Centre (IDRC) Rural Poverty and Environment Programme Initiative. The project was implemented by universities, government and non governmental organisations in Kenya, Malawi and Uganda. The goal of the regional research project was to enhance the adaptation of pro-poor innovation systems to improve food security and sustainable natural resource management in Eastern and Southern Africa (ESA) region. This value chain research was a component of the regional research program implemented in Malawi to fulfil objective number two which was '*to adapt and scale up technology and market innovations for promoting orphan crops that enhance food security, increase incomes and ecosystem integrity in selected areas of Malawi, Kenya and Uganda*'.

The main objective of the paper was to identify and characterise the different actors in the sorghum value chain, and to examine how these actors relate to one another and how these relationships affect the efficiency

of the sorghum value chain. In addition, the paper identifies the existing markets and quantifies the volumes demanded by such markets. Finally the paper suggests the strategies that could be put in place to improve the competitiveness of sorghum in Malawi in order to enhance its contribution towards food security and household income.

Methods

The study was conducted in three areas in Malawi (see Appendix 2), namely Simulemba in Kasungu district, Malingunde in Lilongwe district (*these are in the central region of Malawi*) and Chapananga in Chikhwawa district in the Southern Region. The characteristics of the study sites are presented in below.

Table 1: Characteristics of the study sites

Study Area	Characteristics	Mean annual rainfall	Mean annual temperature	Study site (EPA)[1]
Simulemba (Kasungu)	SAL	800mm to 1200mm	120 C to 300 C	Mkanakhothi
Malingunde (Lilongwe)	MHPDP	800mm to 1000mm	200C to 22.50C	Malingunde
Chapananga (Chikhwawa)	UPH /	170mm to 976.6mm	27.60C to 37.60C	Kalambo

Note: Unexploited high potential area (UHP), Semi-arid lands (SAL), Low Potential Area Medium to high potential area with declining potential (MHPDP)

Simulemba represented areas of semi-arid lands (SAL). It is located in the range of 800m to 1600m above sea level. Its topography is generally gentle to moderate gentle slopes. In selecting Simulemba the main consideration was that it is a sorghum growing area and represents areas with high food deficit with a poor natural resource base but with potential for improved production through use of appropriate and available technologies such as high yielding drought tolerant varieties of crops, such as sorghum.

Malingunde represented Medium to high potential areas with declining potential (MHPDP). It lies at mid-altitude topography between 1000m to 1400m above sea level. Dzalanyama forest forms part of this study site.

Chapananga represents an area with unexploited high potential (UHP). It lies in the lower flat basin of the Shire River which is along the Great African Rift Valley characterized by meanders (Chikwawa District Assembly, 2006). It lies on an altitude of between 200m to 400m above sea level (Chikwawa District Assembly, 2006). Chapananga, like the whole district has a great variety of soil types. For this study Chapanaga was chosen to represent areas that are pockets in which the potential is either underutilized or locked due to a number of constraints.

Sampling Design

This study followed a baseline study, which had been conducted by a team of researchers of the Lilongwe University of Agriculture and Natural Resources (LUANAR). The baseline study was one of the first activities in the regional Agri-food Systems Innovation Project. The baseline line study reported sorghum as being one of the orphan crops in the areas of study. The value chain study was thus aimed at exploring further the structure, conduct and performance of the sorghum value chain. While the baseline study mainly targeted the farming communities in the study areas, the value chain study went further by contacting all the main actors in the sorghum production and marketing system.

A total of 161 farmers were interviewed across the three study areas. From this 161, 34% were sorghum farmers 14 % were finger millet farmers and 17 % were pear millet farmers. The rest grew other traditional crops such as sweet potatoes, Bambara nuts and pigeon peas. Sorghum traders, mostly located in the local markets were also contacted. Being a minor crop, there were not many traders that were found. Twenty One (21) traders were contacted in the areas of study (*Eight traders (8) were contacted from Chikhwawa District, seven (7) in Lilongwe and six (6) in Kasungu*).

A combination of qualitative and quantitative techniques was used. A check list was used as a guide in all key informants while structured questionnaires were used to collect quantitative data. A detailed literature review was also undertaken to examine previous value chain studies, the methodologies used and the results and conclusions and policy implications derived. In this way, secondary data were collected from various documents and organizations. Subsequent to the data collection and preliminary analysis, agricultural experts were consulted to validate the draft results and seek feedback on major bottlenecks and recommendations for improvement. The analysis for sorghum first began by mapping the chain for the crop as identified key informants at critical nodal points in the value chain and then followed these on to the next level. In addition, site visits of the study area particularly the input and out market facilities were made and in-depth interviews held with key informants. This helped to cross check data gathered through questionnaires.

Several analytical techniques were applied on the data collected. Value chain analysis was the main analytical methodology that was used. Value chains have been defined by Webber ***et al.,*** (2010) as an important tool for understanding how inputs and services are brought together and used to grow, transform, or manufacture a product; how the product then moves physically from the producer to the customer or final consumer and how the value increases along the way. In value chain analysis all inputs and outputs carry forward there inherent value from the previous to the next stage in the chain. This concept is called value adding, value is therefore transmitted along the stages.

The concept of value addition as pointed out by (Keyser, 2006) is important where the focus is on the analysis of accumulated costs at different stages as the key determinant of trade competiveness. The competiveness of every domestic product is said to depend on the efficiency of value adding activities such as input supply, farm production, assembly, processing and logistics until the product reaches the final consumer.

Gross margin analysis was also used to measure the profitability of sorghum at production level. Gross margin analysis is a tool for assessing enterprise's contribution to fixed costs and profit after variable costs have been paid (Kay and Edwards, 1994). The gross margin of a farm activity is the difference between the gross income earned and the variable costs. It is probably the most commonly used measure in farm analysis and planning. A SWOT (Strength, Weakness, Opportunity and Threats) analysis was also conducted to identify the opportunities and strengths of the sorghum sub-sector in Malawi.

Results

In Malawi sorghum is an important staple food especially in the Shire Valley area and is a food security crop in other marginal rainfall areas (GAP, 2005). Sorghum is also reported to be more drought tolerant than maize, this makes the crop more adaptable to these areas. The Government of Malawi aims are to increase smallholder yields to up to 3,000 kg per hectare with use of improved varieties and 1, 299 kg per hectare for unimproved varieties under good management. It is therefore the objective of the Government of Malawi to increase yields to these levels to meet food requirements and surplus for sale in the marginal rainfall areas.

According to Tchale (2011), sorghum in Malawi is used for a number of delicacies as follows:

a. *Mtsonyole* (Chapananga): fresh sorghum roasted, pounded to make a paste and salt is added to taste

b. *Chigodo* (Chapananga): raw sorghum or pearl millet pounded, removing the husks, then pounded into a paste after adding water. Sugar is added to taste.

c. *Msoswe* (Chapananga): fresh sorghum cooked like rice

d. *Thobwa* (all sites): sorghum or finger millet sprouts milled into flour. A thick maize porridge is prepared to which the sorghum/finger millet sprout flour is added and then left to ferment for at least over night. It is important to note that whilst in Chapananga and Malaingunde they use millet and sorghum to produce thobwa, in Malingunde they use fermented maize. This could explain the minimal level of production of millet and sorghum in Malingunde.

e. *Opaque beer*: sorghum or finger millet fermented with maize flour porridge to make opaque beer

Sorghum productivity remains rather low. Table 3 below shows the mean production yields per ha in the three districts. The mean yield for sorghum across the three districts was 741.85 Kg per Hectare for Chikhwawa, only 116kg for Kasungu and 148.26 Kg per Hectare for Lilongwe. The mean yield per ha across the three areas was 335.4 kg, which was 28% of the potential yield for unimproved sorghum varieties[2].

2 Most of the farmers grow unimproved varieties of sorghum

Table 3: Production Yields in Kg per ha

District	Kg/Ha
Chikhwawa	741.85
Kasungu	116
Lilongwe	148.26

From the production quantities, it was found that only 34%, 83% and 50% of total sorghum produced goes to the market in Chikhwawa, Lilongwe and Kasungu respectively. At national level the mean harvested amount that goes for sale was estimated at 141 Kg. As noted, the proportion of sorghum marketed in Chikhwawa is relatively smaller than the other districts. This is probably because the crop is largely used as a staple food in Chikhwawa; as such, most of it (66%) is consumed at home.

At national level the general trend of sorghum productivity has been variable, as depicted by Figure 1 below. This is likely to be due to the droughts in the south where 68% of the crop is grown (USAID, 2009). In drought situations (like in the case of the growing season 2004/05), there was a drop in the production of sorghum. The loss, however, was not as severe as was the case with other cereals since it is a drought-tolerant grain with a strong adaptive advantage and lower risk of failure.

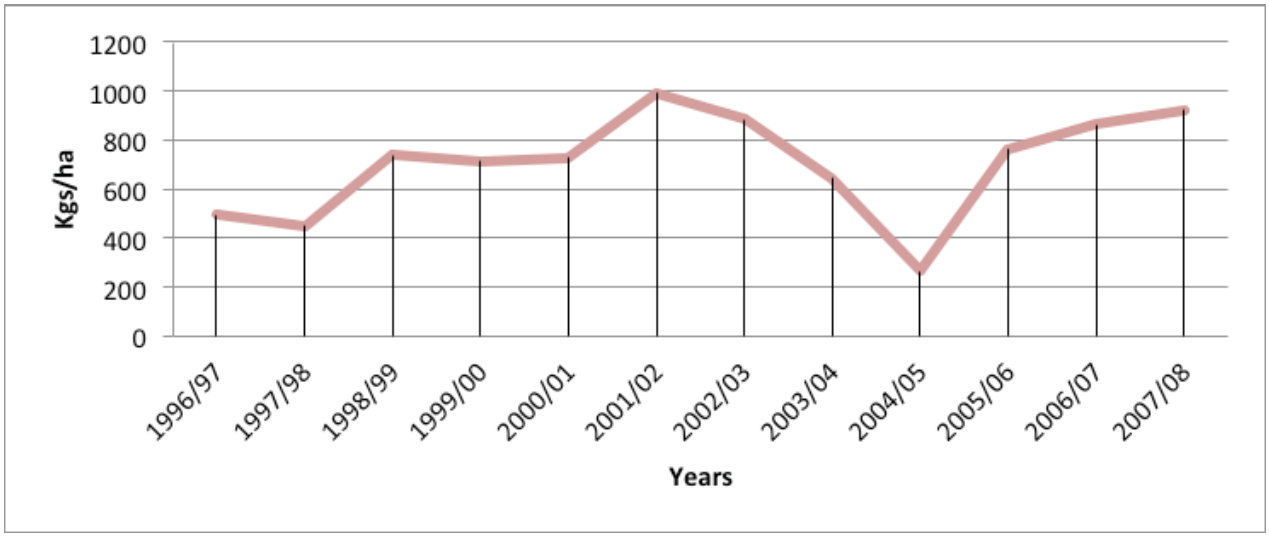


Figure 1: Yield trend for sorghum production (1996-2008)

Gross margins for each farmer were calculated as the difference between the revenue per hectare and total variable costs. Family labour was also priced using the equivalent market value.[3] This analytical technique was used to estimate the return to land and return to labour. Table 3 below shows the results of the gross margins analysis for sorghum. The estimated gross margin per ha was found to be MK 4,554.29.

In terms of labour requirements, Chikhwawa had the highest demand for casual labour in the production of sorghum, while Lilongwe had the least. This would suggest the emphasis that this crop is given in these districts. As a matter of fact Chikhwawa is the major growing and consuming area for sorghum in Malawi. The activities that demanded more labour were land preparation, ridging and weeding.

Table 4: Gross Margin for sorghum across the study areas

Activity	Unit	Chikhwawa	Kasungu	Lilongwe	Average
Directs Inputs					
Seed	MK/HA	250	250	250	250
Chemicals	MK/HA	-	-	-	-
Fertilizer	MK/HA	-	-	-	-
Labour					
Land prep.	MK	1,491.17	356	623	1,454.75
Ridging	MK	985.98	534	623	970.6
Planting	MK	320.74	178	89	313.93
Weeding	MK	1,281.26	623	623	1,257.33
Fertilizer	MK	-	-	-	3.42
Banking	MK	352.64	623	-	357.65
Harvesting	MK	708.58	267	178	690.57
Processing	MK	503.19	356	623	502.69
Total Labour Cost	MK	5,643.56	2,937.00	2,759.00	5,550.94
Total Input Cost	MK	5,893.56	3,187.00	3,009.00	5,800.94
Other costs					
Storage	MK	676	50	-	660.38
Transportation	MK	2,201.00	-	-	2,201.00
Total Variable Cost	MK	8,770.56	3,237.00	3,009.00	8,662.32
Produce Sold	MK	361.41	20	150	349.9
Selling Price	MK	50	40	80	44.22
Gross Value	MK	18,070.50	800.00	12,000.00	15,472.58
Gross Margin	MK	9,299.94	-2,437.00	8,991.00	6,810.26
Quantity Sold	KG/ha	252.23	96.28	74.13	140.87

3 The cost is based on the minimum wage of 178 Kwacha per day. However taking into account that these farmers do not work the whole day this figure was divided by 2. Thus 1 labour day was equivalent to 89 Kwacha.

Activity	Unit	Chikhwawa	Kasungu	Lilongwe	Average
Gross Margin	MK/KG	36.87	-25.31	121.29	48.34
2 Gross Margin/Ha[1]	MK/HA	8,691.53	-3,930.65	8,901.98	4,554.29
Return to variable	MK	1.06	-0.75	2.99	0.8
Breakeven price	MK	11.82	27.91	20.30	24.76
3 Return to labour [2]	MK/PD	147.62	-73.85	290.03	-14.93

Supply and Value Chain Mapping for Sorghum

This section details the results of the supply and value chain mapping of sorghum. The study has shown that sorghum displays a very characteristic flow from producer to the final consumer. Several actors have been identified to be playing a role a various stage of the product chain: producers, middlemen or rural assemblers and of course the consumers. Through this chain, price transmission takes place, which in a way influences what producers should get at the beginning of the chain and what consumers finally pay for at the end of it.

Figure 2 and 3 below depict the supply chain of sorghum. Sorghum is being mainly marketed by traders who manage larger volumes ranging from 300 to 120 000 Kgs per year. While Figure 2 shows the Schematic view of the main stakeholders in the sorghum supply-chain, figure 3 depicts the various market channels through which the commodity flows from one actor to another. In this case the horizontal and vertical linkages existing in the sorghum marketing system are displayed.

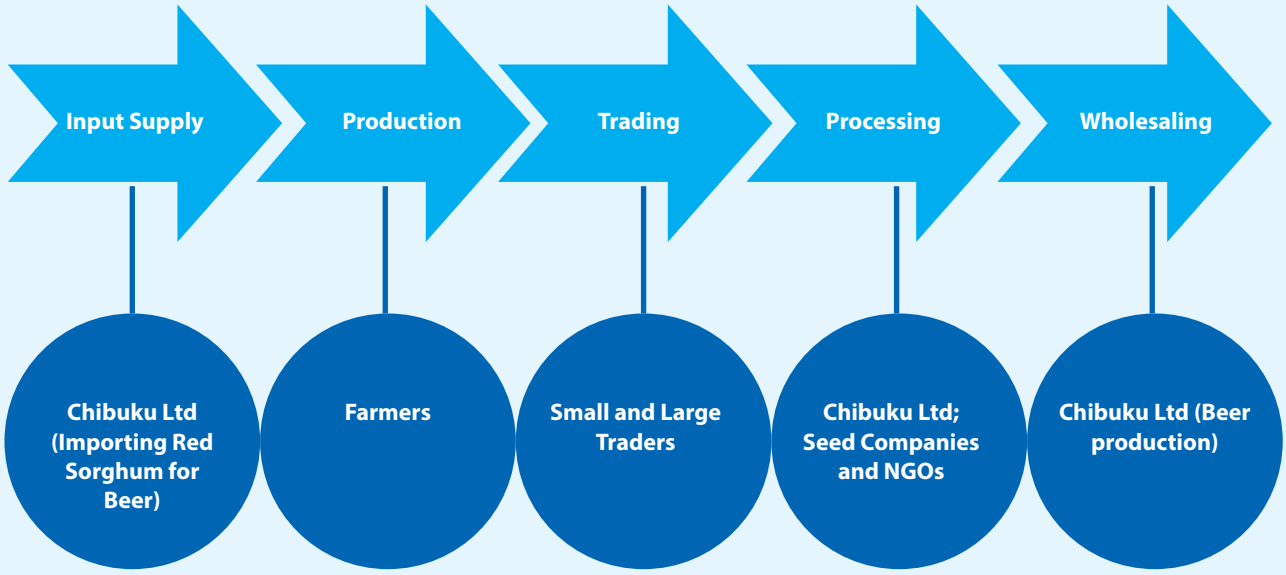


Figure 2: Schematic view of the main stakeholders in the sorghum value-chain

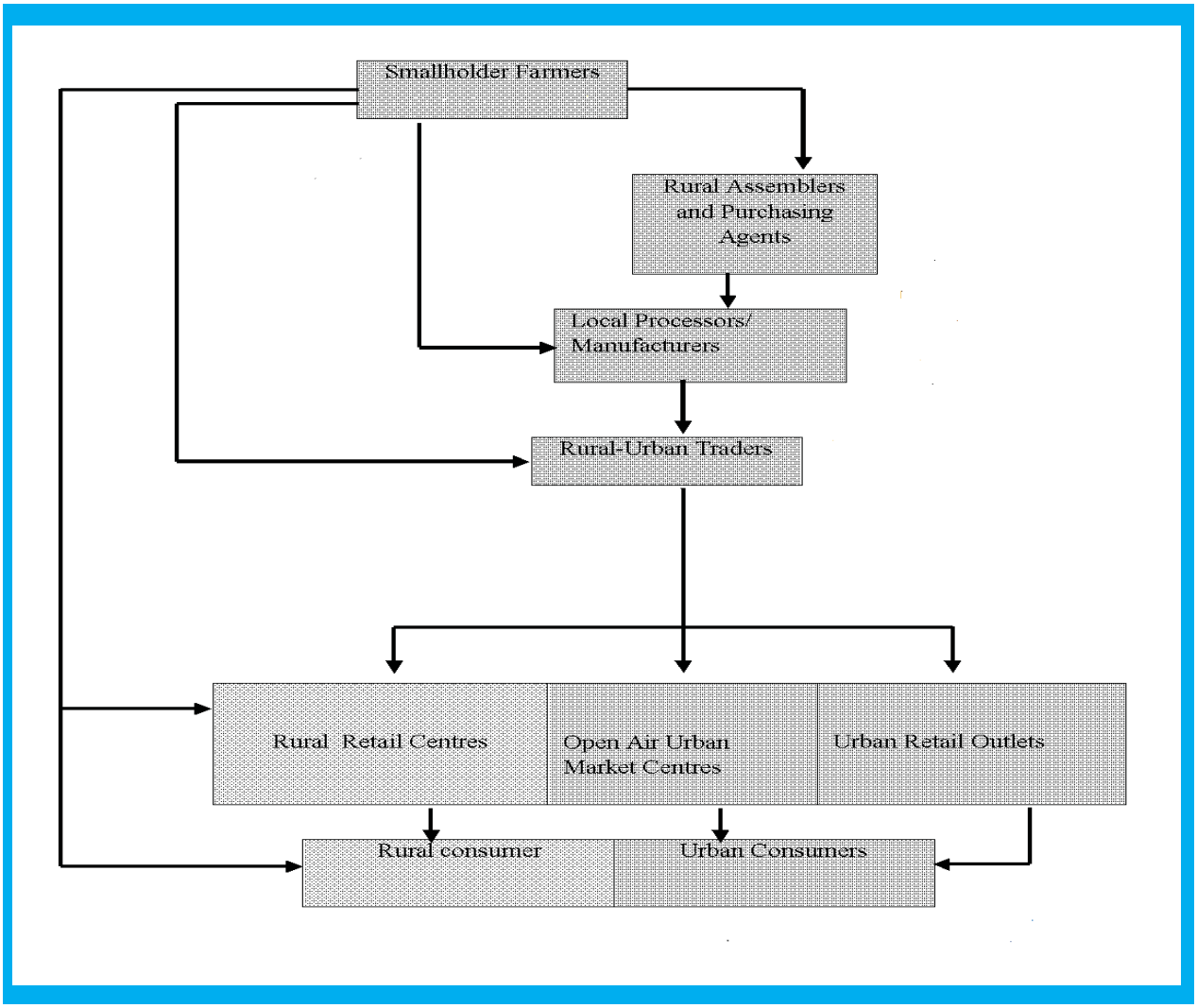


Figure 3: Supply chain of Sorghum

Most of the sorghum produced in Malawi is consumed by producing households or sold in informal markets, primarily for traditional beer production (USAID, 2009). Farmers usually recycle their own seed to grow in successive growing seasons. This practice results in low yields. Sometimes sorghum seed is bought from fellow farmers in the local communities or from local markets. Most of such seed is local unimproved varieties.

A niche market is available for red sorghum with Chibuku Products Ltd (CPL) who uses it to process secondary products such as flour and then opaque beer. The company sometimes supplies seed to farmers in some parts of the country under contract arrangements, though this does not suffice its annual demand for the commodity. The fact that large companies are involved in the supply chain means that the commodity has some promising market potential. Sorghum is highly demanded by some large agro-companies (Chibuku Company) which process them into secondary products such as flour and then opaque beer.

The total annual demand for sorghum alone by Chibuku Company Ltd is well over 700 metric tonnes. Apart from these companies, some NGOs also buy lots of sorghum seed to distribute to their project beneficiaries. Such organizations include Total Land Care, World Vision Malawi, and Concern Universal, just to mention a few.

Figure 4 below shows the changes in the value of the commodity as it moves from one stage of the chain to another. It is worth noting that the price per kg of sorghum at farm-gate is only 16% of the final price that the final consumer pays. Most of the final consumers are in the urban centres and the commodity gets there through traders/middlemen. Large companies such as Chibuku transform the seed into high value products such as beer and sell the beer at premium prices. There also processing of sorghum at local village level. Some farmers process the sorghum grains into traditional beer which they sell to members of the communities and/or in local village markets.

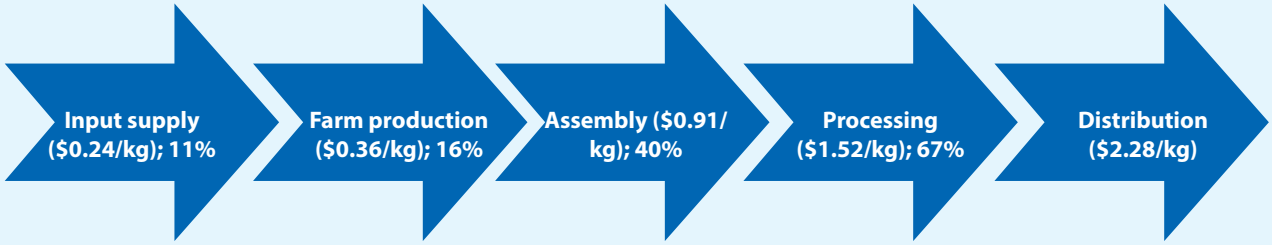


Figure 4: Sorghum value flows (Price build-up) from farm-gate to distribution

Note: 1 US$ was equal to MK165 at the time the study

Strengths, Weaknesses, Opportunities and Threats towards the promotion sorghum production and marketing in Malawi

A situation analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT analysis) was conducted for the sorghum sector in Malawi to identify the major constraints that inhibit production and marketing, as well as to identify the opportunities that can be exploited to promote the subsector. This was done through consultations with input suppliers, farmers and other chain actors such as buyers, traders and exporters, as well as other stakeholders such as the Government of Malawi and through the use of secondary data (see Appendix 1).

Discussions and Conclusions

The results of the study indicate that sorghum is still a very important crop in Malawi, though it is mostly grown by smallholder farmers in selected areas of the country. Malawians put the crop in many different uses. Production of the crop is however constrained by very low productivity, arising from persistent use of unimproved varieties. In other areas such as Kasungu District, the very low yield figures in Kasungu for yield can be attributed to the reason that only a small proportion of land is allocated to sorghum production.

Although, the yield in Chikhwawa is relatively higher than the national average of 600kg per ha, it is far much lower than the potential yield of up to 3,000 kg per hectare (for improved varieties) and 1,200 kg per hectare (for unimproved varieties) under good management. Productivity of sorghum in the districts is therefore an issue that needs to be improved if farmers are to realise adequate surpluses for the market. This is crucial if sorghum is to be commercialised.

Although the total production costs are often lower than those for maize, the productivity of sorghum measured in terms of returns of labour tend to be low. To make sorghum competitive it is necessary to improve their productivity with an assured quality of the grain.

Sorghum marketing is largely informal, with limited commercial value addition activities at farmers' level. There are a number of key actors in the seed value chains for sorghum. They include farmers, research institutions, the Ministry of Agriculture and Food Security who play key roles in varietal development, inspection and certification, and in providing extension services. From the private sector, there are some seed companies that mainly deal in maize hybrid seed even though other cereals such as sorghum are also sold. The seed companies perform multiple functions which include varietal development, seed production, seed processing and distribution. The most important seed end users are small scale farmers themselves who are mainly subsistence and mainly use recycle their seed. Collaboration among the actors in the sorghum value chain is limited, as such, the value chain business model is ***buyer-driven*** at the expense of the small-scale farmers.

Access to support facilities relevant for agricultural development was rated poor by these farmers. These included poor access to agricultural information, modern inputs, and poor quality of seed, lack of processing technologies and lack of strong and stable markets. Where market linkages are weak, such as is the case in many rural areas in Malawi, small and medium sized producers, input suppliers, traders and millers, are forced to depend on scanty and skewed information and business opportunities that usually result in low levels of profitability. They tend to have a narrow picture of their sector, which breeds suspicion and mistrust among the various actors and contributes to overall stagnation of the entire sector.

In an efficient value chain marketing system, chain actors are linked together and will work closely based on a system of needs and wants. The system will generally work on a notion of demand and supply. For example, farmers will be linked to and respond to the product demands of consumers, and work closely with suppliers and processors to design or produce a desired product range. In Malawi for example, only one company, Chibuku Products Limited, buys Sorghum from Farmers in Malawi to process into high value opaque beer. Unfortunately, the company requires red sorghum, as opposed to white sorghum which the farmers usually grow. Most sorghum farmers do not even know these market preferences.

Production location matters. Lower Shire is better suited to sorghum production. It may be worthwhile to consider establishing sorghum production zones where the necessary enabling environment should be provided to facilitate farmers' uptake and profitability from sorghum production as an agribusiness.

Top priority should be to implement strategies aimed at raising both the productivity for sorghum in Malawi. This could be achieved through promoting adoption of better seed technologies. Besides, although Malawian agricultural policies have historically favoured crop production, sorghum has received less attention. Consequently, the subsector somehow lacks policy anchorage to propel its development. In recent times for example, maize and legume production has been enjoying farm input subsidies and nothing of that sort has ever been implemented for sorghum, despite the fact that sorghum is a staple food in some parts of the country (like the Shire Valley area) It is against this background that deliberate interventions in the sorghum sector are being suggested.

In addition, sorghum farmers need to have mindset change regarding the objectives of sorghum production. They need to go beyond subsistence objectives if the crop is to be commercialized. Farmers also need to diversify the varieties of sorghum that they grow. Most Sorghum farmers appear to prefer white sorghum, yet the commercial variety is red sorghum. The demand for red sorghum is available by Chibuku Products Ltd, which buys over 700 Metric Tonnes annually from domestic producers. The company struggles to get this quantity every year and has to supplement through imports.

One of the constraints to sorghum production is lack of lucrative market access. Good markets are found in the urban centres, especially in the produce Markets. There is virtually no sorghum in the retail shop outlets. Since the majority of farmers are in rural areas a number of marketing bottlenecks arise in the form of increased transaction costs (transport, information gathering etc). The marketing liberalization policies have over the last decades seen the government increasingly withdrawing from public sector agricultural services. As such, only some of these services are being provided instead by the private sector, and only in locations promising financial returns to private investors. Wherever farmers are unable to pay for services, the gap between demand for and supply of services widens. Hence, there is a need for a greater involvement of the "***third sector***" to assure that the necessary services are provided in an efficient and effective manner. Hence, the organized farming sector (cooperatives and farmers' associations) is expected to take over local service functions and/or to influence policies to assure access to agricultural services or to improving the terms upon which such services are delivered.

Conclusion and Recommendations

The study mainly employed the value chain analysis model to investigate the sorghum sub sector. Value chain analysis acts as a social system approach, as the functions are performed by different actors (farmers, traders, processors and consumers etc). The study found that sorghum value chain is rather weak. Farm yields are low (0.7 ton/ha). It has also been found that adoption of improved seed and fertilizer is very low among sorghum growers, as such farmers recycle their own seed, which further reduces sorghum productivity. The gap between research station yields and farm yields is very large. The potential for sorghum under sound crop management is 3000kg per ha and this is 77% higher than mean yields realised by farmers. There is only a limited number of large sorghum buyers located mostly in the city centres, thus making market access difficult.

The area under sorghum will not increase significantly unless the productivity of the grain is improved substantially. Therefore there is an urgent need to improve the production technologies for these grains and to disseminate this knowledge to the farmers 'fields. Only in this way can these cereals compete locally with maize. Identifying a few well-researched alternative uses for sorghum would yield new avenues for increased utilization and thus act as a catalyst to improve production and productivity.

References

Esfeld K.. (2009). *Bringing high throught techniques to orphan crops of Africa: Highlights from the Tef TILLING Project. zerihun.tadele@ips.unibe.ch.*

GFU [Global Facilitation Unit for Underutilized Species]. No date. Underutilized Plants – Achieving the Millennium *Development Goals. Available online at: www.underutilized-species.org/Documents/PUBLICATIONS/gfu_poster_07_achieving the_mdgs.pdf*

Kay, R.D. and Edwards, W.M. (1994) Farm Management. 3rd Edition. Mc Graw-Hill, Ney York.

Keyser, J. C. (2006). Definition of Methodology and Presentation of Templates for Value Chain Analysis, Competitive Commercial Agriculture in Africa (CCAA), The World Bank, Environmental, Rural and Social Development Unit, Washington DC.

Hawtin, G. (2007). Underutilized Plant Species Research and Development Activities- Review of issues and options. A report submitted to the chairs of the GFU Steering Committee and the ICUC Scientific Advisory Board. GFU.

Malawi Government (2006) *Lilongwe District Socio-Economic Profile.*

Malawi Government (2007) Kasungu *District Socio-Economic Profile .*

USAID, (2009) Staple Foods Value Chain Analysis. Country Report – Malawi.

Webber, C.M. and Labaste, P. (2010). Building Competiveness in Africa's Agriculture. A guide to Value Chain Concepts and application, the World Bank .Washington, DC

Tchale, M. S. C. (2012) The Role of 'Orphan' crops among Smallholder Farmers in Simulemba, Malingunde and Chapananga areas. MSc Degree Thesis, University of Malawi, Lilongwe.

Acknowledgements

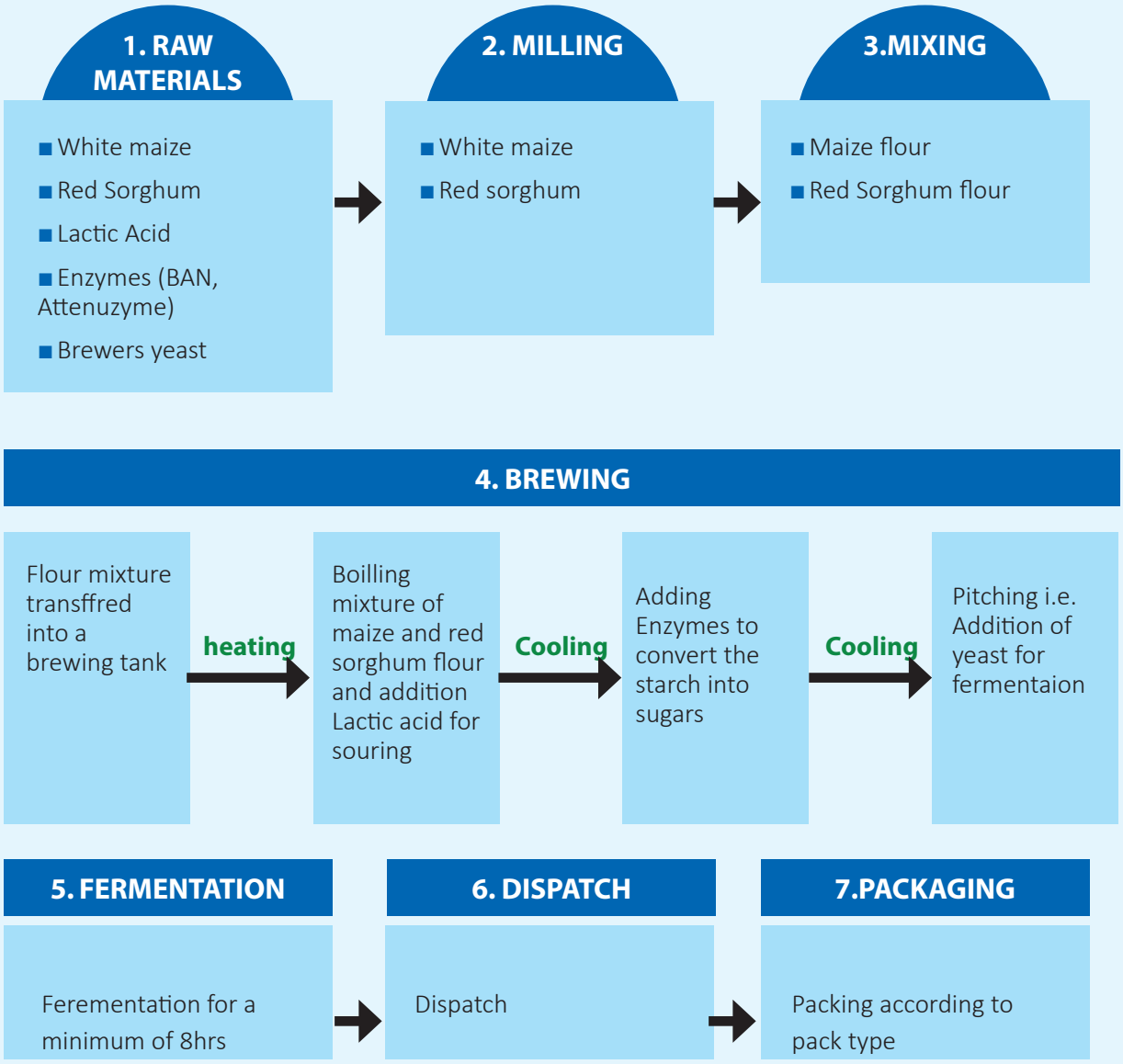
The authors sincerely acknowledge the support received from IDRC for conducting this study. Comments from stakeholders who attended the workshops organized by IDRC to discuss the earlier drafts are greatly appreciated. The paper's findings and proposed policy implications are the views of the authors and do not represent the expressed views of the organizations which funded the initial study.

Appendices

Appendix 1: SWOT Analysis of Sorghum in Malawi

Weaknesses	Strengths
■ Limited use of improved varieties ■ Limited and inadequate private sector participation in production and market of sorghum ■ Unorganized sorghum farmers ■ Limited collaboration among the various sorghum stakeholders (e.g. farmers, Government, Traders and Processors, etc) ■ Lack of organized markets for sorghum products ■ Limited value addition. ■ Attach by pests and diseases in filed and storage greatly reduces farmers' returns ■ Limited vertical linkages in Malawi's sorghum millet value chains, largely because sorghum and millet have been considered as low value unimportant crops for development. ■ Lack of market information ■ Low bargaining power at farmers level as each farmer negotiates on his own for prices with traders	■ Sorghum can grow in drought prone areas. ■ Availability of conducive agro climatic conditions for sorghum production ■ Resistant to many tropical diseases ■ Sorghum has multiple uses (beer, snacks, building materials etc)
Threats	**Opportunities**
■ Unpredictable climatic conditions ■ Lack of cold storage facilities in produce urban markets pausing a health hazard to consumers ■ Lack of clear policies and strategies to promote the production and marketing of the crop in Malawi ■ Limited use of improved varieties by farmers ■ Recycling of seed reduces yields. ■ No credit institutions that offer loans for sorghum commercialization ■ Land is becoming scarce as the population continues to increase ■ Presence of limited number of large scale processors causes power asymmetry among players in the chain. Farmers have very little power to negotiate with Chibuku Ltd for example. ■ Expensive imported ingredients by processing companies such as enzymes, lactic acid and yeast[4].	■ New technologies development and new varieties are being developed ■ High demand for the livestock and livestock products. ■ Labour availability ■ Local demand available for consumption and industrial uses ■ Main stream crops such as maize are struggling to cope with the effects of climate change. This provides opportunities for sorghum to gain recognition ■ Availability of export markets to be used for animal feeds ■ Increased donor support for women participation raises motivation for women to take up opportunities and market participation. Sorghum is considered to be a woman crop

Appendix 2: Chibuku Production Process Flow Chart



(Footnotes)

1 EPA: Extension Planning Area

[1] The average land holding size for Chikhwawa was 1.07 and 0.62 for Kasungu and finally 1.01 for Lilongwe

[2] The average person days or Chikhwawa were 63 for Chikhwawa, 33 for Kasungu and 31 for Lilongwe

4 Chibuku Products Limited for example needs 1138.8L, 2190L, and 6,570kg of enzymes, lactic acid and yeast respectively annually.

Lessons from pre-incubation of graduate feed manufacturing enterprises in Zimbabwe

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Abstract

Unemployed Zimbabwe university graduates are often ill-prepared for self-employment in the informal sector because their education system mainly prepares them to be employment seekers and not employment creators. The objectives of this project were to develop, implement and evaluate a business incubation model for graduate livestock feed manufacturing entrepreneurs. The research adopted a single case study methodology and used a qualitative approach to investigate a possible model for incubation. Pre-pre and pre-incubation activities were mainly graduate incubatee recruitment, opportunities and constrains survey, identification of graduates' entrepreneurial skills needs, training workshops and development and evaluation of business plans. Fifteen incubatees were recruited and between 9 and 11 attended all project training activities. There is need for better incubatee selection to extend the criteria to assessment of mental attitude and attitude towards work. Lack of capital, marketing skills and business entry points were some of the major training needs. Most incubatees reported significant knowledge improvements after training in various topics such as general entrepreneurship skills, company registration and marketing. Continuous multi-tooled approach of skills need identification was found very useful. Four of the seven business proposals produced by the incubatees had potential for funding. The narrowing of scope to feed manufacturing made it difficult for incubatees to realize immediate entrepreneurial prospects. Innovative capitalization options have to be explored. This business incubation intervention has the potential of solving unemployment problems among the agriculture graduates but the scope of enterprises and capitalization should be broadened.

Keywords: university graduates, agriculture, business incubation,

Introduction

Zimbabwe's education system has often been criticized for preparing students for white-collar jobs in the formal sector and failing to equip them with technical and entrepreneurial skills. School leavers and

graduates are often ill-prepared to enter self-employment in the informal sector when they fail to find paid employment in the formal sector (Luebker, 2008). There is therefore need to promote employment creation through entrepreneurship development approaches such as business incubations.

Incubation is a process of assisting new and growing businesses to become established and profitable by providing them with support and advisory services, networking and access to finance (Etzkowitz, 2002). Business incubations are important because as more countries move up the value chain, the nations that will thrive in the global knowledge economy will be those which are not only able to produce the highest-quality research, but can also translate this most effectively into innovative new products and services (Patton, Warren and Bream 2009). The involvement and interest of higher education institutions such as the University of Zimbabwe in incubation research is because emphasis is now being placed upon the importance of the incubation process and the more intangible qualities related to business support, access to networks and the development of management teams that underpin firm development (Patton, Warren and Bream 2009).

The aim of this project was to use livestock feed manufacturing training as a tool for entrepreneurial development of young tertiary education graduates. Specific objectives were to develop, implement and evaluate an innovation incubation model for graduate livestock feed manufacturing entrepreneurs

Methods

One year funding (2012-2013) was secured from International Development Research Centre (IDRC) for the incubation. This research adopted a single case study methodology and used a qualitative approach to investigate a possible model for incubation of Zimbabwe university graduates entrepreneurs. Project activities were mainly graduate incubatee recruitment, opportunities and constrains survey (results of which are being published elsewhere), identification of graduates' entrepreneurial skills needs, training workshops and development of business plans. While often 2-4 years is considered the most optimal period of business incubation (Sipos and Szabó (2006); Infodev (2010)), the focus of this 1 year funded project was on pre-pre and pre-incubation. This report focuses on these two phases which are requisite to the incubation model development.

Project management

After the project inception workshop, a project management team was established from the two University of Zimbabwe's departments of Animal Science and Agricultural Economics and Extension and the Business Development Department of the Ministry of Small and Medium Enterprises and Cooperatives Development. Coordination was by Dr Prisca Mugabe of the Department of Animal Science. Incubators are more likely to succeed when supported by a broadly-based partner-ship of public and private sector sponsors (Infodev, 2010).

Selection of incubatees

Immediately after the project inception workshop in June 2012, an advertisement for candidate incubatees was run in two of the most circulated public newspapers in Zimbabwe namely the Business Herald and the Sunday Mail. Fifteen candidates expressed interest in the project and had the following characteristics:

- 6 females and 9 males; 24 to 50+ years age range;
- 9 Bachelors degree holders, 1 MSc., 1 Bachelor of Veterinary Science, 1 accounting degree and 1 commerce and marketing; mainly from University of Zimbabwe and 5 other institutions;
- 2 were jointly running an agrochemical business, 1 was a farmer, 3 were former NGO workers, 1 was an agricultural extension worker, 1 was a pig producer and 3 were in other small business ventures.

Due to the limited number of initial applicants and due to the diversity of their backgrounds, the project team decided not to impose tough selection at the initial stages. This was also because learning from other incubators' experiences, drop-outs of 5-10% were to be expected just at the pre-incubation stage. Therefore maintaining the initial 15 candidates was expected to leave reasonable numbers even in the event of drop-outs. This magnitude is related to the experiences elsewhere, such as the University of Southampton Incubator in which from its establishment in 2003, 70 business proposals were seriously considered, subsequently 28 very early stage firms had joined the incubator and 15 firms were current members in 2009 (Patton, Warren and Bream 2009).

A half-day registration workshop was conducted on 30 June 2012 in the Department of Animal Science to familiarize the 15 candidates with the project. Main presentations were project description, feedback on self-administered baseline survey, entrepreneurs' constraints and opportunities, expectations from the project and a project workplan. A brainstorming activity was conducted during the workshop on the needs of these potential incubatees.

An Incubation Centre manned by a full-time project assistant was set up in the Department of Animal Science as a dedicated room for project meetings and trainings.

Four approaches for identifying entrepreneurial skills development needs and hence the content of the training modules were used namely: graduate needs that were identified in the surveys, a self administered baseline questionnaire survey on candidate incubatees, plenary brainstorming and discussions with the candidate incubatees at the registration workshop, and, training needs assessments during the agribusiness training workshops.

Four training workshops were conducted for the incubatees with intensive input from practitioners and experts from agribusiness and the feed manufacturing industry as well as academics from the Departments of Agricultural Economics and Extension, and Animal Science at the University of Zimbabwe (Table 1). Continuous feedback and training needs assessment within the training workshops were used to develop the training modules and hard copy versions of the modules were prepared just before each workshop.

The following monitoring and evaluation activities were performed:

a. Development of a business plan by 20 December 2012- the incubatees were required to make at least 2 class presentations of their draft plans with feedback from expert training resource persons and their peers.

b. An 'outcome' evaluation session was conducted on the last day of the last training workshop. The students were asked to make a class presentation on what had changed in their practices and attitudes to entrepreneurship since joining the project.

Results and Discussion

Most of the incubatees did not have access to office space and computing facilities. They used the Incubation Centre mainly to develop their business plans and to access the internet. The dedicated room also enabled scheduling the numerous meetings and training activities without scheduling clashes with the rest of Animal Science activities and without incurring high venue costs. This was in keeping with the global practice of 'hot-desking, for the provision of normally a small room with desks and internet connected computers that potential entrepreneurs can use for short periods of research and preparation of their business ideas. Permission to use the free facilities is for relatively short periods that are only renewed if progress is being made and the facility is not abused (Infodev, 2010).

Training impact

Training workshop attendance ranged from 9 (60%) to 11 (73%) of the initial number admitted. This was an acceptable rate as those who could not commit to the process quickly dropped out. The incubatees continually reported improved understanding and appreciation of agribusiness realities as shown in the example of a training evaluation below.

As indicated in this figure, most gained significantly more entrepreneurial knowledge after training in various topics. The project learnt that entrepreneurial skills identification and design of training modules should be a continuous process of incubation such that these modules are designed in a manner that allows flexibility in meeting the needs of the cohort of incubatees. Continuous multi-tooled approach of skills need identification also allows for nurturing the incubatees to a point where they are comfortable in expressing their real needs. This can take time for some who are more attuned to the straight-jacket method of instruction which is typical of the university systems. The incubator has a role to play in managing the expectations of those with interesting ideas, explaining how the incubator process can assist in taking the proposals forward and providing some indication of the realistic scenarios that might evolve from their involvement with the incubator (Patton, Warren and Bream 2009).

It was apparent that some of the drop-outs had misinterpreted the project as a potential funding facility and not the entrepreneurship development facility that it was meant to be. The project should have employed better and proven incubatee selection tools. In order to increase the probability of the incubatees' commercial success it is indispensable to develop different systems of supervision and control, starting with the activity of selecting and choosing the entrepreneurs in the pre-incubation stage. While selecting future tenants of the incubator it is necessary to take into account as many criteria as possible, such as market potential, prospects of product development, business experience of the entrepreneurs, mental attitude and attitude towards work (Sipos and Szabó, 2006).

The project focused on the development of business plans and to exposing the incubatees to diverse examples and options of capitalization. Two examples are the inclusion of a presentation on franchising by a successful graduate businesswoman who runs an Irish pub franchise in Zimbabwe, and a presentation by ABS TCM, a Technoserve funded feed manufacturing outgrower/franshise hub.

Business plans

Seven incubatees completed the business planning task. The business proposals were given to independent assessors from two different banks with agribusiness units. The assessors used their banks' criteria in assessing the projects' bankability or fundability (Box 1). Four of these seven proposals had potential to be funded according to the decision by either one or both of the assessors. Given that this was the first time to do such proposals, and the nature of the assessment, it is believed that the group has shown a lot of potential. With more practice and individual coaching on the identified proposal weaknesses, the incubatees have potential to produce bankable proposals thus in this regard one of the objectives of training, to equip students with skills to develop business proposals was met. Rice (2002) suggested that the relationship between the incubator manager and the incubatee is of some importance to the development of the business proposal. Having joined the incubator there is an expectation among all participants that firms will be able to gain access to know-how and resources that will facilitate the development of their proposals.

An innovative lesson here was that of using mock evaluations of the business plans by external experts in the banking sector, rather than using internal (academic) evaluations. All the incubatees took the comments seriously and appreciated the experience. The comments on non-fundable proposals also provide lessons in what areas to keep focusing on during the trainings. These areas include cash flow planning, project focus, viability and market research. Unfortunately, there was not enough time within the project to follow up on the fundable plans to where they would be submitted to a bank. Even if they were submitted, most would probably face challenges of prevailing high bank interest rates, requirement for collateral and lack of operational space in some cases. A proposed extension of the incubation project would address these issues a revolving-fund supported initiative at UZ Farm will help in building the incubatees bankability.

Changes in attitudes and perceptions

Another positive output of the project was the perceived change in attitude as reported below.

A report on the application for the accreditation of the business incubation training by the University of Zimbabwe was produced. The project was given 3 options of issuing certificates to incubatees and has chosen the Certificate of Participation which allows flexibility of tailor-making the incubation activities. The Certificate will be a useful bargaining tool for the incubatees when they approach the banks for financing.

Area for further considerations

1. The available project funding was adequate only for pre-pre and pre-incubation and hence no final conclusions can be drawn on the incubation model. In the early stages of the development of business incubators it is indispensable to count on stable and long-term financial resources which are often found in different forms of assistance and donations (Sipos and Szabó, 2006).

2. The narrowing of scope to feed manufacturing made it difficult for potential candidates to realise immediate prospects. Future project approach will be to broaden the scope to include not just Animal Science but agriculture graduates and agribusiness situations in general, and later even other non-agricultural enterprises.

3. Most incubatees did not have financial resources to try-out their business ideas, even on a small scale. Innovative capitalization options have to be explored. A number of incubatees considered chicken production as an avenue for rapidly building up their own financial capital, which would be later channelled into the perceived lucrative feed production value chain.

Conclusion

For successful incubation of agribusinesses for University graduates, some of the key skills that need to be addressed are innovativeness, how to get started, capital mobilization, company registration, financial management, marketing and the crucial support gaps are access to finance, access to operational space and bank risk averseness. A successful business incubation model will involve: flexible programming, continuous needs assessment, training workshops, supervised incubator farm learning, supervised operation at own space and, exposure and links to diverse capitalization options. This business incubation intervention has the potential of solving unemployment problems among the agriculture graduates but the scope of enterprises should be broadened.

References

Etzkowitz H. (2002). Business incubators Incubation of incubators: innovation as a triple helix of university–industry–government Networks. Science and Public Policy, Volume 29, Number 2, April 2002, pages 115–128

Infodev (2010). Global Good Practice in Incubation Policy Development and Implementation. The World Bank and infoDev Communications & Publications Department. October 2010. 51 pages.

Patton D,. Warren L and Bream D. (2009). Elements that underpin high-tech business incubation processes. Journal of Technology Transfer 34:621–636

Rice, M. P. (2002). Co-production of business assistance in business incubators: An exploratory study.Journal of Business Venturing, 17, 163–187.

Sipos, Z, and Szabó.(2006). A Benchmarking of Business Incubators in Cee and Cis Transitio Economies. Http://www.Erenet.Org/Papers/Download/Benchmarkingbusinessincubation.Pdf

Acknowledgement

This project was funded by International Development Research Centre, Project Name: 'Developing a livestock Feed Business Incubation Model for Zimbabwe Graduate Youths'; IDRC grant number: 107001-001

Table 1: Details of training workshops

Workshop	Topics covered
Agribusiness 1&2	■ basic strategic tools used in scanning the internal and external business environment, viable business ideas, importance and procedures of formalizing business ventures, basic accounting requirements, financing options, marketing basics; ■ how to prepare a business proposal, the banks' point of view of a viable business proposal, monitoring the success of a business, market research and market planning in the feed manufacturing industry, networking in the industry, possible business models, human resources issues
Feed formulation and manufacturing	■ opportunities for new business in stock feed industry, 3 fundamental pillars of least cost feed formulation, formulation of simple diets, nutrient requirements of different livestock species; ■ plant equipment, plant design ,types, procurement, storage and processing of raw materials commonly used in Zimbabwe, processing, of stock feed plant, packaging and presentation, business plan development

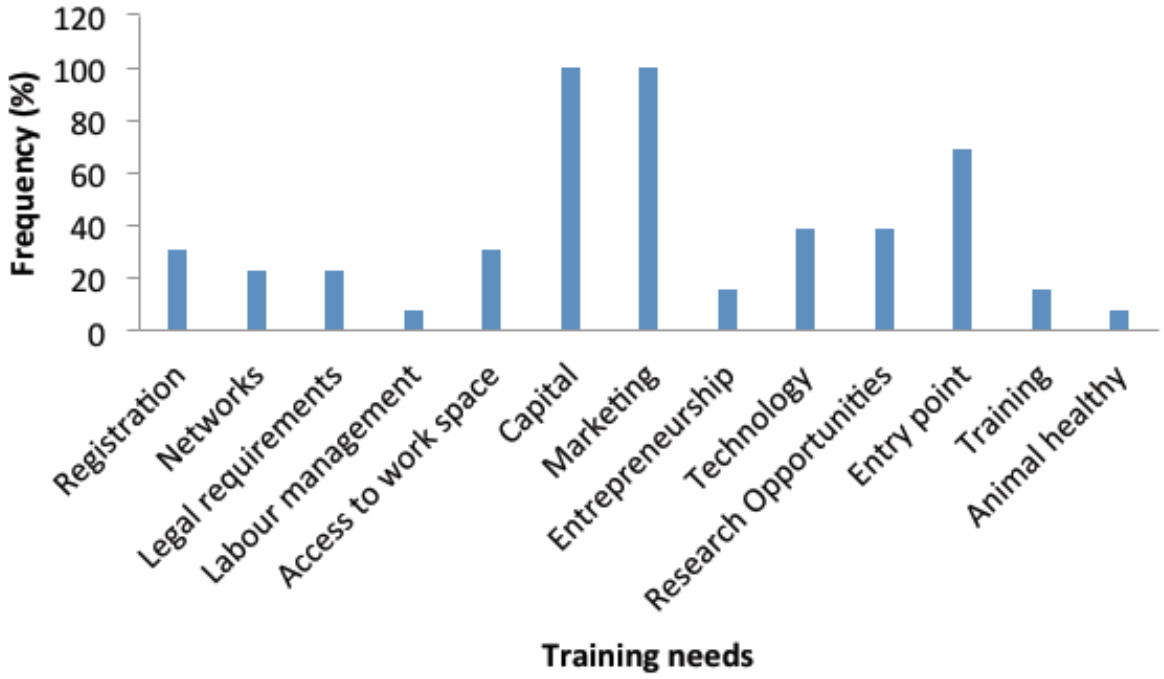

Figure 1: Training needs identified at the first training workshop

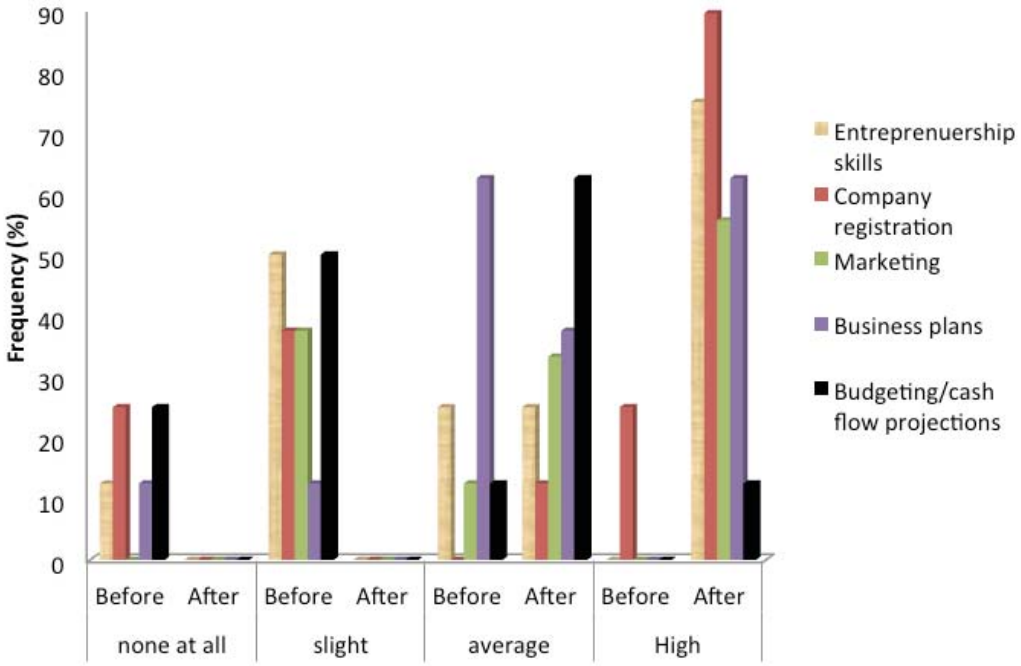

Figure 2: Knowledge levels before and after Agribusiness training

Box 1: Bankers' comments on the business plans

Fundable business plans comments	Non-fundable business plans comments
■ A viable project well demonstrated in its cash flow projections and the assumptions accompanying the financial plan	■
■ Viability is well displayed in the financials i.e., the marginal costing and the projected income statement.	■ Poor business model with regard to an unclear arrangement with U.Z and marketing strategy
■ The business model appears to have been given some considerable thought and it is one that the bank would consider funding.	■ Cashflow assumptions not practical in the broiler industry and cashflow also not showing repayment strategy
■ The business model is small and simple enough for a beginner. The bank can be interested in funding	■ The borrowing entity (individual/company) not clear
■ It is well researched but not stating how much the required funding is and also not showing how costs and income would relate in a cash flow projection.	■ The items appearing in the cashflow projections show that the project's monthly variable costs actually outstrip the monthly inflows, an unviable project a bank would not fund.
	■ The financial requirement not stated
	■ The personnel and expertise behind the project not clear
	■ The nature of the product, its competition, and its markets not mapped out clearly
	■ This project on the surface seems viable, but lacks the detail that would demonstrate its viability
	■ Not enough information to assess the borrower
	■ Applicant has not carried out sufficient research on the environment
	■ Viability of each enterprise is not being clearly brought out
	■ Neither the amount nor the purpose being applied for is stated anywhere in the proposal and the cashflows presented are not very clear on this aspect.
	■ There appears to be lack of focus in the way the model is structured as the promoters seem to want to do stockfeeds for all livestock classes at once.

Box 2 Incubatees interim outcomes as reported by them

- Glad that our previous loan application was not successful because we now realize that we were not ready to handle that money
- My eyes have been opened on the business way of doing things
- Used only to keep production records e.g., mortality of pigs, but now also know the importance of keeping financial records
- Started keeping records more systematically
- Have taken a vibrant approach to marketing my porkers and so far have secured a verbal contract with a butchery
- Had a closer look at my cost structure and noted that my overhead costs are too high.
- Before the training I had a lot of business ideas but now am more focused on broiler production
- Before the training I was in the business of buying and selling cattle but have now realized that I was working for nothing as I could hardly break even
- When I joined I wanted to do feed manufacturing and consultancy, now thinking of feed manufacturing in focusing on dairy and poultry feed
- I now know how to do the business plan so I will not just plunge into the market
- Have been making broiler feed manually and now I know the basic machinery needed to improve on the quality of the feed
- I am also able to calculate profits
- I also feel very networked as a result of the training
- We have formalized meetings and now document more information than before
- Now banking all cash inflows before use so as to track activities

Trade-offs to Wetlands Control and Management in Uganda: a Multi-Objective Decision Analysis Approach

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Abstract

Globally, there are wide fears of more severe pending environmental impacts stemming from inappropriate use and poor management of environment and natural resources, particularly wetlands. In Uganda, wetlands have been and continue to be cleared for agriculture, human settlement and other economic purposes. Though, wetland resources have been traditionally used sustainably by local communities to support human life under various management protocols, the ever growing human population rates and pressures have over time outweighed the regeneration capacities of these wetlands. The situation has warranted a dire need for conservative environmental protection measures to secure a purposeful future environment. This study assesses the available wetlands control regimes in Uganda against several measures of human needs and guides policy on the best alternatives, relying on a multi-objective decision analysis approach. Using a structured random sampling method, 120 individuals including natural resources policy makers and implementers at districts, government officials, private wetland owners and wetland using households were interviewed from the five districts of Wakiso, Pallisa, Mbarara, Isingiro and Kibuku; covering three agro-ecological zones of Uganda in 2013. The government exclusive control of the wetlands regime was ranked high on several measures that were important for the wetlands' economic and environmental benefit to the community. Common users of wetlands had more trust in the government to be fair is distributing benefits from the wetlands as well as having ample resources to maintain wetlands wholesomely beneficial. The regime was ranked the best for wetlands management in Uganda. The regime must be more popularized to the communities, as well as involving the communities in designing better management practices for the regime for better success.

1. Background to the study

The world over about 5% of land is reserved for exceptional purposes of nature including protection of unique species, and water and air purification, (Pimbert & Pretty, 1995). Despite the different conservation efforts,

degradation mainly attributed to misuse of resources, lack of management controls and negative impacts of global warming and greenhouse gasses are quite evident (CIGI, 2007). Impacts of degradation on wetlands have been largely associated with mismanagement, including changing of land uses to other purposes, (Emerton et al., 1998), and excessive use, characterised by enormous land fragmentation (Sanginga et al., 2004) and/or change of purpose of environmental resources. Emerton et al (1998) adds that most notably, depletion of natural resources, particularly wetlands by local communities, mostly for economic interests, has not spared the environmental abilities to support humanity sustainably. Such irrational use of natural resources has partially stemmed from negligence of their proper management that was in earlier times adaptive and based on knowledge that was cultural ecologically sustainable , (Berkes et al., Golding & Folke, 2000). In the recent decades, international authorities like the World Wide Fund for Nature (WWF) and The World Conservation Union (IUCN) have approved more conservative plans of managing, controlling and using environmental resources to save especially the existing forests and wetlands. For instance, IUCN has approved the use of traditional ecological knowledge, where resident populations, who are the custodians of the resources, manage resources through cultural rules and norms (Berkes et al., 2000) and participatory management, where government may partner with local communities in wetlands management (Gawler, 2002). These new measures, however, require huge capital investments in terms of initial buying capital for these lands and maintenance fees in cases where the local communities may be bought out for effective management, for instance in the case of privately or exclusively government owned areas. However, these effective wetlands management practices tend to accessibly victimize the poorest of the communities (Maclean et al., 2004). As such, it has been difficult to effectively implement the practices in several of the world's developing countries of Asia, Eastern Europe, South America and Africa, where the local communities dearly derive incomes from wetlands and want to participate in their management, alongside national economies that are still weak, (Gawler, 2002). As a remedy, several traditional, informal and customary alternatives of using, managing and controlling wetlands in these countries have been used along the new more effective formal alternatives. They have included exclusive control of wetlands by government, exclusive control by private landlords, shared control between government and communities and most notably the open access alternatives that seem to be the most common in Africa, especially where social settings are still largely based on customs.

In Uganda, while following the decentralized system of governance, the above methods of wetlands control have been under use at least since 1986, when the National Resistance Movement under President Museveni took power. Under decentralization that was enacted under the 1995 Uganda constitution, wetlands control regimes that allowed wetland management by local governments shared with communities was also adopted, adding to the earlier regimes that involved exclusive government control, private control and communal regimes,(Hartter & Ryan, 2010). However, the rate of depletion of common pool resources, including, wetlands in Uganda is still alarming (Baldascini, 2002). For example, it has been reported that Uganda lost about 11,268 km2 of wetlands, down from 37,575 km2 (15.6%) in 1994 to about 26,308 km2 (10.9%) in 2009; representing a loss of 30% of the country's wetlands (WMD et al., 2009). To date, this loss is expected to be even higher given the increasing human population and use of wetlands for different benefits (Kakuru et al., 2013). Corruption tendencies within authorities where laws to protect wetlands and other resources are applied selectively on different users has, among other factors, hampered tangible progress in saving

environmental resources wetlands inclusive, more so in the Ugandan case where laws ignored specificity in local terms and regional and cultural variations, (Banana et al., 2004; Nkonya et al., 2005). Heavy clearances of wetlands by private wetland owners, investors and local communities, for agriculture and for purposes of erecting industrial and settlement premises is widely evident in Uganda, even on wetlands closest to the capital city and other regional urban areas. In Uganda, as in other regions in Africa, many communities depend on wetlands for multiple benefits, including social, economic, ecological and aesthetic values (Kakuru et al., 2013 and Turyahabwe et al., 2013). Wetland agriculture provides a means to reduce crop yield losses associated with low and unreliable rainfall and frequent droughts and thus enhances food security and incomes of poor agriculture dependent communities (Turyahabwe et al., 2013).

Besides agriculture, wetlands provide other provisioning services which are important for supporting the livelihoods of most poor people. These include dry season livestock grazing and watering, fisheries, wildlife, building materials, crafts, medicine, fuel wood, clay for pottery, water supply for domestic, irrigation and industrial use (Breen et al., 1997; WMD et al., 2009; Kakuru et al., 2013). Whilst wetlands play a key role in supporting the livelihoods of many communities, their continuous unguided use for cultivation and grazing has a potential to degrade wetland ecosystems and undermine their capacity to provide services in future. Assessing the tradeoffs between use of wetlands for human well-being and their ecological integrity involves quantifying the impacts of alternative wetland uses on wetland systems, the services they provide and human well-being. The main empirical approaches used by Cai & McKinney (1997), Daniels et al. (2001) and Makowski (2001); for assessing ecological- economic trade-offs include: (i) economic valuation of ecosystem services and economic activities (ii) multi-criteria analysis and (iii) integrated ecological-economic models. This study adopted the multi-criteria approach. Multi-Objective decision analysis importantly helps assess available alternatives of choice to the user and enable him/her choose the best alternative that can serve several intended goals composed of various measures of importance for the resource being assessed. An alternative with the best score generally across all considered measures is ranked the best to achieve the set goal, (Yoe, 2002; Smith, 2007).

1.1 The Problem

Several recent environmental catastrophes for instance the tsunami, global warming and others have made a serious alarm for the need to use environmental resources effectively, sparingly and sustainably. International and regional protocols championed by the World Conservation Union (IUCN), to protect and save the environment from depletive use have been signed and member states urged to effect these protocols, under which several alternatives of environmental resources management are proposed, including those on sustainable use of wetlands, (Berkes et al., 2000). However, because of the fact that some of the protective measures for wetlands are capital intensive, some member signatories of these protocols especially developing countries cannot afford to effectively implement them, (Maclean et al, 2004). These governments have continuously let their communities fully participate in wetlands management, use and control, under various control regimes. For instance in 1988, Uganda passed the Community-based Conservation Policy of managing protected areas that also included Wetlands, calling for more government expenditure to effect the regulations, (Mugisha, 2002). Uganda, being a signatory to the Ramsar convention on wetlands has

also been promoting wise use of wetland resources and has included wetland management provisions in a number of policies and legislation such as the constitution, Environment Act, Water Statute and the National Policy for the Conservation and Management of Wetlands.

However, there have been limited studies on the tradeoff and sensitivity analysis, comparing the various wetlands control regimes in Uganda. Such information makes it difficult to effectively guide policy makers on which wetland use options and regimes the relevant policies should concentrate on, if Uganda must use her wetlands efficiently, acceptably and economically, whereas sustainably conserving the wetlands and the environment (WMD et al., 2009). This study serves to add to the existing literature by, assessing management control regimes of wetlands in Uganda and create a ranking for these alternatives on an intended services delivery criterion to ease policy focus and effort for wetlands control in Uganda.

1.2 Exploration of the Problem

Uganda has over fifty ethnic groups that are much grounded on their customs. These several ethnicities are located in the various parts of the country and are generally responsible for day to day use of the environmental resources found in those areas (Hartter & Ryan, 2010). The multiple ethnicities create a vacuum for unified decisions over the use and management of wetlands (Mugisha, 2002). Therefore several regimes of using wetlands in Uganda have been given a green light by government most of which have been structured on customary means since customs are deemed reliable in avoiding conflicts over resource use, (Sanginga et al., 2007). Most notably, the open access control of land, including wetlands is a customary norm for many of the communities in Uganda resident in the northern, eastern and western regions of the country Bakema & Iyango (2001). In these regions safety of the wetlands has been in the hands of the communities and the private landlords in the respective regions, respectively running wetlands under clans, local and private establishments in conformity with national policies, (Sanginga et al., 2007). Private land ownership, including wetlands is also highly practiced and originates from the customary norms of the ethnicities inhabiting the central region of the country. In addition to use of wetlands for agriculture, public developments such as settlements and markets in town centers have also largely contributed to the elimination and degradation of wetlands in Uganda (Pender et al., 2002). Furthermore, the arrival of the British in Uganda in the late 1800s, established other land ownership regimes that included land (wetlands inclusive) that was owned exclusively by the government especially in the capital and regional urban areas. The other alternative that was as a result of a combination of the customary means and the British innovations was the shared regime, where land and wetlands inclusive was co-managed between the government and local community authorities. The latter two methods were and still are predominant in the central region of Uganda (Sanginga et al., 2007). In the 1970s, the president of Uganda, General Idi Amin, introduced the land decree, where all land was exclusively owned and managed by government, including wetlands. Under the Amin decree, no body or individual had authority to change use, clear or sale land except government (Mutibwa, 1992). However, local communities were still allowed to harvest non-depletive quantities of wetland resources for home use, for instance papyrus, water, fish, firewood and harvesting of all commercial quantities had to strictly be sanctioned by government. During the period before the 1980s, there were no fears of large scale environmental degradation internationally and locally in Uganda. For example one of the policies in Uganda

to increase agricultural land available for production was encouraging drainage of wetlands and this led to reclamation of wetlands in south-western Uganda. Since the late 1980s, with a new government and the 1995 Uganda constitution, a free market environment was introduced, which included establishment of proper land rights regimes and where national policies for conserving wetlands were embedded, (Bakema & Iyango, 2001). According to the 1995 constitution, wetlands are held in trust for the good of the people to provide the important functions and services. Accordingly, individuals, as well as other bodies like resource user groups, government, religious bodies, ethnicities, clans and schools are not allowed to parcel out wetlands. All land owners who had received legal ownership of wetlands before the promulgation of the constitution are also obliged to use wetlands in line with the laws governing the environment under the supervision and monitoring of the National Environment Management Authority (NEMA, 2001). NEMA has also been tasked to always sanction private investments through proper environment impact assessments if developments have to be done on private wetlands since even private owners in Uganda to make personal decisions on the use of wetlands, (Sanginga et al., 2007).

In Uganda, control, use and management of the wetlands has solely been left to those with lawful rights to manage, control and use these wetlands because even where the policies are applicable, costs of effecting these policies hinder government interaction to protect even those forests and wetlands in gazette and in other instances these policies are too weak for any meaningful penalties, (Nsita, 2003). Since the ultimate short-term goal of most households is economic welfare, much of these natural resources have been used beyond their regenerative capacities and have in some areas largely cleared the wetlands without accounting for the loss of the other benefits (Kakuru et al., 2013). According to WMD et al. (2009), in certain areas of Uganda neither the local leaders nor the residents know the status of the wetlands that they repetitively use which most often lead to misuse. Therefore, studying the trade-offs for wetlands control regimes and alternative plans in Uganda is quite important to guide policy interventions on sustainable, commonly acceptable and efficient use of wetlands. Trade-off analysis will also help to inform the communities on the sustainable, beneficent economic and environmentally friendly management practices and use of wetlands.

1.3 Research Questions

The study attempted to answer the following research questions:

1. What are the commonly acceptable prevailing wetlands control regimes in Uganda and the overall goal of wetland management?
2. How much is the importance of individual measures under particular management arrangements of wetlands, on the overall goal of wetland management?
3. How much utility is contributed by each measure on the overall utility from using wetlands?
4. What are the best options for wetlands control regimes in Uganda?
5. What details make a control regime the best alternative?

2. Methods

2.1 The Study area

The study was carried out around wetlands areas in three agro-ecological zones of Uganda: Isingiro and Mbarara districts for the southern farmlands agro-ecological zone, Wakiso district for the Lake Victoria crescent and Kibuku and Pallisa districts for the Kyoga plains. . The districts were selected purposively, considering the fact that they have several wetlands that are actively used by households in the respective agro-ecological zones. The different zones were considered to enable understanding the variation of wetland use at regional level.

2.2 Characteristics of participant in the study

Generally, selected participants in the study areas had prior knowledge and practical experience of working with wetlands. There were two sections of the formal sector whose responses were of interest for this study. These were the technocrats, for instance, district environment officers who directly advised district authorities on wetland use and management, and Government administration officers like the district production officers who managed sectors including wetlands at a larger level. Private landlords who claimed ownership of wetlands were also a target for the study to have responses on the private wetlands control regime. Local communities, especially households that lived close to and used wetlands either under the open access regime or the community/government shared control regimes were also involved.

2.3 Sampling Procedures

The research team worked with officials from the District natural Resources Department (wetland and environment officers) to randomly identify respondents from amongst those who were using wetlands for social and/or economic purposes in the district. The officials also helped to establish contact with other government officials who were consulted during interviews. The private wetland owners were few and hence only two respondents were selected for interviewing in every district. We zeroed on three agro-ecological zones where wetlands were prominently used in Uganda according to WMD et al., 2009 and Turyahabwe et al. (2013, and these were southern farmlands, Lake Victoria crescent and Kyoga plains. Interviews were conducted with a total of 122 wetlands users from the three agro-ecological zones.- The sample selection is summarized in Table 1.

Table 1: Composition of the Study Sample Size

Agro-ecological zone	Number of Respondents			
	Government Policy Makers	Private Land Owners	Technocrats	Local Communities
Kyoga plains (Pallisa and Kibuku)	3	2	3	25
Lake Victoria crescent (Wakiso)	3	2	4	36
Southern farmlands (Mbarara and Isingiro)	3	2	3	36
Total	9	6	10	97

2.4 Sample Size, Power and Precision

The study relied on the ability of Logical Decisions for Windows (LDW) programme to convert subjective or qualitative responses into quantitative values. Respondents were asked for their views and preferences on how wetlands would be used sustainably and economically whereas maintaining their ecological functions and services. LDW offered this service using single- measure and multi-measure utility functions, which guide the final ranking of alternatives (Makowski, 2001 and Yoe, 2002).

Precision was also ensured while using LDW's sensitivity analysis abilities to further study the alternatives for each measure, considering any possible changes of the measures, to show what the ranking of the alternatives would have been, if the values of the measures used to give a final ranking presented in the study were changed. A comparisons ability of LDW was also used to further assess alternatives per measure to further understand how the best ranked alternative faired against any other. Validation was also made for consistence if this performance was still in line with the final ranking produced by preference sets of all responses. Further analysis was done using STATA programme that is manually quantitative on certain measures to further assessing the precision and consistence in influence of these measures on commons respondents' preference to control wetlands.

2.5 Measures and Covariates

During the study, respondents were asked for their views and preferences on how wetlands in Uganda would be used sustainably and economically, whereas maintaining their ecosystem functions and services. That led to several subjective responses that needed a quantitative translation (Smith, 2007). Several measures identified by Walten & McKersie, (1965); Cai & McKinney, (1997); Makowski, (2001) and Yoe, (2002), were used as the major indicators of how sustainable and beneficial natural resources like water resources and wetlands are to the local community users and all those owning rights over wetlands. Walten & McKersie add that through negotiations and tradeoffs optimal use of these resources can be achieved. These measures included net income benefits, aquatic habitats, upland habitats, initial buying cost and technical acceptance. These measures aid in ensuring that all needs of the wetland users are taken care of and are outlined in this paper.

1. Net Income benefits: This is the difference between monthly incomes from wetland use under a particular control plan/regime and monthly costs incurred to maintain the wetland. We gathered data on net income benefits of each alternative plan in monetary terms.

2. Aquatic habitats (availability of water, living organisms and preservation of a diversity of water species), which considered how different plans comparatively preserved aquatic life. We collected the data on a percentage scale from the respondents basing on how they objectively viewed the abilities and goodness of each plan to conserve aquatics.

3. Upland habitats (availability of land shelter due to reservation and preservation of land life based on existence of the resource). This measure was used to determine the suitability of the wetland as an

ecosystem reservoir or an economic engine for activities like fishing and tourism.

4. Initial Buying cost: This was the initial expected or experienced cost of obtaining lawful rights over the wetland, considering each plan/control regime. This measure was the primary tool if any authority wanted to implement any goals for the wetlands resources.

5. Wetland restored; The measure was used to find out under each plan, how many acres of the wetland were expected to be reverted to wetland use, if it were earlier a wetland and had been encroached on or cleared. However, this was also difficult to estimate quantitatively in real terms by the common person. Due to lack of proper records in Uganda, we collected data on a percentage scale.

6. Technical acceptance: The importance of the wetland as evidenced or hypothesized by personnel with scientific knowledge and understanding of critical characteristics of the wetland, such as its scarcity, representativeness, status of disturbance, level of biodiversity and use for animals and plants. We collected data on a percentage point scale from respondents including technocrats who were asked for what percentage of technical personnel in the areas of segments of wetlands that they used would okay each particular wetland control plan.

7. Community Acceptance: this measure while relying on the respondents' experience or expectations assessed the acceptability of various plans to the central and local governments, as well as community resource agencies and traditional/cultural settings. It was also captured on a percentage scale considering the expected or experienced population.

8. Effectiveness: this measure captured the respondents' experience, considerations or expectation on a percentage point scale how the particular wetland control alternative plan made significant contribution to addressing the specified restoration problems on the wetland and/or potential opportunities from the wetland to and/or from the user local communities.

2.6 Research Design

The study was a follow-up on an earlier one that was aimed at establishing the Total Economic Value (TEV) of wetlands to different beneficiaries (Kakuru et al., 2013), which found out that the benefits that accrued to were linked to the management control plan of the wetland. This study was, therefore, designed to interview wetlands stakeholders in the same districts on the measures that were deemed to satisfy both environmental and economic abilities of wetlands. A structured questionnaire was administered to environment technocrats, district officials, landlords and the local communities to get their experience and/or expectation in the respective capacity. The collected data were entered into STATA software to generate means and modes which were later used in LDW to construct a decision matrix for analyzing which wetlands management control plan was the best as used by Yoe (2002). The study further used a binary Logit model to assess associated private regime preference to control or not to control wetlands. A multinomial Logit model

(MNL) could not be used over all the four alternatives because certain plans, like government and private control had fewer observations and could not statistically stand independent MNL analysis.

2.7 Analytical Framework and Model Specifications

After generating the decision matrix of the alternative wetlands control and management arrangements and the respective measures, a single-measure utility function that would be used in the tradeoff analysis between alternative plans was defined. For a particular measure, its lowest value across alternatives in the decision matrix would generate a utility (U) = 0, and the highest value would generate a value = 1, considering the alternatives ability to achieve the overall goal. In analyzing trade-off between alternatives, a middle preference level for the particular measure that would give equal preference for both considered alternatives was defined following the Single-Measure Utility Function (SUF) as in equation 1. This generated parameters for a smooth curve passing through the preferred levels of the chosen measures (Cai & McKinney, 1997 and Smith, 2007).

$$U(x)l + me^{(-nx)}$$

l, m and n are scaling constants, whereas e is a mathematical constant 2.718, having a natural logarithm of 1, and x is the measure value.

We assumed that individuals do not cooperate with one another in choosing the best exploitative plan for the wetlands, which is a typical human behavior, (Walten & McKersie, 1965). Therefore each measure made its individual impact to the Multi-measure Utility Functions (MUF) formula dependent to its weight as presumed by the using households, and that impact did not hinge on the intensities of the other measures (Cai & McKinney, 1997; Makowski, 2001; Yoe, 2002 and Smith, 2007). We modeled the preference associations in LDW by using a multiplicative MUF formula. According to Smith (2007), every measure in a multiplicative MUF takes on an associated scaling constant (weight). A multiplicative formula necessitates an extra scaling constant, K, which describes the kind and amount of interaction among the measures. But since the weights for each measure did not hinge on the intensities of each other, K was equal to zero (0) depicting a neutral interaction in weights amongst measures. An additive MUF formula was adopted, as illustrated in equation (2).

$$U(X) = ((1 + K\beta_1 U_1(X)) \times (1 + K\beta_2 U_2(X)) \times \ldots \times (1 + K\beta_n U_n(X)) - 1) \div K \quad (2)$$

Where;

$U(X)$ = Total Utility of given alternative X

β_i = Scaling constant for the i measure

$U_i(X)$ = SUF utility on measure i for alternative X

K = interaction scaling constant

To assess the consistence and precision of the measures on local communities' preference for control of wetlands in Uganda, a Logit model as defined by Green (2004) as in equation (3) was used.

Where

$$y = \mathbf{X}'\beta + \varepsilon \qquad (3)$$

y = binary dependent variable with value 1, if preference was to control wetland privately and 0 otherwise

X = Vector of explanatory variables (considered measures) including; upland habitats secured by the plan, community and technical acceptance for the regime, effectiveness of the regime in securing intended goals, years of stay spent by the respondent around the wetland resource, distance between the respondents' home and acres of land under wetlands owned.

β = parameters to be estimated
ε = error term

3. Results

3.1 Measures of alternative control of wetlands in Uganda

Wetlands in different locations in Uganda have different ownership, control and uses. The social and economic uses of the wetlands are well documented in Kakuru et al., (2013). The alternative ownership/ controls considered in this study are government, private, community and government jointly, and open access. The wetlands generate various benefits to the owners or those who control them, and effectiveness and acceptance of control are perceived differently by the different stakeholders. It was on these parameters that statistics for the particular measures were generated and used to formulate the decision matrix for ranking the best wetlands control alternatives. These measures include net income benefits, aquatic and upland habitats, initial buying cost, technical acceptance and commons acceptance (Table 2).

Table 2: Means of Measures used in generation of Decision Matrix in LDW

Alternative wetland control	Measures							
	Net Income benefits (UGX)	**Aquatic habitat (% animals)**	**Upland habitat, (% animals)**	**Initial buying cost (million UGX)**	**Wetland restored, (% acres)**	**Technical Acceptance (% Community persons)**	**Local Community Acceptance (%persons)**	**Effectiveness, (% points)**
Community & Government	263,000	31.9	35.7	12.200	45.0	57.8	64.2	65.4
Privately owned	320,815	29.8	32.8	5.186	45.2	57.5	41.2	61.5
Government owned	2 (10)10	66.1	68.6	1.67 (10)70	72.4	61.2	70.2	
Open access	271,010	29.7	31.7	5.753	72.1 38.6	48.4 55.8	55.9	

Source: Authors data 2013. UGX is currency code for Uganda Currency (USD1=UGX2,500)

Most notably was the average values of what people expected government to be earning or what it would incur if it were interested in exclusively taking the wetlands under government control. Generally, the government control alternative was perceived to have better ability to reserve more aquatic and upland habitats and restore wetlands that had been destroyed or encroached on. The government option was also preferred to be more technically accepted and effective. However, the combination of government and community control was more rated for acceptability by the local communities.

3.2 Tradeoffs of wetland control under different utility functions

Under different regimes of wetland control, different utilities are derived by different users following different or even similar utility functions. The tradeoffs exercised by users of wetlands amongst competing uses define the value of utility derived by users and hence the general utility of the respective control regime (Makowski, 2001; Yoe, 2002 and Smith, 2007).

3.2.1 Tradeoffs under Single-Measure Utility Functions

Net income benefits were assumed the most important measure to households using the wetlands. Thus a tradeoff analysis between net incomes that could be fetched in by any alternative was traded off with preferred levels of other measures to establish an equally preferred situation of the compared alternatives. On this basis, the weights illustrated in Figure 1 were obtained.

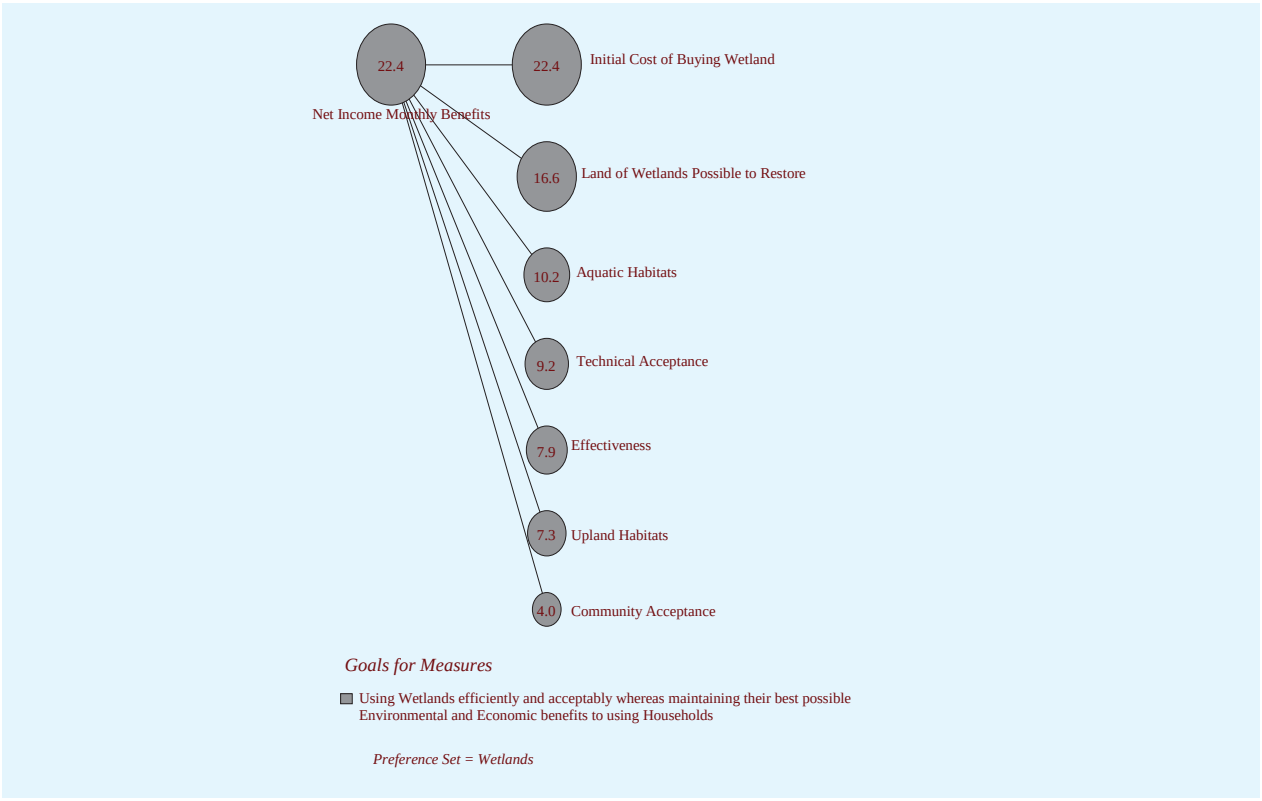

Figure 1: Weights or importance (utility) assigned to individual measures

For recap, the relevant measures were defined as in section 2.5 and utility attached to each measure was estimated following equation 1, from the subjective responses of respondents concerning how they benefited from wetlands under each control alternative. For its paramount importance to the basic needs of households, monetary measures (net income benefits and initial buying cost) were rated most important by households in achieving the overall goal of using wetlands efficiently and acceptably, at the same time maintaining their best possible environmental and economic benefits to the using households. These monetary measures generated up to 44.8% of the general utility that was derived from using wetlands, reflecting how important to households was the monetary benefits of wetlands. Households preferred to earn more from wetlands in terms of cash, whereas they preferred to pay less in terms of initial buying costs, if such households wanted to own wetlands. Land of wetlands restored was rated next. This was because of the higher individual utility derived by households as compared to the other measures such as aquatic and upland habitats, which are more of public than private goods. This also explains why community acceptance was rated least. Land recovered gave quick means to the owning households to earn more liquidity through the rampant land sales, especially to foreign investors and market businesses. It is not surprising for aquatic habitat to contribute next in value to overall utility. Given the frequent daily household cash needs, aquatic organisms from wetlands for instance fish including lung fish, silver fish and others provide a formidable and reliable alternative to solving such liquidity constraints. Generally, measures attached to fetching quick liquidity to households contribute more (at least 10%) to the general utility of households from the use of wetlands. However, measures that also contributes to community wellbeing for instance technical and community acceptance, effectiveness of a control plan and upland habitats that can be preserved for instance grass and trees that may be used for grazing by other community members were also contributors (at least each contributing over 4 %) to general utility. The contribution of such measures reflects that wetland users under various regimes still value the other non-cash (environmental and social) benefits of wetlands. Results from this study are similar to the findings of Walten & McKersie (1965), which indicated that negotiation through accommodating all natural resource users' interests would bring about optimal use of such resources.

3.2.2 Tradeoffs under Multi-Measure Utility Functions

Tradeoff analysis under multi-measure utility functions gave similar results (Table 3). The analysis was also aimed at understanding the particular scaling factors that LDW used to compute the overall utility before concluding on the best alternative for wetland management.

Table 3: Scaling Constants for using wetlands efficiently and acceptably whereas maintaining their best possible environmental and economic benefits

Alternative use measure	Weight
Net income monthly benefit	0.22 42
Initial cost of buying wetland	0.2241
Land of wetlands possible to restore	0.1661
Aquatic habitats	0.0403
Technical acceptance	0.1015
Effectiveness	0.0917
Upland habitats	0.0789
Community acceptance	0.0731

Figure 1and table 3, show a list of the scaling constantshouseholds have been relying on the wetlands mostly for liquidity (cash) opportunities, measures attached to increasing household incomes from wetlands for instance net income through farming and harvesting other resources, land restoration through purchases and controlled use and increase of aquatic habitats through fishing or reducing household expenses on wetlands for instance reduced buying costs for wetlands which reserves household cash, carried more weight to the using households than any other measure. Technical acceptance closely followed the liquidity proximal measures, since for any operations to be successful in a gazette wetland for instance farming, fishing, tourism and other benefits measures had to be put in place to allow use through government regulations that were based on technical approval. Effectiveness followed the above two categories because after ensuring statutory interests, households then had to ensure safety of their own interests and goals. Since much of the environmental quality was usually ensured by upland habitats like grass and trees, environmental quality was only secondary in importance to the quick-cash generating measures. Upland habitats therefore weighed less than effectiveness and cash-linked measures. Households using wetlands did not bother much about how other households were successful in accessing other benefits from wetlands, a scenario observed by Smith (2007). Therefore, other members' acceptance of another household's wetland use strategy carried least weight of all the measures considered.

3.2.3 Ranking Alternative plans of Wetland Control per Measure

Considering the utility levels using different measures clearly shows that the government exclusive control alternative is the best choice for wetlands control in Uganda (Figure 3). For instance, Figure 3 where the ranking is based on effectives shows highest utility (1.0) under this regime, but as low as zero under the open access regime. The government regime ranked highest in effectiveness because the regime could collect substantial revenues from the wetlands that would in turn be used to serve other goals expected from wetlands. For instance, incomes generated from tourism or fishing licenses, would be used to pay wetland patrol police (the Environment Protection Force) to restrict wetland misuse or even contribute to maintenance of the wetland management and conservation infrastructure such as unblocking wetland channels. According to the study, there was no other regime that can be able to collect substantial revenues

from wetlands as government exclusive regime. The open access control performed low in effectiveness, since they had limited resources to meet all the intended goals from wetlands.

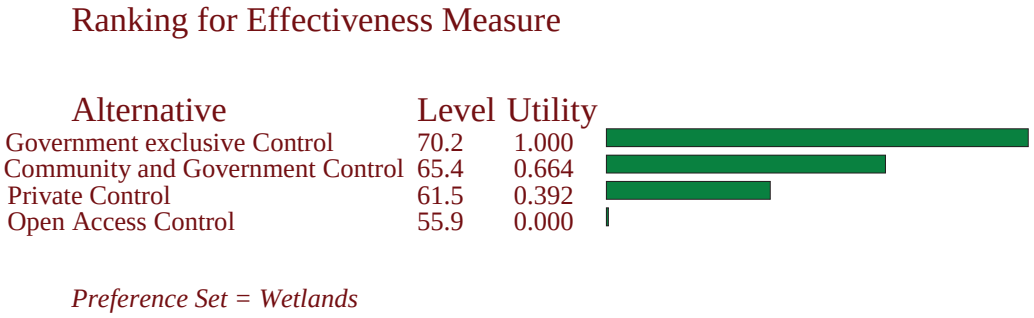

Figure 3: Graph for the Effective measure

Considering the need for preservation of aquatic habitats, the government exclusive control still ranked better than any other alternatives. Other than government control through NEMA, which is statutorily obligated to preserve such aquatics, (NEMA, 2001), government also had the means in terms of financial and human resources to ensure such preservation. Government rangers would protect and gazette wetlands from encroachment which would ensure survival of the aquatics, all too supported by the resources that government sourced from both wetlands and other sources including donors. The other alternatives are more certain over such provisions, hence the low performance. For being shared with government, the community and government control regime ranked next in preserving aquatics.

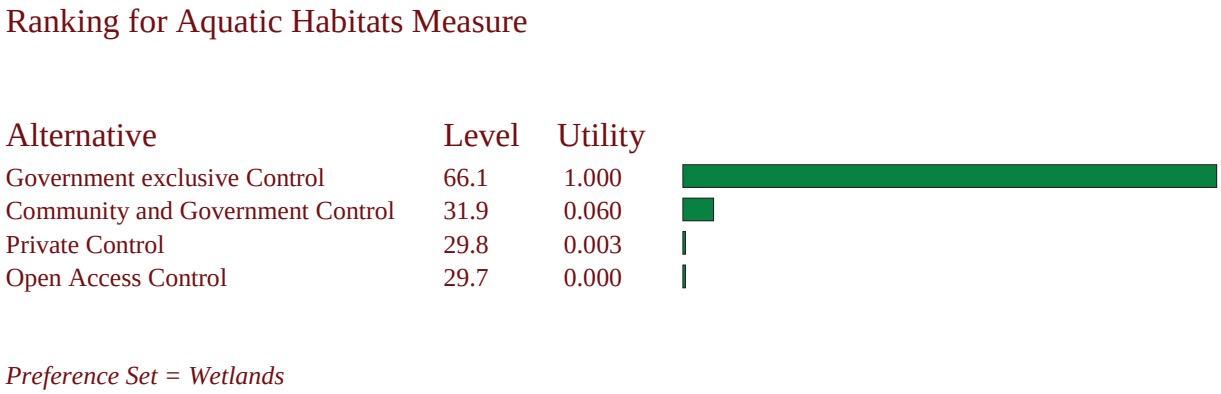

Figure 4, Graph for the Aquatic Habitats Measure

According to this study communities usually prefer sharing responsibilities for control of the wetlands with government, a scenario observed by Mutibwa (1992) and Harter and Ryan, (2010). That fact explains why in figure 5, community and government control ranked ahead of every regime for community acceptance. Due to the general trust of the community for government, government exclusive control ranked second followed by open access control, which of course would allow community access. However, due to the fear of depletive misuse of wetlands, respondents ranked the open access regime to be lower than government exclusive control regime. As expected, the private control regime ranked least in community acceptance because it would exclude communities and generally private owners would selfishly use wetlands without respecting interests of other users or communities, a scenario observed by Yoe (2002) and Smith (2007).

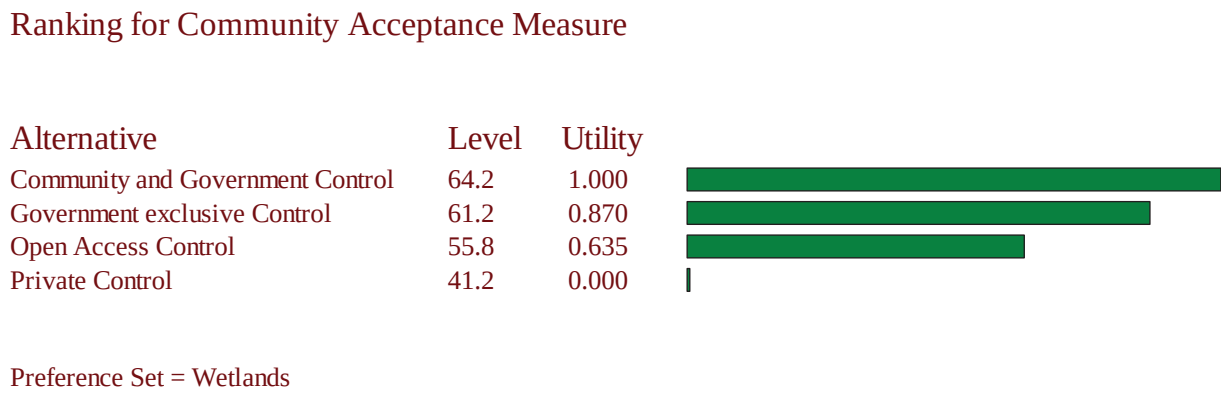

Figure 5, Graph for the Community Acceptance Measure

For instance during the land decree of the 1970s, government annexed all land without compensation to the former owners (Mutibwa, 1992). All subsequent laws after the 1995 constitution still required and mandated close government monitoring of even private land owners where natural resources were found (Bakema & Iyango, 2001; NEMA, 2001). Therefore government could annex natural resources land without even paying any initial cost; hence the measure was not that important to the government exclusive control alternative unlike others as depicted in figure 6.

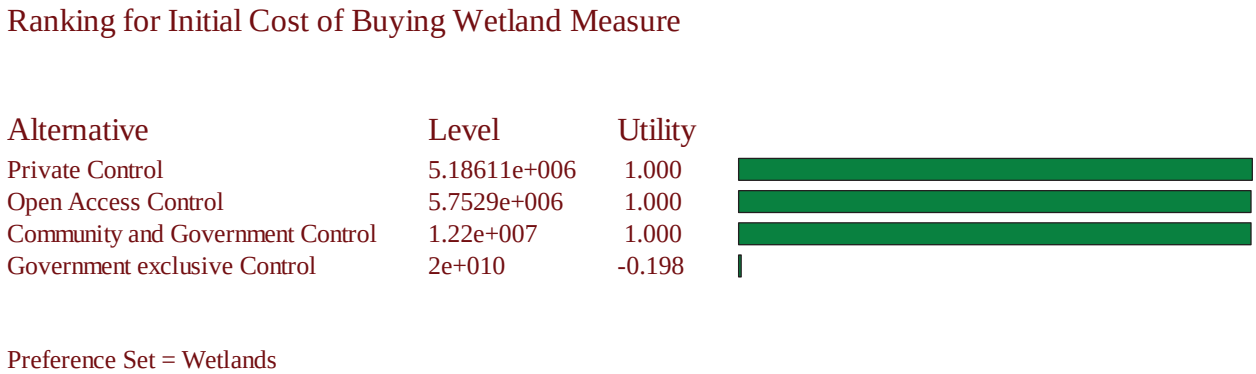

Figure 6, Graph for Initial Cost of Buying Wetlands Measure

Government has statutory powers to revert any land deemed to be a natural resource reserve even when it is privately owned (NEMA, 2001). However, even while using free market forces, government has enough resources generated from both wetlands and other sources to pay off or even resettle communities inhabiting wetlands. Therefore, the regime scores highest in restoring wetlands. Since there are no clear property rights under the open access regime, (Banana et al., 2004) there is extremely limited opportunity to recover such land, hence the regime ranked least on that measure as illustrated in figure 7.

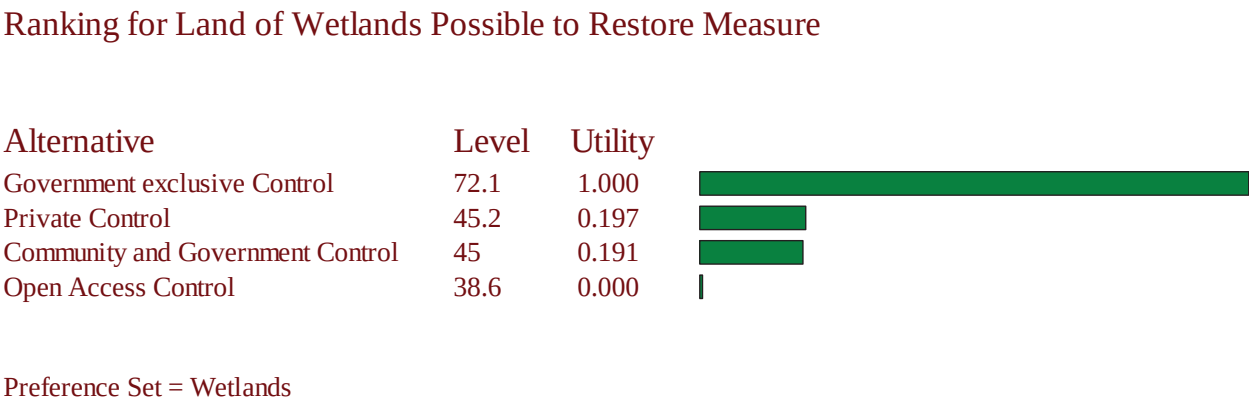

Figure 7, Graph for Land of Wetlands to Restore Measure

Since the community and to a large extent even the private wetlands owners mostly use the wetlands for services like grazing, water for home use and animals, fetching firewood, household food farming and other petty household needs that are not directly cash intended (Bakema & Iyango, 2001; Banana et al., 2001 and Baldascini, 2002), regimes ensuring involvement of communities and private owners in wetlands control scored less in terms of utility generated from the wetlands along that measure. On the other hand however, a government exclusive regime, that even bears a statutory authority to foresee benefits from the wetlands, (NEMA, 2001), derived more utility from the measure since it was much in need of the revenues especially from tourists, so that enough financial resources are generated to fulfill both their statutory obligations over the sustainable use of wetlands and elsewhere thus ranking highest in figure 8.

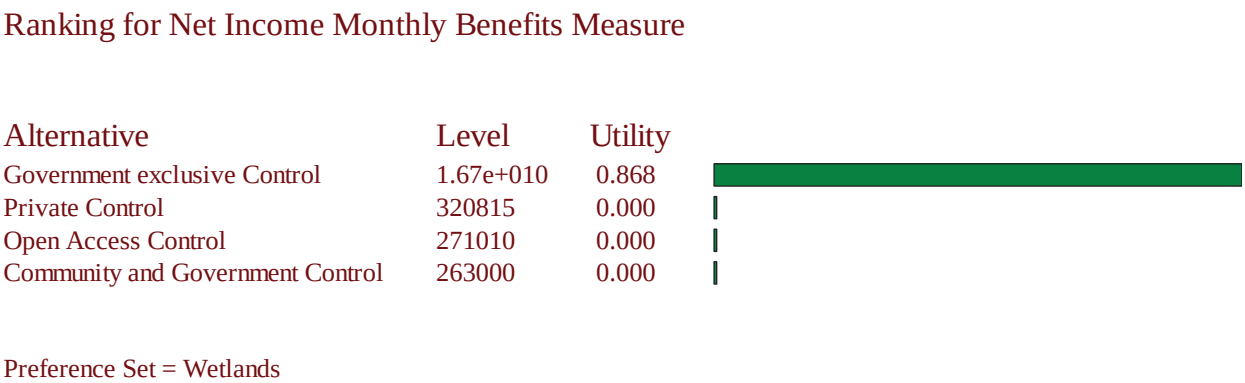

Figure 8, Graph for Net Income Monthly benefits Measure

Technical personnel would take into consideration the abilities and capacities of a particular regime to sustainably use wetlands, whereas preserving the environmental and economic benefits from the resource (Yoe, 2002). However, for this sustainable use of wetlands to be ensured, other resources like finances and human personnel were necessary to support, maintain and protect the wetlands. The government exclusive control regime was more endowed in both financial and human resources than any other regime, hence ranking highest on the technical acceptance measure. Because an open access control regime lacks the above resources or even those available are very poorly mobilized, (Berkes et al., 2000), it ranked least on this measure as is illustrated in figure 9.

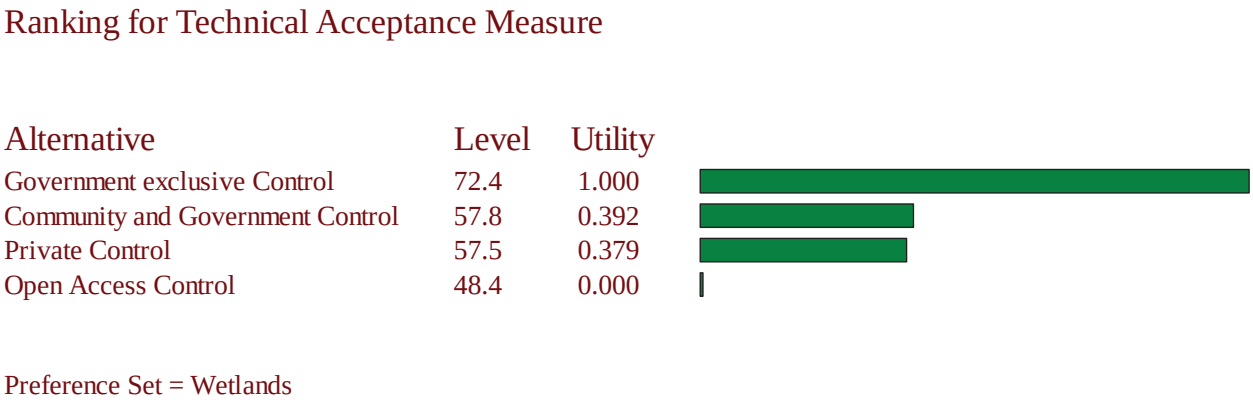

Figure 9, Graph for Technical Acceptance Measure

To preserve reasonable amounts of the upland habitats, a regime had to be better at restoring land formerly encroached on, to wetlands use, must have had enough resources to monitor and protect the habitats, and must have had limited urge to kill these habitats for day to day living. The government exclusive control regime was better at all the above attributes and hence ranked best at preserving upland habitats. Open access is mostly all about exploitative and selfish use of natural resources, especially where there is high pressure on such resources, (Yoe, 2002 and Baldascini, 2002), hence the regime ranked least at that measure as well as generating zero utility from the same measure.

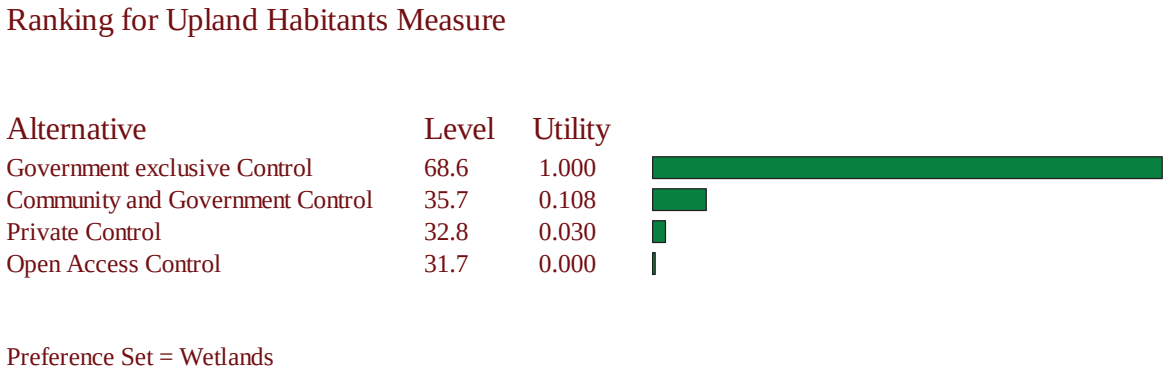

Figure 10, Graph for Upland Habitats Measure 3.2.6 Using Graph Alternatives

Focusing on the performance of individual regimes across all measures considered at ago, figure 11, depicts clearly that except the initial cost of buying wetlands, the regime scored substantially on all other measures from which reasonable utilities were obtained more than in any other regime, hence being a more balanced regime. Figure 12, that the community and government control regime scored next best to the exclusive control across all measures, generally deriving more utility than private and open access regimes. The government support where government provided helping resources enhanced the better performance of this regime. Figure 13, shows that the private regime derived substantial utility at least from four of the eight measures considered. Private investors were also interested in continued gains from their wetlands; however the limited resources at their disposal limited their potential to derive maximum utility from the respective measures. Because under the open access regime, there is usually no cost attached to accessing the resource and usually the most deprived populations as is in Uganda form the largest part of wetland users, (Baldascini, 2002; Hartter & Ryan, 2010), the open access regime only derived substantial (bars clearly above the base line) utility from the initial buying cost of wetlands and community acceptance measure.

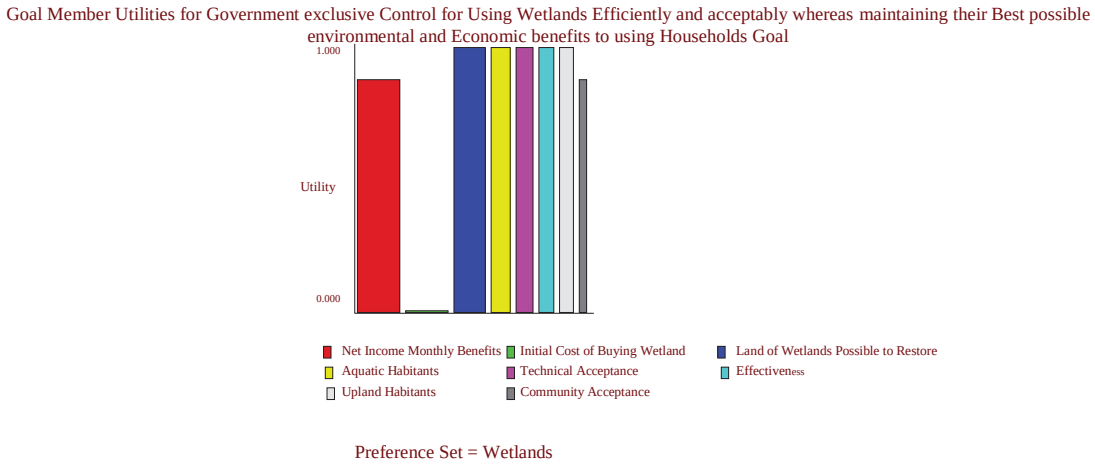

Figure 11: A bar chart or "petal diagram" showing the utilities for the Government control alternative on the various measures

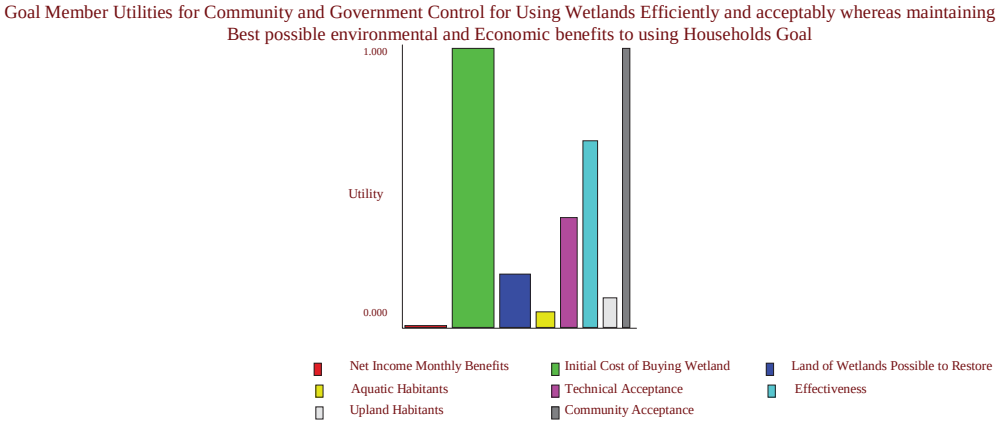

Figure 12: Displays utilities for the Community and Government control alternative on the various measures

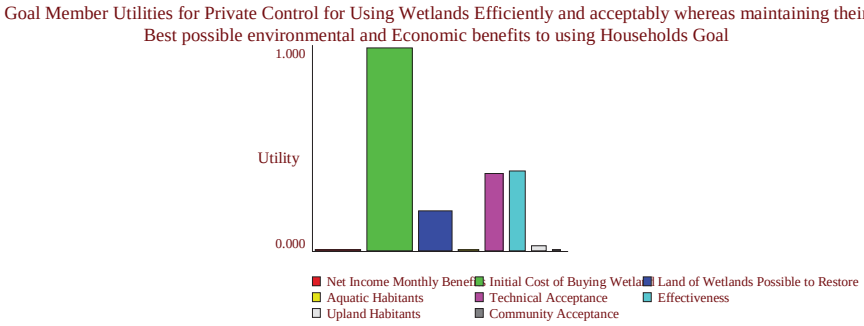

Figure 13: Shows utilities for the Private control alternative considering various measures

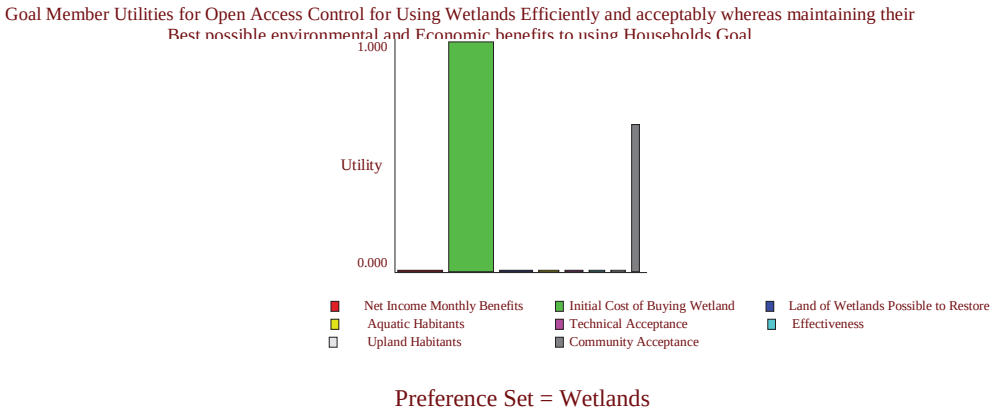

Figure 14: Shows the utilities for the Open access control alternative considering various measures.

3.2.7 Sensitivity Analysis

In the interest of an alternative methodology to investigate the consistence in performance of all regimes across a single measure, a graphical sensitivity analysis was carried out. This was meant to help highlight possibilities of the robustness and precision of the results in the earlier sections. Figures 15 to 22, generally depict that at various levels of the respective measures, including the optimal levels (showed by the vertical middle black line), the government exclusive control averagely consistently performed better that other wetlands control alternatives. The financial and human resources at the exposure of government enabled the regime's consistent outstanding performance in achieving wetlands' environmental and economic goals. Such a finding is not surprising, since under the land decree and the 1995 constitution, there is usually an annual government budgetary allocation towards ensuring proper and sustainable use of the wetland resources, (Mutibwa, 1992 and NEMA, 2001).

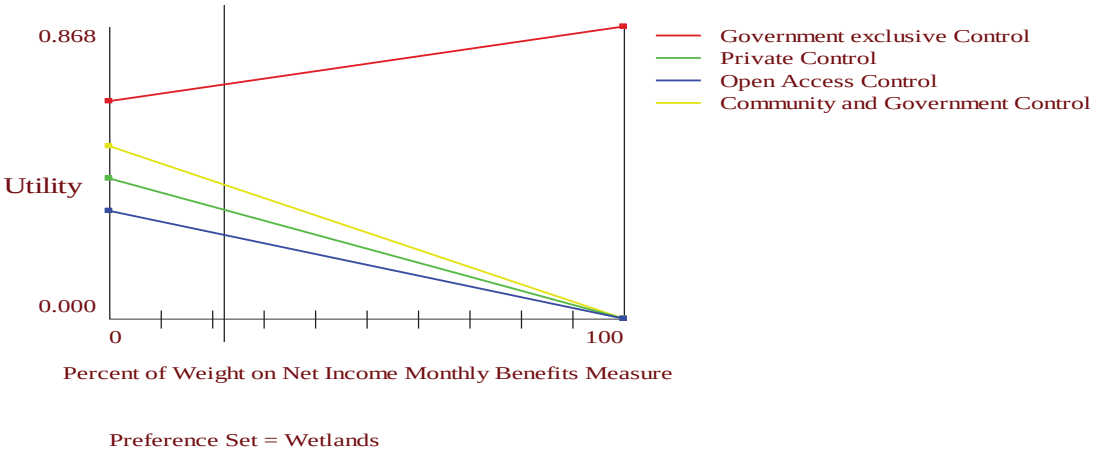

Figure 15, showing sensitivity to the weight for Net income benefits

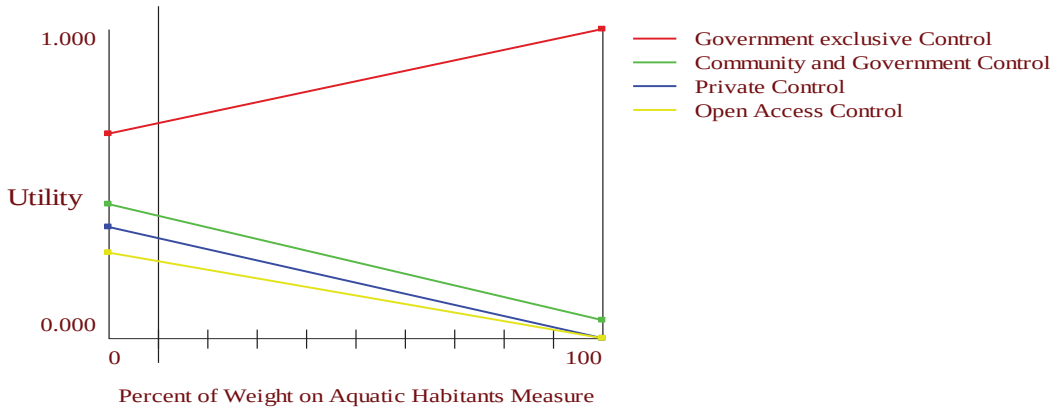

Figure 16, showing sensitivity to the weight for Aquatic habitants

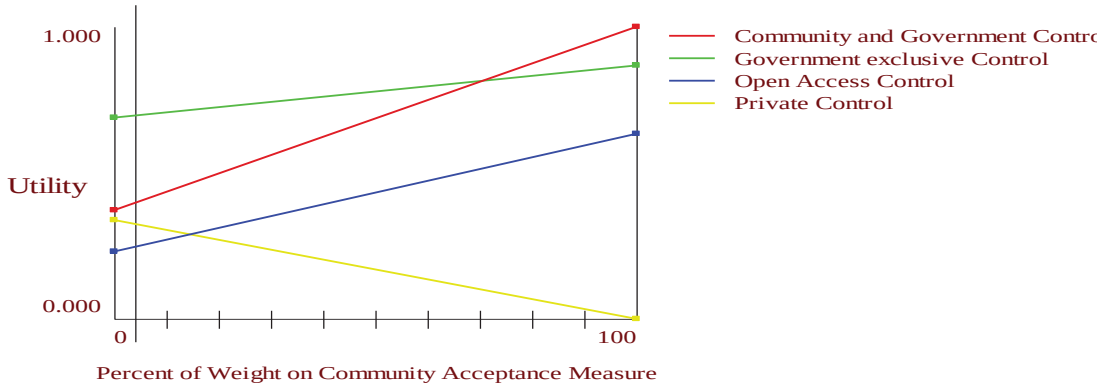

Figure 17, showing sensitivity to the weight for Community acceptance

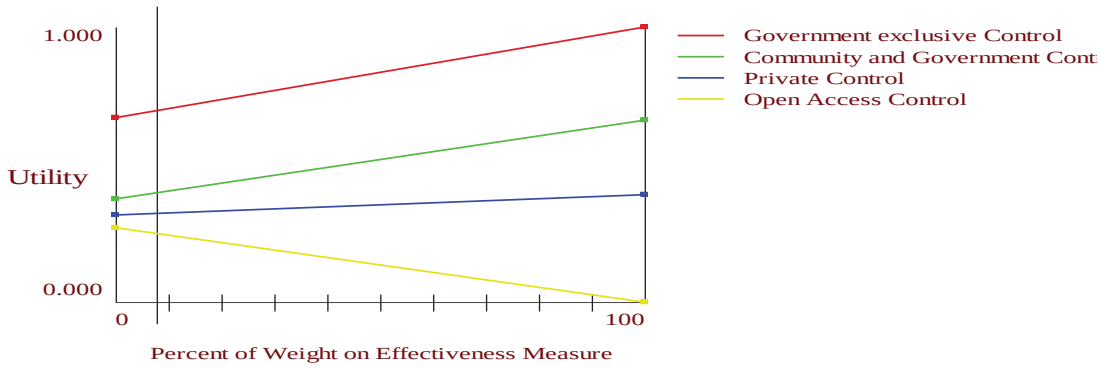

Figure 18, showing sensitivity to the weight for effectiveness

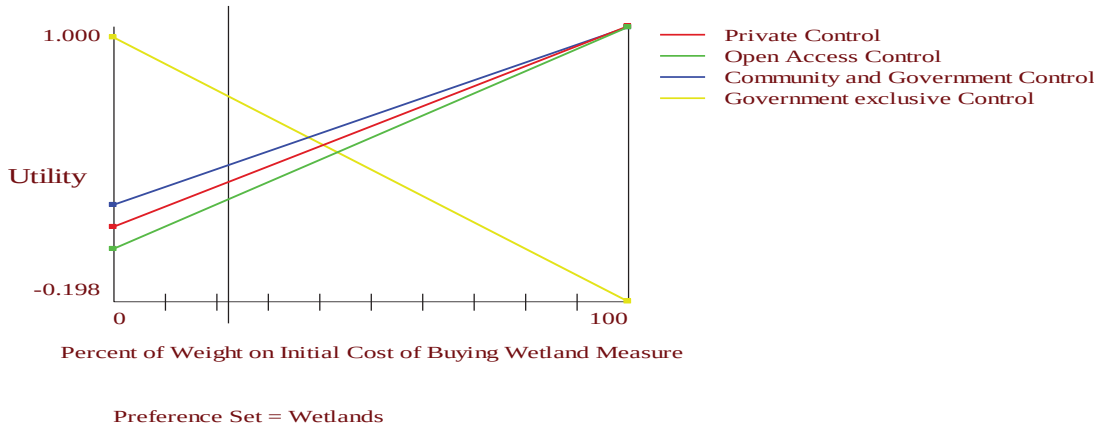

Figure 19, showing sensitivity to the weight for initial buying costs

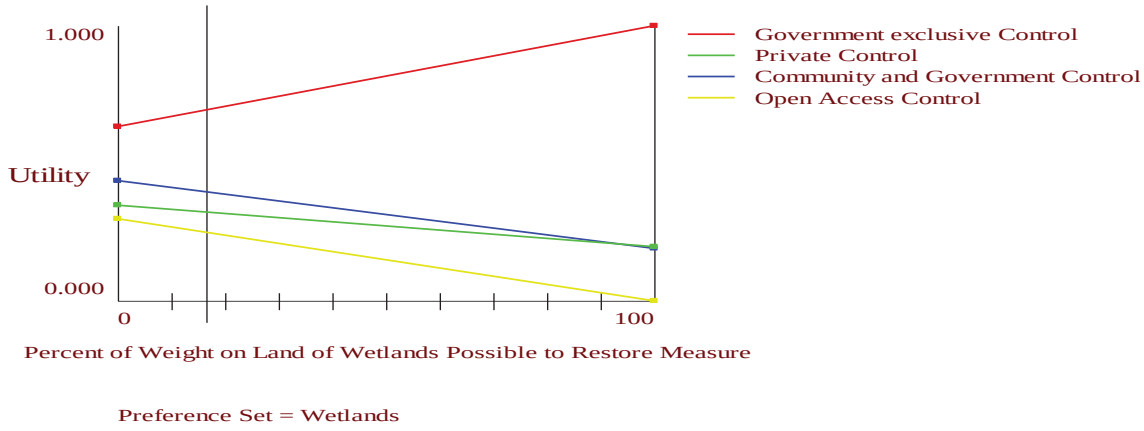

Figure 20, showing sensitivity to the weight for land restored

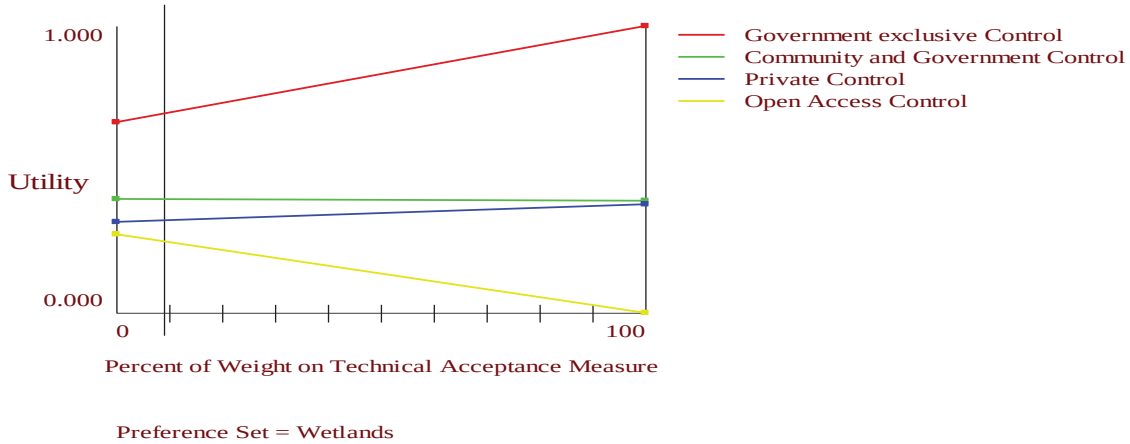

Figure 21, showing sensitivity to the weight for technical acceptance

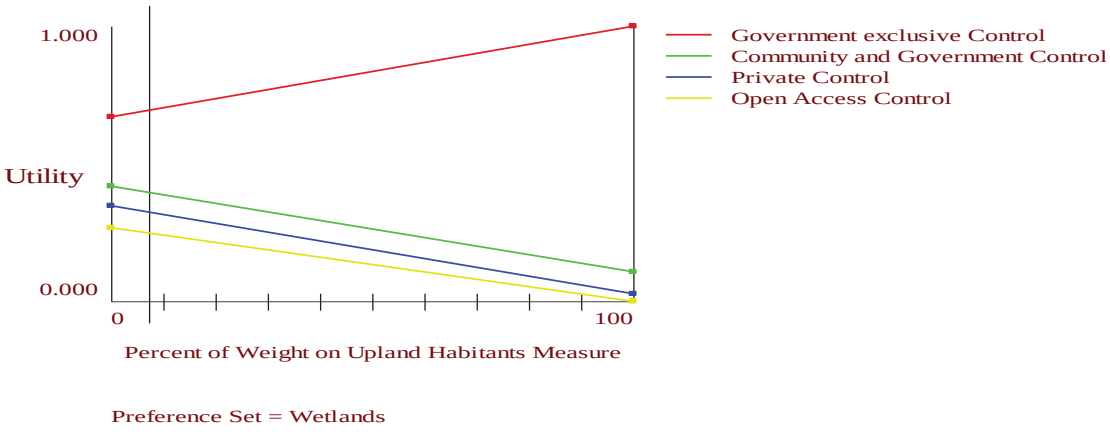

Figure 22, showing sensitivity to the weight for Upland habitants

The government consistently performed better to achieving all goals because it had supporting resources. Financial resources from taxes enable governments to replenish, rejuvenate and re- establish wetland resources, (Gawler, 2002) while monetary human resources of NEMA assist in maintaining and protecting such wetland establishments from encroachment and destruction (NEMA, 2001). Other regimes largely lacked such provisions and where they existed perhaps they were neither well supported nor enforced.

3.2.8 Comparison of Alternatives

To better the understanding behind why the government exclusive control of wetlands was predictably and consistently performing better than other alternatives, we compared different alternatives in an effort to assess their dual performance across the various measures. Figures, 23-25, grade the influence of every measure to the variance in total utility considering the government exclusive control and the respective other three alternatives.

Using Wetlands Efficiently and Acceptably whereas maintaining their best possible enviromental and and Economic benefits to using Households Goal Utility for Government exclusive Control Private Control

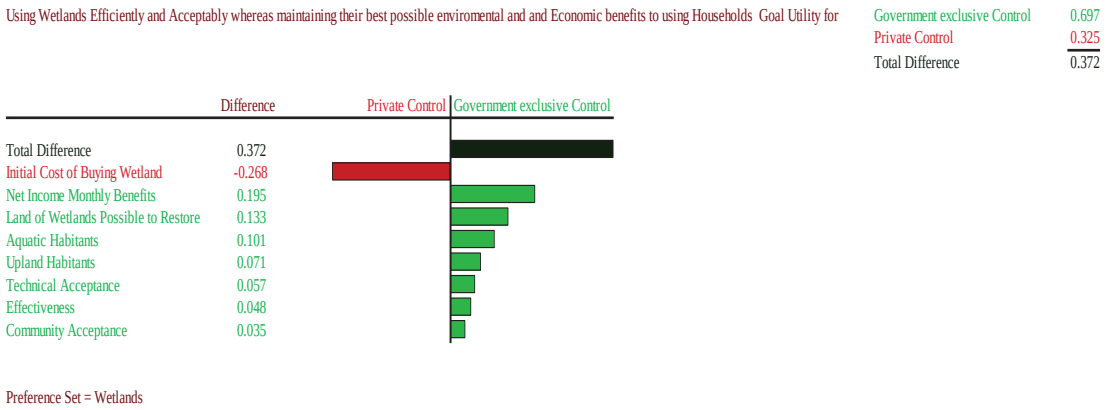

Figure 23, grading the influence of every measure to the variance in total utility between the government and private control alternatives

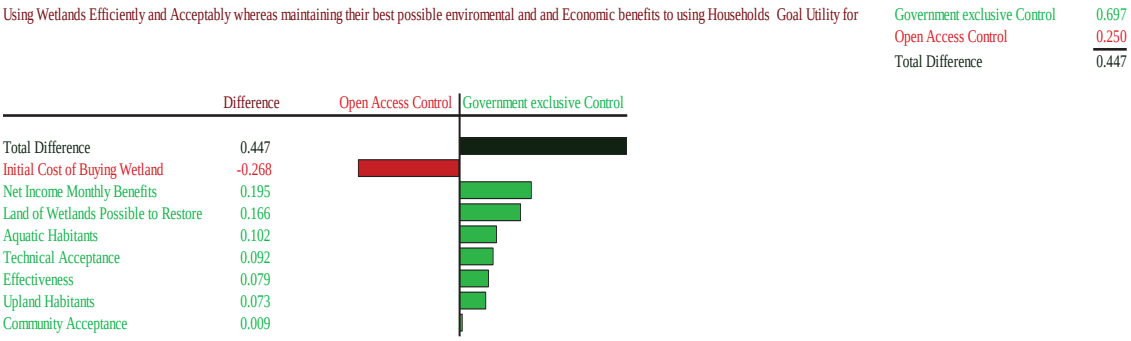

Figure 24, grading the influence of every measure to the variance in total utility between the government and open access control alternatives

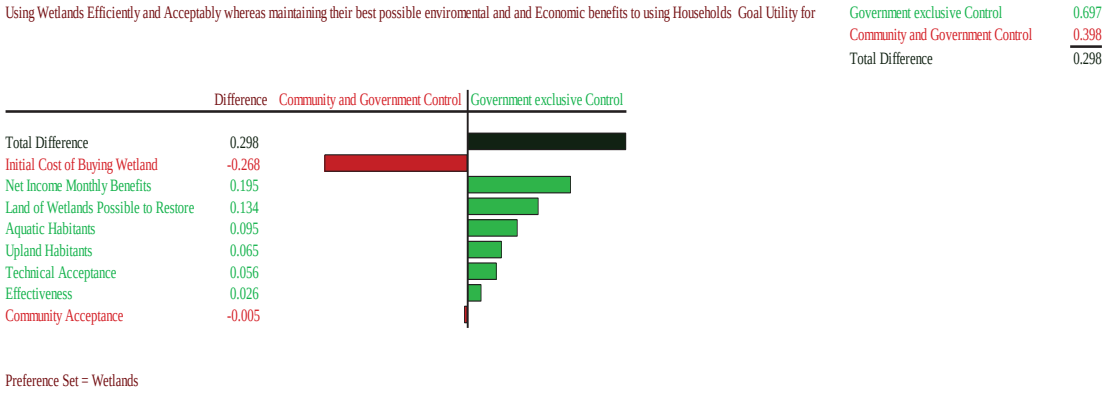

Figure 25, grading the influence of every measure to the variance in total utility between the government and community /gov't control alternatives

Indeed even on a dual comparison, the government exclusive control regime performed better than any alternative generally. The total difference in general utility derived by the control regimes from all measures considered was positive in favor of the exclusive government control against any other regime, implying that generally the government exclusive regime derived better purpose economically and environmentally from wetlands better than any other alternative. Despite the fact that also others (community and private owners) may be interested in managing wetland resources, (Berkes et al., 2000; Bakema & Iyango, 2001) they may lack the resources at the exposure of government to enable substantial gains for both environmental and economic benefits from the wetlands, (Banana et al., 2004).

3.3 General Ranking of Alternative Wetland Control plans/regimes

Based on the weights generated from both the Single-Measure and Multi-Measure Utility Functions, the alternatives as regards to the attainment of the overall goal for wetlands control and management in Uganda were ranked. The ranking, displayed in Figure 25, gives a guide on a decision for the best alternative plan for achieving the overall goal.

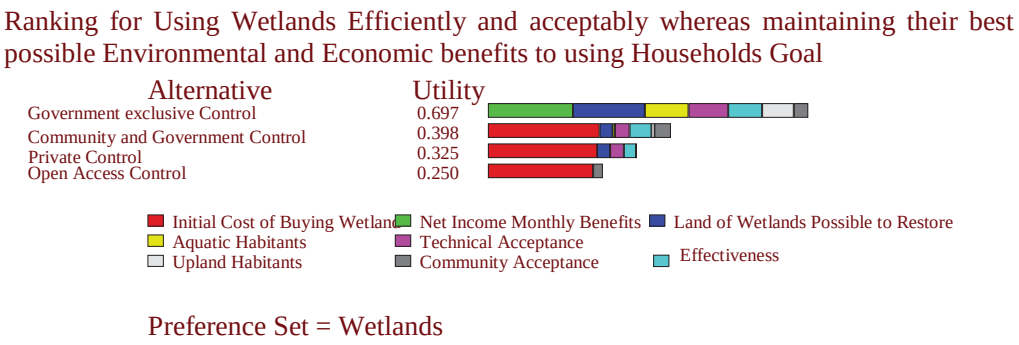

Figure 26: Final ranking of the four wetland control alternatives

From Figure 26, government exclusive control finally ranked highest than any other alternative largely because of the relatively high net income monthly benefits and presence of wetlands suitable for restoration. Considering the utility levels, the other control regimes had much lower levels (less than 0.4) than the government exclusive control (0.7). This was because of the relatively high contributions in terms of, among others, net income monthly benefit from perhaps tourism operations, land of wetlands possible to restore that in turn is availed to investors or allocated to markets all of whom government generates taxes, aquatic benefits, especially fishing that also fetches revenues if well controlled, like how government usually does, and upland habitats that may also contribute to the tourism potentials of the government reserved wetlands directly and indirectly for instance through preservation of other life species attractive to tourists, technical and community acceptance that enhance both community and technical policing on the use of wetlands, that usually yields a positive influence towards wetlands' use. All these were lacking in the other control regimes. What contributed most to the utility in the community and government, private and open access control regimes was the initial cost of buying wetland areas, which was non-existent in the government exclusive control regime. Open access regime ranked least because it lacked almost all the key measures considered; wetlands suitable for restoration, net income monthly benefits, technical acceptance and effectiveness. However, it expectedly had higher levels of community acceptance than the private control regime, since the community believed that they would be more favored by the regime than a private one.

3.4 Econometric Supportive and Explanatory Analysis

Though the Analytical abilities of LDW are more quantitative in utility terms which makes LDW an excellent help decision making software, we further were interested in understanding the LDW output while using a directly quantitative software like STATA and also assess the consistence of the results. While using STATA we modeled some measures and other variables considering a household basis on a binary preference of commons to own and control wetlands under the private alternative. This would help us understand more why LDW had ranked government as the best wetlands control alternative as opposed to private ownership in a liberal free market environment as is existing in Uganda. Table 4, presents the results of a Logit model against a preference of local communities to control wetlands.

Table 4: Logit Model estimates for preference for choice of Wetlands Private control

Dependent Variable	**Prefer Private wetlands control (Yes = 1, No = 0)**					
Variable	Coefficient	Std. Err	P-	Marginal	Std. Err	P-
			Value	Effect		Value
Upland Habitat (%)	-0.015	0.024	0.519	-0.002	0.004	0.513
Acceptance (%)	0.091	0.034	0.008	0.014	0.005	0.007
Effectiveness (%)	0.010	0.026	0.696	0.002	0.004	0.007
Stay length (Years)	-0.014	0.021	0.511	-0.002	0.003	0.507
Distance (meters)	0.0002	0.0002	0.226	0.00003	0.00003	0.226
Land (acres)	-0.007	0.004	0.063	-0.001	0.001	0.050
Constant	-1.647	1.248	0.187	y = Pr(wish_own) = .806		
Logistic regression				**Number of obs = 52**		
LR chi2(6) = 17.03				**Prob > chi2 = 0.0092**		
Log likelihood =-21.7739				**Pseudo R2 = 0.2811**		

From Table 4, acceptance and land under wetlands owned were statistically significant. When an individual wished to own land, his acceptance to sustainably control and use wetlands under private regime increased by 0.7%. However, this was no surprise since private owners wished to earn more exclusively as households from the private regimes rights, including changing purpose and or selling the wetlands altogether. Actually, Pender et al., (2002) established that wetlands had been largely depleted due to establishments of new market places, coming as a result of wetlands owners wishing to maximize economic and environmental benefits through leasing parts of their wetlands though actually not selling them for total change of purpose. However like any other alternative, private control also had some measures where its influence was positive like effectiveness and distance to wetlands though not significant. The more the distance increased from household/town/residential centers to wetlands individuals were more willing to own wetlands. This was because land in and near town centers was more prime and needed for settlements and market establishments, (Pender et al., 2002; Nkonya et al., 2005) thus private landlords were only willing to spare wetlands as their locational distance increased away from town/residential centers.

More interestingly is the understanding behind measures whose direction of influence was negative as individuals wished for private control. With an increasing number of individuals who preferred private wetlands ownership, the land under wetlands owned decreased by 5%. This was because establishment of industrial centers and markets was more possible on private land due to clear property rights than any other regime, consistent with, (Banana et al., 2001; Pender et al., 2002). Furthermore, the influence of private wetland ownership on upland habitats was also negative. Generally wetlands could mostly exist if there was reserved land and naturally multiplying habitats to fulfill both economic and environmental goals. However, private control had a negative influence on these indicators. Finally, though the model specification explains only about 28% of the variation in the choice to own wetlands privately, the constant for all other

unconsidered measures in this model is negative. This implies that the more people would prefer to own wetlands privately; the positive choice would generally have a negative influence on unobserved wetland measures.

4. Discussions

This study used a benchmark of the best ranked alternative "the government exclusive control" in relation to other alternatives. From the results, measures were valued important by households closely in relation to the respective measure to attract better value cash opportunities. This is because households that mostly live near wetlands are poor households and cash availability is very important in ensuring household security, (Pender et al., 2002; Hartter & Ryan, 2010). Because the government had the highest initial buying costs, the measure contributed the least utility for the alternative. The highest initial costs also stemmed from the fact that the government usually needs to buy off large areas of wetlands corresponding to large initial costs, intended to make her investments bear economies of scale. This adds to the fact that usually due to corruption tendencies within government procurement and other officers; government usually acquires property at inflated rates. However, sometimes government also has a statutory right of taking care of any wetland if users did not respect environmental laws, (NEMA, 2001).

The government exclusive control alternative saved more aquatic and upland habitats in terms of water and land organisms living in the wetlands vicinity, because the alternative was able to establish and enforce wetland reserves that could support the regeneration of the wetlands natural ecosystem which favored the proper multiplication of both inhabiting water and land animals. The alternative also restored more land formerly under wetlands from encroachers due to the fact that government had direct access to security organs like the police that would ensure restoration of such land consistent with Banana et al., 2004; Nkonya et al., 2005).

Additionally, the alternative was more effective, meaning that households trusted it more in fulfilling the economic and environmental opportunities of the wetlands and solving wetlands problems. This was because government was more endowed with facilities like vehicles, human resource, access, publicity and financial resources to put in place and monitor interest goals over the wetlands, as provided for under the 1995 constitution, (NEMA, 2001). The government was also more accepted by the technical and community personnel because most of these thought that the alternative was generally fair to all wetlands users. Private landlords repeatedly displaced other local communities and the open access regime had no proper regulation to ensure sustainable wetlands use. Therefore, the government alternative was more acceptable for its fairness and a sense of responsibility that it had to serve equally all the interests of wetlands users. That also implied that technical and common persons added together were more willing to work with the alternative which would enhance easy sustainability and accessibility of the alternative bylaws, hence making the alternative more effective.

Finally and most importantly, the government alternative had the highest net monthly incomes from the wetlands. This was because the government could reserve wide areas of wetlands, which could serve as

reservoirs of several plant and animal resources and these have continuously attracted foreign earnings from both local and international tourists. Furthermore, the government earns legally and continuously from several other economic activities on her controlled wetlands for instance fishing licenses, market vendors residing on these wetlands and many more, (NEMA, 2001; Pender et al., 2002). Further still in the recent wake of investors, government is also involved in selling and or leasing huge parts of wetlands to these investors for locating their industries. These investors in turn pay ground rate fees for the land and also continue remitting taxes to the government. From all these revenues the government would be able to re-invest in several of the wetlands interventions such as land restoration, demarcating protected reserves for endangered habitats for water and land animals and many more. Having the highest monetary resources earnings also made the government able to provide services to the people as this was a government obligation unlike for other alternatives. This explained why the alternative was more acceptable to the people.

Finally the alternative had a cumulative positive total difference in utility compared to all others, because it was scored more positively in several measures by the households that were using the wetlands as opposed to other alternatives. Therefore the alternative ranked rightly best and was more preferred by households to achieve the overall goal of having environmentally and economically benefitting wetlands in Uganda that are managed efficiently and acceptably.

5. Conclusions

Households prefer that there is a functional wetland control regime to manage and control these resources. For its ability to generate enough resources from wetlands, save more water and land, wetland ecosystems, wide acceptability amongst the people for perhaps its fairness, and effectiveness in seizing opportunities and solving problems around wetlands. The government exclusive control regime is the best alternative in Uganda to manage wetlands for sustainable environmental and economically benefitting wetlands to using households and the country at large.

References

Bakema R. J & Iyango L., (2001) Engaging Local Users in Management of Wetland Resources: the Case of the National Wetlands Programme, Uganda. IUCN Eastern Africa Regional Office, Nairobi

Banana A. Y, Gombya-Ssembajjwe W., & Bahati J., (2001)., Explaining Deforestation: The Role of Forest Institutions in Uganda Forests. A policy Brief. UFRIC Makerere University, Kampala, Uganda

Banana A. Y, Vogt N. D, Gombya-Ssembajjwe W, & Bahati J, (2004). Local governance and forest conditions: the case of forest in Mpigi District of Uganda. Paper presented at "The Commons in an Age of Global Transition: Challenges, Risks and Opportunities,"the 10th Conference of the International Association for the Stucy of Common Property, Oaxaca, Mexico, 9 – 13, August.

Baldascini A, (2002). Income Generating Opportunities Arising From Natural Ecosystems in Uganda: An Overview. The International Food Policy Research Institute (IFPRI), Washington D.C, USA

Berkes F, Golding J & Folke C, (2000)., "Rediscovery of Traditional Ecological Knowledge as an Adaptive Management", Ecological Applications, 10 (5): 1251-1262

Cai. X, & McKinney C, D., (1997)., A Multi Objective Analysis Model for Negotiations in Regional Water Resources Allocation. Univ. of Texas, Austin, TX

CIGI (2007) International Risk Report: The Center for International Governance (CIGI).

Daniels J., Werner W. P., & Bahill T. A., (2001). "Quantitative Methods for Tradeoff Analysis", Systems Engineering, 4 (3): 190- 212

Emerton L, Iyango L, Luwum P & Malinga A, (1998), The Present Economic Value of the Nakivubo Channel. The World Conservation Union (IUCN), Nairobi, Kenya

Gawler, M. (ed.) 2002, Strategies for Wise Use Of Wetlands: Best Practices in Participatory Management. Proceedings of a Workshop held at 2nd International Conference on Wetlands and Development (Nov 1998, Dakar Senegal). Wetlands International IUCN, WWF Publication No. 56, Wageningen, the Netherlands

Green HW (2002). Ecomometric Analysis, 5th edition, Prentice-Hall, Upper Saddle River, New Jersey, pp. 663-708

Hartter J & Ryan J. S, (2010)., "Top-down or bottom-up,? Decentralization, natural resource management, and usufruct rights in the forests and wetlands of Western Uganda", Land Use Policy 27: 815-826

Kakuru, W., Turyahabwe, N. and Mugisha, J. (2013). Total economic value of wetlands products and services in Uganda, The Scientific World Journal, 2013 (13)

Maclean M. D. I, Tinch R, Hassal M & Boar R, (2004)., Social and Economic Use of Wetland Resources: A case Study from Lake Bunyonyi, Uganda. GSERGE Working Paper ECM 03-09, University of East Anglia, UK

Makowski M., (2001). "Multi-Objective Decision Support Including Sensitivity Analysis", International Institute for Applied Systems Analysis, Laxenburg, Austria

Mugisha R. A, (2002). Evaluation of Community-Based Conservation Approaches: Management of Protected Areas in Uganda. A Dissertation Presented to the Graduate School of The University of Florida, for the Doctor of Philosophy degree, Florida, USA.

Mutibwa P, (1992). Uganda since Independence: A story on unfulfilled Hopes. Africa World Press, Hong Kong.

National Environment Management Authority (NEMA), (2001)., State of Environment Report for Uganda, 2000/2001, Kampala, Uganda

Nkonya E, Pender J, Kato E, Mugarura S & Muwonge J, (2005). Who knows, Who cares? Determinants of Enactment, Awareness and Compliance with Community Natural Resource Management Bylaws in Uganda,. CAPRi Working Paper No. 41. Washington DC

Nsita A., (2003). Decentralization and Forest Management in Uganda: In support of the Intercessional Country led initiative on decentralization, Federal Systems of forestry and National forestry Programmes. Center for International Forestry Research, Harare, Zimbabwe

Pender J, Jagger P, Nkonya E & Sserunkuuma D, (2002)., Development Pathways and Land Management in Uganda: Causes and Implications. A selected paper for presentation at the 2002 AAEA Annual Meeting, Long Beach, California, USA

Pimbert P. M & Pretty N. J, (1995)., Parks, Peoples and Professionals: Putting 'Participation' into Protected Areas". United Nation Research Institute For Social Development, (UNRISD), Geneva,. Discussion Paper 56

Sanginga P. C, Kamugisha N. R & Martin M., A, (2007)., "The Dynamics of Social Capital and Conflict Management in Multiple Resource Regimes: a case of the southwestern highlands of Uganda. Ecology and Society 12(1): 6 URL: http://www.ecologyandsociety.org/vol12/iss1/art6/

Sanginga P. C, Kamugisha A, Martin A, Kakuru A & Stroud A, 2004. "Facilitating Participatory Processes for Policy Change in natural resource management: Lessons from the highlands of southwestern Uganda", Ug. J. of Agric. Sci. 9: 958-970

Smith R. G., (2007). Logical Decisions Decision Support Software Users' Manual. Logical Decisions, Fairfax, VA, USA

Walten R. E & McKersie R. B., (1965)., A behavioral theory of labor negotiations. McGraw Hill Book Co., New York, USA

Wetlands Management Department (WMD), Ministry of Water and Environment, Uganda Bureau of Statistics, International Livestock Research Institute; and World Resources Institute (2009). Mapping a Better Future: How Spatial Analysis can benefit wetlands and Reduce Poverty in Uganda", Washington DC and Kampala: World Resources Institute,.

Yoe C, (2002). 'Trade-Off Analysis Planning and Procedures Guidebook', A report submitted to U.S. Army Corps of Engineers, Institute of Water Resources (IWR), Alexandria, USA

Transforming innovation platforms into viable farmer institutions for sustainable land management in Uganda

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Introduction/Background

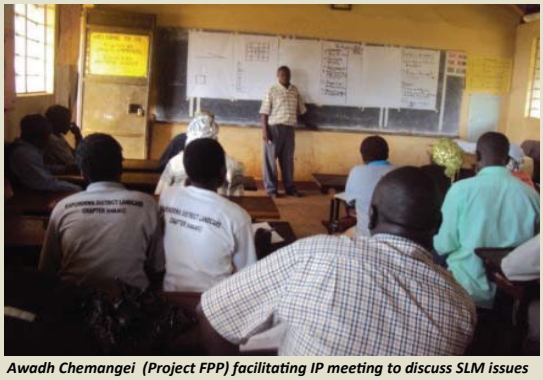
Innovation Platform (IP) refers to a forum established to facilitate interactions and learning among stakeholders with a common challenge to address . An IP operates at two levels, strategically at district and sub-county level and operationally at cluster level .

Past approaches to Agriculture R&D have not resulted into the desired transformation of farming systems and improved livelihoods for farmers to manage land sustainably. The government of Uganda has a rapidly growing saving and credit system with financial products which innovation platforms if transformed into SACCOs can tap into and use to support Sustainable Land Management (SLM).

Materials/Methods

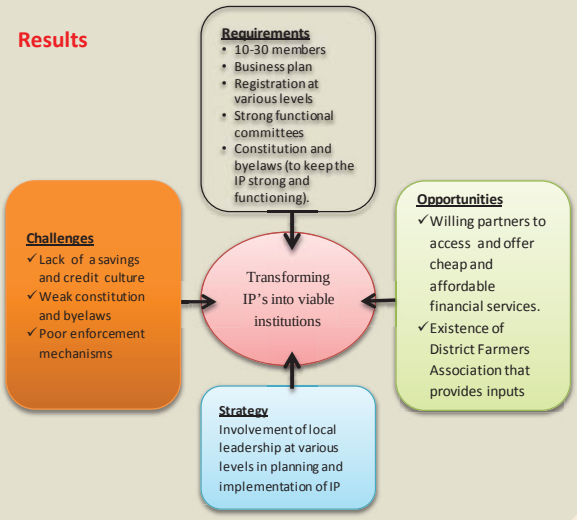
- Mobilization by the focal point person using written invitations
- Focused group discussion with key informant interviews were conducted
- Case study presentation:

  65 participants (35 males and 30 females) from three project sites (Kapchorwa, Bukwo and Kween districts) participated.



Awadh Chemangei (Project FPP) facilitating IP meeting to discuss SLM issues in the project sites.

Results



Group members collectively constructing "fanya chini", "Fanya Ju" for soil and water conservation

Months	Date	Principal	IRR: 2% (SACC0)	Total	Principal	IRF: 13% (Other lending institutions)	Total
1	28-03-2010	500,000	60,000	560,000	500,000	390,000	890,000
2	28-04-2010	500,000	50,000	550,000	500,000	325,000	825,000
3	28-05-2010	500,000	40,000	540,000	500,000	250,000	750,000
4	28-05-2010	500,000	30,00	530,000	500,000	195,000	695,000
5	28-05-2010	500,000	20,000	520,000	500,000	130,000	630,000
6	28-06-2010	500,000	10,000	510,000	500,000	65,000	65,000
	TOTAL	3,000,000	210,000		3,000,000	1,355,000	

IRR= Interest Rate (Reducing rate) IRF= Interest Rate (Fixed Rate). *Source: UMSC report 2010*

Case study for Katenga Potato Bahingi Kweterana, Kabale Uganda , 2007

Lessons learnt

- There is willingness by group members to transform IP's into SACCO.
- The process of transforming an IP into a SACCO is long and requires time.
- IP formation, facilitation, registration and training are key for sustainability.

Conclusions/Recommendations

Sustainable land management can be achieved when a number of interventions involving access to cheap and financial services are promoted. Innovation platforms need technologies, knowledge and skills to support sustainable land management and these cannot be achieved without credit services which members lack.

Acknowledgements

IP platform members, IDRC, Going to scale partners, World agroforestry Centre (ICRAF), Kapchorwa, Kween and Bukwo Local Governments, Government of Uganda.

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ANNEXES TO MAIN TECHNICAL REPORT

Making Agri-Food Systems Work for the Rural Poor

in Eastern & Southern Africa

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