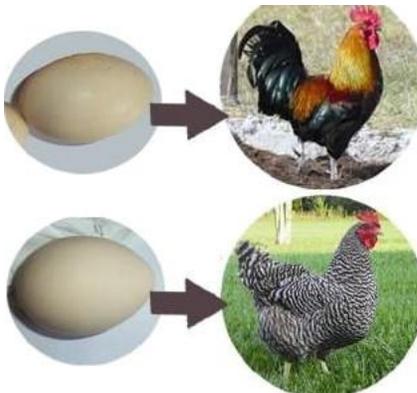


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**BEST PRACTICES BY  
SMALLHOLDER FARMERS IN  
ETHIOPIA**

**BOOK TWO**

DEVELOPED BY

HAILU ARAYA TEDLA AND YOHANNES GEBREMICHAEL

**BEST PRACTICE ASSOCIATION  
&  
INSTITUTE FOR SUSTAINABLE DEVELOPMENT  
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These are, first and foremost, the farmers, their households and local communities for participating in different projects and using this opportunity to undertake and share their good practices with the support of their extension workers and local administrations.

Second are the donor organizations that have provided the funding for the members of BPA, PE and ISD to work with the farmers and their local authorities.

Third are the Church of Sweden and especially Mr Anders Ölund for his interest and understanding of the importance of the documentation and dissemination work of BPA and connecting BPA with The Church of Sweden.

Last but not least we acknowledge the host communities especially EECMY-DASSC areas of Hossana and Arbam Minch Synods during our field visiting.

Hailu Araya  
BPA, PE and ISD  
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## FOREWORD

This publication is the second edition on the “stories of change at the grass-root” brought about through the contribution of different actors, mostly farmers. These stories are about unique grass-roots experiences, which could be construed as “best practices”. These beyond any reasonable doubt demonstrate the innovative capacity of Ethiopian farmers and should be widely shared to inspire other men, women and youth farmers. Research and Development (R & D) organizations can also make use of the information in formulating agricultural development strategies and policies required to ensure sustainable development.

Proponents of environmentally and socially sustainable agricultural development recognize the indispensable role and contribution of the smallholder farmers and their time-tested and extremely rich indigenous farm practices. As supporter and promoter of sustainable agricultural development, the Best Practice Association is of firm belief that if properly synthesized, packaged and disseminated such knowledge could go a long way to spur the country’s economic development even in this modern and globalized world. Among the wide array of existing best practices that can be cited, this publication has covered some of the integrated farming farmers are implementing to escape out of poverty and their daring move towards investment, the awe inspiring sustainable land management practices of the Konso people, the efforts farmers make to engage in research in their own way individually and/or in collaboration with scientists e.g. chick sex identification, biogas and bio-fertilizers.

The new and complex challenges presented by climate change require wide-scale dissemination of technologies and mitigation/coping methods that work best for the farming community, which suffers the brunt of the negative impacts of this phenomenon. Such measures need to be brought to the attention of agricultural specialists, researchers, academicians, policymakers and

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other stakeholders in and outside the country to help them develop a very good understanding of issues involved and be in a better position to support promotion of effective interventions including farmers' innovations. Hence, this publication can be considered timely and fitting as it highlights the second batch of locally available and successful practices in the smallholder farming system with the aim of sharing more broadly with the wider public and motivate stakeholders to support the noble cause of bringing to light indigenous knowledge and innovation. The compilation, synthesis and printing of this publication was made possible with the generous support of the Church of Sweden.

Fassil Reda

ATA, Maize and Sorghum Value Chain Director

Addis Ababa, Ethiopia

January 2015

Some Examples of Best Practices by Smallholder Farmers in Ethiopia

**ABBREVIATIONS**

BPA	Best Practice Association
DA	Development Agent
DASSC	Development and Social Services Commission
EECMY	Ethiopian Evangelical Church of Mekane Yesus
ELAR	Ethiopian Institute of Agriculture Research
FTC	Farmer Training Center
GHG	Greenhouse Gas
GFAR	Global Forum on Agricultural Research
GTP	Growth and Transformation Plan
ISD	Institute for Sustainable Development
ISWC	Indigenous Soil and Water Conservation
NBPE	National Biogas Program Ethiopia
PE	Prolinnova-Ethiopia
PID	Participatory Innovation Development
Prolinnova	Promoting Local Innovation
SCI/SRI	System of Crop/Rice Intensification
SNNP	Southern Nations, Nationalities and Peoples
SSNC	Swedish Society for Nature Conservation
TPLF	Tigray Peoples' Liberation Front

## SOME EXAMPLES OF BEST PRACTICES BY SMALLHOLDER FARMERS IN ETHIOPIA

### I. INTRODUCTION

#### I.1 THE AIM OF THIS BOOK

This book collects together some of the many stories of best practices by smallholder farmers. These have emerged from within and alongside projects focused on solving problems in relation to natural resources management, crop production and food security. Many of these also address the challenges from climate change faced by these farmers. The aims of producing this book are: one, it document and share innovative local practices, participatory experimentation with different actor (farmers, GOs, NGOs, etc) and appropriate technologies with an overall impact on food security and sustainable development of the country; two, it is a platform or networking of different resource persons with a spirit of working together. three, it is an added value of the previous publication to bring these best practices to development partners, local experts, researchers and other professionals so that they can understand and incorporate them into their local sustainable development and research programs. The importance and uptake of these different practices and innovations depends on the particular advantages gained and the problems they solve.

These farmer-developed innovations are localized solutions that are part of wider interventions being promoted by locally-based organizations through projects and programs such as the Institute for Sustainable Development (ISD), Pesticide Action Nexus Ethiopia (PAN-E), PROLINNOVA–Ethiopia (PE), families of the Poverty Action Network of Ethiopia (PANE), the Best Practice Association (BPA) and projects supported by the Church of Sweden.

BPA was born in November 2011 from a deep desire to assess, document, promote and scale up/out some of the best practices that have been developed by farmers. The aim includes creating awareness among agricultural specialists, researchers, academicians, policymakers and other stakeholders in the country about the effectiveness of the local practices and innovations for improving livelihoods of farmers.

This publication is made up of the following sections. Chapter I gives the general background; Chapter 2 describes about Konso: the land of heroes. This describes the social and environmental processes to indicate that why “Konso” became as one of the World Heritage site by UNESCO; Chapter 3 is entitled as “Farmers diversified the co-benefits of desmodium beyond controlling striga and stem-borer. It focuses on innovative behavior of farmers; Chapter 4 describes about “enset” as the mother of millions in the face of climate change; Chapter 5 highlights on innovative women as an example of integrated farming to transform from poverty to investment; and Chapter 6 focuses on the practices of farmers in sex identification of chicks by egg shape. The last section is included as an annex – which is a result of farmers’ practice at the same time it is a manual on how to prepare and use biofertilizer from green plants and vegetables.

## I.2 THE KONYIRONWKNTAL AND POLITICAL CHALLENGES FOR FARMERS

Land degradation, climate change, droughts end up in famine, and war are part of the Ethiopian history mostly in the northern and north eastern part.

However, today Ethiopian farmers are supported by the agricultural and health extension. There are a lot of improvements in the life style of rural people through improving agricultural production and productivity including the developments of irrigation. The high attention given by the Ethiopian government for integrated

Some Examples of Best Practices by Smallholder Farmers in Ethiopia

environmental conservation, the Climate Resilience Green Economy (CRGE) and Climate SMART Agriculture policy of the government reaching the grass root can be a lesson for other countries.

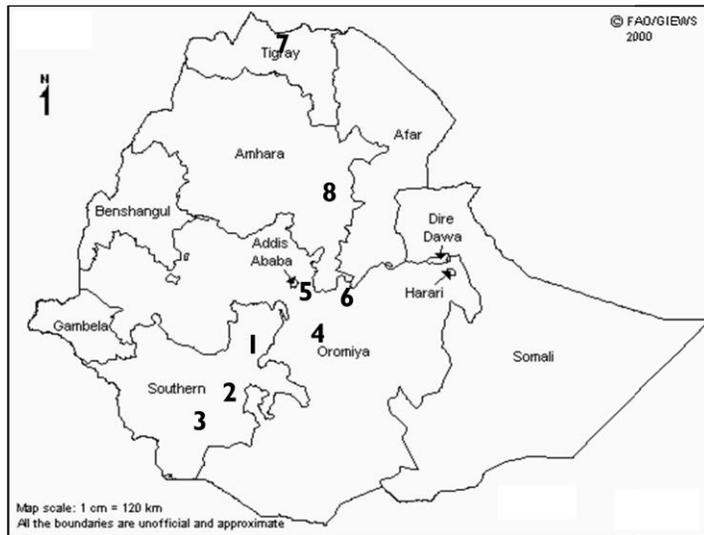
Today the critical issue in the fast growing country is market challenges, where many farmers and local authorities are planning to connect farmers and their farm products into sustainable markets.

Some exemplary works of farmers are mentioned in this document to show how they overcome their market. It is mainly by diversifying their farm products throughout the year.

### I.3 HOW THE BEST PRACTICES WORK SKETCHED

The best practices described in this booklet were chosen after the second study visit to Southwestern part of the country was organized through the support of the Church of Sweden. This study trip was to Hossana, Sodo, Durame, Konso, Chench, Hawassa, Wondo Genet, Arsi and Mojo.

The aim of the study-trip was participants discuss and learn from the local experience of sustainable agriculture in southern Ethiopia, especially in the field of soil fertility, small scale irrigation, soil and water conservation, crop diversification, biogas and bio slurry, agro-forestry and bee keeping. Participants exchanged experience within the study group as well as with the local farmers and they will integrate new sustainable practices in their farms and in their projects. Also they will communication among themselves in the future.



*Figure 1: Ethiopia, the locations visited and/or where the examples of best practices described in this publication are found (1– Butajira-Hossana; 2– Arbaminch; 3– Konso-Segen River; 4– Hawassa-Wondogenet; 5– Ada’a-Modjo; 6– Arsi-Sodore; 7– Axum area; 8– Dessie area)*

## 2. KONSO: THE LAND OF HEROES

By

Hailu Araya and Gelgelo Sado

### 2.1 Background

The name Konso belongs to the people and the land where they live. Konso is located in the Southern Nations, Nationalities and People's Region (SNNPR), in southwestern Ethiopia. It is located south of Lake Chamo at about 85 km south of Arbaminch Town. It covers very rugged terrain with little available flat land. The altitude of Konso varies from 500 masl in the lowlands to 2,000 masl in the highlands. According to the 2007 Population and housing census of Ethiopia the population of the Special Wereda is estimated at about 235,000 (CSA, 2008) with a total land area of 2,430 square kilometers (Bureau of Agriculture, 2000) and a population density of over 90 persons per square kilometre.

Rainfall in Konso has a bi-modal pattern. It is higher during the Belg season (March to June) than in Kermt. The latter occurs from September to November. Moisture is perhaps the most limiting factor of production in Konso. The average rainfall is about 551 mm. The lack of moisture is a principal cause of poor production and crop failure (Tefaye Beshah, 2003). Apart from total rainfall, the erratic nature and skewed distribution of the rainfall caused crop failures for three consecutive years.

As stated by Tefaye (2003) there are six major soil groups in the Konso Wereda. These are Eutric Regosols, Lithosols, Chromic Vertisols, Eutric Nitosols, Chromic Luvisols and Eutric Fluvisols. Farmers have also identified the following soil characteristics based on their functions: 1. Bolbolra: brown soil from alluvial deposits with good depth. 2. Borbora: black vertic nature that sticks between the fingers when wet and cracks when dry. It is difficult for farming tools to penetrate though the depth is adequate. 3. Kelkelira: reddish, slightly sticky, resembling Borbora, but cracks

less. It has a good depth. 4. Arera: grayish (ashy) with fine texture. 5. Tahira: a mixture of sand, rough texture. 6. Amara: soil with a mixture of stone. 7. Wokosha: white in colour and very shallow soil due to erosion. However, Konso is one of the areas in the SNNPR classified as highly degraded.

## 2.2 Economic activities

Farming is the main source of livelihood for the majority of the Konso people. Additional sources of income are obtained from weaving, bee-keeping, trading, sale of forage and forest seeds, local brewing and meat retailing. In the past, weaving was restricted to craftsmen.

Average land size is 0.9 ha, for those who own one plot and 1.5 ha for those who own more than one plot. Average cereal production is 0.5 and 0.3 t ha<sup>-1</sup> for Belg (main rainy season) and Mehir (short rainy season) seasons, respectively. Household variability in terms of socio-economic status goes back to the history of land acquisition, a system of inheritance that favours the elder son. Growing food insecurity is partly rooted in the changes in the balancing mechanisms of natural resource utilization. These changes are: increased population size, declining use of manure, expansion of bush farms without manure and conservation structures, shortage of labour, and short or no fallowing. Change of weather during the last few years has also contributed to the crop failures in Konso.

The Konso people are known for their mixed farming practice in the highly degraded landscape. They are frequently suffered by drought. However, they live with the drought by different means mainly conserving the natural resources through dry stone terraces and water conserving structures. Konso farmers grow many types of crops, where crop diversity within small terraced fields is a remarkable feature of the complex cropping system. The most common crops are cereals of which sorghum is the most important, followed by maize. No less than 20 varieties of sorghum are grown in the area.

#### Some Examples of Best Practices by Smallholder Farmers in Ethiopia

Trees and livestock are an integral part of Konso agriculture for their ritualistic, economic, social and ecological services. Multiple uses of trees have led to different patterns of tree production and management. These are: natural vegetation, ritual forests, homestead forests, agroforestry and plantation forests.

There are a few natural trees used for ritual services that are associated with the regional Poqallas. Konso villages have a remarkable tree cover. The dominant trees grown are *Morinaga stenopetala* and coffee trees. Their presence is not surprising because of the importance of these trees in the daily diet of the community. The survival of Konso's agriculture is due to its integrated nature, which might not be the case if only stone terraces were used. This integration is partly realized with extensive use of agroforestry practices. The vertical and horizontal spaces are occupied by plant species that meet family dietary needs and that are used for cash crops, beekeeping, animal feed, shade for other crops and people, erosion barriers, soil fertility and as a farm boundary.

Tree plantations began following the arrival of the Ethiopian Evangelical Church Makane Yesus (EECMY) in 1954 as community development and rehabilitation programmes. EECMY has introduced exotic tree species such as *Eucalyptus* spp, *Gravillea robusta*, *Accia cyanophylla*. They are commonly seen around settlement areas and roadsides. However, their coverage hardly matches the efforts that have been put into their promotion in Konso. Common trees species in Konso are: *Juniperus procera*, *Euphorbia* spp *Terminalia browenii*, *Olea africana*, *Ficus sori*, *Cordia africana*, *Sterculia africana*, *Accia abysinica*. Among these, *Juniperus procera* has a high significance in Konso's rituals (Olahita) and for its wooden statues (Waga). Olahita is an important part of the 'generation grading' system while the Waga represents an individual's achievement, for instance hunting successes, wealth, and the like (Tesfaye, 2003).

### 2.3 Challenges of agriculture in Konso

Agriculture in Konso has supported its people for several centuries. Its carrying capacity was maintained mainly due to relevant land-management practices and was partly assisted by slow growth of the population, both of which are the results of their institutions. Long ago, agricultural lands were put under long fallow periods. Vegetation cover was then much denser than today. As a result, soil fertility was high. Due to the availability of animal feed from various sources, competition for crop residue was minimal. Crop failure occurred, due to shifts of rainfall patterns and not because of poor land management, from 1998 to 2000, consecutively, whereby many lives were saved by food aid.

In Konso, soil and water conservation structures of most farms are still in place, but the effect of climate change and population increase is very high. When crops fail, people sell their animals to buy food for the family. They cut the trees down that would have had very little chance to rejuvenate. As a last resort, able family members migrate in search of job to support the family. Women and children embark on cutting firewood from the bush lands for sale.

In recent years, the maintenance of terraces has become a difficult task because of the shortage of food to organize a labor party. When productivity in the terraced fields declines, farmers expand the bush farms which are often cultivated only once a year and without a stone terrace. The common conservation practices in such fields are thrash lines. However, the stalks lined for these purposes are eaten by animals grazing in the bush forest, as these areas are normally not used for crop production.

### 2.4 Practices of the land of heroes

The complex but environmentally adjusted and adaptable land management practices of the Konso people are the following. But we have to know that the complexity of the farming system and the

Some Examples of Best Practices by Smallholder Farmers in Ethiopia

land management practices, people's knowledge and skills that were developed over time.

2.4.1 Integrated soil and water conservation

Soil and water conservation in Konso is marked by the combination of physical and biological conservation measures. These include: stone terraces, tied-ridges, thrash lines, agroforestry, intercropping, fallowing, manuring, Kraal shifting, burning of debris and minimum tillage.

The use of stone in both fields and residential areas is their tradition. The skill of the stone building a special design of Konso houses that have two major compartments in individual compounds i.e. the upper layer (uita) where residential huts and the kitchen are built, and the lower layer (arketa) where livestock are kept.



Figure 2: Landscape of Konso around Karat town

The stone terracing in Konso begins from the lower part of the field and moves upward along the slope. During construction, people dig a basement of 30-50 cm, with a width of about 25 cm. The height of the terrace depends on the slope of the area. For example, when an

area is gentle sloping the height of the terraces decrease and the width between terraces and increase. There are several terraces of over two meters while the terrace width in between mostly ranges from 2.5 to 6 meters. The stone wall is built against the newly cut wall face. The soil from the upper part is moved down behind the stone wall and is carefully piled. Spaces created due to irregular stone faces are filled by soil. In this manner they attain a bench terrace immediately. The height of the terrace is often maintained above the ground. This structure, among other components, ensures infiltration of raindrops that fall on each plot.

Everyone in the hoe-farming system acquires the skill of terrace construction. Maintenance of terraces is part of routine farming practice. They construct the lines on a contour without any measuring or guiding instruments, depending on their visual judgment of the ground's features. When the ground is steeper, they maintain terraces with a short width. Sometimes, they use a subsidiary terrace (Paqayta) to support the big one. Paqayta is built on land with irregular patterns. This is done to maintain a continuous line of the main terrace on one hand, and to prevent loss of soil and water due to difference on the slope.

After finishing the terrace, they add organic matter to compensate the covered topsoil. This is achieved by mixing the topsoil (Kefeffa) with the big Payra. The fact that the piece of land immediately under a terrace loses more soil in the process is well understood. That piece of land is given special attention during subsequent cultivation. In addition, the farmers have noted that backward movement of water within the terrace brings more soil and organic matter from the thrash lines on the edge of the terrace to the back of the terrace where most of the topsoil had been lost during construction. Women play a great role in transporting manure from the villages to the farms. During the construction process, they assist in collecting and heaping the stones.

The stone terraces in Konso have been practiced for many years. It is clear that soil and water conservation efforts in Konso are very

#### Some Examples of Best Practices by Smallholder Farmers in Ethiopia

labour intensive. The high demand of labour for construction and maintenance of soil and water conservation structures have proven to be one of the major limitations elsewhere.

However, the Konso people have their labour organizations to meet their labour-intensive agriculture. Their understanding of soil erosion stimulated them to develop a coping mechanism. As a result, they established their 'niche' in a rather ragged and difficult terrain.

Farmers in Konso have an amazing appreciation for stone terraces. The most important advantages of stone terracing are: protection of soil, water-retention in the field, serving as shade for coffee trees at a young stage, serving as a support to climbing crops such as lablab, making hill farming possible, increasing soil fertility; and increasing production.

Tied-ridges are one of the components of soil and water conservation in the agricultural system. It is an age-old practice in the system that also originated in the valleys. Tied-ridges are constructed in order to reduce the run-off from the upper terraces and to retain moisture.

#### 2.4.2 Square terrace farming

As subsequent knowledge of the integrated soil and water conservation system the thrash lines, it combines square terraces with mulch, are used as a mulch and source of organic matter. It is mainly observed after crossing Shelemela a place called Holte Kebele. This place is hilly and moisture deficit. Almost all grass species were dried but there was teff, maize and sorghum stand with good performance. They were supported by physical structures – all fields were divided into squares supported by mulch of maize and sorghum stalk.

The materials used for thrash lines are sorghum stalks that are uprooted during the dry season and maize stalk left in the farm. Cereal stalks easily decompose under the hot climate and the effect of termites in some fields.



Figure 3 - Hillside squared terraces supported by mulching



Figure 4 - teff field in mulch and squared terrace



Figure 5 - sorghum field in mulch and squared terrace

The very idea of using thrash lines for moisture conservation and water-harvesting structures for use of flood water in the valleys was an important turning point for soil and water conservation efforts. For example, by the time we visited it was observed that there was no rainfall but when we dug the soil under the crop stand and the mulch and square terrace the soil has moisture in it.

Over time, the effect of barriers on soil movement was learned after observing layers of soil accumulating behind a fallen tree. Stone lines replaced tree branches and logs. Terraces have been constructed from the floor of the valley to the top of the hill. They were built generation after generation.

#### 2.4.3 Konso terrace

The other amazing visiting was held in Konso area around Karat town. Terracing practices for soil and water conservation purposes of the Konso people is a normal practice and their tradition is estimated up to 500 - 800 years. Their efforts are registered as one of the world heritage sites by UNESCO. It is because Konso people have been suffering from water scarcity and as a result the people adapt the harsh environment through soil and water conservation activities for very long period of time. The people were also

working the similar activities during the visiting days. There is no sign of erosion or flooding that comes from this area.

#### 2.4.4 Cropping pattern and agroforestry

Agroforestry is a typical feature of the hoe-farming system in Konso. This practice is less conspicuous in the ox-plough farming system. Most fields in the hoe-farming system are characterised by a multiple cropping system. Cereals are often intercropped with pulses, among others, for risk aversion, soil fertility and land saving. Pulses grown in the area are: haricot beans, pigeon peas, lablab, peas, chickpeas and cowpeas.

The dominant high tree species is *Morinaga stenopetal*. This is because of the importance of its leaf in the people's daily food. The next important tree is *Terminalia browenii*. It is grown for forage, farm tools and building materials. Other tree species that are grown in association with crops are *Olea africana*, *Ficus sori*, *Cordia africana*, *Strerculia africana*.

The next storey is filled by crops such as coffee, chat (*Catha edulis*), yam, cassava, pigeon pea and cotton. Coffee, chat and cassava are planted under the terraces, whereas yam is planted both below and above the terrace depending on the soil depth. When it is planted above the terrace, farmers maintain an adequate distance from the terrace to avoid damage of the terrace during harvesting. Those farmers who have shallow soil depth do not plant yam at all, as it requires deep soil for its conspicuous rooting system. Pigeon pea is planted near the edge of the terrace, except when it is sown as a ley crop whereby the land is left to fallow in the subsequent season(s). It is confined to the border in order to minimize the shade effect as it stays in the field for 2-3 years. It is worthwhile to note that not all farmers understand the beneficial effect of pigeon peas on soil fertility. Some farmers generally maintain low crop diversity due to a decline in depth and soil fertility.

Owing to their drive to self-sufficiency, the Konso people grow fibre crops such as cotton. The use of cotton became popular after their clothing style. The exchange of cotton with the neighbouring

Some Examples of Best Practices by Smallholder Farmers in Ethiopia

tribes was also important. Mostly cotton is thinly broadcasted in many fields. Sorghum, millet and maize are the base crops for intercropping.

Pulses and oil crops such as fenugreek and sesame cover the lowest ground. All in all, one can count 10-15 crops in a field in addition to a high tree. Note that farmers often try to maintain the intensity of intercropping with the level of soil fertility in each plot. The general pattern of crop association is a mixture of cereals with pulses. A cereal-cereal pulse arrangement may take place depending on the level of fertility of the land. In most cases, 50-75% of the space is allocated to sorghum.

Farmers practice intercropping in order to ensure the availability of food from different crops and to obtain feed by thinning on continuous supply. Some crops are drought tolerant (sorghum, cotton, pigeon pea), while others (e.g., haricot bean) are early-maturing. The harvesting sequence is haricot bean followed by millet, maize and sorghum. Pigeon pea and cotton last longer in the field. This arrangement helps them to minimize risks from moisture stress. In addition, pigeon pea and cotton provide a soil cover, particularly in the ley system wherein pigeon pea gives adequate coverage.. On the other hand, they stated that haricot bean cannot withstand direct sunlight. They use haricot bean to give shade to sorghum and maize and thereby conserves moisture under its shade. In addition, they have underlined the use of haricot bean leaf to improve soil fertility when it decomposes.

Intercropping also helps farmers make better use of their limited land and scarcity of labour. Farmers who have a small farm can grow the major crops they need for their home consumption, though this hardly ensures family food security. Cultivation and weeding practice also benefits different crops in the same field. But unlike sole cropping, weeding in intercropping system requires careful operation, to avoid damaging the roots of crops with different rooting arrangements.

The warm climate of the area also favours production of other fruit trees that they grow lemon, orange and guava trees. In addition, they also grow banana and papaya. Crop diversity, in a seemingly hostile environment also favours the growth of coffee. The ritual practices and traditions in the society also call for the growing of chat and tobacco.

#### 2.4.5 Fertilizing the soil

The major sources of organic matter in Konso are manure, household refuse and thrash lines. Pulses and tree leaves and branches of harvested trees also provide organic matter.

Manure is obtained from animals raised at home and from the community garbage square, located outside the village fence, adjacent to the traditional Dina. Unlike in northern and central Ethiopia, animal dung is not used as fuel. It is normal to see a Konso woman crossing the hills every morning with some organic matter on her back wrapped with skin, a gourd of caqa and her payra or sibilota depending on the season. Konso women contribute a lot to the agriculture of the area, while also fulfilling the home management and reproductive responsibilities.

Farmers, who own cattle and labour, practice kraal shifting. It is practiced for distant farms where the application of manure by human labour is difficult, in spite of the availability of manure. Unfortunately, it is not suitable this kind of practice for families who do not have labour to protect the animals from wildlife and theft.

Minimum tillage is highly practiced in Konso. The major tillage practices carried out every second or third year. The range depends on the fertility status and labour availability, and other management practices such as manuring and fallowing. Due to the shortage of labour, women-headed households often opt for manure application instead of tillage. Tillage is carried out by the larger payra to turn the subsurface soil to the top for aeration and exposure to sunlight. During the minimum tillage years, they simply uproot the sorghum stalks in the dry period and then cultivate (without tilling) the land during the rainy period for sowing.

Nowadays, a few farmers have begun using commercial fertilizers in areas with better moisture availability and access to irrigation from rivers.

#### 2.4.6 Controlled Livestock husbandry

Livestock production has been part and parcel of Konso's mixed agriculture. The types of livestock commonly raised are cattle, goat, sheep, donkeys and poultry. Generally, the system lacks draught animals for transportation. Livestock are highly appreciated for their economic and ritual purposes. Unlike other parts of the country, the majority of Konso people raise live-stock for manure and savings while traction is important in only some parts of Konso. There is a system of animal sharing whereby poor families can obtain access to livestock, which also means access to manure. Cattle ownership ranged from none, to four oxen, cows and sheep, whereas the ownership of goats reached up to eight heads of animals per household.

As free range grazing is the obstacle for conservation practices in most parts of Ethiopia, the Konso people have developed a livestock husbandry system that is compatible with their soil and water conservation practices. People in Konso strictly keep their animals away from the crop fields in order to protect their integrated soil and water conservation system. They achieve this by tethering methods and Fora, a 'camping grazing' system wherein the herd is taken away for a period of time to distant areas. Fora help to minimize pressure on nearby grazing areas and forage plants on the farm. Without these arrangements, age-old terraces, thrash lines, and agroforestry practices could not have taken root. Controlled livestock husbandry is a practice that has developed with state rules and regulations. Then unlike other parts of Ethiopia cattle are not observed grazing outside homesteads.

#### 2.4.7 Irrigation system based on flood harvesting

There are a few seasonal and perennial rivers in Konso. These are: Segen, Woito, Gato, Delbena, Gaba maga, Yanda fero and Regede. Delbena and Gaba maga are relatively accessible rivers. Other rivers

are located in the valley. Because of this, river irrigation has not been developed in Konso in spite of the people's hard-working nature. The Konso people have been adapting the water scarcity and harsh environment through soil and water conservation activities in the highlands but in the lowlands people suffered by the flooding of the Segen River. The Konso people live in the highland but their territory includes this lowland area, which lie in the Great Rift Valley part of the country. As the highland is very dense they also use this for farming and stocking their animals. However, they have developed amazing flood-harvesting structures in the seasonal riverbanks. Some case stories are as follows:

- The irrigation structure built at Teshmele (1,240 masl) is an engineering miracle, for barehanded workers. Massive flat stones are lined to divert the direction of the flood from its river flow. Networks of canals were then constructed. Passage bridges were constructed from local stones to distribute water from its main course to different fields. Excess water is finally guided to join its natural way. The fields at Teshmele have deep soils as a result of years of silt accumulation. The height of the structure ranges from 1-2.5 m in the fields and 3-4.5 m in the riverbanks. Flood harvesting in Konso is a round-the-clock task. A drop of rain has great meaning in that moisture-stressed land. Whenever there is rainfall, every able member of the family runs to his field any time of a day or night. At night they light their torches kept aside for this purpose and reach their farm. Everyone opens his canals by monitoring the field capacity, to protect loss of soil. This practice is common in the Buso, Aba Roba and Nalia Segen areas. This kind of practice is common in the moisture stress areas of Southern Tigray i.e. Alamata-Mekoni area.
- The Arba Minch Diocese of the EECMY DASCC has an irrigation project along the Segen River within 50 km towards Guji. This project was aimed in helping the community improve their food security i.e. irrigate 5,000 ha by diverting water from the Segen River.



Figure 6 - Arba Minch Diocese EECMY-DASCC irrigation project head Mr Galunde showing the diversion



Figure 7 - water harvesting structures within plots at the Segen Irrigation project



Figure 8 - Ato Adane sharing his successful experience for visitors (C)

- All irrigated farms are owned by local resident farmers. There are several fields/plots in each farm land owned by individual farmers. Each plot is also divided into several sub-plots. The plots and sub-plots are supported by well designed canals in order to divert water during the rainy season in the highlands. Their hard working culture has helped for the success of the project.
- Ten dams and soil band structures were built that covered 120 km irrigation sites, of which 5,850 ha of land has already cultivated and 460,000 quintals of cereals harvested per year. The farmers managed to have integrated farm cultivation with papaya, banana and mango. Moringa and onion apart from maize are largely produced crops in the area twice a year, through a community participatory development scheme.
- Ato Adene Korche is a model farmer and beneficiary of the project. He had lived with poverty for a long period of time due to food insecurity resulted from the drought hitting the area repeatedly and even went on resettlement. Yet, being part of the project returning from the resettlement program, benefited enormously planting maize, banana, papaya, mango and onion harvesting up to 40 quintals per hectare in good seasons. Ato Adene built two improved houses, owned a motor bicycle, a pump and installed a grinding mill.

## 2.5 Tourism

Being it is one of the World Heritage Sites of the UNESCO many people from different part of the world and the country visit every year the amazing Soil and Water conservation works of the Konso people. Conservation tourism and more such as dances, housing and settlement, clothing, etc are organized by tour operators, regional governments, NGOs, etc every year. It is becoming one

source of income for the locals by organizing group dance shows, selling clothing, etc. However, it is unknown if many visitors especially from other regions are able to implement when they are back in their places. For instance, if one community some part of Ethiopia begins building terraces after visiting Konso, which is always practiced as an experience sharing among farmers from cross-cultural backgrounds for there are several common experiences among farmers in spite of their geographical locations. For that matter, many of the agronomic practices employed by Konso farmers are common all over Ethiopia. However, the total system of land management that developed in Konso, with both its 'hard' technical side (the terraces), and its 'soft' side (the institutions, culture, and political system) cannot easily be adopted elsewhere.

## 2.6 The prospects of agriculture in Konso

Agriculture in Konso has supported its people for several centuries. Its carrying capacity was maintained mainly due to relevant land-management practices and was partly assisted by slow growth of the population, both of which are the results of their institutions. Population growth remained slow due to Fereyuma, and the social limitations on sexual activities even within marriage. Given the present scenario, what is the future of agriculture in Konso? How can people live from such a fragile environment? The rainfall pattern is very much undermining an unprecedented culture of land management. In view of this, it is high time to look for alternative means of livelihood. Unfortunately, alternatives are not readily available. In my view, a lasting solution remains in the development of valleys. Such measures require the development of infrastructures for irrigation, improved health facilities, improvement of roads, supply of electricity for deep wells, building marketing infrastructures and creating mechanisms for resolving conflicts about resource use within and between ethnic groups. These alternatives are likely to ease the pressure on the cultivated hills and possibilities to restore the indigenous land-management practices, such as long fallow and improved vegetation.

### 3. FARMERS DIVERSIFIED THE CO-BENEFITS OF DESMODIUM BEYOND CONTROLLING STRIGA AND STEMBORER: EXPERIENCES FROM TIGRAY AND WOLLO

By

Hailu Araya, Haileselassie Ghebremariam, Kifle Gereziher, Kidu Gebremeskel, Sue Edwards, Gebreyesus Tesfay, Ayal Abera, Zewdie Seyid, Hailu Legesse, Endris Mehammed, Arefayne Asmelash and Sara Misgina

#### 3.1 Background

In Ethiopia, stem-borer and striga are two high risk crop pests with high negative impact on sorghum and maize production. Striga grows well in all types of soils. Similarly, stem-borer appears in all types of agro-ecology while striga grows in areas lower than mid-altitude. Tigray Region is one of the four Major National Regional States (Amhara, Benishangul-Gumuz, Oromiya and Tigray) in the country highly affected by Stem-borer and striga.

Stem-borer is a problem mainly in maize and sorghum while striga is a problem in maize, sorghum, finger millet and tef. There are two main species of stem-borers (*Busseola fusca* and *Chilo partellus*) which cause heavy damage to cereal crops. *Busseola fusca* lay its eggs in between the stem and leaf sheath, whereas *Chilo partellus* oviposite lays its eggs on the surface of the leaf.

Striga also called witchweed are semi-parasitic weeds that affect cereal crops especially on maize, sorghum and finger millet growing weredas of Tigray Region. It is often exacerbated by the prevalence of low soil fertility.



Figure 9 – Examples of maize crop affected by stem-borer



Figure IO - Sorghum crops infested by striga weed in Humera, Tigrai  
(photo by Haileselassie)

### 3.2 Effects of striga and stem-borer

Losses attributed to striga weeds range between 30 and 100 percent in most areas, and are often exacerbated by the low soil fertility prevalent. Sorghum is the main food crop in the low lands and the third largest crop in Tigrai occupying 350,000 ha. At present the average production is 1.2 t/ha, the maximum being 4-7 t/ha. The two main problems of sorghum and maize are striga and stem-borer, respectively.

### 3.3. Interventions to overcome the challenge of stem-borer and striga

#### 3.3.1 Traditional way

Practical experiences proved that Ethiopian farmers never give up for any challenge. Currently, they are not observed to accept the problem of Stem-borer and striga without going for indigenous and innovative solutions. Therefore, they always try to overcome the challenges related to stem-borer through clearing crop fields,

burning old plant residues, ploughing their fields as many as possible and early sowing. Other practices are: sowing late, cleaning farm plots from weed and disease and Integrated Pest Management (IPM), and farmers use pesticides which require on time application. Other approaches to overcome the challenge of striga are to use crop rotation and inter-cropping especially with legumes such as with cow pea, lablab, and Niger seed. Field practices that retain sufficient moisture followed by the optimum application of farm yard manure and compost is also taken as a major means to control striga.

### 3.3.2 Integrated Striga Management (ISM)

Today a project called ISM is being introduced into some countries in Africa. ISM is also being implemented in 12 Weredas under the “ISM project in Tigrai”. The main activities of the ISM project include; use of selected striga resistant crop varieties such as Gobiye and Birhan, utilization of inputs, soil fertility improving techniques and inputs. Similar to this Push Pull Technology (PPT) and the restricted grazing or cut and carry system. The PPT, which is the first to collaborate with International Centre of Insect Physiology and Ecology (ICIPE) is a promising solution. Locally, ISD is implementing this project in collaboration with Wereda Agriculture Offices, Research Centers and Universities especially Aksum University.

### 3.3.3 Push Pull Technology (PPT)

PPT is an environmentally friendly technology for the suppression of stem-borer infestation and striga weed in cereal crops mainly maize and sorghum. It involves the use of intercrops (desmodium) and trap crops (elephant grass also called Napier grass) in a mixed cropping system.

Desmodium is planted in between the rows of maize/sorghum which produces a smell or odour that stem-borer, the moths do not like. This gives it the name ‘a push crop’. In this system, desmodium is a herb with two main varieties (silver leaf and green leaf) used as a push crop. It holds appropriate crop stand in rows between two maize rows. While Napier grass, Sudan grass or

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bracharia grass are grown around the farm boundaries to be used as trap crops. The trap crop is more attractive to stem-borer, moths than maize/ sorghum and pull the moths to lay their eggs on it. Physiologically, it does not allow stem-borer larvae to develop on it. This happens, when the eggs hatch and the small larvae bore into the nappier grass stems, the plant produces glue like sticky substance which traps and kills them. The roots of desmodium also produce chemicals which is responsible for the suppression of striga weeds. Therefore, striga fails to grow where desmodium is growing.



Figure II - Push Pull Technology demonstration work in Kenya

### 3.4 Effects of piloting Push Pull Technology with farmers and researchers

Joint experimentation with farmers, extension agents and researchers on PPT has been done in selected weredas of Tigray and Wollo since 2009. Farmers in two Weredas, Tahtay Maychew and Tehuledere, have got good results on yields through controlling striga and stem-borers by applying PPT. Some of the successful farmers and practices are described below:

### 3.4.1 Gebreyohannes Tewolde

Gebreyohannes lives in Mai Tsa'eda village of the Tahtay Maychew wereda. It is 5 km off the road to the north direction with another 400-500m walking through a seasonal river bed. He has less than half hectare (in three pieces) of land highly infested with both stem-borer and striga. Unless he planted his field with other types of crop and vegetables his yearly production will always be low. By the year 2012 he planted maize on one of his pieces of lands, inter-planted with desmodium; the second pieces of land was covered by maize alone while the third piece of land was covered with finger millet and intercropped with sorghum.

That year, there appeared to be no single striga and stem-borer in the field of maize inter-planted by desmodium and bordered by elephant grass. However, both striga and stem-borer were observed in both plots planted with maize and sorghum without desmodium inter-planted into the crops.

In the following year (2013) the plot in which desmodium was established was planted again by maize and intercropped with garlic, tomato and green paper. All crops looked good and healthy. Experience sharing field day was organized by ISD. During the field visit, many participants asked the following questions;

Question: How do you evaluate the performance of the vegetable field with desmodium as compared with the other field?

Answer: Where there is desmodium, I did not observe any disease or pest in the vegetables while the vegetables without desmodium are affected by pest and even by bad weather.

Question: Can you tell us the amount of yield you expect from the three types of maize plots?

Answer: When I observe the stand I assumed the yield from the maize inter-planted with desmodium will be higher but let's wait the actual yield to be quantified.

### 3.4.2 Wlro Ayal Abera

W/ro (Miss) Ayal Abera lives in Passo Mile village of the Tehuledere wereda of South Wollo Zone. She was the first person to try the Push Pull Technology around her homestead farm. Her area is experienced with striga infestation for many years. It is very widely spread and the farmers use striga as animal feed especially for cattle and camel. During her participation in a Push Pull Technology training organized by ISD in Axum she understood the technology, visited demonstration plots in Tahtay Maychew wereda and she was convinced about the importance of the Push Pull Technology in reducing the effect of striga and stem-borer.

Then after, she tried to implement in her field. First, she planted elephant grass in the farm boundary; second, at the same time she planted desmodium in rows of 50-70 cm. third, she planted maize in between the row of desmodium. The spacing was 50-70 cm among rows and 30-35 cm between plants. The stand of her maize was strong and healthy as compared to its neighboring.

The yield was 91 quintal of maize production per hectare. At the beginning her father was not happy about the technology especially the spacing, which leaves wide space among the maize rows, but, latter he understood the performance of the maize stem.

This was also a big lesson for extension workers that farmers can understand the performance of the maize crop and they can predict yield before flowering. The other lesson we learnt and result we got was many people could not get good germination of desmodium. Thanks to W/ro Ayal soaked the desmodium seed overnight with warm water before planting resulted into an amazingly high germination rate.

### 3.4.3 Wlro Zewdie Seyid

W/ro Zewdie lives in the Gobeya (012) Kebele of the Tehuledere wereda in South Wollo Zone of Amhara Region. Almost all fields of W/ro Zewdie are experienced with striga and stem-borer. By 2012

and 2013 she planted one of her fields with sorghum inter-planted with desmodium and bordered with elephant grass.

The stand of the sorghum field was very strong and healthy. The number of striga and stem-borer observed was very low as compared to other neighboring plots.

The lessons drawn from her field were: one, crops performed better than the nearby farm plots; two, the striga and stem-borer infestation level was less than 5 percent than the neighboring fields and three; she got good harvest.

#### 3.4.4 Farmer Research Groups in Tselemti wereda

Maize (*Zeamays L.*) is the most important staple food crop for the whole peoples in north western zone of Tigrai. In north western zone of Tigrai, maize was ranked as the most important food crop next to sorghum and finger millet. The average maize yield in north western zone of Tigrai is 2.6 ton per hectare while the potential yield is 6 ton per hectare. Tselemti is one of the weredas of Tigrai Region with high stem-borer and striga problems. Farmers in north western Zone of Tigrai have been using crop rotation, removal of crop residue from the field, and a few using pesticides like endosulfane solution to control stem-borer. There are other biological control options that are environmentally friendly and are effective. According to the research outputs of ICIPE among these the “push-pull” that has been shown to reduce levels of stem-borer damage by 25 percent.

Mai Tsebri Agriculture Research Center has accomplished a joint experimentation of Push Pull Technology by Farmer Research Group (FRG) approach through JICA support. It is by organizing farmers into two groups in Tselemti wereda of North Western Tigrai Region. The research was conducted at Mai-Ayni and Serako villages of Tselemti Wereda. A total of 23 farmers, 15 Male and 8 Female i.e., 15 in Serako (11 Male & 4 Female) and 8 in Mai-Ayni (4 Male & 4 Female) farmers which were interested in undertaking the activities were selected from community for the training.

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After training, farmers in FRG and the technology they planted the Desmodium, elephant grass and maize at the same time. Normally (from the ICIPE experience) the first two are planted one month earlier than the maize.

The treatments were:

1 = control plot (only maize), 2 = plot with Maize + Desmodium + Napier grass (Bana grass).

However, the second treatment has performed well with the following results.

- This research showed the combination of desmodium and Napier grass recorded a plant height of 253cm for the treated plot while 232cm for the control plots.
- The average stem-borer infested maize plants were found 11.5 in the control plot while only 5 infested maize plants were found in the plot treated by desmodium and elephant grass.
- There were 2.5 stem-borer infested cobs at 75% ear filling stage in the plots treated with desmodium and elephant grass while 5 at the control plot.
- The grain yield, biomass yield and harvest index were 6840 kg/ha, 21060 kg/ha and 32.51 for the plots treated with desmodium as compared with 5360 kg/ha, 18300 kg/ha and 28.98 to the control plots respectively.
- The forage production from the Napier grasses were measured with fresh biomass was 666 kg and dry biomass 428 kg per 3 rounds of the plots.
- Farmer's perception on the Push-Pull Technology was mainly limited to its moisture conservation and control of ants and termite problems.

#### 3.4.5 Experimentation conducted in Aksum University

Farmers, extension workers, ISD staff and the vice president for Research and Development of Aksum University have agreed to conduct a joint experimentation on Push-Pull Technology in the main campus. However, the challenge was how to involve the farmers in order to help the extension work. Therefore, visitors

agreed to accomplish most of the work from the beginning to the end by farmers and with a close collaboration with ISD and Tahtai Maychew wereda agriculture office.

This experimentation conducted jointly by academicians, researchers, extensionists and farmers. The result was as follows:

- The farm plot used was not fertile not only for maize but also for other crops as well with the exception of tef and flux alone.
- The design and planting of the desmodium, elephant grass and sowing of maize was accomplished by the involvement of the local farmers. This was deliberately done to create trust among farmers, extension, academicians and researchers.
- However, it became an amazing maize crop. The lessons learned from this demonstration work became educational in that the maize which was sown very late was able to attain necessary stand even at moisture stress. It became resistant to environmental shock because just at the flowering stage a very heavy hail attacked the field and the hail destroyed different farmlands and grasslands. But, the demonstration site specifically was able to resist and produced satisfactorily.

Unconventional use of maize kernel



Figure I2 - Maize crop from Aksum University



Figure I3 - Good desmodium biomass at Aksum University plot

- There was a better yield with less infestation of striga weed and stem-borer in the Push-Pull plot than the control plot.
- This demonstration site was visited by a total of 433 participants. These are 325 farmers, 89 development agents and experts, 19 administration bodies, and many others made an experience sharing visit to the site during land preparation, sowing and ripening stage of maize.

Table I - Yield results of the joint experiment conducted in AKU

Attribute	Demonstration plot (Av.)	Control site
Number of maize plants in the fields	600	722
Total Number of maize plants holding kernels	569	481
Total Number of kernels	778	565
Number of kernels infected with stem borer	2	64
Number of striga plants grown	3	27
Average number of seeds per kernel	525	336

The lessons learned from this experimentation are:

1. Farmers, experts, researchers, and administration bodies can develop trust and then work together effectively and learn from each other.
2. The integrated work is suitable to farmers' context as farmers always go not only to production of main crops but also to animal feed.
3. There is no useless land if appropriate technology is applied.

4. Farmers took this experiment as their own work than that belongs to the Axum University.

### 3.5 Farmers' new dimensions of desmodium

Farmers observed well the result of the push-pull technology, the biological behavior of striga which is similar with the behavior of orobanche and desmodium. Therefore, if it worked in reducing the biological process of striga they assumed it can work with orobanche. This is how they come up with other dimensions that academicians, extensionists, researchers and experts never think of.

Some of the new ideas are as follows:

#### 3.5.1 Reducing the infestation of orobanche by desmodium application

Farmers from Tahtai Maichew and Laelai Maichew weredas suffered a lot by a similar weed called orobanche (locally called Silim - a nap) which affects vegetable crops (tomato, potato and cabbage). Gebreyesus of Kewanit has brought a display to one of the meetings to show participants how it tightly trapped the root system of his tomato. But, this is a bit different than striga because it does not have flower on it and the stems are fleshy than striga. The farmers who are highly experienced with it told us that it has no flower on it. They said whenever it appears in a field it kills the growth of tomato, potato and cabbage.

Farmer Gebreyesus Tesfay and his network team from Kewanit locality of the Tahtai Maichew wereda in the Tigray Region volunteered to try this experimentation in 2012/13. He prepared two plots of tomato. The one plot was planted with tomato inter-planted desmodium (earlier a plot used for push pull experimentation) while the second was without desmodium. The two plots were near to each other divided by farm boulder only.

The result of the experimentation showed that there was no even a single orobanche observed in the plot with desmodium while there

was a lot of orobanche weed grown in the second plot, where there was no desmodium applied. The tomato in the plot without desmodium died within one month while the tomato in the push-pull plot gave yield for more than 4 months. The farmers evaluated desmodium could suppress orobanche and they agreed to use desmodium in their crops, which could be affected by orobanche.

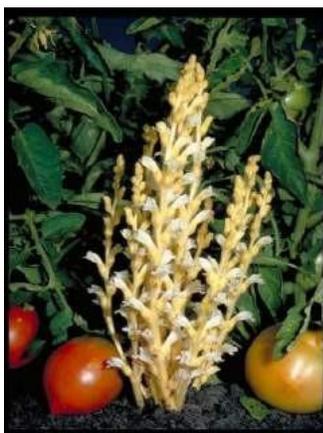


Figure I4 - Tomato suppressed by striga (from website)

### 3.5.2 Reducing infestation of pests on fruit trees

The development of micro-irrigation in Tigray Region is highly related to the development of fruit trees in many farming families. However, they are challenged with pest and disease infestation. W/ro Haregu and her husband Kalayu in Mereb Lekhe wereda of Tigray Region are one of the people who are highly suffered by ant in their fruit orchard. They own a 12 hectare fruit orchard planted by mango, orange, avocado, etc.

Haregu Gobeza is known in Tigray for her effective and progressive farm project. Now she is also known for her use of animal forage from desmodium, desmodium seed and more. She has shallow, stony and saline farm land. Desmodium was introduced into her

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farmer by 1997 as livestock feed by the support of Relief Society of Tigray (REST).

She has been using desmodium throughout her 12 ha fruit farm. Now Hawi Ayna (striga) is eliminated from her farm due to desmodium. Moreover, ants disappeared in her fruit orchard due to the sticky nature of desmodium. No disease and pest is observed in her farm. Due to desmodium plant animal feed increased, soil fertility improved and started growing groundnut, reduce salinity, etc. She said “I have neither pest nor disease problem in the fruit orchard.” She continues explaining that they do not plow or remove desmodium – instead they irrigate and fertilize it like the fruit trees. They should not let it dry i.e. always they keep it moist.

### 3.6 Lessons learned

Lessons learned from this Push Pull project are:

- Every integrated work is suitable to farmers’ context as farmers always go not only to production of the main crops but also other ways like animal feed.
- The maize grown in Aksum University, which was sown very late was able to attain necessary stand even at moisture deficit time and was characteristically resistant to environmental shock. For instance, just at the flowering stage a very heavy hail attacked the field. The hail destroyed different farmlands and grasslands. But, the demonstration site specifically was able to resist and produced satisfactorily.
- We understood it is easier to convince farmers if truly involved in the research process than interviewing.
- The lesson from this case indicated us that any change at local level requires a solution at local level. This is because problems do not mean that solutions are only in the hands of professional people and the government.

## 4. ENSET: THE MOTHER OF MILLIONS IN THE FACE OF CLIMATE CHANGE

By

Hailu Araya, Welde Amanuel and Mifta Ahmed

### 4.1 Background

*Ensete ventricosum*, commonly known as the false banana, or enset, is a species of flowering plant in the genus *Enset* of the banana family Musaceae. It is native to tropical regions of Africa and Asia. It is an economically important food crop in Ethiopia. It is a large non-woody tree (actually a gigantic monocarpic evergreen perennial) up to 6 m tall. It has a stout trunk of tightly overlapping leaf bases, and large banana-like leaf blades of up to 5 m tall by 1 m wide, with a salmon-pink midrib. Enset plant takes four to seven years to mature. The flowers, which only occur once from the centre of the tree at the end of the tree's life, are in massive pendant thyrses covered by equally large pink bracts. Although after flowering the plant dies, the fruits are similar to those of the domestic banana which are edible but insipid, with hard, black, rounded seeds (Wikipedia, 2014).

Wild enset plants are produced from seeds, while most domesticated plants are propagated from suckers. Up to 400 suckers can be produced from just one mother plant.



Figure I5: Enset farm around homestead

Enset grows most in many parts of the densely populated south and south-western Ethiopia as a staple food (i.e. as a primary food crop) in Gedeo, Sidamo, Gurage, Hadiya, and Kembata zones. It is also a co-staple food crop i.e. Enset and cereals as primary food crops in Wolayita, Gofa, Keffa, Amaro and Yem zones.

Grain crop (i.e. cereals as the staple food with supplementation, especially in off-seasons with Enset foods in Welega, Jimma, West Shoa, Illubabor and parts of Kefecho zone. A shifting cultivation (i.e. rotational utilization of cleared forest areas with a variety of crops including Enset) is also practiced in Bench, Shakicho and forested Kefecho zones.

In the Enset growing areas, these cropping systems are adapted to the availability of land and the economy of food production. Once land is cleared and topography allows cultivation, cereal and pulse cropping along with Enset is popular - wheat, barley and horse beans at the higher altitudes and maize, sorghum and haricot beans at the mid-to lower elevations. These crops also produce residual fodder that supports livestock in a supplementary role to draft

power. However, in areas where there is shortage of land, cultivation of Enset and annual crops is done by hand hoeing.

Nevertheless, as the size of holdings in the Enset growing areas decreases, farmers maintain cereal production as much as possible but switch from low-yielding pulse cropping to high yielding root crop culture. Sweet potatoes and/or white potatoes are the main substitutes to Enset with taro, cassava, and yam being common for food variety and food security. The white potato is adapted to loose soil and higher elevations but very susceptible to the devastating late blight disease. Sweet potato is better adapted to the mid-altitude clay soils but can often be limited by shortened rainy seasons or drought.

Vegetables and fruits, although still not large enough for cash cropping systems particularly for self-sustaining farmers, are beginning to cover ever larger farming areas. At present onion, cabbage, carrots, beet root, avocado, mango, koke (peach), ghesho (hop) and zatu (guava) seedlings are increasing through time.

Even though the study by (Robert Shank and Chernet Ertiro, 1996) reports that “the average number of plants harvested per household per year varies from below 12 plants in a few weredas to more than 100 in several”, farmers visited during the field work reported that a family with 7-8 people need 12-17 Enset plant a year only for food. However, this does not mean that they eat Enset only.

Enset is also highly adored as a tree that keeps hunger at bay because it is available in all seasons and moisture conditions. Enset is virtually unknown as a foodstuff in the north and eastern part of Ethiopia other than its being grown as an ornamental garden plant.

#### 4.2 Development of Enset

Enset production has perpetually been practiced in generations. All generations have used it for human and animal food. The information we gathered from field visit and research reports reveals that Enset is a stable food of the local people and beyond. There is no house without Enset in the homestead farm. Many of

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the families we visited told us that their Enset farm was inherited from their parents. The old Enset farms perform better than the new ones. Ato Weldehana has been involved on Enset production since he was married. He has established his own family and the family is working on Enset farm from planting to consumption. This is what all families practice locally. The people tell us that, based on their experience, Enset production has five stages. These are the phases of Dbo, Bitena Sima, Sima, Ero and matured Enset. These growth stages are distinguished as follows:

- i. Dbo: This is the first stage of Enset. It is developed from an Enset plant which has reached the ero stage. Farmers cut the Enset at the ero stage as new shoots grow as Enset seedlings. It therefore, serves the nursery phase of Enset seedlings about 400-500 seedlings are grown from one Enset plant.
- ii. Bitena Sima: This is also called Sima one. They are transplanted plants or seedlings kept apart by spacing. The first spacing helps the plant to grow strong near the seedling sites.
- iii. Sima: This is also called Sima two. It is an act of transplanting the Sima One seedling into another wider spacing. The technique is planting a bigger/major Enset in the middle around which 3-4 other smaller Enset plants are put. Normally the bigger one is harvested first.
- iv. Ero: This is the practice of transferring the plants to the main Enset site from a temporary one. This is done every year. If an Enset at the ero stage is required for seedling, it is cut at its base. If it is required for food, farmers transplant it again so that it grows at its last stage (main Enset).
- v. Main Enset: This is the last stage. No transplanting is done at this stage. The matured stage has flowers.

Enset cultivation is a complex and continuous practice of planting and transplanting the enset tree at an increased spacing. It needs an all year round follow up, labour and harvest than other seasonal crops. Most of the duties at all stages of enset are accomplished by men.

#### 4.3 Enset farming practices

Variation within the enset species are observed due to altitude, soil and climate. This has allowed widespread cultivation in the mid- to highlands of western Arsi-Bale, the Southern Peoples Nations Nationalities Regional State (SPNNRS), and western Oromia including West Shewa, Jimma, Ilubabor and Welega (Shank and Ertiro, 1996).

Enset is also known for its agroforestry and intercropping type of farming. It is often intercropped with sorghum, although the practice among the Gedeo people is to intercrop it with coffee. It is a major crop, although often supplemented with cereal crops, among the indigenous people of Southern Ethiopia; that is, among the Aari, Basketo, Dime, Dizi, Gamo, Gedeo, Gimira, Goffa, Gurage, Hadiya, Dubamo (Danta), Kafficho, Kambaata, Konta, Kullo, Maji, Mao, some Oromo groups, Sheko, Sidama, Welayta, Yem, Uba and the Zala people (Wikipedia, 2014).

The following examples on cropping system and current food security/nutritional situation are extracted from the reports by Shank and Ertiro (1996), and from field observations, as well.

- I. The KnserlCoffeelMaize Culture of Sidamo-Dilla:  
This area is an intensive coffee growing area; as fertilizers and pesticides have been used continuously for controlling the Coffee Berry Disease. Because of this, there are no honeybees in the area. Whenever fluctuations in coffee prices and production happen, farmers have become accustomed to growing their own Enset as assurance for food supply.

2. The KnserlMaize Culture of Jima-Mizan Teferi: Adequate and reliable levels of rainfall and length of the “Kremt” season have been beneficial for this area to cause it become well-known in high maize yields and surplus production. However oxen used to cultivate the maize fields, have consistently been plagued by Trypanosomiasis as a reason of which occasional shortages of food occur. Enset is used during such cropping seasons to fill the gap.
3. The Knserl Root CropMaize Culture of Wolayita-Sodo: Due to land pressures prevailing in this area, livestock production has decreased and the area devoted to low yielding pulse production is also diminishing. Hence, maize is planted in February and in July resulting in two harvests in July and November. Sweet potato is planted in October and February and is harvested in January and May. Therefore, from late February until the end of May, Enset (Kocho) is the only high energy food available usually eaten with a little ‘Ubasha cabbage’ as a source of Vitamin A. White potato is also planted at the higher altitudes in April to be harvested and eaten after June because late blight disease becomes severe with the heavy rains. Taro is harvested in November and Cassava is ready to be eaten in September.
4. The KnserlLivestock Culture of Dawro-Waka: When one traverses across the river from Wolayita, one finds the Omo valley which is dry and stony with pockets of maize/sorghum and cotton production. This stretches to a wider area until one comes to the Enset cultivating highlands of Gofa which is about 30km away before Waka. These highland hills are steeply sloping and not suitable for crop cultivation. Because the soils are deep and rainfall percolation is rapid, erosion turns out to be a serious problem. The growing season is short and supports only early maturing barley varieties and cabbage.

5. Complex intercropping at Kacha Bira Wereda: Today the intercropping pattern is becoming very much diversified than years ago. For example, Ato Weldehana Aalibore Afacho lives in Andegna-Doreba village of the Doreba kebele of Kacha Bira Wereda in the SNNPR. Ato Weldehana and his community practice integrated farming activities on enset, coffee, apple, barely, wheat, beans, chickpeas, spices, potato, home garden and cattle. According Ato Weldehana, enset is the major asset in their area. It plays a major role in reducing poverty and it is the primary plant that ensures food security.

#### 4.4 Uses of Enset

The yield of enset is very high. Every plant produces a lot of food. But harvesting the food and processing it is laborious. It involves digging the entire plant out of the ground. The plant is cut before flowering and the pseudostem and leaf midribs are scraped. Once harvested, the plant can be used to make several kinds of foods (Daniel, 2010). It is a source of food and fodder, fiber, herbal medicine and source of income. It holds moisture and restricts soil erosion. Precisely, all parts of enset are useful. The variety in use is directly related to the fact that enset the main crop of the people that utilize it throughout the year unlike other people who use cereals of specific seasons subject to discontinuity in their growing period. This generally expresses the multipurpose nature of the plant and its valuable role in the livelihood of the community (Yemane and Kibebew, 2006). Some of the uses of Enset are as follows.

##### 4.4.I Human food and animal feed

Enset is the traditional food for most part of the Southern Nations and Nationalities mostly for Gurage, Kembata, Sidama and Welaita people. Enset provides more amount of foodstuff per unit area than most cereals. It is estimated that 40 to 60 enset plants occupying 250-375 sq. meters can provide enough food for a family of 5 to 6 people. Due to the long period of time it takes from planting to harvesting, the enset plants need to be spread out over time so as

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to ensure that there is enset available for harvest every other season.



Figure I6: Enset as cow feed in Aleta Wendo area (Sidama)

As many as 7 million people consume Enset products as staple or co-staple foods, sometimes solely with Vitamin A foods but commonly without the needed protein supplement. According to a study by Shank and Ertiro (1996) in December 1993, the FAO/WFP Crop and Food Supply Assessment document provided estimates of Enset and root crop production for the previous seven years amounting to about 10% of the net cereal and pulse production. Kocho yield varies from 19.7 kg in Bonke wereda of N. Omo zone to 84.6 kg in Yirga Chefe wereda of Gedio zone depending on the variety of the size of the plants. Household Kocho production varied from a low of 78 kg in Seka wereda of Jimma zone to 9,829 kg in Bule wereda and 9,716 kg in Wanago wereda of Gedeo. Several weredas had a household production of 5-7,000 kg but most commonly, weredas using Kocho as a staple food on a subsistence level produced 600 to 1,500 kg per household. Enset production contributes 20 percent of the national carbohydrate and is a staple

food of 18 percent of the Ethiopian population (Shank and Ertiro, 1996).



Figure I7: Visitors invited lunch of enset product

The root of the plant provides food for human beings in the form of starch and the leaves are fed to cattle, whose manure is used in turn to fertilize the plant. According to Ato Weldehana and Ato Wolde'amanuel, the rural families in the enset area between Hossana and Welayta-Sodo categorize Enset products into six while the major food products obtained from it are only three (kocho, bulla and amicho) all of which are simple to produce once the plant is harvested. They can also be stored for a long period of time without spoiling.

- Kocho: It is a baked flat-bread made by scraping the starchy pulp out and fermenting it with yeast, traditionally in a dug-out pit. The resulting mixture is used to make porridge or fermented bread. It is mostly eaten with the Ethiopia's spicy "kitfo". Sometimes urban people consider Kocho as one belonging to the Gurage, but it actually belongs to many people in the SNNPR. It is now eaten,

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though to a more limited extent throughout the country. It is now becoming a common practice to serve “Kitfo” with Kocho on holidays, at weddings and special in restaurants. Many urban restaurants now serve wheat bread, injera and Kocho with meals.

- Meriro: It is the best food provided to honorable guests.
- Bula: The best Enset food in quality is bulla; it is obtained mainly from fully matured plants. It is water-insoluble starchy product that may be separated from Kocho during its processing by squeezing and decanting the liquid. It is extracted rather than being fermented, and is dehydrated to make flour of it that can be stored for extended periods of time. It is food prepared and eaten as porridge, pancake and dumpling.
- Amicho: Amicho is the fleshy inner portion or root of the Enset corm which may be cooked and eaten separately. It is the corm boiled and served like potatoes or other root vegetables and tuber crops. It is food used for immediate feeding when every day meal is not available.

From the response of the rural families of Hossana-Sodo area, Enset cultivation requires continuous budding, composting and mulching. Today it is becoming good source of income. Formerly, one enset was sold for 50 Birr but now it is sold for 1000 Birr due to the high demand coming from other locations. Due to the high demand, farmers were formerly looking for a wetter land to grow enset, but now they grow it at any place by way of proper cultivation.

Since the technology of producing livestock silage is similar to that of fermenting Kocho, additional forage could be stored from the growing seasons. Parts of the Enset growing area experience a rainy season with surplus vegetation followed by a dry season with a shortage of forage. In such occasions, enset stalks that are not used for Kocho could be chopped into old fermentation pits and stored for use in the dry season for livestock fodder.

#### 4.4.2 Medicinal and ritual significance

Farmers responded in similar words to the assessment report by Daniel (2010) that a number of different enset varieties were reported to have medicinal and religious (ritual) significance. Such varieties are used for preventive treatment, healing and other therapeutic purposes including as protection against evil spirits. Incidentally, these medicinal and ritual varieties are given special care. Some examples, of these varieties are given below.

- Tayo: This is a variety with a light red pseudostem and midrib and deep green leaf. The boiled corm amicho and starchy powder bulla are eaten with milk to cure ailments such as broken bone fractures, joint displacement and swelling with pus. It is also used to cure similar ailments in domesticated animals, specifically dairy cows when they are it with salt.
- Choro: This is a variety with a deep red pseudostem, midrib and leaf. The corm amicho of enset is eaten with cheese specially prepared with butter and milk by women who have just delivered babies and whose discharge of the placenta is delayed. It stimulates the placental discharge during delivery. For dairy cows, the amicho is given with salt for similar purposes. This variety also has a ritual significance with the people and is found in both Decha and Chenna districts of the study area. Farmers plant Choro in front of their tukuls as a safe guard against devils' and all evil spirit attacks.
- Machedemi: This is used for the same medicinal purpose as Choro when the later is not available or when there is a need to use as an alternative to Choro.
- Officho: This is prepared as a dehydrated starch suspension like bulla and is served together with milk. It is used for curving a person who has health problems from broken bones, fractures and swelling in order to restore and heal his/her the damaged part of the body.

#### 4.4.3 Other uses

There are other uses of enset in addition to those discussed above. These are:

- Kacha: Kacha is the fiber obtained after every food and feed item is separated from the enset plant. It is provided to factories or individuals for further processing to make rope and is also used for building a house.

Leaf, fiber and plant parts are used for food wrappers; cattle feed, ropes and house construction.

- Hoficho (Wedero): Hoficho or Wedero is a dried leafy part. It is used to make carpets, for house making, to tie materials and animal food in bundles.

In most part of the enset growing areas its leaves serve as a packaging for different types of food stuff & baking traditional bread.

Planting enset is good to cover land with green vegetation; it helps in moisture retention. It captures rainfall with its leaves. This results in soil moisture conservation and reduces run-off when compared with bare earth farming. The moisture kept in the soil by the deep roots of the plant give it greater resilience to drought than can other cereal crops have. Consequently, the people who grow it retain a greater degree of food security.

Soil fertilities of the enset plantation areas are improved due to the long-term application of manure, compost, mulching of leaf and stem residues.

Enset plants also provide important windbreaks and serve as a shade from direct sunlight.

Enset is also a good plant to inter-crop with coffee, potato and other food crops, which benefit from shady growing conditions.

#### 4.5 Enset and gender issue

The whole process of chain or enset production from planting, replanting, harvesting and processing it for consumption requires great effort. Therefore, unlike other crops it requires continuous labor supply throughout the year. It requires the involvement of all members of the family regardless of gender and age. However, the final and laborious manual processing using traditional bladed wooden instruments is left for women. In most enset growing areas, men and women have their own involvement and share different responsibilities.

Ato Weldehana mentioned that boys and girls have their own job description in his family. Boys are mainly involved in enset production whereas girls in processing. For example, men, especially boys, work on cutting Dibo and Sima in order to get suckers; they also work on planting and replanting the Ero and cultivating the enset plants. Boys also support in providing cobas during processing the enset. Digging a hole for storing the raw kocho is also the work of men. On the other hand, women, including girls, are involved in providing boys with dung/manure from the houses. They also do the provision of food by type. They take part in all the steps of processing the enset plant by adding gemama and treating it till it matures for food. They also work the duty of identifying the matured merero, bula and kocho according to the plant's proper stages.

#### 4.6 Adapting to climate change

Enset grows best at altitudes above 1600 meters above sea level; this is not because it cannot withstand heat, but because it needs adequate soil moisture. Irrigation studies in hot climates show that it stores large amounts of water but wilts severely during long periods without rain.

The fact that transplanting it is done in the dry season, usually just before the start of the "Belg" rain its growth resumes at a reduced rate throughout the dry season. Mostly deliberate leaf pruning is practiced to conserve the plants water use, and to enhance moisture capturing through ground cover by the addition of

biomass in the basement. Enset is therefore a reliable crop during seasonal rainfall shortages but could die in prolonged droughts.

#### 4.7 Some challenges and farmers' practices to overcome the challenge

The following challenges are gathered from observations and discussions with smallholder farmers around Hadiya, Kembata and Wolaita.

##### 4.7.1 Challenges

There are many challenges that influence Enset production in Ethiopia. These factors are geared toward independent household survival in farming systems. These are:

###### i. Disease occurrence

The disease currently threatening Enset crop production is Enset Bacterial Wilt caused by *Xanthomonas musacearum*. The bacterial wilt appears to be the only major disease of Enset. While the disease is present and 'of concern' in most Enset growing areas, farmers are not alarmed and appear to be living with the disease though engaged in asking for 'medicine'. The wilt causes complete death of the plant within weeks of the first symptom, i.e. yellowing and drying of the emerging shoot. Individual plant infection and loss is common but 'hot spot' losses can amount to half of the harvestable plants.

Extensive experiments were conducted by Dereje (1984) to explore the mode of transmission. One hundred percent infection occurred from cutting leaves with contaminated knives or injecting the bacteria onto the cut surface. About 30 – 60 percent infection was by dipping transplants or watering the soil surface with bacterial solutions. But no infection occurred when transplants replaced dead infected plants. Bacteria were found to survive on the surface of contaminated knives for up to 3 days under humid conditions and up to 4 days under dry conditions.

ii. High population pressure

Enset growing is highly related to the high population pressure. Portions of the Enset growing area are among the densely populated areas in Ethiopia. Large family size has brought about farm subdivision until present land holdings are small in many zones. In addition to the presence of high population, many immigrants visit this enset area from lowland during drought season. On the other hand, while rural overpopulation, land shortage and poverty encourage migration to urban areas, urban food prices rise higher which forces the poor to seek the lowest priced foods.

iii. Degrading the trust on enset production

As the need for kocho and bulla is increasing, farmers get involved in commercializing enset. However, many of them misuse the trade by degrading the quality and quantity of the enset in the market. This brings about loss of trust on the enset producers.

iv. Occurrence of pests

Another threatening challenges in the occurrence of pest, which is more devastating to an individual house-hold than is the mole rat. These animals, which are the size of large rats, tunnel and move from plant to plant eating the roots and corm, inciting variable damages including immediate decline and death of the plant. Cases were observed where serious infestation had caused 10-20 plants to be too weak to be salvaged for what little pulp was possible to extract.

v. Insufficient rainfallmoisture

Enset growing areas are not different from any other part of the country to the effect of the changing climate. Nowadays these areas are experiencing the risks of rainfall failure and unreliability in enset maturity.

#### 4.7.2 Farmers' practices

From practice, Ethiopian farmers do not sit and wait until someone comes and solves their problems. Instead they try to solve their problems by themselves. For example:

- i. Before planting enset, they clean the ground and fertilize the planting pit. This helps to strengthen the enset plant and to enhance its level of resistance to any kind of disease.
- ii. Whenever disease occurs farmers use their own traditional curing practices. For example, when diseases like an Enset Bacterial Wilt caused by *Xanthomonas musacearum* happen, they spray different types of traditional anti pest solutions. If the infested enset plants do not recover, they cut and burn them all. However, they do not feel comfortable with this.
- iii. To control the pests they add some traditional traps, poisonous plants and sharp materials, fertilizers in the tunnel to kill the pests especially the rats. The controlling strategy also consists of flooding the tunnel and killing the emerging animals. A large fish-hook type snare trap with a string trigger through the tunnel is also being used by the MoA.
- iv. The strategic solutions for the high population pressure and fragmentation of land are: one, educating their children to get a job other than farming; two, enhancing crop diversification through intercropping with enset; three, accommodating immigrants who come to be hosted during drought period since this is a matter of culture and religious ethics.
- v. The farmers are practicing different rehabilitation practices to reduce if not stop the soil loss and insufficient moisture. Hillside conservation practices in Karcha Birra areas are good examples in controlling soil loss and increasing the availability of animal feed.

#### 4.8 Summary and recommendations

Enset is a widely used crop where it is a staple food for many people in the SNNPR. It supports about 10 percent of the food system of the country through family farming. That is why it is named as the mother of millions regardless of the changing climate and drought occurrence. It is also known for its multi-functionality varying from the food system to feed system and other purposes.

However, it has many challenges under smallholder farming such as pest and disease, longer production time-span and laborious process. Therefore, it requires further research and experimentation to reduce the risk of pest and disease, and minimizing time and labor in the farming and processing procedures. Moreover the introduction of new technologies can reduce many of the challenges.

## 5. AN EXAMPLE OF INTEGRATED FARMING: FROM POVERTY TO INVESTMENT AND BEYOND

By

Bisrat Kesete, Leul Haileselesie, Hailu Araya and Haregu Gobeza

### 5.1 Background

Miss Haregua Gobeza and Mr Kalayu are young farmers in Mereb Leke Wereda of the Central Zone of Tigray Region. Haregu is 36 while Kalayu is 42 years old. They are married and have six children (4 female and 2 male). Haregu is one of the energetic and exemplary women in the region.

### 5.2 The way from poverty to investment

Previously she had faced a very challenging life because she was unemployed and dependent on the salary of her husband to cover all expenses of the family. The first thing that came to my mind, as she said, was “Unless I help my husband we can’t go out of poverty. I understood that as his salary is not enough to support the family why I sit and wait for his monthly salary, which is not enough.”

Therefore, she wanted to find another means as an exit strategy from poverty. By 1994/5 she asked her relatives to find her an option. The first option they offered her was not money but one farm plot for one harvesting season. She planted the land with finger millet and sold the grain for 1,500 Birr. The income from this harvest was used as a seed money to improve her life and later she become model for the nearby community members in particular and or the community in general. (Please see the steps she undergone through life in the section below.)

Starting from that seed money, now she is one of the richest people in the district because she has 12 hectare of fruit farms with Mango, Orange, mandarin and avocado plantations. She also owns a dairy

farm with 12 exotic cows. At present she has over 23 million Birr capital. She was awarded by the Late Prime Minister Meles Zenawi in the conference held in Hawassa as one of the best model farmers of the nation.

### 5.3 The Dream Farm

The 20 years old farm became an integrated farm, where it includes soil, crop, human and animal components in the farm compound. It recycles all the necessary nutrients.

Earlier the farm has many challenges. Some of the challenges were: soil salinity, weed invasion, thin soil, rocky landscape, ant, termites, etc. But now the integrated system has helped in solving these challenges. The integrated work has come across different steps. These steps are as follows:

#### 5.3.1 Cereals and vegetables

Cereals and vegetables are the first generation farming system. At the beginning until her fruits plants created wide shade Haregu was planting with different cereals and vegetables with a special focus on peanuts/groundnuts. She still grows peanuts under the shade during the main rainy season.

It was this time she rented land and water pump to plant vegetables with the 1,500 Birr earned from the sale of the sorghum grown on her family plot. With the first money she earned she paid 3 month rent for the land and she got good income from the tomato sale. She was able to buy water pump and again rent another land.

While she was economically moving forward suddenly a flush flood came and took away the water pump from the riverside. It was unfortunate and disappointing but she never gave up. She bought another water pump by credit basis and continued her assiduous endeavor/work.

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5.3.2 Fruits

Growing fruits is the second generation and have also different steps by itself. At the beginning she started planting vegetables and fruits. The vegetables have fast return for her investment in three months while fruits require longer time to mature and earn income. Mostly the vegetables grown were tomatoes. They are good and grown during the dry season.

The fruits planted in the second generation were only papaya together with tomato. In the third generation papaya and tomatoes were mixed with mango fruit. It was by the recommendation of experts from the District Office of Agriculture and the Relief Society of Tigray (REST).

The fourth generation was a turning point where she started to select types and varieties of fruits she wanted to plant and integrate with other farm activities. As the papaya became older she shifted to other types of fruits – orange, mango, mandarin and avocado. Now, as part of her fifth generation she is trying to introduce pineapple in collaboration with Best Practice Association and the Mereb Leke District Agriculture office.

Table 2: The varieties and types of fruits are as follows

R.N.	Fruit type	Variety	Quantity	Remark
I/I.I	Mango	Apple	3,200	Very big and tasty. Give up to 3 quintals of fruits per tree. Many people like them including their seedlings.
I.2		Kent	800	Big and tasty but easily perishable if ripped. Many people do not like even the seedlings.
I.3		Tommy	400	Normal sized and taste mangoes. They are good to be sold in local
I.4		Kit	200	
I.5		Dado	60	

				markets. Their size is good to be consumed in big families.
I.6		Local	120	These varieties are big enough and give higher amount of yield (about 4 quintal per tree) than other varieties.
2/2.I	Orange	Hamleen	600	Tasty and high yield orange variety.
2.2		Valencia	300	Tasty and high yield orange variety. It is also quick to mature.
3	Mandarin	Mandarin	300	Big mandarin and tasty fruit.
4	Avocado	Hass	80	Big and healthy fruit.

### 5.3.3 Animal and animal feed

The fruit orchard is intercropped with different types of grass species, which are good for animal feed. The grass species grown are alfalfa, Rodes grass, Desmodium, elephant grass and tihag. All types of grass species occupy the farm outside the tree canopy.

Now the family has 14 dairy cows of which four are lactating. At the same time they introduce 6-7 oxen in every 3 months and 7-8 goats in every 2 weeks for fattening. They sell them by gaining 2,000 Birr from each ox and 150-200 Birr from each goat. They do not buy any type and amount of feed from outside.

### 5.3.4 Measures to the soil system

As mentioned earlier the soil of this land is characterized by soil salinity, rocky landscape and infested by Striga (Hawi Ayna or Metselem). Then unless the family does some measures they can't survive in this farm. Therefore, all activities introduced to this farm go with the remedial measures to their challenges.

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To improve the soil fertility, thin soil and low organic matter they prepare compost in 12 big pits for their fruit farm. They also introduced one biogas with two pits for bioslurry compost preparation. According to Haregu, they apply compost to their fruit trees every time but the bioslurry compost is used for plants highly deficient with nutrient and become yellowish color and appeared whenever their fruit plants are at younger stage.

The application process is whenever they see some newly planted fruit trees became yellowish color they apply enough amount of liquid bioslurry mixed with water at 1:2 ratio. The fruit plants applied change their color into deep green within 10-15 days.

#### 5.3.5 Pest and disease

The main challenge is infertile soil but the lesser challenges are with the pest and diseases. They said there is no pest and disease problem with mango and avocado but there are limited problems occurred with orange trees. Haregu uses her own pest and disease controlling methods. She prepare pest and disease control from leaves of neem trees mixed with animal urine. She applies the fermented IPM prepared from chopped leaves and mix with animal urine for one week.

At this time Haregu is known in the Tigray Region for her effective and progressive farm project. Now she is also known for her desmodium feed, seed and more. Once she presented her experience to participants in a conference held in Axum that she said "Our farm land is shallow and stony, saline by nature." Desmodium was introduced in 1996 as livestock feed by Relief Society of Tigray (REST). But it was by coincidence that Hawi Ayna (striga) is eliminated due to desmodium.

She cuts desmodium and feed her animals every two months. If we cut desmodium properly, it is good. Its leaves grow again in one week's time. But if animals tethered (walked) on it its leaves regeneration will be delayed for about a month.

In her area many people have stopped planting tomato because of the Striga problem. However, currently tomato is coming back because planting it is being improved due to desmodium. This is after they observed the effect of desmodium from her farm. Moreover, ants disappeared in her fruit orchard due to desmodium because it has a sticky substance and it catches them before they climb to the fruit trees. Some question and answer with visitors.

#### Question and answer

Question one - many people are suffering due to pest and disease how is the situation in your farm?

Answer one – She said that she owns 12 ha of fruit farm, where she grows different types of fruits and she planted desmodium as under growth. It served as animal feed, soil fertility improvement, reduce soil salinity and she said “I do not have any pest or disease problem in my place.” She continues explaining that she does not plow the desmodium instead they irrigate and fertilize it like the fruit trees for a better service and advantage. They keep it moist.

Question two – Somebody asked that “You grow a lot of biomass such as desmodium, elephant grass, etc under the fruit trees - do they have any health problem with the fruits and the animals? If you don’t use crop rotation in your land and then grow different plant don’t you think any fertility problem?”

Answer two – She said “You are right I grow all together for many purposes, of which plant health is one. There is no health or fertility problem I have observed so far now. We give different grasses to our cattle including elephant grass to fill their stomach. We also give alfalfa and desmodium for a better milk production. Sometimes I know by the amount of milk I get that workers did not give enough alfalfa (feed) to the cows.”

Question three – have you ever faced any disease, pest and human problem?

Answer three – It was by default I grow desmodium before anybody. Later all neighboring have planted desmodium – then no problem with mango, orange, etc in all our farms.

Question four – How do you harvest desmodium seed? We are facing challenges in collecting the seed?

Answer four – I mostly grow desmodium in my field for animal feed, pest and disease management, and soil fertility and salinity management. I cut and give to my cattle as feed. However, if I want the desmodium plant to set feed I let the plant to flower and all it until the flower matures.

Now she is rich because she has 12 hectare of fruit farms with Avocado, Mango, Orange and mandarin. She also owns a dairy farm with exotic cows. Now she built water canal structures to deliver water with over half a million Birr investment. She told us that these structures have helped her to water her 12 hectare of land in one day. Earlier she used to water 25 percent of her land in one day, means one turn, because the water leaks on the earth canal way. The next turn to get water takes one week because of the water users' rationing program. To water all her farm needs four weeks. But this water canal structures helped her to use the water efficiently.

#### 5.4 Her innovation for labor requirement and fulfill in the social system

So far she was working alone with some permanent and daily laborers. Sometimes her children and her husband helped her. Her husband who was a policeman earlier did not help her much in the activities she engaged in as he was busy in his duty. Currently he quitted/disencumbered and is working hard on their family farm. According to her his participation in the work is a relief for her because he has shared responsibilities.

In the farm of this family, there are more than 40 employees everyday on average, occasionally even more. Most of the daily laborers are students. This is because in Mereb Leke wereda she

observed increasing number of unemployment from time to time. The main challenges are: first, poverty; second, unemployment and third, school dropouts.

She wanted to contribute in averting the school dropout problem. But as there are many people who are highly affected by poverty she wanted to accommodate more people. The design was employing as many people as possible. But she wanted to get a guarantee that employees should have future plan not to get again into the same problem. This means that no dropout of students seen and they have to improve their achievements in the schools.

She also supports poor women. According to her the women who work with her should have a dream of owning their own self supporting plan such as gardening.

The society understood her plan. They go to her not only to work as a laborer but also with their own future development plan. That is anybody who is facing a problem destined to dropout goes and asks her to work in her farm not at a daily level instead by hour level. She is not a person who wanted people to work with her. Instead she wanted to change their lives with their own future dream. Some of the changes observed are:

- I. The number of school dropout students reduced. Many students completed their high school and even universities. Three of the students working with her became university lecturers in Ethiopian universities.
2. In addition to a startup capital some women got good skill and experience in vegetable and fruit production in her farm. Some of them shifted to their own farm while others leased farm plots for a better profit. In addition to the employment and the skills she supported them in getting quality seed and seedlings.

This case shows us any change at local level requires a solution at local level. This is because problems at local areas do not mean that

solutions are at the hands of professional people and the government at large.

### 5.5 Their future plan

Now as the husband and the children are part of the successful agricultural system they are participating in the plan. Their plans are as follows:

1. First phase – building watering canals to increase water efficiency. Now completed before this paper is published.
2. Second phase – opening a poultry farm in one side of their farm.
3. Third phase – expanding their fruit orchard into the nearby community through advising people. Previously they had challenges of theft, camel, etc. Now the fruit orchard has expanded into 80 hectares.
4. Fourth phase – raising and distribute selected seedling to the nearby community. This is to increase the production of fruits especially Apple Mango. Now they are getting about 1,000 quintals of mango but their plan in the future is over 4,000 quintals.
5. Fifth phase – they have a plan to introduce processing plant i.e. drying and juice. The future expectation is over production of different fruits.

They have started accomplishing their future plan. One of the recent plans was building water canals, which is started to be accomplished this year. The second plan they have was building poultry house. It is constructed but waiting finishing and introducing egg laying chicken.

### 5.6 Conclusion

In Ethiopia in general and in Tigray Region in particular the cause of poverty is war and unfavorable policy. Women are highly affected by the historical wars and consequently poverty has prevailed a lot.

However, the policy of the present government is supporting the smallholder farmers with a special focus to poor women and the environment. Many people are escaping out of the existing poverty regardless of gender and age differences.

Haregu is one of the people who escaped out of poverty through hard work and perseverance, her efforts through farming in Tigray Region. Therefore to go out of poverty it is not only the responsibility of the government but also the responsibility of every citizen like how Haregu supports other women and school children. If we are eager to support the fast growing farming system we have to work to connect farmers either with market or in the value chain which would help both producers, suppliers, distributors, processors and consumers without being selfish.

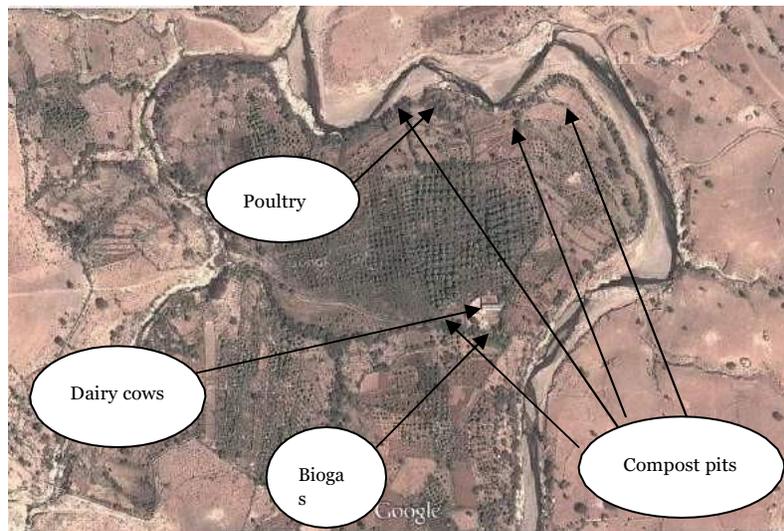


Figure 18: Haregu's integrated farm – fruit orchard with its other services

## **6. FARMERS' PRACTICE: SEX IDENTIFICATION OF CHICKS BY EGG SHAPE**

By

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Bruh W/Mariam, Leul Haileselassie, Haileselassie G/Mariam and  
Hailu Araya

### **6.1 Introduction**

Chicken production is one of the easy, cheap and fast return farms. It has been contributing a lot and plays a vital role in many poor rural households to support their families. Chicken provides a scarce resource of animal origin protein in the form of meat and egg by converting waste materials which couldn't be consumed by humans. Generally chicken are owned and kept by women and children. Therefore, there are many families in the rural and urban areas who own limited number of chicken.

Farmers are trying to innovate different means to support chicken rearing. One of them is sex determination of chicks by shapes of an egg. The inception of this innovation was come to reality after fourteen Innovator farmers from Ethiopia had participated in the East Africa Farmers' Innovation Fair in 28-29 May 2013 in Nairobi, Kenya. Farmers from Ethiopia, Kenya, Tanzania and Uganda presented their innovations. They shared their innovations but most of the Ethiopian farmers gave much attention to one of the farmers' innovations related to identification of female or male chicks by the shape of an egg.

Farmers' preference either to have greater number of male or female chicks from their brooding hen, depends on the purpose of their production objective. Whenever the farmers' objective is to increase the flock size, then to get more eggs and offspring definitely; their first preference is to have the female chicks. On the other hand if market and meat is the farmers' objective they prefer to have more male chicks. In most case farmers tend to have more female chickens than males. However, the possibility of getting male

and female chicks is determined naturally. No farmer can manipulate to the mother hen to change the sex of her baby chicks. There is no knowhow and skill to identify sex of chicks using the shape of eggs and hence unable to incubate the eggs that carry distinguished sex.

Sensing the problems they faced before and foreseeing its advantage for the poultry keeps the participant innovative farmers from Axum area planned to experiment this case in collaboration with Aksum University, Axum Agriculture Research, BPA and ISD through the support of the Rockefeller Foundation through the PROLINNOVA International (ETC Foundation) under the project called Strengthening resilience to change: Combining Local Innovative Capacity with Scientific Research (CLIC-SR).

## 6.2 Objective

The objective of this farmer-led experimentation was sex identification of chicken by looking an egg shape before they are hatched. The hypothesis is shallow/Motmat/ Chelaq is female while the broad edges (dimbilbulo) are male.

## 6.3 Materials and methods

Study area: the study was conducted at Mayberazio and Maisiye PAs, Tahtay Maichew district central zone of Tigray. This district is found around 260kms far northwest to the regional capital Mekelle along the main road. Mayberazio and Maisiye are model PAs of Tahtay Maichew district in which many agricultural technologies demonstrated and popularized.

Researcher farmers have identified different criteria to conduct the joint experimentation. These are as follows:

First, identification of egg shapes. The shapes of the eggs should be very clear either sharp/ narrow edged or broad edged.

Second, identification of good season for the joint-experimentation i.e., according to farmers, the weather for hatching season by chicken should not be too wet or too hot. This is because for the local chicken breed too wet or too hot weather is not comfortable to seat for a required time with the eggs until naturally hatched.

Third, on deciding how to apply the hatching process, because it is not easy to identify which chick is from which type of egg after hatching; the experimentation team has agreed to choose one type of egg to introduce for hatching.

Fourth, identification and selection of volunteer farmers for the experimentation. There were five experimentations conducted during the 2014 seasonal year by two farmers i.e. Ms Brha Tadesse from Mai Siye and Mr Abadi Redehey from Mai Berazio Kebeles of Tahtai Maychew District around Axum.

#### 6.4 Result and discussion

The results of the five joint-experimentations conducted are summarized in table 1 below. Out of the 41 sharp/narrow edged eggs hatched with a hypothesis all will be female the 37 became female. Then the average determination level of the experiment was 90 percent getting the required level i.e. Sharp/narrow edged eggs give female chicken and Broad edged eggs give male chicken.

The average hatching level accounts for 87 percent only with a range from 84.6 to 90 percent. The more eggs given to the chicken to hatch the lower the number of eggs hatched while the less the number the more it hatches. Therefore, the result of the experimentation indicates the number of eggs also matter in the hatching level.

Table 3: Results of experimentation hatching level and sex identification

S.N.	Date	Shape of eggs	No. of eggs	Hatched	Female	Male
1	April 2014	Shallow	13	11	10	1
2	June 2014	Shallow	14	12	11	1
3	ND	Shallow	10	9	8	1
4	ND	Shallow	10	9	8	1
5	January 2015	Shallow	9	8	8	0
6	ND	Shallow	10	8	8	0
7	September 2014	Shallow	10	7	7	0
8	December 2014	Shallow	6	5	5	0
<b>Total/ average</b>			<b>82</b>	<b>69 (84%)</b>	<b>65 (94%)</b>	<b>4 (6%)</b>
1	June 2014	Broad	9	6	0	6
2	December 2014	Broad	8	5	0	5
3	April 2015	Broad	9	6	0	6
<b>Total/ average</b>			<b>26</b>	<b>17 (65%)</b>	<b>0</b>	<b>17 (100%)</b>

Then the average determination level of the experiment was 90 percent getting the required level i.e.

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Figure 19: Sharp/narrow edged eggs give female chicken



Figure 20: Broad edged eggs give male chicken

### 6.5 Conclusion and recommendations

Many people were excited about the result of the research because identifying sex by the shape of an egg is new. Farmers decided they wanted to use the result of this research in order to plan. For example, if they want to get egg lying chicken (female), they planned to use the narrow/sharp edged eggs while if they want to sell cock, as they are expensive, during festivities (New Year, Easter, Christmas, etc) they use the broad edged eggs. At the same time all participants proposed a verifications work by the formal research (Research and University).

## **ANNEX A:**

### **PREPARATION AND USE OF BIOFERTILIZER BY SMALLHOLDER FARMERS**

By

Hailu Araya, Gereyesus Tesfay, Gebremeskel Gidey, Gebrehiwot  
Zibelo, Arefyane Asmelash and Sara Misgina

#### **A.1 What is biofertilizer?**

In this context biofertilizer is a liquid natural fertilizer made from green vegetation mixed with liquids i.e., water and/or dung and/or urine. Farmers also called it as plant liquor, plant juice, liquid manure, plant tea, plant glucose and manure tea. In other words, it is a fermented juice of leaves, fruits, stems or roots of plant materials prepared by chopping and soaking with liquid material. The plants or green materials used for the preparation of biofertilizer are of plants rich with high nutrient content mainly of nitrogen. The plants included are clearly known by their soft leaves and dark green.

Farmers have started to use biofertilizer on fruit trees and vegetables. However, today it is wide spread in its use in cereals/field crops. Accordingly the practical experiences of smallholder framers in Northern Ethiopia, specifically, Tahtay Maychew area of the Tigray Region, has been highlighted below showing evidences that they are used to improve the productivity of crops.

#### **A.2 The necessary inputs for the preparation of biofertilizer**

The necessary materials for preparing biofertilizer by farmers can be generalized into four:

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- i. Leaves, stem, barks and roots of softer plants - to mention some of the plants used in Tahtay Maychew area are astenagir, abisho, hohot/hakot, Beles, Endod, kinchib, ada'ekua, Alke, shibaka, shum'eza, croton, argomane, engule, left-over of fruits and vegetables (orange, papaya, guava, lettuce, cabbage, tomato, etc), and different types of weeds especially parthenium can be added if available. However, this list varies from place to place depending on the availability of vegetation type. The difference is when bitter and/or toxic plants are added they should be well mixed with water during application.
- ii. Urine – this could be of human and animal.
- iii. Fresh dung – mainly cattle, equines, etc.
- iv. Water



Figure 21 - Soft leaved green materials

### A.3 Necessary equipments used in preparing biofertilizer

There are materials used for the preparation of biofertilizer. These are useful to collect, transport, chop, store, etc. However, the best

way for farmers is to recommend simple materials which are very accessible to farming community. To mention some of them are as follow:

- I. Cutter- such as scissors, knife, sickle, etc.
2. Grounding – it varies from mortar to a crushing stone.
3. Even though farmers say softer vegetation materials are not harmful, it is better to recommend for farmers to have covering materials for their hands and eyes. It would be best if farmers are provided with hand gloves and eye glasses.
4. Containers – to soak during fermentation period. This should be big enough to prepare enough biofertilizer. This container could be plastic, barrel or clay material but should not be a material used for food items or preparation of local drinks.
5. Stick – this is to be used frequently for stirring the soaked materials.
6. Sack, cloth or net – in order to filter or separate the liquid from the solid part of the biofertilizer after the fermentation process is finished.
7. Plastic materials such as empty packed water containers in order to store when the biofertilizer is not in use.
8. Nab sac – it is used for spraying during application. However, this does not mean each farmer requires it. They can share. But most farmers use the nab sac distributed by the extension for pesticides application.

#### A.4 Preparation of biofertilizer

Normally biofertilizer can be prepared directly by chopping the vegetation/plant materials, soak with water and apply immediately. But the effect of this kind of application is low because it does not contain the required amount of nutrient. However, there are three ways and types of biofertilizer preparations. These are:

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A.4.1 Preparing biofertilizer from vegetation materials only. This is through:

- i. Making ready and clean any type of available container (barrel, plastic or clay material).
- ii. Collecting leaves, waste/leftover of fruits, stems, roots and barks of plant of vegetation.
- iii. Mixing all together
- iv. Chopping into pieces and then ground them in a mortar if not by crushing with stone.
- v. Making ready the required amount of water.
- vi. Putting all the chopped materials in the clean barrel, plastic or clay container.
- vii. Adding enough water which makes the container almost full altogether.

A.4.2 Preparing biofertilizer from vegetation/plant mixed with urine or fresh dung (one of the two) and water

- i. Follow all the steps i – vii mentioned above (section a)
- ii. If you are to add urine or fresh dung make ready the required amount
- iii. Add 1-2 liters of human or animal urine or 1-2 kg of fresh dung into the container. However, it varies by the size of the container and the amount of materials used.

A.4.3 Preparing biofertilizer from vegetation, urine and fresh dung (both)

- i. Follow all the steps i – vii mentioned above (section a)
- ii. Make ready both 1-2 liters of urine and 1-2 kg of fresh dung.
- iii. Add 1-2 liters of human or animal urine and 1-2 kg of fresh dung into the container. However, it varies by the size of the container and the amount of materials used.



Figure 22 - Chopping and grounding the green materials

#### A.4.4 Finishing the process

- i. Mix all together
- ii. Add everything into a container
- iii. Stir them while in the container regularly (at weekly level is enough)
- iv. Should be placed in a shade, covered and out of reach of children.

N.B.: From farmers experience please do not forget

- i. Stir the soaked materials in every week until it is fully fermented
- ii. If the bubbles observed while freshly prepared is finished in the container it is the sign of maturity of the biofertilizer. Normally the required dates are 21 – 30 days.
- iii. Filter or separate the biofertilizer from the fibrous celluloses before application
- iv. Do not use before diluting with water at **1:10** proportion i.e. one unit of concentrated biofertilizer to **10** units of water



Figure 23 - Soaking the green materials with water

#### A.5 Farmers' application of biofertilizer

We can apply biofertilizer to any types of crops. But care should be taken not to use before diluting the concentrated biofertilizer with water. The steps in applying biofertilizer are as follows. These are:

- i. Check if the fermentation process is finished by observing to the bubbles in the container.
- ii. Prepare clean and enough containers to store the biofertilizer. This is only if you are not to use it immediately.
- iii. Dilute the matured and concentrated biofertilizer at least to a **1:10** proportion i.e. one unit of the concentrated biofertilizer into **10** units of water. This is to indicate if the juice is too strong because it may affect the plant or crop.
- iv. If we are not using the biofertilizer then put in a container until we are ready to use.
- v. After diluting the biofertilizer with water apply to

- Vegetables - first loosen the soil and then apply directly around the root zone.
  - Fruit trees - first loosen the soil and then apply directly around the root zone.
  - Field crops – apply when the crop has to be at least 3-5 true leave level. Better to apply around the root zone.
- vi. If disease or pest is observed in the crops apply directly on the leaves. This will help in protecting the crop. But add more water to the concentrated biofertilizer because it has crop protection work.



Figure 24 - Preparation or mixing the concentrated biofertilizer with water before use by Farmer Gebreyesus Tesfay

#### A.6 Effect of biofertilizer

Using biofertilizer has shown significant results under farmers' application. The best results observed are in vegetables (lettuce, beat-root, cabbage, green pepper, tomato, and pumpkin); fruit trees (banana, enset, papaya, guava and orange) and field crops (wheat, barley, maize, finger millet, sorghum and tef). The effectiveness and efficiency of biofertilizer is high when it is applied in row planting and targeted individual plants. The following evidences were observed from the users. These are:

1. Cabbage - many farmers tried biofertilizer in vegetables. Ato Gebreyesus started using biofertilizer in some part of his cabbage field i.e., to try it out if it works well. He applied the biofertilizer into 5-7 heads of cabbage. The cabbage he applied with biofertilizer was impressive. It was not only bigger but also matured earlier than the cabbage grown by chemical fertilizer. However, he could not sell them in the local market because it was too big for a family use while he did not have a market link with a hotel. Therefore, he used the cabbages for his family consumption and animal feed. According to his research team (mainly neighbors) they understood it worked well whenever they are connected with hotels.



Figure 25 – Ato Gebreyesus’s cabbage field (to the left of the line with chemical fertilizer while to the right of the line is by biofertilizer)

2. Lettuce and salad – all the lettuce and salad applied with biofertilizer look deep green, wide leaves, matured early and there was no pest or disease observed.
3. Green pepper – the green pepper produced by biofertilizer application had healthy stem, deep green, good looking, too many and bigger fruits. It was resistance to pest and disease such as root rotting as compared to the other input application.
4. Maize – the maize applied with biofertilizer had healthy and strong stems and bigger cobs. It was resistance to pest and disease especially to termite as compared to the other input application.
5. Onion and garlic – the onion and garlic applied with biofertilizer were deep green, big sized, matured early and there was no pest or disease observed.

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Figure 26 - The performance of garlic and onion by biofertilizer application (Tahtay Maychew area)

6. Fruit trees – when farmers applied biofertilizer on the root zone, stems and leaves of weak performing mango, orange and papaya trees their leaves became deep green immediately.
7. It also serves as pest control when seeds of chick peas, wheat, field pea, faba bean, etc when soaked before sowing.

### A.7 Diffusion of the technology and approaches

Biofertilizer application was started in Tahtay Maychew since 2008 by four farmers (2 in Kewanit and 2 in Hadush Adi). In 2013 it was spread into 26 farmers in five tabias (Kewanit, Hadush Adi, Tisha, Mai Siye and Akab Se'at). The spreading strategies were:

- First, train selected number of hardworking and influential farmers;
- Second, demonstrating in farmers who are convinced and then agreed to try in a very small plot;
- Third, demonstration of the best performing farmers and their fields through organizing an exchange visit. **N.B.:** Very important - most explanations should be by the best

- performer farmer/s. Give an opportunity for those experimenting farmers to speak frankly and honestly;
- Fourth, train other farmers by the best implementer farmers. This is because farmers trust other farmers because farmers are socially responsible for any fault. Involve the experimenting farmers in the training of other farmers. They have similar psychological and language.

## A.8 Conclusion

As observed above application of biofertilizer has indicated an immediate response in changing the performance of plants (vegetables, fruits and crops). The performances of the stems, leaves and fruits are impressive. The release level of their nutrient is very fast. Their production level has improved dramatically. Therefore, helping farmers to prepare biofertilizer in a simple way is highly recommended. As there is high demand of nutrients for crops in irrigation areas it could be one inlet in dissemination of this technology. It has a high potential in soil productivity improvement with the population pressure and cultivation of marginal areas.

Farmer Gebreyesus produces enough biofertilizer for himself and offer for others for free. He wishes to see all people in his village prepare and use biofertilizer in the future and become as a business to sell for other people. The use of biofertilizer is not confined for household consumption on different plants but also he plans to serve as a source of income by selling the input. This will contribute to the increase of production in the areas and attributes to equity as the price will be lower than the artificial fertilizer.

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PROMOTING Local INNOVATION

### PROLINNOVA

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