

Strengthening Community Resilience to Change: Combining Local Innovative  
Capacity with Scientific Research (CLIC–SR)

## **A COMPILATION OF CASES OF JOINT EXPERIMENTATION FROM ETHIOPIA, KENYA, TANZANIA AND UGANDA**



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## **BACKGROUND TO CLIC-SR**

The project “Strengthening Community Resilience to Change: Combining Local Innovative Capacity with Scientific Research (CLIC–SR)” is coordinated by ETC Foundation in the Netherlands for the international PROLINNOVA<sup>1</sup> network. It is funded by a grant from the Rockefeller Foundation. The CLIC-SR project is working with partners in four countries in Eastern Africa: Ethiopia, Kenya, Tanzania and Uganda.

CLIC–SR seeks to build local adaptive capacities and strengthen community resilience to change specifically aiming at:

1. Strengthening the resilience to change of smallholders and their communities, especially women, by enhancing their innovative capacity and thus their livelihood security through participatory innovation development (PID)
2. Building the capacity of organisations working in agriculture and natural resource management (NRM) so that they can effectively work with and support smallholder communities in their efforts to adapt
3. Increasing insights and awareness on the relevance and effectiveness of PID through sharing and learning
4. Mainstreaming PID as an accepted approach within targeted national and international policies and programs related to agricultural development, NRM and climate-change adaptation (CCA).

One of the deliverables from the CLIC-SR project was the documentation of two cases of joint experimentation (or PID) from each of the four partner countries. This report is a compilation of these eight cases.

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<sup>1</sup> Promoting Local Innovations in ecologically oriented agriculture and natural resources management PROLINNOVA International Secretariat is housed at the Royal Tropical Institute, or KIT,

# **CASE 1: EXPERIMENTATION WITH TIME OF PLANTING TO CONTROL PESTS OF HARICOT BEANS (BOLOKIE) IN ETHIOPIA**

Atalay Yigrem

Alem Berhan Self-Help Community-Based Development Association

## **BACKGROUND**

### **The farmer innovators**

Ediget Farmer Field School (FFS), which was established in 2000, is located in the ENEGURI sub district of Enebse SarMidir District, which is classified as “semi-desert”. The group was established by Agri Service Ethiopia (ASE) to solve farmers’ problems in the area and to support farmers to develop their own solutions to their problems. Currently, it has fourteen members (7 men and 7 women) with ages ranging from 26 to 60 years of age. Of the seven female members, three can read and write. Of the seven male members, four have basic literacytwo completed elementary school and one member has completed grade ten. Members of the group, like other farmers in the district, depend on mixed crop-livestock farming. On average, they spend about 70% of their time cropping (mostly haricot beans, sorghum and teff). For those who have livestock 30% of their time is spent taking care of them (mainly cattle and beehives; 20% of the farmers in the FFS have livestock). The group members suffer from a shortage of both crop and grazing land. The average annual income per household in the group is 5,350 birr (246 USD) for low earners, 16,000 birr (736 USD) for middle-income earners and 32,600 birr (1500 USD) for the high-income earners.



**Figure 1: Some members of Ediget Farmer Field School (Photo: ABSHCBDA).**

## The origins of the innovation process

Starting in 2000, members of the group gained experience from government, ASE and the Alem Berhan Self-Help Community-Based Development Association (ABSHCBDA) in information exchange and experience sharing through modern mass media technologies. They also learned from their fellow farmers' good experience and from their *idir* and *iquib* members<sup>2</sup>.

It has been realised that some of the group members had good experience from exposure visit to the Adet Agricultural Research Centre, which supported them in being innovative farmers. The chairman of the FFS also participated in visits to Debre Markose, Bahir Dar, Addis Ababa, Nairobi and saw opportunities for group members to identify and test solutions to their challenges through local innovation processes and to gradually improve their living standards by diversifying their livelihoods. As a result, most FFS members have attained some degree of food security status.

## FARMER EXPERIMENTATION TO CONTROL INSECT PESTS OF HARICOT BEANS

### Bio pesticides to prevent pest damage

In the early 2000s, the FFS initiated a process of participatory technology development (PTD) that was supported by ASE.

Having decided that the main economic problem they faced was insect pests attacking their haricot beans, the members decided to solve the problem with their local knowledge. Different ideas were proposed and discussion was held within the group. After active debate, they decided to test various locally available plants as biopesticides. The group members collected different wild plant species which they believed to be poisonous. They carried out screening and selection of the species that were most effective against these pests. In the first screening and selection, three plants were selected, locally known as *Antrifa*, *Milas Golgul*. In a subsequent screening the plants known as *Kinbo Dem* and *Domie* were tested.

The group conducted their farmer-based research on a trial and error basis, mixing fluids collected from the leaves and stems of the above-mentioned plants and spreading them on the haricot bean leaf. They conducted their trials on an area of land (5m x 10 m in size) that had been given to them for their research by the local government. They continued this research up to 2008 and through this process identified a number of different mixtures of fluids that can prevent haricot bean insect pests attacking their crop, though the mixtures varied in their effectiveness in preventing attacks.

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<sup>2</sup>*Iquib* is an association established by a small group of people in order to provide substantial rotating funding for members in order to improve their lives and living conditions, while *idir* is an association established among neighbours or workers to raise funds that will be used during emergencies, such as death within these groups and their families. *Iquib* and *idir* can be characterised as traditional financial associations. While *idir* is a long-term association, *iquib* can be temporary or permanent, depending on the needs of the members (Source: [http://www.tadias.com/v1n6/OP\\_2\\_2003-1.html](http://www.tadias.com/v1n6/OP_2_2003-1.html)).





**Figure 2: Some of the plant species collected by the group to control haricot bean pests (Photo: ABSHCBDA).**

The farmers used these plants to control the pests, but there were some problems with this innovation, which included difficulties in obtaining these plants when needed, the time-consuming nature of the process and difficulties in applying the treatment to large areas of land. As a result, farmers sought to test different ways to control the pests.

### **Experimenting with sowing dates to control pests**

At the end of 2013, with assistance from the CLIC-SR project, the farmer innovators began to change their approach to pest control and based their research on investigating how seasonal weather variability affects the breeding of the insect pests (i.e. which seasons are less conducive to pests). This built on the findings of the chairman of the FFS, Mr. Andarg Yigrem. He shared with FFS members that he had accidentally sown haricot beans in the dry season and had got a higher haricot bean yield. This motivated the FFS members to experiment with changing the agronomic practices for growing haricot beans. They divided the plot of land that was being used by the FFS into three plots and started to sow haricot beans at three different planting times:

1. Before the rainy season (when the soil has no moisture)
2. After a little rain (when the soil has medium moisture level)
3. During the main rainy season (when the soil has plenty of moisture).

After repeatedly checking to see what happened to the germinated plants, the farmers found that haricot beans sown when the soil has medium levels of moisture (Scenario 2) were totally destroyed by the pests since the breeding time of the pest coincided with the crop's early growth stage (no more than two leaves), which is when the bean plants are most vulnerable to insect attacks.

In contrast, they found that the insect did not affect that haricot beans which were sown during the main rainy season when the soil had plenty of moisture (Scenario 3). Farmers attributed this to soil moisture not being conducive to its reproduction. However, the crop yield was not great as the plant did not have sufficient time to produce a good yield, as the dry season started before the crop had matured.

Farmers determined that haricot beans sown before the start of rain (scenario 1), when the soil had low moisture, was not as badly affected by the pest, as haricot beans had grown beyond the two leaf stage, making the plants less prone to pest damage. Furthermore, the haricot bean plants had more vegetative growth and could hold more beans and the growth and production were not interrupted by the start of the dry season before the crop matured. These two factors combined to increase productivity dramatically, in some cases doubling yield.

The farmer experimenters in the Ediget FFS therefore recommend that farmers should sow their bean crop just before rain is forecast so that the rains start as soon as possible after they sow the seed. They also recommend that the farmers increase the seeding rate to compensate for seeds that may perish if the onset of rain is delayed. Another benefit of the system is that since the haricot bean crop matures earlier than the end of the rainy season, it enables farmers to plant a second crop and thus obtain two harvests per year from a single field, which further increases productivity and food security status of farmers.

The Ediget FFS's innovation with haricot bean planting date has the potential to improve the socio-economic circumstances of the local rural community through the following effects:

- The farmers perceived it to increase the productivity of haricot beans (before this innovation came in to practice, farmers could not produce more than 300 kg per hectare, but with the new practice they are able to produce up to 600 kg beans per hectare).
- It is easy to apply and acceptable to the communities.
- It has no additional cost for the farmers (except when they adopt a higher seeding rate, which brings the cost of additional seed).

### *The role of the different stakeholders*

The main stakeholders involved in the experimentation process were the members of the FFS and the development agents (DAs, i.e. agricultural advisors hired by the local government) who assisted them. The development agents provided the farmer experimenters with access to the land for their experimentation, while the experimentation activities were carried out by the farmer experimenters.

To assess the effectiveness of the different sowing dates at controlling pests, the farmer experimenters kept records during the experiment, documenting the variation of the occurrence of pests on the small plots of land. The records that were kept during the experiments included the amount of seed sown (in kilograms), the time period that the haricot bean took to reach maturity, the fertility of the farm land and the period when the pest started to attack the crop. The DAs assisted the farmers with recording the whole process, reminding them to maintain the records and to follow the progress in a careful manner.

The absence of multiple stakeholders during the experimentation process was a challenge as the whole task rested with the farmers. In particular, the challenge was that no researchers were engaged to assist with the trials and only the DAs supported the experimentation. If researchers had participated in the experimentation process, they might

have conducted further investigation on soil type and structure in the target sub district and would also have identified the pests attacking the crop.



**Figure 3: Andarge Yigrem, chairperson of the Ediget FFS (left); group members at their research site (right) (Photo: ABSHCBDA).**

In terms of gender aspects of the case, the seven women farmers had the chance to provide input into the innovation process, right from idea generation through to establishment of the innovation as local practice. Female members of the FFS participated in recording events during the experimentation, while the men participated in ploughing the land for sowing. Therefore, the innovation, which has been adopted as a local practice today, is a combination of women's and men's ideas.

#### Adoption of the innovation

All farmers in the area that plant haricot beans on a regular basis are sowing their beans at the end of the dry season to avoid pests. Initially, it was found that some farmers took time to adopt the innovation and it became clear that it takes time to bring about change. Initially, the FFS members shared with their neighbours the result of the experimentation with planting dates. In addition, the members explained the innovation at places where many community members come together, such as church and traditional institutions (*Iqub* and *Idir*).

#### **Conclusions and lessons learnt**

A number of lessons have emerged from the experimentation process. Firstly it is clear that farmers' wisdom must be acknowledged. However, the potential role of formal researchers must also be acknowledged. They are needed to contribute their insights to build on farmers' ideas of how to respond to climate change and other challenges that they face. Researchers could have helped in identifying the kind of pest that was attacking the beans and they could also have formally verified the innovation as being applicable to farmers in other parts of district and further afield. Lastly, from this case it is clear that innovation is not a once-off process; it requires long timeframes and involves complex dynamics.

## CASE 2: THE TRANSITION BEEHIVE IMPROVES COLONISATION BY BEES IN MOYO DISTRICT, UGANDA

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### INTRODUCTION

There are several factors that drive farmers worldwide to come up with innovations within their reach to address various challenges they face in their farming activities. This case study documents the innovation of a transitional beehive developed by a farmer innovator, Mr Fred Matalocu, in Moyo District in Uganda. The innovator was identified by Environmental Alert, which in collaboration with other development players (such as Moyo District Production Department, Abi-Zonal Agricultural Research and Development Institute and the Political leadership at Metu sub-county) has added value to the innovation through a process of participatory innovation development (PID). Through various engagements the farmer has been supported to share his experiences and challenges in the innovation process among key stakeholders at different levels.

### Selection of the case study

This case study was promoted and documented because it meets most of the requirements under the TEES test i.e. [T-Technical effectiveness (*It should address the challenges or problems being faced by the local community*); E-Economically viable (*Uses locally available and inexpensive materials within the community*), E-Environmentally friendly (*Should not have adverse environmental concerns or negative impacts on the environment*); and S-Socially acceptable (*It should confirm to the norms, values and culture of the people so that they will be willing to accept and adopt*)].

The decision to document this case study was reached during the PROLINNOVA-Uganda Network<sup>3</sup> Core Team meeting held on the 27<sup>th</sup> April 2016. The innovation has the following positive contributions:

- It uses locally available materials, making it cheap and affordable;
- It conforms to the local context, culture and customs of the farming community and the potential buyers of the products;
- Diversification of production and income generation reduces the risks of depending on one enterprise, thereby strengthening farmers' resilience to the impacts of climate change and variability;
- It promotes bee-keeping, thereby maintaining bees in the ecosystem to play the important role of pollination of the farmers' crops and trees, ensuring food production;

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<sup>3</sup>. The core team is one of the governance structures of the PROLINNOVA-Uganda Network. They provide technical oversight and guidance towards promoting farmer innovation development in Uganda.

- Improved household food security and nutrition, especially if the honey is consumed as part of the diet by the household members. Honey is reported to have both nutritional and medicinal attributes. According to Fred Matalocu, 'he keeps his honey for two years and it supplements food during food scarcity'.

### **The farmer innovator**

Fred Matalocu resides in Pajakiri village, Metu Sub-County, Moyo District. This district is located in the West Nile Region of Uganda. Agriculture is the major livelihood activity in Moyo District. The population depends on rain fed agricultural systems. The people in Moyo practice animal rearing, crop farming and bee keeping. The animals kept by the community included goats, cattle, pigs and poultry. In crop farming the dominant crops are cassava (the main cash crop) maize, beans, sorghum, sweet potato, ground nuts and *simsim* (a sesame species). Bee keeping is practiced in mountainous areas like Pajakiri village where Fred Matalocu lives.

Many people practise mixed farming, integrating crops and livestock. In addition, many farmers grow mixtures of crops, practise multiple cropping, and keep different species of animals. Furthermore, crop farming is mixed with beekeeping.

Fred has been a bee keeper for the last 20 years. He benefited from various trainings on apiculture from several development players and has used both the Kenya Top Bar (KTB) and traditional long hives in his beekeeping activities. He aims to own 200 beehives on his farm in order to generate additional income from the enterprise.

He was identified during one of the engagements conducted as part of Environmental Alerts' programme implementation in Metu Sub County, which focused on promoting food security among farming communities. Through interactions with the sub county officials and as part of the process for identifying farmer innovations in agriculture and natural resources management, Fred was identified as a progressive farmer in the area. This prompted Environmental Alert staff to visit his farm in order to learn more about his farming activities and experiences. It was during this visit that his innovation of the Transitional Beehive was observed.

### **Fred Matalocu's motivation for innovation development**

Fred Matalocu explained that his motivation for coming up with the innovation was his long-standing interest in bees and his wish to increase his household income through his beekeeping activities. He also found the KTB hives to be unaffordable. Furthermore, the colonisation rate for the conventional beehives (KTB and traditional beehives) was low, reducing net honey productivity. As a result of these limitations, he decided to construct through a trial-and-error approach a new beehive using locally available materials. As a result of the surprisingly high rate of colonisation (only 2–3 weeks) with his new design, he was encouraged think more and develop the idea further.

## ADDING VALUE TO THE INNOVATION THROUGH JOINT EXPERIMENTATION

After Environmental Alert identified Fred Matalocu's innovation, the PROLINNOVA-Uganda Network Core Team decided that value addition to the innovation be conducted through the process of PID, with financial support from the CLIC-SR project.

PID involved joint experimentation with active participation of different stakeholders (farmers' group members, NGOs, researchers, extensionists, political leaders), each with a differentiated but equally important role, with the farmer innovator at the centre stage. In addition the innovator's family members (wife and children) and his farmer group were also involved in the process at different stages.

Before the joint experimentation began, the stakeholders agreed on its overall purpose and their individual roles and responsibilities during a series of meetings held at the sub-county office and at the innovator's farm. In Table 1, the responsibilities of the different stakeholders in the PID process are presented.

**Table 1: Stakeholder's involvement in the PID for the transitional Beehive in Moyo district, Uganda**

<b>Participatory Innovation Development stakeholder</b>	<b>Role of stakeholder in the PID process</b>
Farmer innovator	Took the lead role in innovation development and implemented all the agreed action on-site at his farm.
Farmer innovator's family members (wife and children)	Provided moral support to the innovator. They also learned about what was going on and also took follow up action when the innovator was not around.
Farmer groups	Provided social capital to the innovator in the case where he needed support with his innovation - they recommended him to receive local innovation support funds. They also undertook regular monitoring of activity implementation at the innovation site and also participated in the evaluation of the innovation.
Environmental Alert	Facilitated the process of innovation identification and PID. They also supported the innovator by providing local innovation support funds and they linked him to several other development players through networking.
Metu sub county agricultural officer	Provided regular technical backstopping to the innovator and the farmer groups. They were also a direct link between the innovator and the farmer group to which he belongs, and several other development initiatives in the area.
Secretary for Production, Metu sub county	Disseminated information about the innovation in the sub-county council and also lobbied for support for the innovator and the farmer group.
Abi-Zonal Agricultural Research and Development Institute	Provided technical backstopping as part of validation of the innovation during the joint experimentation. For instance, provided specifications in respect of a standard beehive.



Prior to joint experimentation through PID, Fred had already tried and tested the first design of the hive. It was very big, not standardised based on recommended specifications. It was smeared with mud to fill the holes. Also, during the rainy season the mud would wash off and water would enter the hive. In addition, the large size resulted in high temperatures in the hive, which are not suitable for bees. Due to the beehives not being watertight and becoming too hot, there was a high rate of absconding by the bees. Furthermore, the original hives that the farmer innovator made were not durable. Despite this, he was not discouraged from further development of his innovation.

During PID, it was agreed that the target should be to come up with a design that reduces the cost of beehive construction and improves colonisation by bees. In addition, there was a decision to make a comparison with the conventional hives (i.e. KTB and traditional beehives).

Fred's innovation was also selected to receive funds to further support the joint experimentation. This decision was reached after he responded to a call for applications to access the Local Innovation Support Fund (LISF). The call was circulated by the Local Innovation Support Fund Allocation Committee, which comprised representatives of farmers' groups, the parish development committee and community based organisations (CBOs) in the area. He was considered the most suitable of four farmer innovators who applied for the award because he had already started with his innovation and reported some results, and his innovation passed the requirements of the TEES test.

Using the LISF funds, Fred set up the experiments at his farm. For purposes of reducing costs for production of the hive, he used locally available materials such as bamboo, timber, old iron sheets, cow dung, reinforced polythene sheet and nails. He developed a new design for the hive which reduced the size. He selected local trees that produced timber with a good smell, which attracted bees to colonise the hive. The hives were hung 3 feet from the ground to allow for ease of honey harvesting later. They were also positioned to allow for protection from strong winds, fire and pests.



**Figure 2: The process for construction of the transitional beehive (Photos by Moses Sekate and Noel Alabi).**

Participatory monitoring of the innovation process was conducted on a monthly basis involving all PID stakeholders to track progress. In the process technical backstopping was provided to the innovator by the Metu sub county agricultural officer and officials from the Abi-Zonal Agricultural Research and Development Institute. There was also information sharing and cross learning among the stakeholders who participated. Planning and review meetings were conducted by Environmental Alert and technical staff of Metu sub-county and

Abi-Zonal Agricultural Research and Development Institute to track utilisation of the LISF by the innovator. Thus, Fred Matalocu presented reports and updates on utilisations of the funds in the farmer group meetings and to Environmental Alert. Process documentation was conducted as part of the PID. This involved on-farm field visits at the sites where the innovator established the trials. During these visits, visual observations, photos and notes were taken. Furthermore, it was during these visits that the innovator and the different stakeholders held further discussions for clarification about the innovation.

### **Key results from the joint implementation**

Preliminary findings indicated the following:

- a) The large size of the original hive rendered it difficult for proper fitting of the top bars on the transitional hive.
- b) The costs for construction of the Transitional Beehive are much lower compared to the KTB. While a transitional hive costs approximately 60,000 Uganda shillings (18 USD), a KTB costs approximately 200,000 Uganda shillings (60 USD). Therefore, the Transitional Beehive is simple, cheap and easily replicable.
- c) The period for colonisation of the hive by bees was only 2-3 weeks compared to about 3 months required by the KTB and the traditional hive. This was attributed to the following:
  - The reduction in size of the beehive, resulting in a more regulated air temperature.
  - The use of reinforced polythene sheet to cover the hive, which prevented water from entering the hive.
  - The use of bamboo and cow dung, which has a good smell that is palatable for bees and hence attracted them into the hive.
  - The positioning of the hives in site that adequately protects it from strong winds, fire and pests such as ants.
- d) The innovation has minimum labour requirements, hence can be utilised by both men and women, including disadvantaged groups (such as people with disabilities, the aged). The involvement of the farmer innovator's family members (wife and children) and other members of the farmers' group to which he belongs means that the innovation was shared among different gender categories at the household level.

### **Out scaling of the innovation**

With the aim of promoting the innovation beyond the locality where it was developed, Fred Matalocu has been supported to attend various forums and events at the district (e.g. the World Food Day, and World Environment Day celebrations and national level (e.g. the National Honey Week) where he exhibited and shared experiences and challenges about his innovation among fellow farmers as well as with policy- and decision-makers. In addition he has also been hosted on radio stations such as the Voice of the Nile for area-wide sharing of his experiences with his innovation.



**Figure 3: Fred Matalocu displays the transitional beehive during honey exhibition in Kampala; Photo by Noel Alabi.**



## **Challenges encountered**

Despite the progression with respect to development of the Transitional Beehive, the innovation is limited by some challenges as listed below:

- Attack of the colonised hives by pests such as black ants which results in the bees absconding from the hives.
- Poor packaging of the produce (i.e. honey) negatively affects the price. In addition, customers do not trust that the packaging meets health standards.
- Effects of climate change and climate variability in the area, particularly the long dry spell, directly affects the bees in terms of availability of pollen.
- Joint experimentation with innovations requires time and resources and commitment of stakeholders involved in PID.
- The fear of innovators that their innovation will be taken over by elites and other opportunistic people, results in them concealing some information about the innovation.

## **Moving forward**

Further development of the Transitional Beehive is ongoing. Additional evaluation will be conducted by members of the innovator's farmer group. Transitional Beehives were distributed to 13 farmer groups, (each comprising of 25-30 members) within the region for further testing and assessment. Fred will be working closely with the groups in the process. Samples of the Transitional Beehive will also be sent to the National Agricultural Research Institute for further testing at the research station.

It may be necessary to conduct further assessments (in terms of honey quality and quantity in comparison with other types – KTB and local) in future through the involvement of farmer groups and other stakeholders.

## **KEY LESSONS LEARNT (POSITIVE AND NEGATIVE)**

Some lessons were learnt during the PID process for the innovation, including that:

- Farmers do not realise the potential of their innovations until after they have been promoted/supported. In the process they realise various benefits ranging from income generation, exposure, increased self-esteem, and confidence-building, meeting with new people and creating new friendships.
- Farmer innovators benefit from being linked to government research institutes and universities for joint experimentation. There is the possibility of obtaining funds through those institutions.
- Farmers are knowledgeable and have a lot of information on agricultural practices because they are doing it practically. Therefore, there is a lot of horizontal and vertical learning among all the stakeholders involved in PID so long as there are opportunities for free sharing of knowledge, information and experiences.
- Short listing of the innovations, as part of the process for identifying beneficiaries of the LISF funds, motivated the farmers to pay close attention to their innovations and also

encouraged them to seek more support from other relevant stakeholders for supporting joint experimentation and documentation of the innovations.

- Some innovations may not require the support of the LISF as they utilise readily available materials.
- Joint experimentation requires a lot of resources such as funds and time. The funds provided through the LISF are inadequate to offset all the costs associated with joint experimentation (such as administrative costs, technical backstopping, and monitoring and evaluation).
- Most farmers in apiculture are not interested in working in farmer groups. They prefer to work individually. The LISF mechanism of disbursing funds promoted by EA requires collaborative research (so that innovation process can be monitored by the broader farmer group), which provided an incentive for them to work closely with other farmers.

## **FINAL MESSAGE**

Farmer innovators should be supported to improve their local innovations through packaging, branding and labelling of the products from their innovations. This will help in enhancing competitiveness of their products in the market and this will result in increased incomes. Where relevant, they should receive support to ensure that their products are certified by the Uganda National Bureau of Standards to increase customer confidence in their products.

The experiences of this and other innovations should be used as a spring board for continuous policy engagement at local and national level to influence decisions for promoting local innovation for ecologically-oriented agriculture and natural resource management.

## **Acknowledgements**

We hereby acknowledge the farmer innovator, Fred Matalocu for the initiative he took in the development of the Transitional Beehive. Further appreciation is given to the farmer group members and all the other stakeholders who provided the necessary support to add value to the innovation through PID. The Rockefeller Foundation is appreciated for the financial support through the CLIC–SR project, which provided the framework through which innovation for building resilience to change was promoted. The PROLINNOVA International Secretariat, originally in ETC Foundation and now in the Royal Tropical Institute (KIT) in the Netherlands, is thanked for its international coordination role and technical backstopping during project implementation.

## **CASE 3: REJUVENATION OF PAWPAP TREES THROUGH PRUNING: EXPERIENCE FROM KENYA**

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### **CONTEXT**

Pawpaw trees are a popular crop in the semi-arid areas of Kenya and provide fruit for home consumption and income generation. Pawpaw requires rich, well drained soils and cannot withstand prolonged wet soils/water logging. Mwingi is an Arid / Semi-Arid Land (ASAL) area found in lower Eastern part of Kenya where growing of paw paws is widespread. The pawpaw plant can grow all year round despite a long dry season making its economic potential very high. Over the years however fluctuating weather conditions resulting in low rainfall and drought conditions, pawpaw production in the area has been greatly disrupted. Local varieties take long to mature meaning that many pawpaw trees do not attain maturity due to extensive droughts. The longevity of pawpaw trees depends on many factors, but in all cases the production of the trees drops as age sets in and they produce fewer and poor quality fruits and are more susceptible to diseases.

Grace Musyoki, a pawpaw farmer from Mwingi County, was experiencing a decline in productivity from her pawpaw farming enterprise due to aging of her trees. This led her to plant more trees each new season, however most did not reach maturity due to scarcity of water in her region. She therefore needed to find ways to ensure that her mature pawpaw trees remained productive. In order to address this challenge, Grace came up with a method to rejuvenate the trees by pruning the shoots to encourage new growth. This case study looks into this technique of rejuvenating old pawpaw trees.

### **THE JOINT EXPERIMENTATION PROCESS**

#### **Introduction**

Grace had experienced some level of success with her innovation (rejuvenating old pawpaw trees) but other farmers in the area, who were interested in adopting the innovation, were not sure if it really worked. Thus it was decided to validate the innovation through a process of joint experimentation (JE). The process involved several stakeholders that included herself, other farmer innovators from the area and partners from extension and research.

#### **Stakeholder involvement**

The joint experimentation process began in July 2015, with engagement meetings between the Mwingi Local Steering Committee (LSC), which comprises 8 members (5 women, 3 men), the agricultural extension officer, researchers from Kenya Agriculture and Livestock Research Organization (KALRO) and PROLINNOVA Kenya (PK). The stakeholders discussed the experimental design that would enable them to validate or improve the innovation.

The various stakeholders played different roles in the experimentation process, which included:

1. The farmer innovators actively participated in the design of the joint experimentation (JE) process and undertook participatory monitoring and evaluation.
2. The agricultural extension officer from Mwingi sub-county backstopped the farmer innovators during the experimentation and assisted with monitoring and evaluation.
3. PK provided funds for the process.
4. KARLO offered technical support and assisted with development of the experimental design.

### **Experimental procedures**

The experimentation was undertaken in Grace Musyoki's farm. The objective of the experiment was to establish and compare the rate of re-establishment and productivity of pruned and unpruned pawpaw trees. In total, 16 farmers (9 men and 7 women), some of whom were members of the LSC, were involved in the PID process.

A sample of six pawpaw trees clustered together in Grace's farm was used for the experiment. In July 2015, during the dry season, four of the trees were pruned while two were left unpruned. Pruning entailed removal of the terminal branch as well as pruning unproductive and dead lateral branches at their bases. The healthiest and most vigorous shoots were left intact



**Figure 1: Joseph Mwanzia, a farmer and an LSC member, cutting the tree's terminal branch (left); and the terminal branch of the pawpaw after cutting (right) (Photos: Geoffrey Kamau and Eunice Karanja).**

The experimentation was carried out over a period of 11 months during which the members of the LSC (which comprised farmer innovators from the area), together with the extension officer met every month to analyse changes that occurred between the pruned and unpruned pawpaw trees. The parameters that were considered included tree height, number of new branches formed, and number of new fruits produced. These parameters were selected by the farmers with guidance from the agricultural extension officer.

## Findings of the joint experimentation process

The main idea behind pruning the pawpaw shoots was to increase the tree's productivity. The goal was to improve general plant health, improve rate of fruit production and ensure that fruits were easy to harvest by reducing the height of the plant. Pawpaw trees present strong apical dominance and therefore can grow to great heights if left unpruned leading to low production of lateral shoots. The initial impact of pruning the trees was stress that led to the abscission (detachment) of both leaves and fruit. This could be attributed to the loss of latex (white sap) from the tree, once the shoots were pruned. The loss of leaves and fruit occurred during the first month after pruning. Re-establishment of the plant was a process that took place over a period of several months, as is shown in Table 1.

**Table 1: The changes that took place following pruning of the pawpaw trees**

Duration	Impact of pruning
1 <sup>st</sup> month	<ul style="list-style-type: none"><li>• Plant was stressed causing leaves and fruit to wilt</li><li>• Loss of sap (latex)</li><li>• Abscission of leaves and fruits</li></ul>
2 <sup>nd</sup> month	<ul style="list-style-type: none"><li>• Tree grew rapidly reaching a height of approximately 2 m</li></ul>
3 <sup>rd</sup> month	<ul style="list-style-type: none"><li>• Growth of 4 new lateral branches in all 4 trees that were pruned</li></ul>
8 <sup>th</sup> month	<ul style="list-style-type: none"><li>• Plant began to flower</li></ul>
11 <sup>th</sup> month	<ul style="list-style-type: none"><li>• Plant had fully formed fruits</li></ul>

There were therefore notable differences between the trees that had been pruned as compared to those that were unpruned. Some of the differences are summarised in Table 2:

**Table 2: Differences noted between the pruned and unpruned pawpaw trees**

Pruned pawpaw trees	Unpruned pawpaw trees
Pruned trees had on average produced four new branches each	Only one new branch formed on each of the unpruned trees.
The four pruned trees remained at a height of 1.8 m during the period of the experimentation	The two unpruned trees shot up to a height of approximately 2 m during the period of the experimentation
The four pruned trees produced 33, 22, 29 and 34 fruits respectively after 11 months	The two unpruned trees each produced 13 new fruits after 11 months
Fruits formed were bigger and oblong in shape	Fruits were small and round in shape



**Figure 2: Tree before pruning (left) and after pruning (right).**

## **Challenges**

The following challenges were faced during the experimentation:

- At the onset of the JE, the area had experienced an extensive dry season; however the paw paws trees were still thriving. When pruning was undertaken the trees experienced major stress.
- The experiment took a long time to produce results (11 months) and this was exacerbated by extended dry seasons. In wetter seasons farmers start to harvest paw paws after nine months.
- With the experimentation taking a long time, it was a challenge to keep the farmer innovator motivated throughout the process.

## **Lessons learnt**

During a write shop to analyse the findings of the JE, Grace Musyoki made the following observations:

- Pruning led to the proliferation of branches which ultimately increased the productivity of the pawpaw trees.
- Pruning lowered the tree's height and allowed sunlight to penetrate down into the tree, promoting fruit production on the lower branches.
- Covering the pruned shoots with finger millet flour (which was done on a trial basis with one tree based on a suggestion from Mr Kongo, one of the farmers involved in the experimentation), reduced the rate at which the plant lost the latex, leading to reduced abscission.

## **Conclusions**

Farmers in Mwingi are now taking up the innovation on account of the projected high returns associated with the increased yields after pruning. The innovation can potentially promote farmer resilience, increase food security and enhance economic growth in the larger Mwingi area.

The benefits of the innovation are being disseminated within the Mwingi area by Grace Musyoki and the Mwingi LSC members. Women and children are now involved both in harvesting paw paws and in the post-harvesting handling processes of the fruit since the fruit on the pruned trees grow at reasonable heights, which they can reach.

## **Acknowledgement**

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## CASE 4: RAISING FINGER MILLET SEEDLINGS IN NURSERIES IN KENYA

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### INTRODUCTION

#### Local context

Finger millet (*Eleusine coracana*) is an important crop for food security in Kenya. It used to be a common cereal crop in the semi-arid areas of Machakos, southeast of Nairobi. Its popularity was mainly due to its high nutritive value and it was used as a weaning food for babies and for feeding invalids. However, cultivation of finger millet has been declining due to increasingly erratic rainfall and increasing failures of the crop using current production methods. At the same time, demand for finger millet is high and its popularity is spreading all over Kenya.

Finger millet is an ideal crop in the dry areas because the seed can lie dormant for weeks, germinating once the rains come and producing a crop in just forty-five days. Furthermore, the grain is resistant to rot and insects and keeps well in storage (up to 5 years if kept dry), making it an important staple when no other food is available. Due to the effects of climate change, the semi-arid regions have been receiving below normal rainfall and increasing temperatures and this has led to low finger millet yields over a prolonged period, even though it is a drought resistant crop.

#### Local innovation

Conventionally, most farmers use the traditional broadcasting method when establishing their crops and these frequently fail because of shifting weather patterns and poor distribution of annual rainfall. Furthermore, farmers face the threat of insects and birds destroying the crop in the very young stages, which forces them to over-seed and hence waste a lot of seed in an effort to compensate for the damage.

To improve finger millet production under these conditions, Simon Masila, a farmer from Machakos County, Kalama Sub-County, came up with an innovative way of propagating the crop. He found that it was beneficial to plant the finger millet crop in a nursery before the onset of the rains and then transplant the seedlings to the main field at the onset of rains, rather than directly sowing the seeds at that time..

Simon experimented on his own initiative with establishing finger millet in a nursery bed. He watered the nursery and closely tended the emerging millet seedlings, which he later transplanted to the field. Despite minimal rainfall, the finger millet flourished compared to seeds that his neighbours broadcast directly in the fields, as their crops failed completely. Other general observations that he made were that transplanted finger millet was of better quality and gave higher yields than millet sown directly in the field. The intense tillering of the



single finger millet seedlings produced up to 25 tillers per stand. Through this approach, he saved about 60% on seeds and also gave his plants a head start at the onset of rains. This innovation therefore addressed the challenge of seed wastage as well as adverse environmental conditions arising from climate change, namely a less reliable start of the wet season and often shorter wet seasons.

## **FARMER-LED JOINT EXPERIMENTATION**

### **Background**

It is with this background that the joint experimentation (JE) activities were initiated with the aim of testing the performance of the transplanted finger millet. The Lower Eastern Kenya region receives short rains from October to December and then a long period of rainfall from March to May. The short rains are normally the most reliable hence this is when farmers plant most of their crops. During the long rains, crops such as finger millet are not planted because farmers expect it to fail.

From earlier work also supported by the Rockefeller Foundation, PROLINNOVA-Kenya (PK) had a functioning Local Innovation Support Fund (LISF) system that supports local innovation and JE, otherwise known as participatory innovation development (PID). Simon sought a grant from the LISF and was awarded KSh 20,000 (approximately 200 USD) to support his further experimentation. The LISF-supported experiment attracted the attention of formal researchers, who wished to work with farmers so as to come up with improved practices that farmers in the region could use.

The JE team, composed of various partners – Kenya Agricultural and Livestock Research Organisation (KALRO) Katumani Center, the Ministry of Agriculture (MoA) and INADES–Formation – negotiated a PID process with farmer groups to work together on JE with finger millet nurseries. The purpose of the experimentation was to validate this farmer-developed innovation, to assess the appropriate nursery size and management methods, to assess transplanting approach and consider possibilities for scaling out the innovation to other parts of eastern Kenya.

INADES–Formation, a partner within the PK network, was identified as the organisation on the ground through which funds to support the JE activities would be channelled for disbursement to farmer innovators. The funds supported farmer mobilisation and awareness raising, purchase of inputs (e.g. seeds, nursery bags and fertiliser), and monitoring and evaluation.

### **Planning the joint experimentation**

The first meeting where all stakeholders came together was held at the INADES–Formation offices in Machakos in August 2013. The main aim of the meeting was to plan the experimentation. At this meeting, dates were set for farmer mobilisation, training, nursery planting and transplanting. Planning for site selection was also discussed. A core team was established and Simon Masila, as the farmer innovator, was a member of this team. The roles of the different stakeholders (farmers, researchers and extensionists) were clearly

defined at the start of the process, as well as the various aspects to be monitored and documented.

Two sub-counties where the joint experimentation was to be undertaken were selected: Kalama and Mwala. Within each sub-county, two sites were identified for the trials. These sites were selected because they had existing and functional farmer groups.

MoA staff in Mwala and Kalama and the farmer innovators, through the Local Steering Committee (LSC) in Machakos, were tasked to mobilise farmer groups to take part in the JE. Five farmer groups were mobilised; their membership is summarised in Table 1.

**Table 1: Number of selected farmer groups and farmers**

Farmer group	Males	Females	Total
KALAMA SUB-COUNTY			
Kiatuni sub-county	4	31	35 (13 growers participated in the JE)
Kalama sub-county	5	20	25 (12 growers participated in the JE)
MWALA SUB-COUNTY			
Nitutonya self-help group	7	26	33 (all growers participated)
Mbukilye Ngukilye	6	18	24 (all growers participated)
Miu Fruit growers	9	9	18 (all growers participated)

The process of engaging farmers started with PID training, when participants were trained on aspects of JE as well as aspects of crop production. The farmers were trained by participants who had previously been trained by PROLINNOVA–Kenya (PK), which included KALRO Katumani staff, MoA staff and some farmer innovators.

### **The experimentation process**

Joint experimentation was undertaken on a common demonstration plot as well as on individual farmer demonstration sites (each divided into two plots). In Kalama sub-county, Simon established a finger millet plot before the commencement of the JE process. It was therefore agreed that the nurseries he established would be used as demonstration plot for comparison against the ones established during JE. The plots demarcated on Simon's farm were two 6 X 6 m plots, while the plots on individual farmers' lands were not a standard size and depended on the availability of land.

At each of the joint experimentation sites one plot was planted using the conventional method (broadcasting the seed) and one was planted with seedlings that were transplanted from a nursery.

At the initial stage, each of the farmer groups was given the tasks of demarcating the plots, preparing the furrows, transplanting the finger millet and determining the plant population. The farmer groups were also trained in data collection, for which they were responsible.

At Kiatuni (Kalama Sub-county) the experimentation was only carried out in individual farmer plots by the 12 participating farmers and no joint plot was used. The experimentation at each farmer's field was undertaken on two 3x3 m plots. Monitoring and evaluation by extension officers who trained them was minimal, however farmers undertook their own monitoring.

### Raising of seedlings

Following the demarcation of plots, the farmers were trained on establishing a finger millet nursery. They were provided with plastic nursery bags and one seed of finger millet was planted per bag. Watering of seedlings was done 3 times a week by the farmers engaging in the experimentation.

It took approximately a month from planting in nurseries to transplanting in the field. This was in line with the recommendation from Simon, who said that the seedlings normally take about 25 days to be strong enough for transplanting. Before transplanting seedlings to the field, the farmers washed the roots to remove excess soil. They then transplanted the seedlings into the field.

Raising finger millet in the nurseries was done in two phases. In Kalama Sub-County, the first planting of finger millet in the nurseries was done on 15 September 2013 and a second planting on 1 October 2013. The main objective of planting in two phases was to ensure that the farmers obtained some harvest even if the rains would be delayed, since the farmers could not predict when the rains would start. If the first crop was transplanted too long before the onset of rains and was unsuccessful, the second crop would have higher probability of being transplanted at the onset of rains. This also allowed for farmers who delayed in planting to be part of the experimentation. A quantity of 250 g of finger millet seeds was planted in the nurseries and 250 g of seed was set aside for broadcasting.

### Land preparation and planting

In Mwala Sub-county, land preparation was done in October 2013, with assistance from the Ministry of Agriculture. As shown in Figure 1, a ripper was used to make the lines instead of the normal ox-drawn plough to incorporate conservation agriculture principles, which proved very useful in moisture conservation, both for transplanting and direct sowing.

A 60 cm inter-row spacing and 15 cm intra-row spacing was used for the transplanted crop, while the direct planting was done using the normal broadcasting method. Transplanting and planting was initiated at the end of October by farmers from the three groups in Mwala sub-county a day after the rains started. The seedlings were about 7 cm tall when planted.



**Figure 1: Land prepared for transplanted finger millet seedlings (Photo: Eunice Karanja).**

In both the transplanted and sown plots the finger millet was grown with a combination of DAP fertilizer and fully decomposed manure. The seed used was a local variety. Farmers provided the manure used in the experiment, while other inputs were covered by the LISF funds – this included a camera for documentation.

By 25 November 2013, the transplanted crop was over 30 cm tall while the direct planted crop was less than 10 cm high.



**Figure 2: Finger millet transplanted from the nursery to the field (Photo: Geoffrey Kamau).**

#### Day to day management of the experiments and data collection

The farmers were responsible for monitoring and maintaining the experiments (including weeding). During the experimentation process, they undertook monitoring and evaluation at two weekly intervals. This was important to establish difference between the two modes of planting. Farmers kept records and checked on variables including date of nursery establishment, date of rainfall onset, total rainfall, date of transplanting, weeding frequencies,

plant vigour, date of first flower, average number of tillers, number of harvested heads, total grain weight per block (i.e. treatment and control), diseases and pests amongst other variables. An example of records kept is provided in Table 2, which shows the timing of agronomic practices and crop stages.

**Table 2: Different stages of crop development for the three groups at Mwala**

Stage	Trial (Transplanted)	Control (Direct sowing)	Nursery
Land preparation	5-7 Oct 2013	5-7 Oct 2013	
Nursery planting date		15 Sep 2013	15 Sep 2013
Germination date			19 Sep 2013
Nursery weeding			28 Sep 2013
Transplanting /sowing	11-13 Nov 2013		
Field weeding	25 Nov 2013	25 Nov 2013	
Top dressing	3 Dec 2013	3 Dec 2013	-
Flowering	16 Dec 2013	19 Jan 2014	-
Harvesting	28 Feb 2014	28 Feb 2014	-



**Figure 3: Finger millet transplanted from the nursery growing with several tillers (Photo: Geoffrey Kamau).**

## Results

The general observation of farmers during experimentation was that the finger millet that was propagated in the nursery was of better quality and gave higher yields than that which was broadcast directly onto the open field (More detail is provided in Table 3).

At Mwala for example, the yields from the experimental plots ranged from 6 - 9 kg for a 10 x10 m plot (600-900 kg/ha), while the yields from the control ranged from 2 - 3.5 kg for a 10 x10 m plot (200-350 kg/ha). This substantial difference in yields between the control plots and the experimental plots is likely to have been because the direct planted finger millet in the control suffered water stress during flowering, but the transplanted millet flowered before the water stress set in.

**Table 3: Summary of results from the experimentation conducted at the various sites**

<b>Broadcasting method</b>	<b>Nursery method</b>
Finger millet dried out before the rainy season began	Finger millet germinated and grew to approximately 4-5 mm before the rainy season
Finger millet was weed infested and was therefore stunted	Finger millet was resilient after transplanting to the field, therefore could outcompete weeds as it had been well tended during the early growth stages in the nursery
Each seed produced one tiller and one singular head. Note; Strength of the head depends on growing conditions i.e. availability of water	Each seed produced several tillers with multiple heads that were strong
Initially less labour intensive as it just involved scattering seed in a field.	Initially labour intensive as it involved preparing the nursery and constantly tending to the crop before transplanting
More seeds were wasted as they were scattered at random, and exposed to various impacts (e.g. being eaten by birds, lying dormant even after rains)	Less seed wastage, as seeds were planted systematically and closely tended to.
Roots of the broadcasted millet were weaker	Roots of the transplanted millet were stronger as they had already established in the nursery
Only one harvest was obtained during the season	Continuous harvests (up to a maximum of 3) were obtained with subsequent rainy seasons
Generally required more attention and tending	More attention and labour was required at the beginning but thereafter the crop grew with very little care as it was already well established
Crop produced millet heads unevenly with some having no heads	Crop produced heads uniformly where every plant produced a head
Lower chances of survival during periods when there is a lack of water	Higher chance of survival during periods when there is a lack of water
20 – 30 tillers produced per plant	30-50 tillers produced per plant and continues to reproduce in consequent seasons



In Kalama sub-county, farmers also noted that they made more profit from the crop that they planted in the first phase (mid-September as opposed to early October) as the rains were more stable when it was transplanted into the fields. The second phase was not as successful due to insufficient rain (dry spells), lasting up to about 2 weeks. The crop that was broadcast was unsuccessful during both phases.

Farmers involved in the experimentation concluded that the benefits accrued from the finger millet innovation included:

- Although the initial cost of planting in a nursery is high, the end result is better yield, a more resilient crop and better-quality grain.
- The transplanted crop grows faster and can therefore be harvested earlier.
- Less space utilisation (because crop planted systematically in rows).
- Less seed wastage.
- Monitoring of the crop is easier, as it grows systematically after transplanting from the nurseries as opposed to broadcasting, where the crop establishes anywhere in the field.
- Less labour-intensive in the long run.
- Estimates of harvest can be given with surety.
- The transplanted crop maximises available rainfall.
- Because seedlings are of high quality, there are opportunities to sell them to other farmers.

With women playing a major role in ensuring family nutrition and food security, it was interesting to note that women fully supported the innovation. The farmers from Kiatuni village in Kalama sub county, who were women farmers, described the innovation as being beneficial to them because:

- The crop is easy to harvest as the plants grow individually.
- The plants grow tall and easy to harvest as bending is not required.
- The plants are planted in a systematic manner and thus it is easy to apply fertilizer.
- Finger millet is useful because it produces a more nutritious grain and can be used to make cakes, porridge and local foods such as ugali and chapatti.
- The crop is good for young children and old men and can be used for detoxifying the body.

## **Challenges**

Farmers mentioned two categories of challenges – those associated with the experimentation process and those of a more technical nature. Regarding the PID process they highlighted that the funds for the activities were delayed a bit but all the planned activities were ultimately done. Delay in funds disbursement as a result of channelling funds through different organisations on the ground such as INADES Formation Kenya, led to difficulties in acquiring inputs, data collection and monitoring. It was later recommended that in future JE processes funds should be transferred directly to the LSCs. In addition, limited communication between the partners led to poor coordination of activities. At some sites, farmers faced the challenge of a lack of follow up by extension officers, which hampered their ability to record variables that would have allowed a proper comparison of the two

methods. However, farmers were able to individually determine the differences and continued to utilise the innovation after the experimentation as they deemed it beneficial.

Some of the more technical challenges encountered by the farmers were:

- The seed used was of mixed varieties and matured at different times.
- Heavy rains during the first three weeks caused leaching and stunting of the crop.
- There were delays in weeding, spraying, top dressing and data collection due to water logging.
- The heavy rains were followed by a long dry spell and high temperatures, leading to high evaporation and drying out of the plants.
- Low temperatures caused low grain set.

During experimentation, one main challenge that the farmers experienced were pests at early stages of growth, including in the nursery. There was need for insecticides and as an alternative farmers used ash mixed with soil to reduce insects' pests. However, once the nursery crop was transplanted there was little insect attack but the attack continued on the broadcasted crop in the early stages of establishment.

### **Lessons learnt**

As with the challenges, there were some lessons related to joint experimentation processes in general and other lessons pertaining to the finger millet trial only.

The following consist of some of the research team's lessons directly related to the millet innovation:

- Planting two days after the onset of the rains affects the seedling establishment and hence it is advisable to plant just before the onset of rain.
- Increased size of the experimental blocks is required for better conclusions.

To efficiently implement the JE, it was noted that:

- Resources and inputs should be well assembled for smooth running of activities.
- Prior knowledge of the process by all the partners involved together with proper communication is very important for better coordination of activities.
- Gender participation is important for the success of the experimentation. For example, when the host husband is not available, the wife can take up the field activities (this was key as experimentation was done on individual farmers' plots).

### **Gender aspects of the innovation**

Finger millet is considered locally as the domain of women (though men are becoming increasingly involved as they see the economic benefits) and its successful cultivation is likely to enhance their status at both household and community level. Its nutritious grain is rich in vitamins, amino acids and minerals and is also easily digestible, and the market prices are significantly higher than those of sorghum and maize (which are grown by both



men and women). Besides recognising the general benefits of finger millet, they saw benefits with the innovation because it makes it easier to manage the crop and to harvest the grain.

## **CONCLUSION**

Since the JE on the finger millet innovation involved farmers in Machakos and actors from extension and research, it promoted sharing, learning and dissemination of the innovation, thus potentially addressing a common problem in the area. Farmers in Machakos have taken up the production of finger millet again using the finger millet nursery innovation, which gave them a harvest unlike the failed efforts through broadcasting. It was encouraging to note that farmers who were not part of the experimentation obtained seedlings from the nurseries of experimenting farmers and established their own nurseries the following season, indicating good uptake of the innovation.

The JE process enhanced the innovative capacity of farmers to address local challenges that they are facing. Such innovations include applying the finger millet innovation to other food crops such as watermelon, maize and butternut. The plants are established in polythene bags in the nurseries and, at the onset of rains, are transplanted into the field, thus giving them a head start. Such crops mature a month earlier than the conventionally planted crops and the farmers are therefore able to fetch a good price before the market becomes flooded with produce.

This practice has the potential to enhance food security in the area by stabilising crop production for smallholder farmers and their families. Ultimately, the JE process created opportunity for farmers to be more innovative and to solve other challenges they face in the larger Machakos area. It is important to note that, for the nursery innovation to be beneficial, it has to be accompanied by improved soil fertility, proper seed selection and pest control, among other good crop management practices. The additional labour that the innovation entails at transplanting time could be a hindrance to its increased uptake, especially for the aged farmers who may continue to use the conventional method of broadcasting, albeit with disappointing results.

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## **CASE 5: ECONOMIC UTILISATION OF WATER IN A TREE NURSERY BED: THE CASE OF A FARMER INNOVATOR IN NAKASONGOLA DISTRICT IN UGANDA**

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### **INTRODUCTION**

Nakasongola District is located in Uganda's cattle corridor in central Uganda. Geographically, Nakasongola borders the districts of Apac to the North, Masindi to the West, Luwero to the South and Kayunga to the East. While the cattle corridor is not currently classified as semi-arid, it has many semi-arid characteristics. These include: i) high rainfall variability; ii) periodic droughts or late onset of rains; and iii) historical reliance on mobile pastoralism as an important strategy to cope with resource variability. The cattle corridor is vulnerable to climate change, and this affects national and local food security.

While pastoralism and crop production are the major socio-economic activities in the district, there have been changes in land use and land cover in Nakasongola District over the last 29 years (1986 to date). The area under grassland, bushland and forest decreased by 96.1, 25.6 and 17.2%, respectively; while open water, wetland, and small scale farming increased by 5.3, 2.7 and 26.8%, respectively. Of serious concern is the increase in bare ground by 211% over this period<sup>4</sup>. The local communities, including individual farmers and groups, have had to adopt coping mechanisms that include the use of local knowledge and innovations to increase resilience.

One of the innovations documented through the CLIC-SR Project is an innovation aimed at minimising the amount of water needed for watering tree seedlings in a nursery. The experimentation made use of Pawpaw (papaya) trees as they are fast growing.

Following the baseline and field studies conducted under the CLIC-SR project, farmers who were identified. One of the innovators identified was Fredrick Kavuma, who is 48 years of age. Mr Kavuma's innovation was included in the environmental protection category with his peers Ms Najja Robinah, Ms Sebyala Beatrice, Mr Sebyala Mosses and Ms Kabugo Betty who are working closely with him. This group of innovators was supported through a process of participatory Innovation Development (PID).

### **The origins of the innovation process**

Fredrick Kavuma wanted to produce his own tree seedlings, especially fruit trees, but was faced with the challenge of water being scarce in Nakasongola. The alternative sources of tree seedlings are private tree nursery operators in Luweero District, and Nakasongola District Local Government who occasionally supply seedlings to farmers. He went on to investigate water-efficient ways of producing tree seedlings.

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<sup>4</sup> [http://www.unpei.org/sites/default/files/e\\_library\\_documents/uganda-NakasongolaDEP25may08.pdf](http://www.unpei.org/sites/default/files/e_library_documents/uganda-NakasongolaDEP25may08.pdf)

The innovation was identified by Kulika Uganda, an NGO that has been working with farmers in Nakasongola District since 2005. Fredrick is one of the farmers with whom Kulika Uganda has been working. Kulika Uganda is also an implementing partner of the CLIC–SR Project, under the PROLINNOVA Uganda Network.

### **Reasons for selecting this case for documentation**

The various innovation cases identified were presented to the core team of PROLINNOVA Uganda, Fredrick Kavuma's innovation was selected because Nakasongola District is a dry area characterised by prolonged droughts, reduced tree population, environmental degradation, poor soils and low food and income security. The core team evaluated the case and found it to conform to the criteria that had been set for choosing innovations that are of good value. The innovation was perceived to contribute to environmental conservation, economic emancipation directly or indirectly, be socially acceptable and technologically simple to carry out and scale out. To summarise, the innovation requires relatively low financial input, but has a good economic value, and it is not associated with any cultural barriers.

### **Funding support for joint experimentation**

The process of joint experimentation was supported through the provision of funds that were to be used in development of the farmers' innovations. The funds were disbursed to Kulika Uganda by Environmental Alert, the host organisation for PROLINNOVA Uganda. Kulika received a total of USH 4,000,000 (approximately USD 1,080) and disbursed the allocation to the different groups according to the budgets and plans that they submitted. The funds made available to farmer innovators through this mechanism were given out as a grant and not a loan.

In the case of this joint experimentation process, the request for funding submitted to Kulika also showed the groups' own contribution. The secretary and treasurer of the farmer group were responsible for keeping records and disbursing funds to the rest of members in the group, while the chairperson had the task of overseeing implementation. The other group members were to follow up and ensure accountability during the experimentation process.

## **THE PROCESS OF JOINT EXPERIMENTATION**

Joint experimentation started in 2014 and continued into 2015. Before starting, PROLINNOVA–Uganda carried out two PID trainings with lead farmer representatives, staff and stakeholders that were to be involved in the joint experimentation at national level. Later on, community trainings in PID were carried out by the earlier trained staff and a local consultant. Funds were provided by PROLINNOVA–Uganda to support farmers in their innovation development.

The farmer innovators in the different agricultural and socio-economic thematic groups, which included the environmental conservation group, formed research and fund management committees (one per group) comprising of a chairperson, secretary and treasurer, while the farmers whose innovations had not been selected for PID remained as active members throughout the process.

The PID process involved key stakeholders, which included the lead innovator, his family members (wife and children), farmer group, NGOs, researchers, extension workers and local political leaders. Each stakeholder had a differentiated but equally important role in the joint experimentation process. Before the joint experimentation started, the stakeholders agreed on its overall purpose and the roles and responsibilities of each stakeholder.

### **Planning and running the experiment**

The experiment was planned by Frederick Kavuma as the lead innovator and four other members of his group (the environmental conservation group). The experiment was carried out by the group with Fredrick being in charge of the day to day care and management of the nursery. The group came together twice a month to carry out joint physical observations of growth and counts of the seedlings, in order to monitor the experiment and to keep records. Technical backstopping was provided to the innovator and the group. This was achieved through discussion and visualisation of what was on ground and what else needed to be done. It included an assessment of the treatments and their performance. This process was led by the farmers, since they live within the community - on or near the farms and experimental sites.

### **Documentation of the experiment**

The more regular documentation of the experimental process was done by the group with the innovator and his family members taking the lead. Ms Harriet Ndagire from Kulika–Uganda led the process documentation working with the farmers and stakeholders from NARO-MUZARDI (Mukono Zonal Agricultural Research and Development Institute) and technical staff from Nakasongola Local Government. In both cases, the process of documentation involved visual observation, note taking, photographic evidence and field visits. Reports were compiled that documented progress with the innovation process. Planning and review meetings were also held with respect to the funds provided for supporting farmer innovation.

Participatory monitoring of the innovation process made use of focus group discussions (FGDs) that included the different stakeholders mentioned above. Techniques such as interviews and question-and-answer sessions were particularly important for probing for any changes in the innovation.

### **The treatments tested through joint experimentation**

Table 1 presents a summary of the treatments applied during the experiment to test different methods of raising tree seedlings. These treatments were chosen by the farmers with guidance from NARO-MUZARDI and Kulika Uganda staff.

**Table 1: Treatments applied during experimentation with raising tree seedlings**

Treatment	Pictorial Illustration of the treatments
<p>Treatment 1 - Raising seedlings in bottles in a raised (ridged) nursery bed with no manure.</p>	
<p>Treatment 2 - Raising seedlings in a raised nursery bed in plastic bottles in soil with manure.</p>	
<p>Treatment 3 - Raising seedlings in a sunken nursery bed with soil in plastic bottles – but soil not mixed with composted manure. The area was lined with polythene sheeting to prevent water loss through infiltration.</p>	
<p>Treatment 4 - Seedlings raised in a mixture of soil and composted manure directly in the soil (no bottles) with polythene sheeting to prevent water loss through infiltration.</p>	

Photos by Harriet Ndagire Sempebwa of KULIKA-Uganda, 2015

A summary of the key aspects of the different treatments is provided in Table 2.

**Table 2: Summary of information pertaining to the different methods that were compared**

Treatment	Polyethylene lining	Sunken / raised	In plastic bottles	Composted manure
1	No	Raised	Yes	No
2	Yes	Raised	Yes	Yes
3	Yes	Sunken	Yes	No
4	Yes	Raised	No	Yes

## **FINDINGS OF THE JOINT EXPERIMENTATION**

The findings associated with the different treatments tested by the farmers are summarised below and include germination performance, seedling vigour, survival with reduced watering (resilience to water stress), water requirements, seedling growth rate, seedling survival and ease of transplanting. These are all aspects that were of importance and interest to the farmers.

### **Germination performance**

For each treatment, 60 seeds were planted to test germination performance. All seedlings in all treatments germinated on the same day, but the overall germination rate varied across the treatments as shown in Table 3.

**Table 3: Germination rates of the four treatments**

Treatment	Germination rate	Discussion of the results
1	40/60 (66.7%)	The soil nutrients and water levels were lowest, thus much lower germination than in treatment 2 and 4
2	55/60 (91.7%)	The soil nutrients and water levels were good thus best germination performance
3	45/60 (75%)	The soil nutrients were low thus only fair germination performance compared to those in treatments 2 and 4
4	55/60 (91.7%)	The soil nutrients and water levels were sufficient for germination thus best germination performance

As shown in Table 3, Treatments 2 and 4 - which both had composted manure, gave the highest germination rates.

### **Seedling vigour**

In terms of ranking the vigour of the seedlings from best to worst, the following results were obtained from the experiment:

**Table 4: Comparison of seedling vigour across treatments**

<b>Treatment</b>	<b>Seedling vigour</b>
4	Best
2	Second-best
3	Second-worst
1	Worst

Again, the treatments with manure outperformed those where the seedlings were grown only in soil.

#### **Survival with reduced watering**

The rate of survival of seedlings when water was withheld for a period of two weeks was assessed for the four treatments.

**Table 5: Survival of seedlings under the 4 treatments after a 2 week period of reduced watering**

<b>Treatment</b>	<b>Survival rate</b>
1	50% (20/40 seedlings died)
2	100% (All seedlings that germinated survived)
3	56% (20/45 seedlings died)
4	100% (All seedlings that germinated survived)

Treatments 2 and 4 prevented water loss and thus allowed the seedlings to survive the two week period. More detail of the findings from the research is provided in Tables 6 and 7, which consider water requirements and seedling growth rates, seedling survival to transplanting and ease of transplanting.

**Table 6: Results of the experimentation regarding water requirements and seedling growth rate**

<b>Treatment</b>	<b>Water consumption</b>	<b>Discussion of the results</b>	<b>Seedling growth</b>	<b>Discussion of the results</b>
Treatment 1 - Raising seedlings in bottles in a raised (ridged) nursery bed with no manure	The tree seedlings required watering daily, both in the morning and the evening. The seed bed required 5 litres of water per day.	The soil did not have manure in it and thus had very little capacity to retain water.	The seedlings in treatment 1 showed the slowest growth.	The soil did not have manure in it and thus it had low levels of nutrients and it had little capacity to retain water thus the low growth rate of seedlings under this treatment.
Treatment 2 - Raising seedlings in a raised nursery bed in plastic bottles in soil with manure	This ranked second in economising water usage. Seedlings required watering twice a week for the first month and thereafter required watering once (2 Litres) per week.	The composted manure in the soil could have increased the water retaining capacity of the soil but probably the size of the water bottles could have been limiting the amount that was available to the individual seedlings	The seedlings grew faster than those in treatment 1 but slower than those in treatments 3 and 4.	The soil had manure in it to support fast growth but the walls of the bottles could have limited the access to the nutrients by the roots of the seedlings and this could be the reason for the slightly lower growth rate than in treatment 4.
Treatment 3 - Raising seedlings in a sunken nursery bed with soil in plastic bottles – but soil not mixed with composted manure. The	The tree seedlings required watering every day (once in the evening).	The soil did not have manure in it but the walls of the plastic bottles could have helped to keep the soil moist longer than in treatment	The seedlings grew faster than those in treatments 1 and 2 but slower than those in treatments 4.	The soil did not have manure in it and it also had less capacity to retain water thus it had low levels of nutrients and slower growth than in treatment 4



area was lined with polythene sheeting to prevent water loss through leaching.		1.		and 3 but the walls of the plastic bottles could have helped in keeping water around the roots longer than in treatment number 1.
Treatment 4 - Seedlings raised in a mixture of soil and composted manure, with plastic lining but not in plastic bottles.	Water usage was most economical. The seedlings required watering twice a week but were consuming little water (about two litres per watering).	The composted manure in the soil could have helped in increasing the water retaining capacity of the soil.	The seedlings showed the fastest growth.	The soil had manure in it and most likely enough nutrients to support fast growth
SUMMARY OF THE FINDINGS	From best to worst performance in terms of economising water use: Treatment 4 (Best) Treatment 2 Treatment 3 Treatment 1 (worst)		From best to worst performance:  Treatment 4 (fastest) Treatment 3 Treatment 2 Treatment 1 (slowest)	

**Table 7: Seedling survival up to transplanting and ease of transplanting in the four treatments**

<b>Treatment</b>	<b>Survival up to transplanting</b>	<b>Discussion of the results</b>	<b>Ease of transplanting</b>	<b>Discussion of results</b>
Treatment 1 - Raising seedlings in bottles in a raised (ridged) nursery bed with no manure	10/60 (16.7%) seedlings survived up to transplanting stage	Most of these seedlings succumbed to death during the 2 weeks period of no watering due to water stress. Others died later due to poor soil and further water stress.	Seedlings were the hardest to transplant	The soil was hard and compacted because of there being no manure.
Treatment 2 - Raising seedlings in a raised nursery bed in plastic bottles in soil with manure	50/60 (83.3%) seedlings survived up to transplanting	The composted manure in the soil had nutrients in it and could have helped to increase the water retaining capacity of the soil thus ensuring better survival of the seedlings than in treatment 3 and 1 during the 2 weeks when there was no irrigation. The rest of the seedlings could have died due to attack by root collar disease.	Seedlings were fairly easy to transplant	The bottles allowed the lump of soil around the seedling to be pushed out from below. Also, the soil had manure in it and was not compacted so it easy to push out.
Treatment 3 - Raising seedlings in a sunken nursery bed with soil in plastic bottles – but soil not mixed with composted manure. The	20/60 (33.3%) seedlings survived up to transplanting	The soil had no manure but walls of bottles helped to retain some moisture more than in treatment 1. The seedlings died due to water stress.	Seedlings were difficult to transplant	The soil was compacted because of there being no manure, but the walls of bottles helped to retain more moisture than in treatment 1.

area was lined with polythene sheeting to prevent water loss through leaching.				The bottles also allowed the lump of soil around the seedling to be pushed out from below.
Treatment 4 - Seedlings raised in a mixture of soil and composted manure, with plastic lining but not in plastic bottles.	50/60 (83.3%) seedlings survived up to transplanting	The compost manure in the soil had nutrients in it and could have helped to increase the water retaining capacity of the soil thus better survival of the seedlings during the 2 weeks when there was no irrigation than in treatment 3 and 1. The rest of the seedling mortalities could have been due to an attack of root collar disease.	Seedlings were the easiest to transplant	The soil had manure in it and was not compacted but loosely bound the roots of the seedlings. The bottles also allowed the soil around the seedling to be pushed out from below.
SUMMARY OF THE FINDINGS	From best to worst: Treatments 2 & 4 (Best) Treatment 3 Treatment 1 (worst)		From best to worst: Treatment 4 Treatment 2 Treatment 3 Treatment 1	

## **SUMMARY OF THE FINDINGS**

Treatment 1 performed the worst in seedling survival to transplanting. This is attributed to the lack of organic matter that reduced water holding capacity resulting in poor survival. Treatment 1 also performed worst in terms of and also in terms of ease of transplanting, which is also attributed to the lack of manure resulting in compacted soil in the bottles. Treatment 1 also performed worst in efficient water use and seedling growth performance. This is attributed to lack of manure, resulting in low fertility and water holding capacity.

Treatment 2 performed well in terms of seedling survival to transplanting, attributed to the manure increasing water holding capacity. Treatment 2 was second best in terms of ease of transplanting, attributed to manure reducing compaction in the bottles. Treatment 2 performed second best in efficient water use and seedling growth performance. This is attributed to the manure, which improved soil fertility and water holding capacity.

Treatment 3 performed second worst in terms of seedling survival. Although there was no manure, being sunken and surrounded by a plastic sheet did reduce water loss to some extent. It also performed second worst in terms of ease of transplanting, due to lack of organic matter resulting in soil compaction, but not as compacted as in Treatment 1, because there was some residual soil moisture. Treatment 3 performed second worst in terms of water-use efficiency, but second best in terms of seedling growth. While there was lower soil fertility and water-holding capacity because of the lack of manure, being in a sunken bed reduced water loss, which allowed better growth of the seedlings.

Treatment 4 performed equally well as Treatment 2 in terms of seedling survival to transplanting, attributable to the manure. Similarly, it performed best in terms of ease of transplanting, because to manure reduced soil compaction in the bottles. It also performed best in terms of water-use and efficiency seedling growth, on account of the manure, which improved soil fertility and water-holding capacity.

## **CONCLUSION**

The inclusion of manure is important for increasing germination and survival of the seedlings to transplanting. It is also important for increasing plant performance in terms of growth and water-use efficiency. This is due to the better fertility and water-holding capacity of soils with manure. Inclusion of manure also improves soil structure, making soil less prone to compaction, so the seedlings are easier to transplant. In addition, sunken beds also seem to conserve water. It is therefore recommended that for, best water-use efficiency, the tree seedlings are grown in a mixture of soil with manure and placed in plastic-lined sunken beds.

## **GENDER ASPECTS OF THE INNOVATION**

The seedling raising innovation is technically simple and the activities were carried out by men, women and the youth. The innovation is relevant for both men and women. It can be carried out on a small piece of land, making it well suited for adoption by women and youth, who usually have less access to large pieces of land. Even youths, who are sometimes landless, can borrow or hire land - even along the roadsides - and can earn income from the sale of seedlings. They can later invest this money in land acquisition. They would however

need to have access to a source of manure and would need to be able to purchase the plastic lining and/or collect plastic bottles.

## **SPREAD OF THE INNOVATION**

The farmers in this group and those beyond the group in Nakitoma and Nabiswera Sub-county have learnt that lining a nursery bed with polythene sheeting before putting in the soil mixture is beneficial because it economises the amount of water required. They have also seen that the addition of manure improves the vigour of the seedlings as it provides an effective growing medium. Two farmers have already adopted the technique. One is Ms Kabugo Betty, who is from the group, while Mr Lwanga Kajura, from another group has also adopted this practice. Two other farmers from Mr Lwanga's crop production group have expressed interest in adopting the practice and have requested support with purchasing the high gauge plastic sheeting and the plastic drums needed for the innovation.

## **HOW DOES THE INNOVATION IMPROVE RESILIENCE OF COMMUNITIES?**

Tree growing, if practised on a wide scale, can lead to lowering of ambient temperatures and creation of a cooling effect in the drylands of Nakasongola District. Roots of trees grown on farms can bind soil particles together and reduce soil erosion. Fallen leaves help to cover/mulch the soil and thereby further protect it from heat and erosion. Moreover, when dead leaves decompose, organic matter and fertility are added to the soil and better yields of crops and pastures can be expected. When fruit trees are grown, food in the form of fruit will be more abundant which will, in turn, allow for better human nutrition. Trees can also improve income security and thus contribute to improved livelihoods. In the long run, if this innovation is scaled up, it is likely to contribute to strengthening resilience, leading to a reduction in the negative impacts of climate change on the livelihoods of the farming communities, especially in the cattle corridor in Uganda and possibly drylands elsewhere in Africa.

## **LESSONS LEARNT**

Some of the lessons learnt through this process of joint experimentation are:

- Through joint innovation processes, the confidence of the farmer innovator or innovators to take charge of their own situation increases.
- When other people (extension workers, scientists, civil society organisations (CSOs) and other farmers) allow the farmer innovators to be centre stage, they gain recognition and this serves as motivation and helps to boost their enthusiasm to continue innovating and engaging in PID.
- Farmer-led joint experimentation strengthens team work, sharing of knowledge, and wider learning. However, for groups to work together effectively, the members need to be cooperative, good 'hearted' and transparent, and willing to share and to take on roles identified according to each one's capacity/ability.
- Funding for PID plays an important role in helping farmers to acquire materials and/or equipment to use to bring out the results of the experiment or innovation.

- To go through the joint-experimentation process and obtain results requires persistence and consistence.
- For wider dissemination of beneficial results from farmer-led joint experiments, local governments, media, CSOs and extension workers have to participate and support the process.
- Joint experimentation needs continuity - from obtaining of results to applying those results to solve a problem, meet need(s) or bridge gaps in livelihoods or development.
- There is a need to strengthen the resilience of communities through technical support and encouragement to pursue and enhance their own initiatives. Local innovations geared towards farm-based water conservation will improve the production of crops, trees, plantations and livestock products such as eggs, beef, honey, milk, fruit, etc.

In terms of the tree raising innovation, a number of lessons also emerged:

- This innovation has reduced the challenge of water shortages and allows farmers to raise tree seedlings on their own in order to plant new trees or replace trees that have been cut down.
- For the innovation to have a longer-term impact on livelihoods, more knowledge in tree growing and other technical aspects of tree nursery management and tree growing would need to be given to the farmers in Nakasongola District.

## **NEXT STEPS/ WAY FORWARD**

Encouragement has been given to the all interested farmers to use the innovation so as to be able to raise their own seedlings. Once more technical and financial support is provided to current and emerging farmer groups, this innovation has great potential and it is expected that fruit tree seedlings as well as other types of tree seedlings will be propagated using the innovation.

## **FINAL MESSAGE**

Raising seedlings in a sunken nursery bed that has soil mixed with decomposed manure and is lined with polythene sheeting to reduce water loss is an effective way to raise tree seedlings. The practice needs to be promoted as a best practice and currently there is an opportunity of mainstreaming climate change impact mitigation and resilience building among communities. This practice can be popularised and included in implementation programmes of government departments and NGOs.

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Sarah, and the District NAADS Coordinator, Sebwato Joshua, as well as other leaders of the technical staff team including Fred Kitaka, Director of Production; Ms Nakamya Sarah, District Agricultural Officer; Fred Nsambansole, District Fisheries Officer; Chief Administrative Officers Kasozi and Byekwaso; as well as all the other stakeholders in the village; the PROLINNOVA International Support Team including Ms Chesha Wettasinha, Laurens van Veldhuizen, Ms Ann Waters-Bayer and Ms Brigid Letty, and all others who provided technical backstopping during the CLIC–SR project.



## **CASE 6: ASSESSMENT OF MARGINALISED WOMEN'S GROUP – AN INNOVATION THAT HELPED THEM TO CHANGE AND BECAME SOCIO-ECONOMICALLY ACTIVE**

### **Research Team:**

- Lucy Mtimi and all 15 (of whom 2 were men) group members
- Daines Sanga Researcher with Agriculture Research Institute Makutupoa Dodoma.
- Grace Mketo Gender Specialist and trainer INADES Formation Tanzania.
- Aithan Chaula District Extension Officer Chamwino Dodoma.
- Patrick Lameck CLIC-SR Coordinator-Tanzania and trainer INADES Formation Tanzania.

### **CONTEXT**

The study area was Makoja Village, which is located in Chamwino District in Dodoma Region, Tanzania. The semi-arid central parts of Tanzania, including Makoja, are characterised by infertile soils, fragile environments and erratic weather conditions. This makes it difficult to practise sustainable agriculture (SA), which poses a risk to the livelihoods of smallholder farmers and rural communities. Climate change (CC) is adding to the problems of subsistence farming communities who, because their livelihoods depend on farming, are most vulnerable to the impacts of CC on agriculture and natural resources. The area receives annual rainfall of 500–600 mm on average, which is not adequate for maize production. The main food crops grown in the area include sorghum, millet, cassava and sweet potatoes. The unpredictability of rainfall is a key feature in semi-arid areas that makes agriculture a risky and uncertain undertaking. Rainfall shortages regularly lead to serious droughts, which impacts on livelihoods, because of competition and conflicts over natural resources. Soil erosion and bush encroachment have been concerns since the late 1920s as regeneration of vegetation has greatly reduced over the decades and human activities such as overgrazing and land clearing to expand the area under cultivation has occurred.

According to the 2007 Household Budget Surveys (HBS), the proportion of people below the Food Poverty Line is 16.5% and that below the Basic Needs Poverty Line is 33.3%. The number of people living under one US\$ per day or less has risen by 1 million to reach 12.7 million in 2007, compared to 11.4 million in 2000/01. The situation in rural areas, where the majority live, is even worse.

These findings challenge the effectiveness of current policies and strategies in fighting poverty and inequality, and points to failure to achieve poverty targets of the National Strategy for Growth and Eradication of Poverty (MKUKUTA) - 14% for food and 24% for basic needs by 2010.

The incidence of poverty varies greatly across the country but is highest among rural families living in arid and semi-arid regions that depend exclusively on livestock and food crop production. The people of the central Tanzania are nutritionally the most deficient.

Farming systems in the area has seen farmers growing sorghum and millet mixed with groundnuts and sometimes bambara nuts with a ley crop of sunflower. They also keep some

livestock, mainly local cattle, goats and sheep, as well as local chickens and guinea fowls. Yields from agricultural production are very low – about 5 bags (100 kg) per acre (200 kg/ha) on average, with average size of land holdings being 3–4 acres and average household size being five persons.

Women play a central role in sustainable agriculture. They manage the majority of the work and operate a third of the smallholder farms. However, they are disadvantaged when it comes to the roles traditionally held by men such as power in decision-making on selling, allocation and use of farm land, access to credit and new agricultural methods. As one of the coping mechanisms, men go to potential agricultural areas to sell their labour and are expected to come back with something for the family.

INADES Formation Tanzania has been promoting sustainable agricultural practices in semi-arid areas for increased productivity and food security. These relate to land-use management, farmer innovations in soil and water conservation (specifically rain-water harvesting), and soil fertility management. Others include use of indigenous knowledge (IK) and locally available resources (instead of costly industrial inputs) for soil nutrient management, environmental conservation and diversification of crop and livestock systems at farm level. These initiatives have demonstrated the potential of sustainable agriculture for improving soil and water conservation, farm productivity and enhancing adaptation to CC in the semi-arid areas of Tanzania.

In Makoja Village, INADES–Formation Tanzania started its work in 2005 and encountered the strong and functional Raia Makini group. The group has 15 members, of whom two are men. INADES was struck with the management ability and performance of the group. Through the CLIC–SR project, the group was identified as having a social innovation and was included as one of the target groups under the project.

## **AIM OF THE STUDY: UNDERSTANDING THE INNOVATION**

Raia Makini is seen as an innovation where marginalised women have formed a voluntary group to share and solve problems that are common to all of them. They have organised themselves into a group, have developed a strong group constitution, have identified and pursued socio-economic activities that have changed their poor socio-economic situation to become strong and functional. This is an institutional innovation of self-organisation and management, developed without help from any other organisations. The process of forming the group is summarised in Table 1.

The group is very strong and functional. For example, if there are visitors to the village and the village leaders are not around, they can receive them and respond to their needs as they are well informed and are aware of the roles and responsibilities of village leaders and the village leaders trust them. Their Ngoma dancing group is invited to attend festivals held at village, district and Regional level.

**Table 1: Summary of timeframes related to establishment of the group**

<b>Timeframe</b>	<b>Activity</b>
1994	<ul style="list-style-type: none"> <li>• Start of the idea</li> </ul>
1995	<ul style="list-style-type: none"> <li>• Promoting the idea among their colleagues (local women), resulting in the formation of the Raia Makini group and development of the vision, mission and constitution (including members' commitments).</li> <li>• Formation of the Ngoma dancing group</li> </ul>
2005-2009	<ul style="list-style-type: none"> <li>• Group members attended training in sustainable agriculture and gender offered by INADES–Formation.</li> <li>• During that time, they applied the agriculture practices they learned.</li> <li>• They grew both food and cash crops to have money and become more food secure.</li> <li>• They also started small businesses to supplement household incomes.</li> <li>• They started constructing improved houses and sending their children to school.</li> <li>• They used performances of the Ngoma dancing group in the village to educate village members on various things they have learned.</li> </ul>

The objectives of the CLIC–SR study of this local innovation were: i) to learn about how the group had become strong and functional and how it was able to reach the achievements it had made; and ii) to document and share the findings.

## **EXPERIMENTATION PROCESS**

The joint investigation process started in 2012 through the CLIC-SR project and continued up until 2016, as shown in Table 2. The research team (farmer group members, extension staff and researcher) developed questionnaires and held group discussions to collect relevant information. The questionnaires were tested with farmers who made improvements to make the questions more clear. The questionnaires were administered to both group members and non-group members and discussions were held with village government leaders and other influential people in the village. The information was analysed collectively and results drawn in 2016.

**Table 2: The process of jointly exploring the institutional innovation**

<b>Time-frame</b>	<b>Activity</b>
2012	<ul style="list-style-type: none"> <li>• Makoja village was identified as a CLIC-SR Target village.</li> <li>• The group participated in PID trainings and that is when the innovation was uncovered and included in joint exploration.</li> </ul>
2013 – 2015	<ul style="list-style-type: none"> <li>• The group identified the research agenda and developed joint experimentation proposal using PID approach and won research funds from CLIC-SR.</li> <li>• The research involved the collection of information about the group from the village to determine whether the group's claims were valid (i.e. "That self-group organization and management has helped them overcome marginalisation and poverty").</li> </ul>

2016	<ul style="list-style-type: none"> <li>• Analysis of the joint experimentation and results</li> <li>• External evaluation of CLIC-SR that visited the group.</li> </ul>
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**Figure 1: Raia Makini research group in some of their advocacy work.**

### **Securing funds to support the joint investigation process**

In the CLIC–SR budget, funds were allocated to “joint experimentation”, so the project was able to provide a Local Innovation Support Fund (LISF). The group drew up a proposal and budget that was submitted to the CLIC–SR project team. The proposal was sent to the Regional Coordination Committee, which consisted of two farmer innovators, researchers and extension staff. This committee evaluated and approved the proposal. The funds were sent to the group using a memorandum of understanding, which clarified that the funds would be managed as per approved budget and proposed activities.

### **Reason for choosing to document the case**

The reasons that this case was chosen for joint exploration through the CLIC-SR project include:

- Institutional innovations are not often encountered.
- It comprised a group of women who are more marginalised in the community
- INADES participated in a gender study conducted by a PhD student in a sorghum producing area in the same village, where some crucial information about the marginalisation was uncovered in 2009
- The interest of the whole team to in learning what lay behind their success
- That other women in the village are forming similar groups
- That the group is well spoken of in the village and neighbouring villages, is successful and has sustained itself for 20 years!

- There was also an impact evaluation of Strengthen Women Change the Climate Project funded by GIZ conducted by a PhD student from Germany. In the evaluation, the difficulties faced by women in Makoja and a neighbouring Ikowa village were identified.
- Other women in the village are forming similar groups.
- Additional organisations want to work with the group.

### **Background and origin of the innovation**

The idea of the group was started by Lucy Mtimy after she could not finish her secondary school education because of problems with her eyes. Her parents (who had a good number of cattle and could easily have had her treated) did not have her eyes attended to – for reasons best known to themselves – and she therefore could not return to school and attain her dream. Furthermore, she decided not to get married, as she saw married women suffering in their village.

Women were often poor. Frequently their husbands abscond, leaving them to do all the productive and family care work of the household. Some husbands did not come back and those who came back brought nothing to the family but relied on the work of their wives. Many women had poor health status as they could not afford medical care and some villagers called them bad names.

Lucy Mtimi wanted to start her own home, but her parents (especially her father) would not agree. Then one day she come up with an idea of forming a women's group that could step forward and try to solve their common problems. The group was initiated in 1995 when Lucy was 22 years old.



**Figure 2: Ms Lucy Mtimi, the woman who initiated the idea for the innovation.**  
**Planning the joint investigation**

During PID trainings conducted from 2012, the innovation was uncovered. The group received training on “development of joint experimentation” and identified a research team with whom to work. The external researchers then visited the group to collect preliminary information. The group was left with the PID Joint experimentation application form and started filling it in after discussing among themselves. Using the knowledge of PID imparted to them by the project they discussed among themselves what joint experimentation/exploration they could do. In discussing among themselves, and challenged by others who wanted to know the secrets behind their strength and success, they came up with an idea that forming a group without help of any other institution was the secret behind their success.

The group then presented their proposal to the rest of the research team for their contributions. It was jointly agreed to use a questionnaire to collect experimentation information and data, which was written in terms (in Swahili local language) that could be easily understood by farmers. Researchers suggested having two samples - one of group members and the other of non-group members in order to also hear the perceptions of non-group members. The group members initiated the investigation and came up with a research agenda. Group members and non-group members responded to the questionnaires to give the required information. This information was triangulated in focus group discussions facilitated by the research team that included one researcher, one gender specialist, one district extensionist, the project coordinator, village leaders and the Raia Makini farmer group.

### **Running the experiment**

The questionnaires, after finalisation, were administered to each individual in the two groups of 15 members each. The joint experimentation team mentioned above also visited members’ houses, their petty businesses and their farm plots to observe what the group members had achieved. The team also attended one ngoma dancing performance.

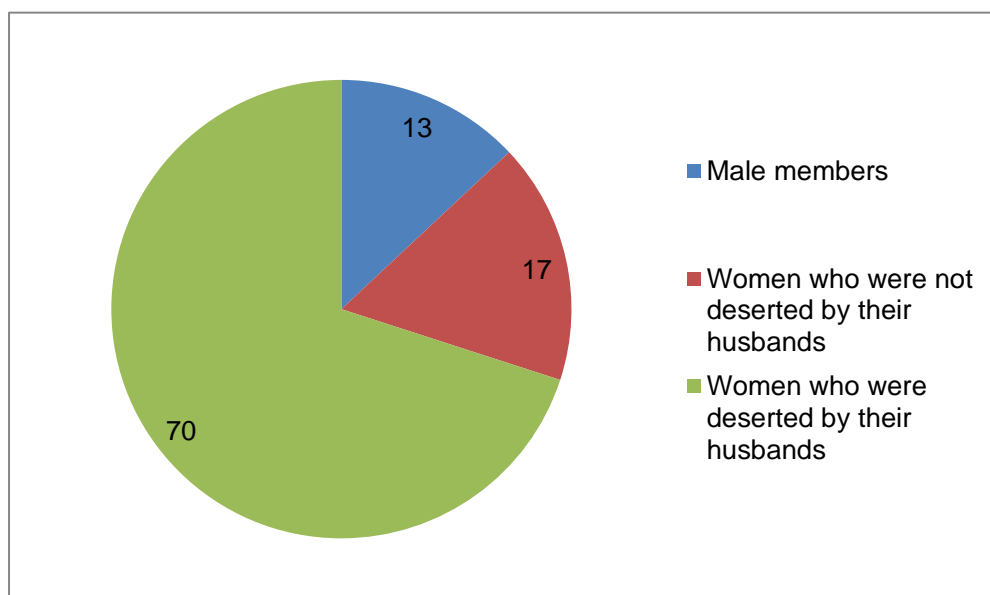
### **Findings of the joint experimentation process**

All information collected was consolidated and analysed. The following were the findings:

- There was very strong agreement from all group members, that the establishment of the group under their own initiative and without support from any other institution was the foundation of their achievements. It should be noted here that, usually groups are sensitised and formed by development organisations/institutions in Tanzania. It is not usual to find such a strong group without such support.
- Commitment in their constitution of the group was also considered very important.
- Certain rules also had to be followed. To become a group member each person has to fulfil the follow obligations:
  - Have one acre of food crops using best agricultural practices for food security
  - Have one acre of cash crops for earning income
  - Send their children to school and higher learning institutions
  - Construct an improved house
  - Have a mobile phone

- Be smart and wear good clothes
- Do petty business (such as selling clothes) to complement the farm income
- Attend group meetings.

The status of the group's members is shown in Figure 3 below. While there are some male members, the majority of members are women who have been deserted by their husbands.



**Figure 3: Group members' status (showing percentage of members).**

### **Challenges encountered**

#### *Some of the challenges faced by the group members as women*

- They had to start from zero (without finance or materials).
- They were marginalised by their parents, husbands and the whole community.
- They were called bad names such as prostitutes, mad women, etc.
- No one trusted them at the beginning.
- Climate change made their harvest very poor at the beginning. The group was formed in 1995, where they made their constitution and commitments. In improving their crop productivity, they started attending workshops where they learned and applied climate-smart agricultural practices and improved their yields.
- As women, they lacked decision-making power in the house. This was addressed to some extent by training on gender issues.
- They had very limited ownership and control of household resources and assets.
- They had a heavy workload at home (doing both productive and reproductive<sup>5</sup> work).
- They could not afford health services and hence had poor health status.
- They were vulnerable to diseases such as HIV/AIDs.

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<sup>5</sup> i.e. raising children

### Some of the challenges faced by the group members during the exploration process

- In 2012 was the first time the members heard of the PID approach, so it was a challenge for them to understand what it was (however, before the CLIC–SR project, they had made an exchange visit to some farmer innovators as part of INADES training, so at least they had an idea about innovation). They felt that they did not have any innovation but, during the initial field study in the CLIC–SR project to identify local innovation in the face of change, the group was identified and was told that what it is doing is actually an “institutional innovation”.
- The members had never worked with formal researchers before, and they wondered how they could work with them. They thought a researcher was a very big person who could not work in the field with farmers. After understanding and engaging in joint investigation (a form of PID), they now see the formal researchers as their partners.

### **General perceptions about the group**

The community appreciates the group because of its intensive involvement in various development, leadership and advocacy activities in the village. Despite the challenges and limitations they are facing, a number of activities related to awareness creation, lobbying and advocacy work have been done by the group.

The approach used by this group has stimulated other economic groups in the village to emerge. This is because Raia Makini group interventions aim to improve the livelihood status of the whole community, not only the group. Members of this group are well organised and committed to guide the development process through sharing experiences with new groups within the community.

The joint investigation revealed that, on account of the successes attained, the group members have increased their credibility and recognition from their families and the broader community. This led to increased morale as well as increased support to the community from various development practitioners who have come to visit the village.

In terms of improved status of group members, it was found that 85% of group members have improved houses (as shown in Figure 3). Being a requirement as members of the group, the majority also had mobile phones, looked smart and wore good clothes. It also emerged that 67% of husbands who deserted their families were coming back to their homes and that among those returning, 37 % were not accepted by their families. There is a case reported in the village where a wife rejected a returning husband who came back empty-handed after a long period when he had been away without helping/supporting his family.

According to 95% of the group members interviewed, the factor that helped them was their group's innovation in self-organisation and management – and that the group has overcome marginalisation and poverty. Non-members (85% of those interviewed) confirmed that the group's innovation in self-organisation and management helped them and revealed that the increased income generation from economic activities contributed to an increase of the group members' ability to access health services and afford education costs for their children where previously it was difficult. They insisted that the group has a strong commitment and co-operation, and are involved in various economic activities including: crop production for



home consumption and for selling; educating the community through songs and reinforcing norms (traditions and culture); and keeping animals (mainly local chickens and pigs). They are also involved in small businesses such as selling clothes as a means of increasing income. They highlighted that the group members visit and meet each other regularly to discuss their challenges.



**Figure 4: Houses before and after the innovation.**

The community members perceive the group as very strong and an eye opener for socio-economic development in the village. Initially, there was only one group but now another 20 groups in the village and neighbouring villages are at different stages of adopting or adapting what the Raia Makini group has done. One young man said that, if the youth of the village don't work hard, these women will be better than them. Some youth have also started to adopt what the group is doing in fear of being left behind. The new chairperson of the village government said that he has learned a lot from the group, which influenced his ability to obtain his position as chairperson.

### **Analysis, documentation and sharing**

Documentation of the investigation process and its findings was done by the group, which produced a draft report and presented it to the formal researcher members of the Research Team for corrections, contributions and improvements. After the analysis, a feedback session was held in the village. Group and non-group members as well as village leaders took part in the meeting. The group was happy with the findings and results.

### **EVALUATION OF THE INNOVATION**

Through the process of joint investigation of the group as an institutional innovation, the following strengths have been identified:

- Their innovation in self-organisation and management really helped the members to overcome marginalisation and poverty.
- The group is also a farmer training based organisation which offers training to fellow farmers in their respective groups.
- The innovation is making them more resilient to the impacts of climate change as it is making members adopt and adapt Climate Smart Agricultural practices

- The innovation is making not just its members, but the broader community more cohesive
- The innovation is overcoming the challenge of women traditionally not being allowed to own land (this being a cultural rather than a policy issue).
- The innovation and the farming practices utilise locally available resources and open them up to other technologies that they can afford.
- The group undertakes public development activities (social investment).
- It is an advocacy entity in the village.
- There is high potential for uptake of the innovation by other people, especially women.

It should also be noted that the group is also an advocating entity and has advocated among other issues for land ownerships by women. The Tanzania government Constitution, land Policy of 1996, and village land act of 1999 allows women to inherit and/or own land. The act allowed formation of Village Land Councils (having 7 members and at least 3 female members) and Adjudicative committee to take care of land issues. This was not known to villagers and the group informed them about these developments.

The innovation has also addressed some gender issues that include:

- It allows for collective decision-making (husband and wife) at household and village level, which was not occurring prior to establishment of the group.
- Group members now own household resources and assets.
- Men are now assisting with tasks traditionally undertaken by women (collecting firewood, fetching water, caring for children, etc.) to reduce women's workload.
- Women are now generating income and contributing to the overall household income.
- Women are now competing for leadership positions from group to village committee levels.
- Women's voices are now heard in the community.

The joint investigation process has also had positive spin-offs for the group members and for the broader community: Some of these benefits include:

- The group that has gained skills to use participatory approaches to design, implement and evaluate research. They conducted joint investigation successfully and produced a research paper.
- Other institutions – for example, universities, District Councils, NGOs and research organisations – are now coming to work with the group after the CLIC–SR project began, as a result of the growing awareness raised during multi-stakeholder activities such as workshops and exchange visits.
- The innovation is proving attractive to outsiders, and many people wish to adopt and adapt the innovation.

## **LESSONS LEARNT**

The process of exploring and documenting this institutional innovation has generated some interesting lessons for the research team and others. Some of these lessons, both positive and negative are summarised here:

- Sustainable development comes from within the affected people (internally driven, local solutions).
- Farmers can organise themselves.
- Joint experimentation is cost effective (cheap) compared with conventional research as they use locally available resources, build on farmer experiences and farmers contribute in kind through on-farm experimentation.
- Training on PID has widened the group's scope of knowledge and they can undertake new research for development. It was their first time working with researchers and they now understand their roles.
- Also the formal researchers learned a number of things:
  - Research becomes more relevant if building on farmer experiences/innovations. Farmers were keenly following the research team and asked for results (created demand for research products and information).
  - Farmers can contribute knowledge from the formulation of the research idea through to the production of results of the research.
  - Farmers can collect data in investigation and experiments and can also analyse the results.
  - Researchers can assist farmers to record the information that they have.

## **WAY FORWARD**

The next steps in the process will be to continue publicising this institutional innovation. This can be accomplished through participation of the group members in farmer shows and demonstrations, preparation of policy briefs, exchange visits, radio programmes and the development of technical notes. For example, the Raia Makini group was invited by to its pavilion during the Annual Agricultural Show on 6–9 August 2016 in Dodoma. The group will sing about INADES-supported activities including PID lessons and experiences. The Research Team, especially the external members, aim to link the group to other stakeholders for mutual benefit. They also plan to undertake follow-up visits to the group to strengthen it further.

## **Acknowledgement**

The formal researchers in the Research Team wish to acknowledge Ms Lucy Mtimi, woman farmer from Makoja Village, who initiated the idea, and the entire Raia Makini group, who accepted the idea and worked on it successfully, without which the joint investigation would not have been possible. Acknowledgements also go to the Zonal Director for Agricultural Research and Development (Central Zone) for allowing her researcher to take part in the investigation; the Chamwino District Development Director for allowing the District Extension Officer for Chamwino District to take part in the investigation; and the Managing Director of INADES–Formation Tanzania for managing the CLIC–SR project and releasing two of its staff to take part in the investigation. Last but not least, we are grateful to the PROLINNOVA International Secretariat (previously with ETC Foundation and now with KIT) for technical backstopping of the PID and to the Rockefeller Foundation for funding the CLIC–SR project. We owe them all deep gratitude.

Note: All photos by Aithan Chaula, Chamwino District, Dodoma, Tanzania

## **CASE 7: CATTLE FATTENING USING FISH MEAL AS A SUPPLEMENT IN LOO VILLAGE, DODOMA REGION IN TANZANIA**

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<sup>3</sup>Kondoa District Council

<sup>4</sup>Loo Village

### **CONTEXT**

INADES Formation Tanzania coordinates the network PROLINNOVA (Promoting local innovation in ecologically oriented agriculture and natural resource management) in Tanzania. They also coordinate the project “Combining Local Innovation capacity with Scientific Research in climate change resilience”, known as CLIC-SR.

This experiment, which was supported and documented through CLIC–SR, was conducted in Loo Village, Kalambo Ward in Kondoa District of Dodoma Region, Tanzania. The area is located at 35°58' N latitude and 4°45' S longitude. Elevation is 1300–2000 m above sea level. Rainfall is on average 650 mm mainly in the period from December to May. Mean temperatures are 25–30°C.

The farming system of this area is mixed crop and livestock production. Zero-grazing and semi intensive feeding systems are among the management practices which are becoming important, especially for dairy production and stall feeding of beef animals. The main constraints in this system are poor animal nutrition due to inadequate feed resources in terms of both quality and quantity, low production potential of indigenous livestock, poor veterinary services, water shortages and drought. Based on the production constraints, innovative farmers have developed indigenous knowledge systems to overcome some of them - such as development of cattle fattening practices using natural pastures, crop residues and supplementation with fish meal. They purchase zebu cattle from livestock markets, fatten them using this method and sell them at a higher price.

### **INNOVATION DEVELOPMENT PROCESS**

The innovation was developed by Saidi Ninga about eight years ago. He had been keeping cattle for many years, but one day he asked himself why the herd ran to one point of the riverbank near his house. He went to that point and found the remains of fish that had died some time before. That is how he discovered that cattle can consume fish. He started to do simple experiments and discovered that a soup made from fish flushes the cattle and, after some time, the cattle fatten. He has been practising this ever since he made this discovery.

A focused survey to identify and diagnose relevant innovations used by farmers to absorb the shock of climate change was done by the INADES team and financed by CLIC-SR at the project sites in Kondoa and Chamwino District of Dodoma Region. Filtering of a long list of identified farmer innovations was done jointly by INADES Formation Tanzania, extension

officers and researchers in an organised workshop. The potential innovations were critically screened according to set criteria.

Then, PROLINNOVA–Tanzania (PT) organised a workshop for selected farmers, extension officers and researchers to provide training on how to conduct farmer-led joint experimentation. Another workshop was organised to train stakeholders on how to write farmer-led joint research proposals, which were duly submitted. The PT Steering Committee screened the joint research proposals, considering the rationale of each innovation. The fish soup innovation was approved for support to joint experimentation. The innovation, which involves supplementing stalled cattle with a fish soup made from catfish meal, was the innovation that came from the farmer Saidi Ninga.

Through the process of participatory innovation development (PID) involving the innovative farmer Saidi Ninga, INADES FT, extension agents from Kondoa District Council and researchers from Tanzania Livestock Research Institute (TALIRI) Mwapwa; and with financial support through the CLIC-SR project, the innovation was validated within the farmer's situation. The CLIC-SR budget had an amount of funds allocated to the joint experimentation and thus functioned as a local innovation support fund (LISF). In developing the proposal, the innovator's household and the village government executive officer drew up a budget for the experimentation. The proposal was sent to the regional coordination committee, which includes two farmer innovators together with researchers and extension staff. The coordination committee analysed the budget and approved the proposal. Funds were then sent to the group who managed the funds as per the approved budget and activities, which were laid out in a memorandum of understanding (MOU).

## **THE PID PROCESS**

### **Planning**

Planning of the research to be done on-farm under farmers' condition involved three key processes: problem identification, problem ranking and the identification of possible solutions. Possible causes of cattle emaciation included:

- Diseases such as tuberculosis, paratuberculosis, trypanosomiasis, liver flukes, gastro-intestinal worm infestations, external parasites.
- The presence of plastic material in the rumen.
- Other animal husbandry practices such as inadequate feeding.

Differential diagnosis was conducted using observable clinical signs to eliminate other conditions that may cause emaciation in cattle by pair wise ranking. Nutritional disorders as a result of limited feed resource during the long dry season ranked high as the cause of the livestock's poor condition. The long dry season was considered a consequence of climate change. The research team saw the use of cat fish meal soup as a potential solution, but this required validation of the farmer's innovation.

The research team identified the necessary material for conducting the experiment, which included three cows purchased from the livestock market, a weight band for determining live

weight, a thermometer, syringes, sprayer pump, restraining rope, anthelmintic (albendazole 10%), Samorin, an acaricide (Alphacypermethrin) and 14 kg of cat fish. Important activities, implementation strategies, responsible stakeholders and milestones were jointly identified. The plan was to keep the experimental animals on a semi-intensive grazing system using standard dry season feeding regimes and then supplementing them with fish meal soup once a week for a thirteen week period. Responsibilities of the farmer innovator groups included determining the bodyweight of the experimental animals weekly and recording the findings in the recordbook provided, as well as providing security to prevent theft.

The extension agent was assigned responsibilities as follows: to monitor the experimental progress closely, to put the recorded data into electronic form ready for analysis, and the preparation of leaflets, booklets and other extension materials (e.g. DVD, radio, TV programs) to disseminate the findings in collaboration with the rest of the team.

The responsibilities of the research scientist were to take various parameters from the experimental animals, in collaboration with other stakeholders, at the start and while the experiment was in progress. The researcher was also responsible for monitoring the progress of the experiment, analysing the data collected, writing up the scientific report and providing feedback to the members of the research group.

### **Experimentation process**

Three cows purchased from the livestock market were grazed together for a week to familiarise them with each other. Their body weight was determined before experimentation using a standard weight band.

**Table 1: Summary of three cows used for the experiment**

<b>Cow Identity</b>	<b>Cow description</b>	<b>Starting weight (kg)</b>
A	Cow with black colour and short horns	133
B	Cow with grey colour	135
C	Cow with black colour and long horns	120

Cow C was selected as the control (i.e. not receiving the fish soup), while cows A and B were selected as the treatment animals. Faecal and blood samples were taken from all animals by the researcher from the Tanzania Livestock Research Institute for laboratory analysis for gastro-intestinal and haemo-parasites respectively. Body temperatures of all animals were taken to confirm the absence of any infectious disease agents. All animals were drenched with 15 ml albendazole 10% as a blanket treatment against nematodes, cestodes and trematodes. They were also injected with Samorin as a prophylactic and treatment against Trypanosomiasis due to the fact that part of Kondo District is infested with tsetse flies. Lastly, they were sprayed with an acaricide (Alphacypermethrin) concentration as a prophylactic and treatment against ticks, mites, fleas and other biting insects. The spraying exercise was repeated weekly. Body condition scoring was carried out by all members of the research team using the Tanzania beef cattle grading system (i.e. I for fat, II for fairly thin, III for thin and for IV emaciated). All animals were graded as Tanzania IV:

emaciated, dehydrated, ribs bones, pin bones and lumbar processes were prominent, hair rough and dull with alopecia in some parts.

The fish meal soup was prepared by boiling 1 kg cat fish in 3 litres of water for half an hour. The cooled soup was provided to the treatment animals as a drench at a rate of 1 litre per cow, repeated every week for three months.

## Results and discussion

Faecal and blood samples were analysed at the Tanzania Veterinary Laboratory Agency (TVLA) laboratory in Dodoma and none of the samples were positive for worm egg counts or haemo-parasites. The body temperatures of the experimental animals were all normal indicating the absence of infectious diseases.

Fishmeal is an animal byproduct with a good source of fatty acids (8.4–9%), crude fibre and protein (42.7% crude protein) and a good proportion of essential amino acids such as lysine and methionine. Some of these constituents are normally not found in plant-derived protein sources such as cottonseed cake, sunflower-seed cake and soya bean. For example, fishmeal is a good source of eicosapentaenoic acid (EPA) and decosahexaenoic acid (DHA), which the fats of plant origin do not possess. Proteins of animal origin are able to escape ruminal microbial digestion and are termed ruminal undegradable protein (RUP), unlike those of plant origin, which are degraded in the rumen by assistance of ruminal microflora. This results in more nutrients being available to the host animal, whereas with proteins of plant origin, some of the nutrients are normally used by the microbes and only a portion is available to the host animal.

**Table 2: Gross chemical composition of fish meal**

By-product	% DM	% Ash	% Crude fat	% Crude fibre	% Crude protein	% NFE	GE Mj/kg DM
Fish meal (Cat fish)	96.7	45.2	9.0	1.0	42.7	2.1	-
Fish meal Saato	92.1	25.7	9.9	-	62.6	-	18.53
Fish meal Prawns	93.3	22.5	5.6	-	55.5	-	-
Fish meal Perege/Tilapia	93.7	25.7	12.5	0.6	59.8	1.4	19.27

Note: DM = dry matter, GE = gross energy and NFE = nitrogen-free extract  
(Source: Chemical composition of selected Tanzanian concentrate feedstuffs<sup>6</sup>)

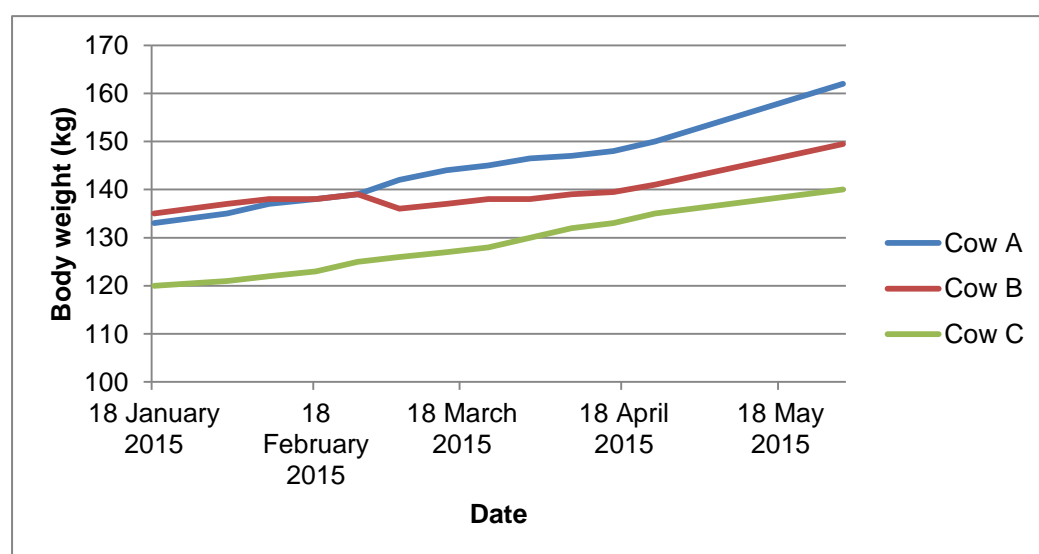
The body condition score (BCS) for cows A and B, which were receiving fish meal soup improved. After the 13 week experiment Cow A was graded as Tanzania I (fat). Cow B was graded as Tanzania II although this is attributed to an illness that Cow B had during the

<sup>6</sup> ISBN91-576-2852-1 Tryck:Sveriges lantbrus universitet, Uppsala 1986

experiment (see Figure 1). Cow C was graded as Tanzania III (thin). Cow A did not show any ribs after the 13 week period compared with cow C, where the ribs and pin bones were still prominent. The condition of the cows is described in Table 3. From this study it was found that the average daily body weight gain (ADG) for cow A was 0.22 kg/day, while for cow C, which did not receive the fish soup, it was only 0.15 kg/day. Cow B achieved only 0.11 kg/day but was sick during the experiment which is likely to be the reason for her having the lowest daily bodyweight gain.

**Table 3: Cows' body weight and condition before and after experiment**

Variable	Cow A	Cow B	Cow C
Bw start (kg)	133	135	120
Bw end (kg)	162	149.4	140
Bw change (kg)	+29	+14.5	+20
Bw gain/day	0.22	0.11	0.15
BCS beginning	Some ribs, pin bones and lumber process could be seen, hair coat rough and dull and with alopecia in some parts	Some ribs, pin bones and lumber process could be seen, hair coat rough and dull and with alopecia in some parts	Some ribs, pin bones and lumber process could be seen, hair coat rough and dull and with alopecia in some parts
BCS end	Ribs, pin bone and lumber processes not visible, smooth hair coat.	Ribs, pin bone and lumber processes not visible, smooth hair coat.	Some ribs, pin bone and lumber process could still be seen
BCS change	From thin to fat	From thin to fat	Little change



**Figure 1: Changes in body weight of the three cows in the experiment.**



From this study we can conclude that the fish soup had contributed to fattening emaciated cattle. The team perceived that the fat globules resulted in an abnormal ruminal environment, which led initially to diarrhoea but then appeared to increase the cattle's appetite. Furthermore, stall feeding reduces the amount of energy used by grazing animals searching for feed and water, which leads to increased efficiency of production.



**Figure 2: Condition of the experimental cattle during week 13 (left) and farmer innovator using the weight band on cow B (right).**



**Figure 3: Mr Ninga taking measurements of cow A (left) and Mr Sambuta instructing on the use of the weight band (right).**

This innovation is a good strategy to mitigate the effect of climate change since farmers can buy emaciated cattle from the primary stock market at low prices, add value by fattening them using fish meal as supplement and eventually sell them at higher prices.

### **Challenges encountered**

Some of the challenges encountered during the PID process were:

- The experimental site was far from the research station therefore restricting frequent visits by researchers.
- The number of research animals was few therefore restricting replication of treatments.
- Financial resources limited further research that could have determined the optimal levels of inclusion of fish meal for maximum fattening as well as the applicability for other cattle breeds as well as other ruminants such as goats and sheep.

### **Evaluation of the innovation**

Environmentally, the innovation is environmental friendly as it is appropriate for the eroded areas of Kondoa since few animals are kept and stall feeding is a part of the mixed crop and livestock farming system.

Socially, the innovation is acceptable since it does not cause conflict with societal norms. In addition, since the animals are housed during the night and grazed partially in the farmer's crop field and sometimes in the communal grassland during the day, there is minimal conflict with neighbours.

Economically, the innovation is good because it adds value to emaciated cattle purchased from the livestock market, which increases the sale price and hence generates income for the family. The venture also pays because it makes use of crop residues and recycles them into meat that can be sold or eaten and manure which increases fertility to the crop field.

Technically, this innovation can be practically up-scaled as it builds on local practices and makes use of local resources.

This innovation is expected to add value to the beef value chain. The innovation can be practiced in combination with other technologies used in the value chain and enhance productivity for improved household income and eventually increased contribution of the livestock sector to the national gross domestic product (GDP).

In terms of the gender aspects, all family members were involved in herding, watering and stall feeding the experimental animals as well as collecting crop residue and other natural grasses. Preparation of fish soup, drenching, weighing, recording and provision of security were all done by family members.

## **LESSON LEARNT FROM PID**

Through the experimentation process, a number of lessons were learnt about conducting PID:

- PID is a good mechanism for research and development processes because it involves farmers in problem identification, planning, experimentation and evaluation of the results.
- Research questions evolve from the farmers in a specific farming system and experimentation is done with their being an integral part of it.
- The farmer participates in the experiment and therefore owns the results.
- Extension agents are involved in planning, experimentation and evaluation and they also own the results.
- Researchers and extension agents are involved as collaborators and not consultants.

Livestock experiments are costly if animals such as cattle have to be purchased and this limited the number of cattle that could be used in the current experiment. In turn this made it difficult to validate the innovation because one of the treatment cattle became sick during the experiment and therefore did not perform well. In order to strengthen such experiments such that the findings can be shared with more trust, there is a need to find ways to be able to include more cattle, for example by involving more farmer innovators who each contribute their own cattle.

## **CONCLUSION**

The innovation improves the resilience of communities, especially their capacity to cope with the effects of climate change. This is because farmers cultivate rainfed crops such as sorghum and maize, but in years of low or erratic rainfall, the crops fail to reach maturity. Innovative farmers buy beef cattle and feed them with crop residues and natural pastures and then sell the animals to buy food from other areas where the rainfall was good. Further research is needed to determine: the optimum level of inclusion of fishmeal for effective fattening, the use of other fish species as supplement and the effectiveness of this innovation for other livestock types.

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## **CASE 8: FARMERS' EXPERIMENTATION WITH DETERMINING THE SEX OF CHICKS BY THE SHAPE OF THE EGG: EXPERIENCE FROM ETHIOPIA**

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The case study is on determining chicken sex before hatching by the shape of the egg. It is an experience of innovator farmers from Tahtai Maichew (TM) District, Tigray Region, Ethiopia.

### **BACKGROUND**

This experimentation is in a continuous process by the TM group of farmers, experts and researchers, who are still trying to reach a point where they are 100% confident. The farmers encountered this innovation when some farmer innovators from Ethiopia took part in the Eastern Africa Farmer Innovation Fair in May 2013 in Nairobi, Kenya. At the event, they met a Kenyan woman innovator who had developed this innovation. The reason we chose this case to be documented is because of the economic importance of the innovation and because it has the potential to be adopted by many people, especially by female farmers.

Through the CLIC–SR project, funds were made available to support the farmers' experimentation. The project also allowed for training of farmers. The training was given by experts from Aksum University, Aksum Agriculture Research Centre, TM Agricultural Extension, the Institute for Sustainable Development (ISD) and Best Practice Association (BPA) and focused on strengthening the joint experimentation process.

### **THE EXPERIMENTATION PROCESS**

The experimentation process started in 2014 and continued until 2016. The objective of the Ethiopian farmers' experimentation was to test the innovation that they had seen in Kenya, namely sex identification of chicks before hatching, just by observing the external shape of the egg. The hypothesis was that, if the egg had a pointed end, it would produce a female chick, while the broad-ended shape would produce males. The two egg shapes are presented in Figure 1.

During the planning process, the farmer innovators identified a number of criteria and procedures for the joint experimentation, which are summarised below:

- When selecting eggs for the experiment, the shape must be very clear - either sharp-ended or broad-ended.
- Regarding choice of season for conducting the joint experiment, the farmers said that weather that is too hot or too wet is not comfortable for the hens to brood for the required time (21 days) so the timing had to accommodate this.
- The decision was to use hens that are the local breed.
- In terms of the experimental procedure, it was decided that, since it is not easy once the chicks hatch to identify which chick is from which egg, each farmer innovator eggs was



to receive a clutch of eggs that were the same shape. Thus, some farmers received broad-ended while other received sharp-ended eggs for brooding.

- Volunteer farmers were selected for the experimentation such that five experiments were conducted by 5 farmers during 2014 (3 women and 2 men). In 2015, 10 additional farmers participated in the experiments (7 women and 3 men).



**Figure 1: Sharp-ended eggs are believed to give female chicks (left) while broad-ended eggs give male chicks (right) Photos: Abadi Redehey (farmer) and Hailu Araya.**

## RESULTS

The results from the experiments carried out over the two years are presented below.

### Prediction of chick sex from egg shape

In the years 2014 and 2015, 10 and 15 batches of eggs were hatched respectively as part of the experimentation. The farmers identified the sex of the chicks within 3 - 4 weeks of hatching. The success with using the shape of the eggs to predict the sex of the chicks is summarised in Table 1. It appears that overall the rate of prediction increased from 2014 to 2015. Furthermore, it seems that the broad-ended eggs provided a higher level of success than the sharp-ended eggs.

**Table 1: Success rate of using egg shape as a prediction of chick sex**

Egg shape	Success rate in 2014	Success rate in 2015
Sharp-ended eggs producing female chicks	92% (7 broods)	95% (10 broods)
Broad-ended eggs producing male chicks	100% (3 broods)	97% (5 broods)

## Hatchability

The farmers also investigated the hatchability of their eggs, the results of which are summarised in Table 2.

**Table 2: Hatchability of eggs for the two years of experiments**

Egg shape	Success rate in 2014	Success rate in 2015
Sharp-ended eggs producing female chicks	84% (7 broods)	87% (10 broods)
Broad-ended eggs producing male chicks	65% (3 broods) Note: 3 eggs broke	86% (5 broods)

The average hatching rate for all eggs was 83%. Furthermore, it was found that, when hens are given a large number of eggs (above 10), a lower percentage of eggs hatched and vice versa. This indicates that the number of eggs that a hen broods also affects their hatchability. More detailed information about predicting sex as well as hatchability is provided in Tables 3 and 4.

**Table 3: Results of experimentation conducted in 2014**

	Name of farmer	Egg shape	No. of eggs	No. Hatched	No. Female	No. Male	Dates
1	Brha Tadesse	Sharp	13	11	10	1	April 2014
2	Brha Tadesse	Sharp	14	12	11	1	Jun 2014
3	Abadi Redehey (M)	Sharp	10	9	8	1	Feb 2014
4	Abadi Redehey (M)	Sharp	10	9	8	1	May 2014
5	Brha Tadesse (F)	Sharp	10	7	7	0	Sept 2014
6	Abadi Redehey (M)	Sharp	6	5	5	0	Dec 2014
7	Gebreyesus Tesfay (M)	Sharp	10	8	7	1	Oct 2014
	<b>Total</b>		<b>73</b>	<b>61: 83.6%</b>	<b>56: 92%</b>	<b>5: 8%</b>	
8	Abadi Redehey	Broad	9	6*	0	4**	June 2014
9	Mebrat Abay (F)	Broad	9	6	0	6	June 2014
10	Brey Tetemke (F)	Broad	8	5	0	5	Dec 2014
	<b>Total</b>		<b>26</b>	<b>17: 65%</b>	<b>0</b>	<b>15: 100%</b>	

\* This was not because of a hatching problem but three of the eggs were broken before hatching.

\*\*Two dead before their gender was determined.

**Table 4: Results of experimentation on hatching level and sex identification in 2015**

	Name of farmer	Egg shape	No. of eggs	No. Hatched	No. Female	No. Male	Dates
1	Abadi Redehey (M) ***	Sharp	9	8	8	0	Jan 2015
2	Zafu Amare (F)	Sharp	10	8	8	0	ND
3	Birha Tadesse (F)	Sharp	10	8	7	1	June 2015
4	Birha Tadesse (F)	Sharp	6	5	5	0	June 2015
5	Hiwet Tsegay (F)	Sharp	11	10	9	1	April 2015
6	Brikti G/Selassie (F)	Sharp	5	5	5	0	April 2015
7	Fiseha Sibhatu (M)	Sharp	5	4	4	0	June 2015
8	Asefu (F)	Sharp	8	6	5	1	April 2015
9	Asefu (F)	Sharp	10	10	10	0	April 2015
10	Wahid Berhe (F)	Sharp	12	11	10	1	Oct 2015
	<b>Total</b>		<b>86</b>	<b>75: 87%</b>	<b>71: 95%</b>	<b>4: 5%</b>	
11	Gidey Hagos (M) ***	Broad	9	6	0	6	April 2015
12	Birey Tetemke (F)	Broad	10	9	0	9	April 2015
13	Gebreyohannes Tewolde (M)***	Broad	5	4	0	4	April 2015
14	Zafu Amare (F)	Broad	6	5	0	5	April 2015
15	Mebrat Abay (F)	Broad	12	12	1	11	September 2015
	<b>Total</b>		<b>42</b>	<b>36: 86%</b>	<b>1: 3%</b>	<b>35: 97%</b>	

The research group of farmers, who represent the local level in TM, did its best in conducting the experimentation and sharing the results within the locality. The farmers also share their experiences every month at the district level and discuss the results and the challenges they have encountered. With support from the governmental agricultural extension staff, they maintain records in their files. The agricultural extension people are also responsible for reporting to other stakeholders, who include the district and the regional agriculture offices.

## **EVALUATION OF THE INNOVATION**

This innovation is environmentally friendly because chickens are a good source of manure that is useful for improving soil fertility and crop production when used in compost and/or farmyard manure. Keeping chickens is a very important source of income through selling both eggs and chickens. It is also very important for enhancing family diet and nutrition.

Brha, one of the farmers who started this experimentation, said “God has created everything [it is] left for us to try and identify the secret of nature. From this experience, we can see everything around us to see and test it in our own way why He created everything differently. It could be that the shape of an egg was with an aim and we tried and identified it.” Another farmer (Haleka Gidey Hagos) said “we started to know part of the natural secret and we can plan and implement 100 percent.”

The innovation has already spread to some other farmers. However, all participants proposed verification by formal research (research centre and university) for more precision and to enable them to convince other researchers and policymakers or senior officials about the validity of the practice. While there are some farmers who have changed their chicken-keeping practices, most are still using the old style. Sensitisation is necessary in order to ensure wider dissemination of the results of the innovation. Local experts from Health, Agriculture and Micro- and Small Enterprises regard this innovation as a source of information for their extension work. If farmers are able to produce enough chickens from the preferred breed and to use the shape of egg to plan their production, they can start small businesses. Even though the innovation has not yet spread widely within Ethiopia, many people in the District, Zone and the Region have heard about it and are trying it out. Many people were excited about the results of the research because identifying sex by the shape of an egg is a new concept for them. Farmers decided that they wanted to use the results of this research in order to be able to plan. For example, if they want to get egg-laying chickens (female), they plan to use the narrow/sharp-ended eggs, while if they wanted to sell cocks, as they are in high demand and bring high prices during festivities (New Year, Easter, Christmas, etc.), they use the broad-ended eggs. Farmers are always eager to have more cocks than layers available during periods of festivity.

The main challenges encountered were (1) the lack of market links with consumers and getting the right type of breed that the market wanted, (2) the extreme weather (hot and cold) that was not good for hatching, (3) women being very busy, especially during the main rainy season, and (4) convincing decision-makers to include the results of the farmers' experimentation into the government's extension package at regional and national level.

## **CONCLUSION AND LESSONS LEARNT**

From the many experiments conducted by farmers thus far, it is now possible to determine what sex of chicks one will produce if one selects either sharp- or broad-ended eggs for brooding. Over time, the rate of success in determining which eggs will produce male chicks has improved to 100%, but the farmers have not yet reached this level of precision with eggs that are expected to produce female chicks.



It was interesting to note that women mostly plan to get female chicks while men prefer to select eggs that will produce cocks (males). This suggests that the women have an extended vision or plan to grow or maintain their flocks while the men generally seek short-term income. Women have also requested their farmer group representative to assist with obtaining eggs of the correct shape and of the preferred breed.

It also emerged from the experimentation process that farmers adopt an innovation readily if it is economically important or has potential to improve their food security. Moreover, the level of adoption is likely to be higher when the source of the innovation is their peers (i.e. other farmers), as they have more trust in such cases. Another lesson learnt was that farmers do not wait until somebody tells them to try something – if it meets a pressing need or they trust it, they will try it out.

In terms of the way forward, the different stakeholders have agreed to conduct verification of the innovation at a university and research centre. Aksum University and Axum Agriculture Research Centre intend to install their own incubators, which will allow them to verify sex-prediction by egg shape, but there are some delays with procurement.

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