Farmers Innovations in Natural resource Management: Lessons and Challenges from Lushoto, Tanzania.

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Abstract
During phase 2 of the AHI, documentation of the farmer innovations emerged as an important theme. This paper discuses: methodology, the innovations documented so far, the benefits that farmers think they are realizing, the mechanisms for sharing innovations and the issues that arise and possible impact on the scaling out process from farm level to watershed level. It was evident that some farmers were making some innovations and adaptations to the technologies that they either tested or researched on with the researchers. Data collection was done through individual interviews where the farmers responded on how the technology was modified, the motivating factors for modification and the physical circumstances under which modifications were done. Farmers seemed to innovate on the introduced technologies to adapt and fit them into their farming systems, financial status, age and social circumstances and whether they need collective action to implement. However, the challenge remains: will the modified technologies be spilled over to more farmers?

Introduction
African Highlands Initiative (AHI) seeks to improve and enhance land productivity in a sustainable way within the intensive land-use systems of the highlands in eastern and central Africa by working with farmers to evolve policy and technologies that increase agricultural productivity while maintaining the quality of the natural resource base at the same time. In order to accomplish this, a participatory rural appraisal (PRA) was conducted in Kwalei pilot village in Lushoto in 1998, where problems and solutions were identified with farmers. Low productivity due to lack of awareness of improved farming was among the major problems identified by farmers. As a result, numerous linked technologies were introduced to farmers in 1998 and 1999 to increase productivity, household income and improve their livelihood. Immediately after the introduction of technologies, farmers were found to modify some elements of the technologies in different ways and sometimes opposing some of researchers methodologies in their fields. When they were informally asked the reasons for the modification, they gave very meaningful answers such as experience of locally available alternatives. Upon seeing the validity of farmers’ reasons, it was decided to conduct a formal survey to trace the innovations, search out the motivating factors for innovation and its effects on adoption. The objective of this paper, therefore, is to document and publish experiences of Lushoto farmers on their different innovations on introduced technologies. The paper will also highlight some recommendations and way forward.

Literature review
From time immemorial, farmers have not waited for the creation of research institutes before improving their farming systems through innovation. When farmers are faced with problems that threaten their survival, they get courage and capacity to experiment and innovate and in so doing new solutions are devised. Farmers’ innovation like plough and domestication of plants and animals that revolutionized (indeed invented) agriculture, date back over 10,000 years (O’Neil 1995, IFAD). Throughout the centuries farmers, out of their inner urgings, have devised,
developed, adopted, adapted ingenious technological ways and means of ensuring food security and economic welfare for their extensive households (O’Neil 1995, Chinkhuntha 2004). Several authors have defined what farmer innovation is and the majority of them seem to agree that ‘farmer innovation’ is a form of indigenous knowledge – is a process under which farmers themselves develop ways of, for instance, improving crop varieties through careful selection of seed, harvesting rain water from roads, soil conservation measures – often without any outside help (Reij and Waters-Bayer (2001), Critchley and Mutunga (2002), Chinkhuntha (2004)). The ingenious traditional irrigation (furrows by Chagga and Sonjo in Tanzania and Qantas in Iran) (Goldsmith 2003), local knowledge on weather forecasting (Kihupi et al 2003), biological control in soybean (O’Neil 1995), production of new pesticide concoctions (Minja et al 2003), use of different plants and roots for soil fertility improvement (Wickama and Mowo 2001) and cure for different animal and human ailments are some of the well documented farmers innovations. These innovations clearly played a significant role in the improvement of the rural communities and will continue to do so.

Unfortunately, this local knowledge, and its capacity for innovation, has been downplayed and neglected by scientists, especially since colonization. It is not surprising then that Egziabher (2001) commented that farmer innovations are positive developments that have never drawn headlines in newspapers yet they are remarkable and newsworthy. The curiosity to learn from indigenous knowledge had almost totally - but not fully – been lost until when some of very technically sound technologies did not fit in with the local production systems (Critchley et al 1999, IFAD). As a result farmers were said to be ignorant and not interested in saving their natural resources. Even today, more than 40 years after the cessation of the colonial rule, downplaying of farmers knowledge still lingers in R & D staff. This is exemplified by farmers in Kwalei refusing to attend nursery plots because the type of cabbage brought by researchers was not of their choice (Urasa 2000. personal communication).

Nonetheless there are some success cases where farmers were noticed to be using their own technologies to deal with soil erosion, pests, etc. It is at this point, and only recently, that the scientific community started recognizing, studying and documenting about farmer innovation particularly in Africa. The majority of studies found that local people posses sophisticated knowledge about their environment and that this knowledge can aid in the sustainable land use. The studies emphasized that coupling the experimental protocols of the scientific method to the farmer’s deep appreciation of their system would seem to be a powerful way to generate new agricultural practices (Simpson 1998, Winkelerprins, A.M.G.A., 1990, Barrios et al 2001, Reij and Waters-Bayer (2001)). A quote from O’Neil (1995) would be illustrative;

“Farmers are the ultimate integrators of the information they receive to increase production, stabilize yields, use pesticides etc. It is the farmer that ‘lives the problem’, gains the benefits and suffers the consequences. Therefore a combination of farmers’ and scientific knowledge will increase the rate of success and identify new areas of effort that neither group alone would have discovered”

Scientists should treat farmers as equal partners and create a learning dialogue by accepting and respecting each other’s knowledge. Scientists have important tasks to play by bringing in information, methods and analyses which complement what farmers already know and can do themselves.” (ILEIA 2000, IFAD, Kihupi et al 2003). Research and extension practices that build on farmers’ knowledge, engages farmers’ creativity and allows for their active involvement
in outreach activities is capable of producing results that far exceed and outlast those possible through more traditional approaches. Therefore the conventional ‘transfer-of-technology’ paradigm in which scientists develop technologies on station and extension workers pass these technologies on to farmers should change and start with what farmers are already experimenting to develop a joint research and development agenda. By including farmers in the research agendas, we will increase the number and diversity of approaches, and increase the likelihood of adoption of appropriate methods for natural resource management (O’Neil 1995, Simpson 1998, Winkelerprins, A.M.G.A., 1999, ILEA Editors 2000, Egziabher 2001, Franzel 2001, Barrios et al 2001, SciDev.net, August 2002, Critchley and Mutunga 2002).

On the other hand, there has been some challenges which should be considered as links are being established between farmers knowledge and science. These are:

- Those in-charge with improving local decision-making (R & D staff) are frequently unclear with farmer innovations or local priorities.

- Much of the farmers’ innovations are developed in response to new constraints and therefore are very location- and culture-specific. The same constraint is not necessarily resolved the same way across cultures, even within the same ecological region therefore difficulties can arise when exchange and diffusion are attempted between cultures and locations (IFAD)

- Considerations on intellectual property rights, - who owns the innovation and who may use it?, who decides how to use it and for what purpose? And should the owner be compensated? (SciDev.net, August 2002)

**Methodology**

This study was conducted in Kwalei village in Lushoto district, Tanzania. Lushoto district is situated between Latitude 4° 24’ S and 5° 00’ S and longitude 38° 10’ E and 38° 36’ E with an altitude ranging from 900 to 1200 m.a.s.l. The data used for this paper were obtained from three main sources namely, literature review, observations of the AHI-Lushoto research team on the farmers participating in the introduced technologies, and informal interview with the innovating and non-innovating farmers. Case studies are used to capture some few innovations in Lushoto.

**Findings**

Farmers listed a number of innovations they have made to the introduced technologies. The innovations are both physical and social oriented. The physical ones include; use of Fanya Juu ditches for making compost (Box 1) and use of sugar cane for stabilizing soil conservation structure (Plate 1).
Simple and easily available, but equally effective alternatives are used by farmers to modify technologies. Sugarcane is used for stabilizing SWC structures instead of the recommended napier grass.

Box 1.
Several technologies on soil and water conservation were disseminated to the farming communities and many of them were adopted. Among them were use of cut-off drains for rainwater harvesting and compost making techniques. Some of the adopters were found to have filled the cut-off drains with crop residues and weeds. When asked as to why they did that while they were trained that the drainage should be free of any trash they replied; “We are using the drainage for making compost. When the run-off comes it soaks and covers the trash with soil and in so doing we are making compost at the same time – killing two birds with one stone. When they get filled we follow the same procedures of unearthing them”.

Other farmers are using sugar cane to stabilize their soil conservation structures instead of the recommended napier, desmodium, trees etc. Lack of funds to buy the introduced materials is the main reason given by farmers thus looking for inexpensive alternative materials. The introduce Napier, Desmodium, and trees were not native of Kwalei therefore there were some costs farmers had to pay to get them.

Other innovations are use of indigenous trees and shrubs for soil fertility improvement eg *Vernonia subligera, Vernonia amyridiantha* as depicted in Plate 2 and also making different concoctions against pests and diseases (see Table 1 and Box 2). Some farmers reported to have increased their bean yields by more than 10 times by applying these concoctions on improved varieties (Minja et al 2003).
Plate 2: Farmers are knowledgeable of their soil fertility and remedial measures. Above (left) Vernonia subligera used by farmers to amend soil fertility from time immemorial; Right: A farmer learning how to use it more efficiently in Kwalei village.

Table 1: Different traditional materials and their different uses in Lushoto

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Use of innovation</th>
<th>Target pest</th>
</tr>
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<tbody>
<tr>
<td><em>Vernonia spp</em> (Tughutu and Mhasha)</td>
<td>- Soil fertility improvement,</td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>- stabilizing soil conservation structures</td>
<td></td>
</tr>
<tr>
<td>Concoctions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vernonia spp</em> (Tughutu and Mhasha)</td>
<td>- crude leaf extract + chilli + water</td>
<td>foliar/pod feeding pests</td>
</tr>
<tr>
<td><em>Euphorbia spp</em></td>
<td>- white sap in water</td>
<td>cutworm</td>
</tr>
<tr>
<td><em>Solanum incanum</em></td>
<td>Crushed fruit and water</td>
<td>cutworm</td>
</tr>
<tr>
<td><em>Datura spp</em></td>
<td>- crude leaf extract + chilli + water</td>
<td>cutworm</td>
</tr>
<tr>
<td><em>Tithonia spp</em></td>
<td>- crude leaf extract + chilli + water + soap</td>
<td>Foliage feeding pests</td>
</tr>
<tr>
<td><em>Ocimum suave</em></td>
<td>- crude leaf extract + chilli + water + soap</td>
<td>Foliage feeding pests</td>
</tr>
<tr>
<td>Cow urine</td>
<td>- fermented urine + water</td>
<td>Foliage feeding pests</td>
</tr>
<tr>
<td>Fresh milk</td>
<td>- Fresh milk + ash + water</td>
<td>Potato and vegetable leaf diseases</td>
</tr>
<tr>
<td>Wood ash</td>
<td>- ash + <em>Cyprus spp</em> or <em>Eucalyptus spp</em> or <em>Tagets spp</em></td>
<td>Bruchids and weevils in stored grains</td>
</tr>
<tr>
<td>Social</td>
<td>Elders who have ample land join with youth who have no land but ample labour to cultivate tomato. Youths also contribute FYM and all benefit from the cooperation.</td>
<td></td>
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Box 2:
Fruit sap-sucking insects, commonly known as fruit flies, are very destructive for fruits and vegetable production. An affected plant/fruit will get stunted, have scars and gets infected with other organisms. Farmers end up loosing tones of fruits and vegetables from these insects. Treatment against these fruit flies is through the use of commercial pesticides, which are in most cases expensive, not readily available in the rural areas and not environmentally friendly. Based on these difficulties, Mr. Shebughe, a fruit grower in Mombo Tanzania, designed a trap whereby a concentrate is made from a fruit (watermelon, mango or paw paw), mix it with spirit alcohol and half-fill a mineral-water plastic bottle (see insert below). This mixture produces good aroma that attracts the fruit flies. Several holes are made on the top-half of the bottle to allow the fruit flies to enter into the bottle as they go for the good smelling concentrate. The insects will feed on the concoction, get intoxicated, trapped and die in the bottle. “This trap is very effective and cheap, it has really helped in reducing the fruit damage in my garden” said Mr Shebughe

Social innovations include teaming up in groups so as to collectively accomplish some tasks which none could have accomplished alone. A good example is a case where elders with ample land join with youth who have no land but ample labour to cultivate tomato. The landowner lends the land to the youth under conditions that they will only use farmyard manure for growing tomato and not inorganic fertilizers. At the end of the season they all benefit from the cooperation – fertilized land for the landowner and more income for the youths. Other social innovations are the challenges farmers were putting on the scientists research protocols like opposing replication, controls and use of small plot sizes after the first year of experimentation (Box 3).

Farmers mentioned that some factors that motivated them to innovate are: i) interest with the introduced technology, ii) local knowledge of simpler and easy to access alternatives to the problem, iii) desire for quick results (greater efficiency), iv) seeing and learning from their fellow farmers, and v) self esteem.

Modifications are perceived as ‘short cuts’ to many of the recommended technologies and in so doing it saves their time, labour, land and other resources. “Sometimes the whole or parts of the technology, is/are too expensive for us – therefore we look for simple and easily available alternative. For instance instead of spending my meagre money in buying napier to stabilize my terraces as we were trained, I used sugarcanes for the same and it is doing fine. With sugarcanes I am getting an extra benefit from canes for human”. In Kwalei sugar canes have stable market for making juice and local brew. Other factors mentioned were enhancement of self esteem because they feel proud to have contributed something worthwhile and instils a sense of ownership and
respected. Quick attainment of results was emphasised as one of the most important factors. This is reflected in the farmers’ opinion about control treatments and small plots in Box 3.

**Box 3.**
As usual, researchers are used to setting up experimental plots with several replications and treatments without missing controls. Normally, the treatment plots are small – sometimes as small as 1 m$^2$. These principles/mentality were applied during experimentation with farmers in their farms. One of farmers’ roles was to supply labor for land preparation, seeding, weeding and harvesting. After one-year of experimentation, farmers noted and learned several things from the experiments like the fact that controls were not as productive as the other treatments and from the small plots they earmarked the high yielding treatments. In the second year, farmers refused inclusion of controls and demanded bigger plots. As a result, they refused weeding the control plots and wrote a formal letter insisting on bigger plots. When asked as to why they thought so and stopped weeding the controls, they said: “we have already seen that treatments on these control plots do not give good yields. Why should we continue wasting our energy and time on them? Why repeat it this year again? Actually this is a wasted land”

Regarding the size of the plots they said “last year we saw several treatments and their effects on the small plots. We already know which are the best treatments; why repeat them again this year? We want to move forward and apply them on bigger plots this year”.

Researchers emphatically did not like the ideas arguing that the data cannot be analyzed without control and replication, no Chi, no Duncan MRT, significant differences etc. The leadership insisted on respect to other partners’ opinions and accommodate them.

**Discussions and Conclusion**
Farmers have valid reasons for modifying the introduced technologies. Farmers perceive modifications as shortcuts to the aimed results, saves cost and an opportunity to utilize their knowledge and resources more effectively. Despite the common reasons among the farmers, the types of modifications were different for each individual. The differences were largely dependent on individual’s resource endowment and age. The wealthy farmers and youths were better innovators than the rest in the communities. Other differences in social and biophysical factors may also warrant some changes to the technology, bearing in mind that in most cases, where technologies are developed is different from where it is disseminated. Therefore farmers modifying the introduced new technologies is an inevitable situation and should be encouraged, as it is them who ‘live the problems’, gain the benefits and suffer the consequences. Allowing farmers to modify technologies empowers them through contributing to technology development, instilling the sense of ownership and increasing adoption. On the other hand, care should be taken when disseminating technologies to new farmers especially through farmer-to-farmer exchange visits as each farmer has different social and biophysical factors. It is therefore recommended that new farmers should be exposed to both original and the modified technologies so as to see the different options and let them modify based on their social and biophysical conditions.
Integration of farmers’ knowledge with the scientific knowledge has shown to increase productivity in Lushoto. Capturing local innovations and integrating them in research, extension and development activities, adoptable and sustainable solutions can be found and scaled up. However, the majority of R & D staff are yet convinced that farmers are full conversant of their environment and have immense local knowledge which when tapped and complemented with the scientific knowledge, can revolutionize agriculture of the rural poor communities. As AHI tries to scale up to reach more farmers and from farm level to watershed level, capacity building of the R & D teams on how best to integrate the two knowledge, is of utmost importance.

Farmers’ innovations are a result of long-time investment by farmers themselves. The scientific community should come up with some ways to motivate the innovators. Intellectual property rights should be considered when using these innovations so that farmers could start benefiting from their valuable investment. Also, establishment of a mechanism whereby farmers themselves can publishing their innovation just like scientists do, may motivate in innovating.

This paper highlights some interesting innovative practices by farmers in Lushoto. It is very likely that farmers in other parts of Tanzania have developed other innovations but most of these may not have been documented. It is therefore suggested that efforts should be made to capture and document these innovations to assist in better understanding of farmers’ capacity in natural resource management; and wisely integrating it with science so as to bring quick and positive impact on the rural communities.

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