



Combining soil conservation and fodder production for an adaptation to climate change

Southern region – Ethiopia



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Forewords

This work reports the story of a major innovation in the farming practices of southern Ethiopia. This innovation was born 10 years ago and its success has never wavered since. The main reason of its favorable outcome comes from its triple relevance: relevance to the perceived needs, to the environmental challenges and to the available local resources. This document describes in detail the different aspects of the innovation, starting by a presentation of the climatic stakes and the consequences of rainfall pattern change in the global picture. Then a brief history from the beginning recalls that the process of an innovation is anything but linear. The methodical description of the innovation process and more specific highlights on the major aspects of the technical sequence are the main subjects of the chapters C & D. The different factors at play in local adoption, as a decisive dimension of any promoted practice, are then covered in the following section, including the sustainability of the adopted practices. The chapter F focuses on a critical analysis of the innovation's impact, documenting the produced effects under multiple reading angles. Together with the adoption issue, the question of impact assessment remains central to any scientific approach. Therefore, this part of the document is trying to identify all the objective and measurable benefits and profits generated by the dissemination of the innovation. Eventually, the last section is dealing precisely with the issue of diffusion and scaling up, as the last but not least dimension of an innovation story...

Figure 1: Woman harvesting fodder on soil and water conservation structure



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Figure 2: Location of Inter Aide intervention

The experience presented is located in the Southern Region of Ethiopia, the "SNNPR" which counts about 16 million people. The targeted districts are Kembatta and Wolayta (total population of 2,3 million people) where over 85% of the household depends on agriculture. Family farming is based on the culture of Enset (*Enset ventricosum*), cereals and tubers, and a fairly small home garden, intended primarily for family consumption (cabbage, yams, spices, coffee ...). The average surface of the farms is about 0.5 hectare, which makes Food Security an objective difficult to achieve. While Enset and garden byproducts are largely self-consumed, cereals are primarily a cash crop. In the upper climatic stage of Kembatta (above 1900m altitude), cereal production is composed of wheat and barley, teff being auxiliary. In lower agro ecological stages, there is a higher biodiversity of cereals, including corn, sorghum, teff, wheat and barley).

A. Climate changes: farmers' perception and highlights

Considering the diversity of the mountainous landscapes of southern Ethiopia, it is difficult today to forecast the effects of climate changes on specific local areas (Hubert Cochet, 2009¹). However, it appears that these changes contribute to exacerbate an already fragile situation. This section provides an overview of farmers' local perception on the climate changes, in parallel to an analysis of 14 years of records of daily precipitations. A second part addresses the main causes that affect the resilience of small-holder families and their difficulties to face changes and uncertainties in the local context. The problem is not so much the climate change itself but more the poverty that affects their capacities to cope with changes and hazards in general.

Rainfall variability: the highest source of risk felt by farmers

The local farming system is based on rain fed agriculture and cattle breeding... and **rainfall variability is seen as the highest source of risk and insecurity by 81% of the households**². Further, farmers consider local rainfall as increasingly irregular, delayed and with inadequate seasonal distribution during the last decade:

- ⇒ **85 % of farmers** report delays of the first rains during the small rainy season (*Belg*), with serious consequences on crop, fodders resources as well as livestock production and productivity.
- ⇒ **63% of the respondents perceive an increase of rain intensity events**, aggravating erosion problems.

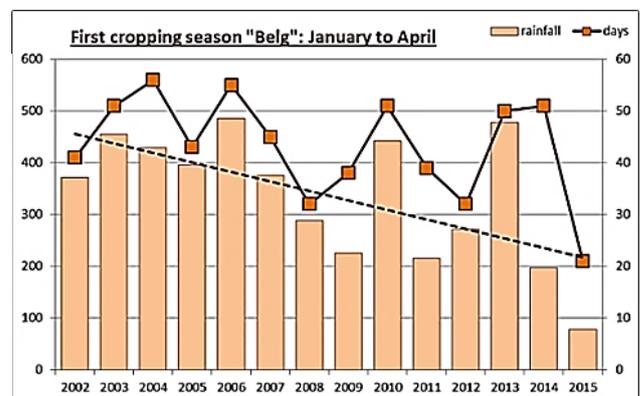
Farmers emphasize that late sowing during the first cropping season (*Belg*) prevents adequate soil preparation for the main cropping season (*Meher*), as the time gap between the first harvest and the following sowing does not exceed one month. They also notice that crop yields are affected by seasonal changes: **62 % of farmers highlight a drop of food availability during the hunger gap** (April-May) due to the shortage of their own farm products and to a substantial increase of food prices; they relate inflation to a general reduction of yields. Finally, as the hunger gap is longer, they mention that the food stock and fodder resources are getting scarcer.

Daily rainfalls record: global trends

An analysis of the 14 years of daily rainfall collected by Gununo research center (Wolayta Zone) shows several tendencies that will of course need to be confirmed with the future records:

A decrease of seasonal precipitation recorded during the small rainy season (*Belg*):

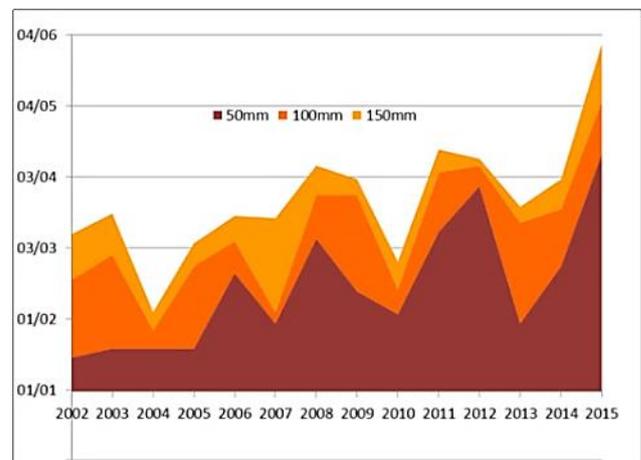
For 14 consecutive years, the following chart focuses on the period "January to April", that corresponds to the onset of the small rainy season. It indicates, for every year, the cumulated precipitation for this period (with the linear regression) and the number of days recorded with rains. A clear downward trend concerning the global amount of rain recorded can be observed, coupled with a progressive reduction of the number of rainy days.



An increasingly late arrival of the small rains accompanied by a decline in rainfall:

This scenario is confirmed by the fact that the mark of 50mm of cumulated rain gradually occurs at a later period in the year, as indicated by the following chart.

It shows, for each year, the dates corresponding to the attainments of 3 cumulative thresholds of precipitation (50, 100 and 150mm).



Understanding the rainfall pattern and its link with the cropping system:

In southern Ethiopia (Wolayta and Kembatta zones), the rainfall pattern includes three main seasons:

- A small rainy season: "*Belg*", from February to April
- A main rainy season: "*Meher*" from June to September
- A relatively long dry season, from October to February.

The timing and opportunities of the Belg cropping season is critical for farmers' food security, as it determines the following 2 successive and complementary harvests, as well as the distribution of farm productions all year long.

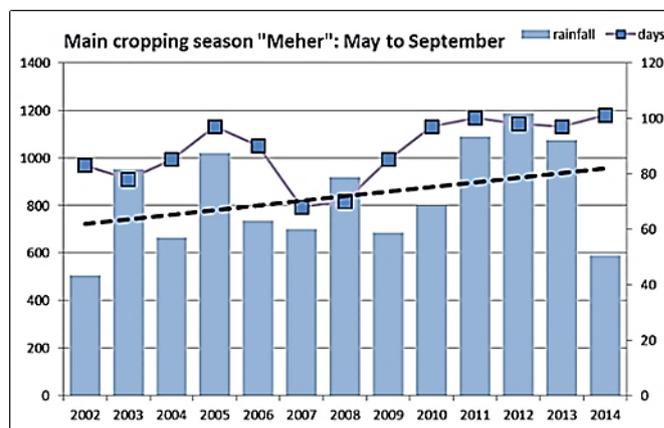
1 Cochet Hubert, Agro Paris Tech, 2009, L'agriculture éthiopienne face à l'accroissement du risque" (<http://www.cfee.cnrs.fr/spip.php?article176>)

2 Survey conducted among 43 farmers in 2015

A slight upward trend as regards both number of rainy days and global amount of rain during the main rainy season (Meher).

The linear regression indicates the trend on the cumulated seasonal precipitations.

Related to that, there is a 20% increase of the number of annual intense rainfall events (more than 20mm of precipitation per day) over the 14 years, which may negatively impact soil erosion.



Those observations indicate that farmers are affected by climate changes mainly during the first cropping season, which is essential for their food security. Indeed, traditionally, the early harvests at the end of the *Belg* mark the termination of the hunger gap (food and fodder) after the dry season.

Causes of poverty, resilience and climate change

In South Ethiopia, wealth at the household level is primarily determined by two factors: the size of cultivated land and the number of livestock owned. **The role of the demographic density in chronic food insecurity is absolutely central.** As a clear indication, the surface of arable land per family has been divided by 3.48³ on average within one generation. Today, a farm in Wolyta or Kembatta has an average surface of 0.4 to 0.5 ha. Besides, erosion is worsening the situation, reducing year after year the surface of land. Some farmers are gradually compelled to abandon part of their plots, and most of former grazing areas have become unfit even for pasture.

A recent Agrarian Diagnosis (*Cheveau & Hoornaert, 2011*)⁴ revealed that the historical reduction of the cultivable plots was much faster than the decrease in the number of livestock per family, resulting in a decline of fodder units per cattle head. The intensification of farming practices have also led to the gradual replacement of pasture by stabling. So far, farmers have overcome the increasing shortage of fodder resource through the adoption of a feeding system based on a "cut-and-carry" practice, but at the cost of more labor and/or expenses. The expenditures to get fodder represent nowadays a substantial proportion of the tight family budget.

The repeated droughts due to the extension of dry periods, linked with the recurrent food and fodder shortages, coupled with the inadequate extension programs and the continuous land fragmentation have resulted in a progressive weakening of the farming system and family resilience: decrease of the number of species and varieties grown (loss in biodiversity), decrease of biomass level in the ecosystem, reduction of livestock, depletion of Enset grove. All these elements contribute to a gradual decline of soil fertility and affect farmers' capacities to adapt to climate changes.

3 keys of the south-Ethiopian Rural Paradigm.

1/ The role of demographic density in this part of south Ethiopia chronic food insecurity is absolutely central: the division of the family land between the male heirs leads to a splitting up process which severely deteriorates food security. Wolyta, for instance, has some of the highest rural population densities in the world, from 300 to 600 inhab./km² in some areas, which is comparable to Rwanda. Rural exodus is still in its early stage in Ethiopia, and is therefore not mitigating demographic growth. The progressive reduction in the size of cultivable plots induces an intensive exploitation of every square inch of available land, leading to a totally anthropised environment.

2/ Southern highlands agriculture depends on a very large extent on animal traction. However, less than 25% of rural households have presently the opportunity to possess a yoke of oxen, others are forced to find arrangements, sharing animals under multiple types of contracts. Increased food insecurity explains the multiplication of those agreements in the sole prospect to have access to animal workforce, whatever the conditions, sometimes extremely unfavorable for the applicant. Furthermore, maintaining cattle is becoming more and more difficult in a context of land and fodder acute shortage

3/ Soil erosion and the gradual loss of fertility. From a physical point of view, the concerned areas have a mountainous profile that split the environment in different altitudinal and agro-ecological zones from 1300 to 2500m and above. In a highly densely populated rural area, the combination of a steep topography and high rainfall events pattern results, in the absence of adapted measures, in intensive erosion of the open fields. Over the past 14 years, the prevalence of intense rainfall events is increasing as well as the overall amount of annual rainfall. This evolution negatively affects the traditional mixed cropping & breeding farming system, reduces soil fertility and compels more and more families to give up land plots becoming gradually unfit to cultivation and even pasture.

³ Data collected from 34 interview families in July 2015

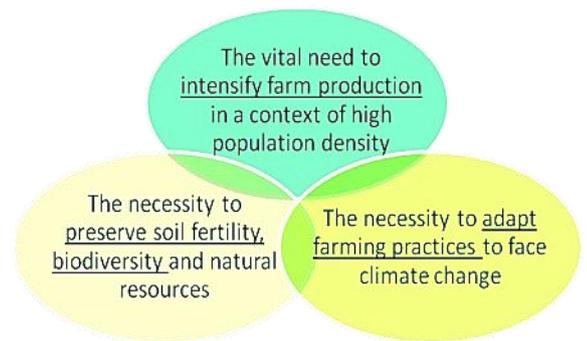
⁴ Cheveau Aurelie et Hoornaert Camille, 2011, Analyse diagnostic d'une petite région agricole du sud de l'Éthiopie : Kambatta, Woreda de Doyo Gena,

B. Combining soil conservation and fodder production for an adaptation to climate change

Presentation of the practice

As many other small-holder farmers, families of south-Ethiopia are facing 3 major challenges:

- The **vital need to intensify and diversify their farm productions**, on very small surfaces, in a context of high population growth. In these rural areas, the population is expected to double in less than 35 years (*est. Index mundi*);
- The agricultural practices must **preserve the environment to maintain its productive capacity**, for the current and future generations
- The necessity to rapidly adapt farming practices to **cope with climate changes**



In this context, the core innovation that has been developed and widely diffused consists in **combining soil conservation and fodder production**, in a view of protecting entire **micro-watershed**, and better adapt to **challenges induced by climate change**

The basic idea is to consider the necessity of soil conservation and climate-changes adaptation as an opportunity to directly improve and diversify the farm productions, through the integration of fodder and biomass production, and gradually engage the farmlands in the preservation of entire micro-watersheds.

Three elements reinforce the relevance and sustainability of this practice:

- The multiplication of vegetative material by the families themselves in **farm based micro-nurseries**;
- The promotion of forage production, by **associating grasses and legumes**, in unproductive or underused spaces to address the crucial livestock feeding problems and reduce the pressure on Enset (*Enset ventricosum*), a fundamental plant for the food security of many families in the area
- The involvement of vernacular organization to create a dynamic of soil conservation at the micro-watershed scale and to address the critical issue of **animal open-grazing control**.



Figure 3: Soil bund planted with *P. Riparium* associated with *Cajanus cajan*



Figure 4: Panoramic view of a rehabilitated micro-watershed in Doyo Gena

Origin and development of an innovation process...

From the beginning, Inter Aide has focused its attention on meeting environmental challenges, notably in the field of erosion control. The first objective was to respond effectively to the soil leaching issue by installing physical structures to regulate the water flow, in order to curb nutrient losses and to improve soil moisture and fertility. Soil bunds (embankment-and-ditch structures) were progressively adopted as the main technical option, on the basis of farmers' acceptability more than technical standards. Those structures presented some limitations: they are labor intensive (5 to 10 hours for 1 person to build 10m), they occupy up to 6 to 8% of the cultivated land and need regular maintenance to avoid the leaching effect.

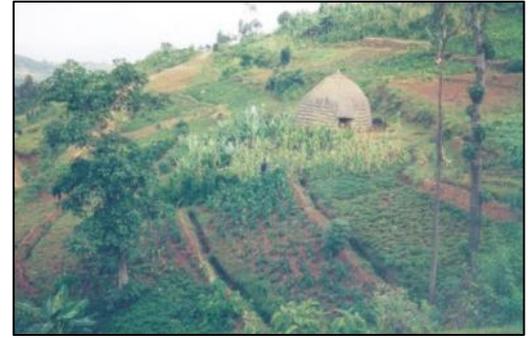


Figure 5: Promotion of physical structures (soil bunds) to control erosion, 2004

To fix the top soil of the structure and consolidate the soil bund with vegetation, Inter Aide team initially promoted the plantation of Vetiver (*Vetiveria zizanioides*) on the embankments. This grass species is usually recommended against erosion, as its deep vertical root system enables a strong anchoring effect and helps water infiltration. Ironically, Vetiver was also selected for its thick unpalatable leaves that animals do not eat, as the main purpose was to protect the vegetative material against grazing!!!

Figure 6: Planting Vetiver grasses (as "non-palatable grass") to consolidate the physical structures finally appeared to be a wrong track, considering the context specificities.



A key limiting factor quickly appeared to be the quantitative availability of the vegetative material and its survival. Indeed, the project was mainly multiplying Vetiver plantlets in a central nursery. But the onerous logistic and the related substantial expenses, allowed to reach a restricted number of farmers only, with relatively low survival rates of the plantlets. The promotion of farm based micro-nurseries to multiply and grow grass species was an appropriate logistic and methodological response. It gave the opportunity for farmers to independently multiply and transplant seedlings at the right moment, resulting in a higher survival rate.

In 2005, an agrarian diagnosis commissioned by Inter Aide emphasized the vital role played by fodder in the local farming system. This was an actual methodological cornerstone and an eye opener in the understanding of the milieu: a mixed cropping and breeding farming system in a context of accelerated depletion of fodder. Integrating fodder on the soil bund became a decisive component as access to fodder influences family vulnerability. Ten years ago, no family grew fodder and women, in charge of animals' feeding, spent up to 1 hour per day to collect crop residues and glean weeds in order to feed livestock. In the dry season, many households would resort to Enset leaves to feed animals to the detriment of family food.



Figure 7: Fodder production on soil bunds using drought resistant varieties gives farmers the opportunity to have reserves to feed their livestock during the dry season or/and an alternative source of income. They can decide the more appropriate time to harvest the fodder

The introduction of fodder production became the core of innovation. Based on the above observations, Inter Aide identified species with appropriate rooting system, highly productive in biomass, easy to multiply and with a good feeding value for animals. *Pennisetum riparium*, an endemic grass, little known and poorly disseminated, met the required criteria: (i) deep rooting, (ii) good quality forage, (iii) rapid growth allowing several cuts in the year and (iv) easy to multiply in family backyard nurseries.

Nowadays, the innovation also relies on two complementary aspects:

1. The progressive diversification of species grown on the embankments to preserve fertility and increase biomass production leading to the concept of productive hedges. The promotion of biomass production, combining fodder grasses and leguminous species on anti-erosive embankments, provides a direct response to animal fodder scarcity while contributing to maintaining soil fertility on the long run
2. The mobilization of traditional organizations, the "Iddirs", as the coordinating body to manage anti-erosive master plans at micro-watershed level and to setup rules to control open-grazing. Iddir is a traditional system of mutual aid based on a contribution of the members in exchange of material support at the time of funeral or other hard blows. Benefiting from a strong collective recognition, this vernacular organization has a tremendous economic importance, notably for the poorest, but had never really been integrated in the institutional landscape. Iddirs have played a determinant role in the diffusion of the new practices and in the establishment of rules to control open-grazing.

The integration of fodder production coupled with the strong involvement of Iddirs have been the triggering effect that encouraged farmers to setup vegetalized soil bunds to control erosion and rapidly obtain alternative sources of fodder and/or incomes.

Local adoption and comparative advantages

Supporting smallholder-farming families to reduce food insecurity through a dual strategy, combining soil and water conservation with fodder production became the main project goal. If a number of projects have focused on soil and water conservation, in parallel to improve crop and fodder production, few have considered the combination of conservation and biomass production as one of the little opportunities offered by such a constrained and “anthropised” environment. As Indeed, the success is undeniable: since 2006, this model has been successfully tested and duplicated in more than 200 micro catchments, each of them involving on average 80 families (which represent about 100 000 people in total). The main advantages are:

In 10 years, the project has supported 13.000 families who have constructed more than 1.800km of vegetalized soil bunds.

- **The land loss due to erosion control structures** (estimated at 6-8% of the plot) is **offset** by the intensive use of embankments as biomass production support (grasses, legumes, banana trees, shrubs).
- **The vegetalized structures help reducing the effects of soil erosion, avoiding further loss of fertility** (through better nutrient and water retention and due to the presence of leguminous plants on the structures, such as *Cajanus cajan*).
- **Fodder production benefits to all categories of families.** Intensive fodder cultivation on anti-erosive embankments (where the fertility is maximal) proved extremely profitable for the poorest families as the most important source of cash in an environment where such opportunities are extremely rare, as well as for the better off farmers, who can increase their livestock, milk production and animal fattening.
- **Fodder production also benefits to women and young girls** by reducing the burden on gleaning natural grass
- **The decrease of the pressure on Enset plantation**, usually overexploited for cattle breeding in the dry season, brings a positive effect on human food security. Enset is a key element for those smallholders’ farmers in terms of food reserves, shade generation or protection against wind and drying of soils. Enset plantation is an objective marker of poverty: the poorer the family, the smaller the number of Ensets...



Figure 8: Anti-erosive structures and fodder production in various farmlands

Institutional, national and regional policy aspects

Since 2011, the policy is guided by a new framework document, the Growth and Transformation Program (GTP) with a specific rural development program, the Agriculture Growth Program (AGP). The latter develops a clearly productivist vision, focusing on growth agricultural production with the aim to cover domestic demand and generate sufficient surplus to feed a food industry. Regarding the management of natural resources, the different policies put forward a series of instruments: (i) strengthening land tenure (land certification), (ii) strengthening community capacity for participatory watershed management (iii) promoting scalability of relevant models and (iv) strengthening the exchange of information on natural resource management and dissemination of the most relevant and innovative practices. As a matter of fact, **in 2007, The Southern Nations, Nationalities and People’s Regional State** issued the **Rural Land Administration and Utilization Proclamation** putting a strong emphasis on land conservation and rehabilitation.

To implement sector based policies, the Ministry of Agriculture (MoA) has established an office in each district with a network of Development Agents (DAs) assigned at field level. Since the beginning, Inter Aide has opted to closely collaborate with them looking for multiplier effects. The original reluctance of the Ethiopian State towards private enterprises and civil society organizations prevent the local agents of the MoA to naturally recognize the traditional organizations called "Iddirs" as key stakeholder resource. Nevertheless, such a model has succeeded in convincing some local agents of the MoA of the great interest to rely on Iddirs to coordinate the operations and help their communities to control open grazing. The same remark may apply to the production of fodder, which is not a traditional focus of local policies, but which progressively gains ground in the decision makers’ mind... The results have been remarkable in Kembatta area, where institutional agents have adopted the main technical options and developed similar activities in the neighboring areas.

Main lessons learned

Identifying practices and innovations combining risk mitigation (soil and water conservation) and **increasing resilience strategies** (management and storage of biomass), is what ultimately counts. The promising innovations are those that improve resilience. Today, the success of the model is primarily based on the diffusion of a combination of practices, which complementarity is paramount in the adoption, ownership, dissemination and sustainability of the action: the promotion of biomass production, combining fodder grasses and leguminous species on anti-erosive embankments, provides a direct response to animal fodder scarcity while contributing to maintain soil and fertility on the long run. Moreover, fodder production today represents one of the most important sources of short term cash for farming families.

The major elements of the innovation can be classified into 2 groups: those that improve resilience and those that reduce risks while preserving natural resources:

- **Improving Resilience and alleviating poverty** (between brackets, the corresponding poverty markers):
 - ⇒ Anti-erosive structures maintain soil fertility and allow degraded land reclaiming (*no anti erosive work and poor soil fertility*)
 - ⇒ Fodder plant multiplication is managed by the farmers themselves in micro farm-based nurseries (*absence of conservation of vegetative material*)
 - ⇒ Forage production generates a quick alternative income, facilitating the access to livestock and organic manure (*no animal owned under contract*).
 - ⇒ Fodder production is a factor of diversification (*loss of biodiversity*)
- **Risk mitigation and natural resources management**
 - ⇒ The innovation encourages an integrated approach of the micro-watershed, not only as a geographical unit, but also as a socio-economic unit and a bio-physical unit, and aims at a complete protection of the catchment.
 - ⇒ Activities correspond to the guidelines and priorities of the Ethiopian government and could be promoted by the local training centers.
 - ⇒ The role of Iddirs in enforcing anti-erosive measures and coordinating the work at micro watershed level is fundamental for social acceptance and allows an important lever effect.
 - ⇒ Further, Iddirs are the relevant bodies which can take constraining measures to control open-grazing for instance, which is of paramount importance to sustain the structures.

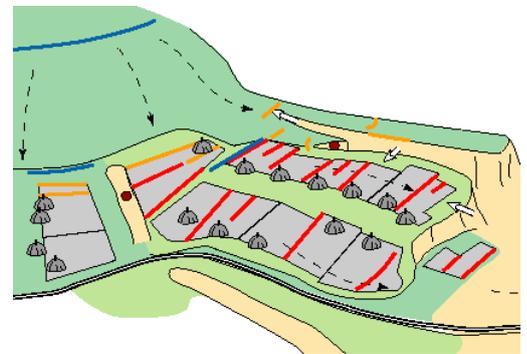


Figure 9: An example of master plan to effectively control erosion at community level



Figure 10: Panoramic view of a micro-watershed protected with vegetalized anti-erosive structures – Hadero district

C. Best practices at a glance

This part concentrates on the technical aspects of the proposed solutions. It has been organized around 3 mains topics:

- Family farm-based micro-nurseries allowing a rapid introduction, multiplication and diffusion of vegetative material
- Integrating fodder production and soil & water conservation
- Open grazing control and fodder production management



Figure 11: Various farms integrating diversified fodder species
a) Permanent fodder production plot with *Pennisetum .riparium* associated with *Desmodium*;
b) *P. riparium* on anti-erosive structure and *Cajanus cajan*;
c) One can see the levelling effect of the vegetalised structures planted with *P.Riparium*;
d) *Penisetum riparium* with *Cajanus cajan*;
e) Dedicated plot of diversified fodder species including *P.riparium*, Bana grass, *Desmodium*, and a hedge of *Sesbania sesban*

Farm-based micro nurseries: a rapid access to large quantities of fodder

Integrating fodder in the farms: the constraint of access, multiplication and conservation

Growing fodder is not a widespread practice in Southern Ethiopia. Many reasons can explain the very limited development of fodder production, among which Duncan A. et al (2011) emphasize the very low availability of forage seeds, as the Ethiopian seed system is mainly dedicated to cereal production. In addition, according to researchers from the International Livestock Research Institute (ILRI) and the International Food Policy Research Institute (IFPRI), organized markets for quality forage practically don't exist, both at a local level and on a larger scale. Moreover, the demographical pressure on resources is correlated with a gradual imbalance between available natural grass and farmers' needs to feed their cattle, which is essential in the agrarian systems of South Ethiopia.

An article written in 1988 by Tolera and Said⁵ already highlighted the relevance of integrating fodder production within farming systems: "*Because of the high population density, land holdings per household are small. Inadequate feed supply is the main constraint to livestock production. In order to optimize overall productivity there is a need to integrate food and feed production. Introducing forage legumes seems an acceptable approach: forage legumes will improve soil fertility, crop yields and herbage quality, and make the system more sustainable. Hedgerows of multipurpose fodder trees, productive backyard forages and under-sowing or inter-planting improved forages with food or plantation crops will probably be the most successful forage development strategies in this area. Research should look at temporal interactions between forage supply and form of feeding and nutrient demand by animals to exploit opportunities for marketing animals and their products*".

Several varieties of fodder grass and leguminous can be multiplied in family backyard nurseries before being transplanted in the farm. The multiplication of seedlings on a small plot near the home garden (from 6 to 15 m²) is an efficient way to facilitate access to new varieties for a large number of farmers, who directly control the multiplication and transplantation process. For some fodder grasses, as certain *Pennisetum*, the multiplication can easily be done by cuttings.

But practically, the issue of distributing (new) vegetative material, such as fodder seedlings, for a large number of families often represents a major bottleneck for organizations and institutions (Ministry of Agriculture, Research Centers, NGOs...). When Inter Aide started to work in south-Ethiopia, the team was relying on large central nurseries to multiply and provide planting material to farmers, especially Vetiver (*Vetiveria zizanioides*), in order to consolidate anti-erosive structures made with soil bunds. But the cost to maintain those project nurseries, to produce and to transport the plantlets to farmers' field was substantial. Paradoxically, this heavy logistic and the related expenses only allowed to reach a limited number of farmers, mainly those living close to accessible roads. Furthermore, the survival rates of the seedlings after transplantation on the farms were sometimes below 50%.

Farm-based nurseries to address several constraints

Involving farmers in the production and propagation of seedlings has considerably and rapidly increased the number of targeted families, for a similar cost. The introduction of farm-based micro nurseries has also largely improved the average survival rates, reaching more than 90%.

With a small quantity of planting material, backyard nurseries give farmers the autonomy to control the multiplication and transplantation of interesting fodder varieties. It highly contributes to reduce the initial inputs. And once some farmers have propagated the species, they can exchange their vegetative material and know-how with other farmers, who in turn, easily multiply the clumps. Individual small nurseries can address several difficulties faced by farmers:

- Limited access to fodder seeds and planting material
- Onerous logistic constraints for the transportation of planting material from "central" nurseries to farmers' site and related risk of low survival rate of the plantlets
- The conservation and the renewal of the seeds: especially for certain graminea or for annual crops, compelling farmers to search for and buy their seeds every year
- The difficulty for farmers to recover their planting material when affected by drought

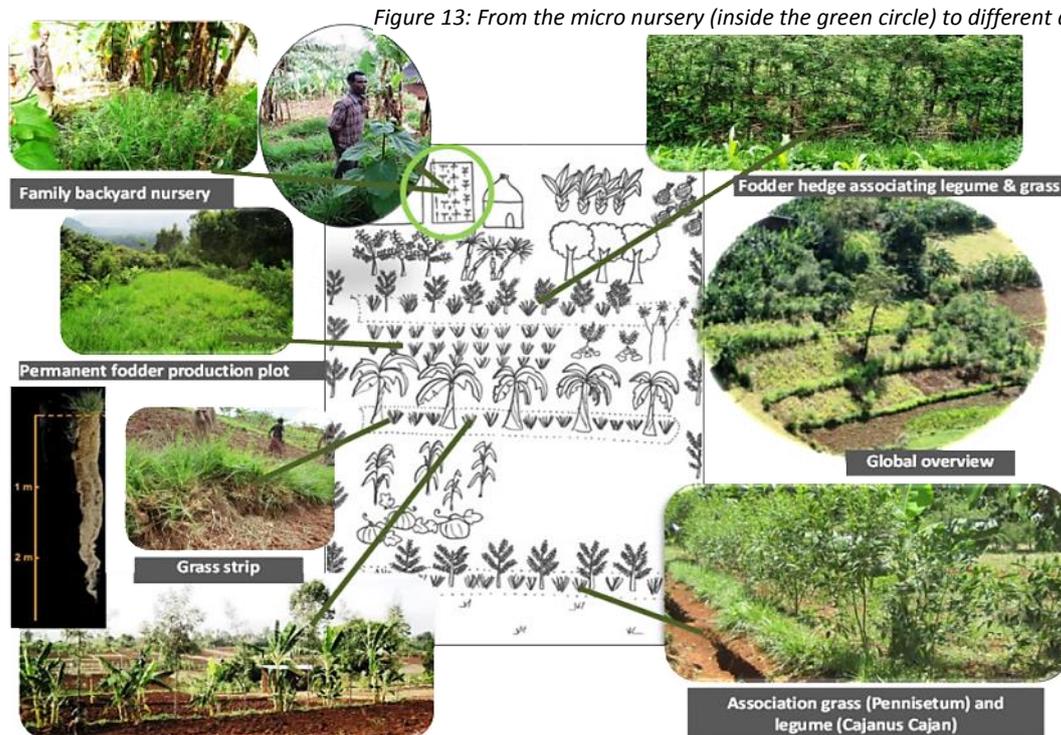


⁵ Tolera Adugna and Said An, 1988, Prospects for integrating food and feed production in Welayita Sodo, Ethiopia,

From the family backyard nursery to the field

The combination of farm based micro-nurseries and fodder integration on anti-erosive structures appeared as a key innovative solution for the families. Farmers generally start to practice the multiplication and the cultivation of fodder grasses on very small plots, essentially to transplant the seedlings on anti-erosive structures. But rapidly, notifying the benefits of integrating fodder within the farm, and the given possibility to autonomously control the multiplication of the grass, most farmers are extended fodder production in new areas: along hedges, on farms' contours, and even on dedicated small areas within their farm to develop permanent fodder plots.

This model of farm based micro-nurseries, mainly used for the multiplication of *Pennisetum* varieties (*P. riparium*, *P. purpureum*...) was a real innovation for a lot of farmers. This new practice does not compete with the traditional cropping systems and also paves the way for the diffusion of other new fodder species, notably legumes. More information about the experience developed by Inter Aide on farm-based micro nurseries in Ethiopia on: <http://www.interaide.org/pratiques/Agriculture>



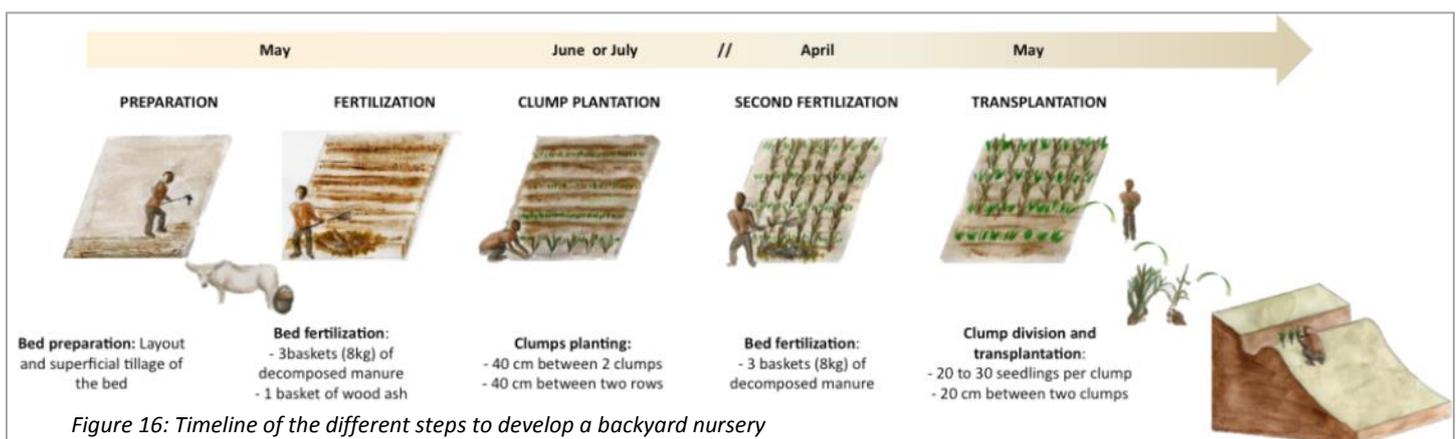
Vegetative multiplication (example of *Pennisetum riparium*) and calendar

With 5 clumps of *Pennisetum riparium* as starting material for one family:

- ⇒ 100 seedlings (each clump containing about 20 seedlings) can be planted at a distance of 40 cm x 40 cm from each other in a nursery of about 15m²
- ⇒ 1 year later, each seedling planted can produce in turn 20 new slips, corresponding to a total of 2000 new seedlings (if the moisture is good, the seedlings can already be harvested after 2 to 3 months)
- ⇒ Transplanted every 20 cm on anti-erosive soil bunds, these 2000 seedlings can vegetalize 150 to 200 m of anti-erosive soil bunds.



Figure 14: a) Clump removed from the nursery with several seedlings; b - c) Division of a seedling from the clump



Integrating fodder production and soil & water conservation

Inter Aide innovation implementation is based on a farm-to-farm approach; the type, number and size of anti-erosive structures depends on farmers' land conditions and wishes. The proposed solutions are mainly vegetalized soil bunds or fanya juu and/or fodder grass strips, whereas cut of drains (upstream of the land), and simple check dams (on gullies) are more punctual. In mountainous sloppy areas, one important cause of erosion is the force of water flowing over the soil's surface. Levelled anti-erosive structures planted with fodder have an efficient role to:

- **Reduce the speed at which water flows**, stopping water streaming and sediment run-off.
- **Increase water absorption**, as water collected in the ditch or stopped by the planted grasses during rainstorms slowly percolates into the soil increasing water infiltration and soil moisture.
- **Help terracing the fields** by changing slope angle and length. As rainwater erodes soil uphill of the structures, the soil gradually accumulates above it creating an increasingly levelled planting strip.

Building the physical structure

The following paragraph focuses on planted and levelled soil bunds and fanajyuu structures, adopted by 89 % of the farmers. The construction work of those anti-erosive structures is based on common techniques used all around the world, but adapted in the south Ethiopian context.

Inter Aide relies on local referent farmers, called "peer farmers", to measure and estimate the slope range, evaluate the number or rows needed and level out the structures. They also advise farmers for the construction work process, and are responsible for tools' distribution. Peer-farmers are trained and equipped by the project.

The construction work is initiated in February (during the dry season) and last until May, for several reasons: 1) Farmers have more time regarding their farming work calendar, 2) Even if the soil is drier, the weather conditions are more favorable, 3) Seedlings multiplied in individual backyard nurseries are ready to be transplanted in May, 4) Most of the structures can be achieved before the first heavy rains so that they can be stabilized thanks to the grasses and resist better during water flow.

Three people are required to measure the slope using the line level method, to determine the location of the rows, and level out each row (for detailed information, see technical guideline at <http://www.interaide.org/pratiques/Agriculture>).



Figure 18: a) Farmers measuring the slope of the farm; b) Digging process; c) Levelled soil bund

Ditches of 50 cm deep and 50 cm wide are dug. The soil is placed either on the downhill side of the ditch, making **Soil bunds**, either on the top-hill of the ditch, creating **Fanya juu**. The base of the wall (100cm) is typically twice as wide as the wall is high (50cm). A **partition wall** is necessary every 10 m for several reasons: (i) it strengthens the SWC structures, (ii) it keeps sediments, slows down water flows and improves its retention, (iii) and it avoids water concentration that may break the bunds and damage the field.

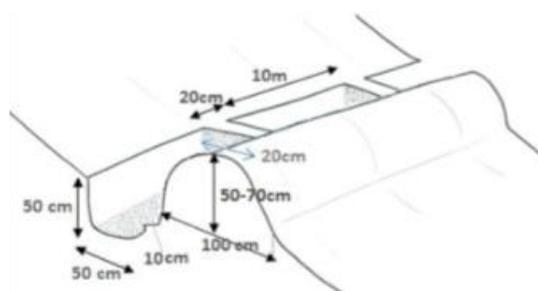


Figure 19: Recommended dimensions for soil bund construction

Inputs for 100m structures	Costs (€)	% met by farmer (first year)	% covered by IA (first year)
Labour			
Levelling contour line (1hour/3operators)	0,40	100%	
Digging structures (10 days/1 person)	13,2	100%	
Planting the bunds (1,5 days/1person)	2	100%	
Equipment			
Measurement kit (spirit level, rope)	2		100%
Tools: spade, hoe, "3-fingers"	10		100%
Agricultural			
Seeds, seedlings, clumps	0,2		100%
Manure		100%	
Total fees	27,8	56,1%	43,8 %

Figure 17: Estimation of the costs to build 100m of vegetalised structure

Establishment activities: Five main steps for embankment and ditch structures construction:

- 1) Slope measurement / estimation using the line level method
- 2) Number of anti-erosive structures using Vertical interval
- 3) Validation with farmers
- 4) Leveling and digging the structures
- 5) Bunds planted with various fodder species

At the micro-watershed level, anti-erosive structures are not continuous from one field to another. Farmers prefer to shift their structures if the row is longer than 50m and with the neighbors in order to facilitate the passage of people and oxen while ploughing, and ease farming works. The time spent to build 10 m of anti-erosive structure varies from 5 to 10 hours, according to the number of people working and on the type of soil. **On average, it has been evaluated that 14 days are required for 1 farmer to construct 100 m of SWC structures.**

Planting soil bunds

Farmers usually transplant their seedling between April and June, depending on moisture availability. This is the optimal period for grasses to grow quickly and play their key role as soon as possible (i) to avoid too much maintenance of the bunds after heavy rains, and (ii) to get rapid available feed for livestock.

Once fodder seedlings are separated, they are planted on the top of the bund every 20cm. **Around 1,5 days are necessary to vegetalize 100 m.**

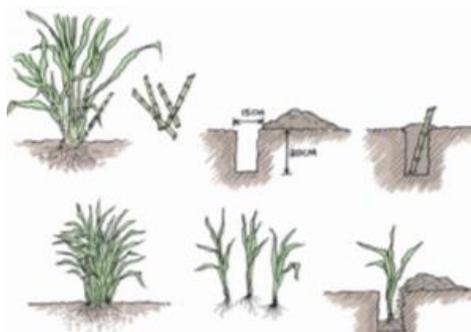


Fig 20: a) Steps to propagate *P. purpureum*; b) Fodder recently transplanted on bunds

Maintaining the structures

The two main factors responsible for soil & water conservation's structures degradation are **heavy water flow (run-off) coupled with sedimentation, and animal grazing & stampings**. A first elementary condition to avoid damages on structures is to **control and restrict open grazing**, through the implementation of communal bylaws and punishments. Animals stamping on bunds and grazing of the growing grasses substantially increase the maintenance works and decrease fodder production.

- Three main operations of maintenance consist in:**
- Ditch clearing and bunds strengthening
 - "Gaps" filling with new grasses
 - Vegetative cover fertilization, intercropping

Inputs to maintain 100m	Costs (€)	% met by farmer
Labour		
Trenches scraping, bunds reinforcement (5 days /1 person)	6,5	100%
Equipment		
Spade	1,3	100%
Agricultural		
Seedlings for "gaps filling"	0,2	100%
Manure/ fertilizer	2,1	100%
Total fees	10,1	100%

Figure 21: Estimated costs to maintain 100m of vegetalized soil bund the first year following its construction

According to 76% of the farmers, most of the SWC structures require maintenance several times during the first year after construction, especially at the rainy season. Maintenance works mainly consist in scraping the trenches out and shoveling the soil up on the bunds to reinforce them. On average, **3 hours are needed for a farmer to maintain 10 m the first year** (5 days for 100m).

Along the years, the preservation of the structures involves "gaps filling" on the bunds with new grass seedlings, as they can become "favorable paths" for water flows to evacuate resulting in small gullies. Moreover, *Pennisetum* require N and P to ensure their viable productivity, their longevity and their nutritional value. Depending on their social class, farmers use soil, manure (if they have animals, as in the picture below), fertilizer (urea) or a combination of the three.

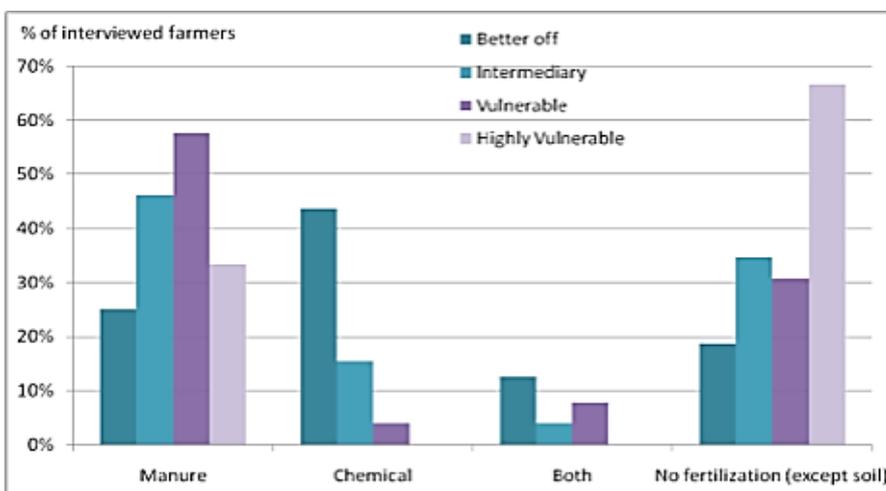


Figure 22: a) Fertilization management for different social classes of farmers; b) Soil bund fertilized with manure after harvest

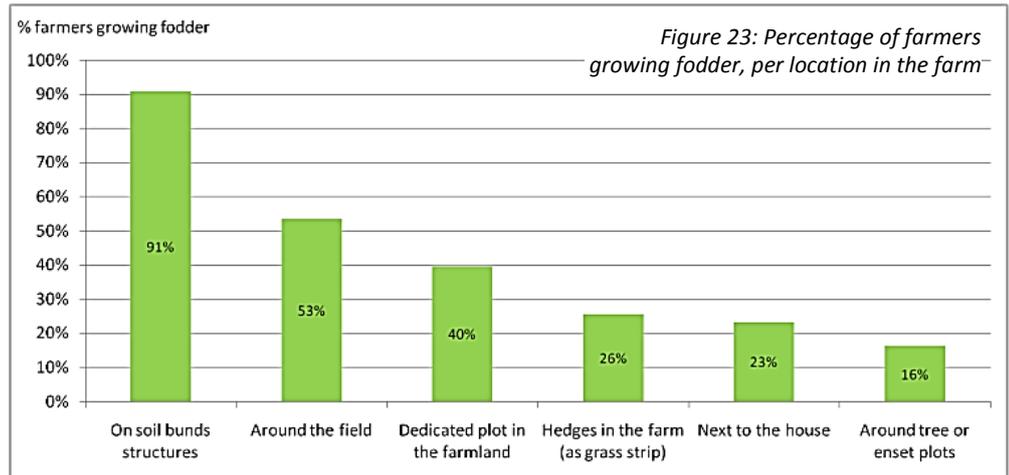
Fodder production, a key element of the innovation

With the increasing pressure on land and natural resources, small-scale farmers of Wolayta and Kambatta, like many other families, are facing an irreversible fodder crisis. During the dry season, farmers mainly rely on straw and Enset (competing with human feeding). However, because of their low digestibility, crop residues remain in the rumen for a long time, limiting intake. Their other major limitation comes from the fact that they do not contain enough crude protein to support adequate microbial activity in the rumen. Now a day, providing a balanced feeding to livestock all year long remains a critical challenge for small-scale farmers. Integrating diversified fodder production within the farming system presents various advantages and is well adapted for the cut-and-carry practice system.

Inter Aide is promoting the multiplication and diversification of 3 main types of fodder grasses (*Pennisetum riparium*, Elephant grass, and Bana grass), as well as 7 species of legumes (*Cajanus cajan*, *Sesbania sesban*, *Medicago sativa*, *Desmodium uncinatum*, *Vicia villosa*, *Lupinus albus*, and *Chamaecytisus proliferus*). Indeed, the association of high biomass productive grasses with nitrogen-fixing plants as high-protein forages can help supplying balanced animal feeding.

91% of the farmers are growing fodder on their anti-erosive structures, as their rooting system help stabilizing and strengthening the bunds.

The increase of fodder grass production is mainly done around the field and on dedicated plots



*Figure 24: a) Fodder production on embankments of anti-erosive structures; b) *P. riparium* grown around enset plot; c) Dedicated plot of permanent fodder production*

To maintain a good productivity and have satisfactory feeding quality, fodder grasses should be conducted following special care:

- The interval between two harvests should not exceed 3 months for *P. riparium* and 2 months for Elephant or Bana grass. Indeed, the feeding value declines rapidly while fodder grasses are becoming older, as the amount of lignin is increasing. Although longer intervals between two cuttings may result in higher dry matter yields, animal production usually remains poorer.
- Fodder grasses should be cut 5 to 10 cm above roots level to insure an optimal new regrowth. The regrowth rate is initially directly related to the amount of leaf remaining to intercept light and support photosynthesis. A severe cutting or heavy grazing results in delays of active growth.
- Clump division is a good way to lighten the plantlets and improve their productivity, giving them more space and light and reducing the competition for nutrients and water. Clump division should be preferably done at the end of the dry season (May-June)
- Intercropping fodder grasses with legumes maintain soil fertility while increasing feeding quality. It also decreases the competition for nitrogen between fodder grasses and neighboring crops.

In lowland areas, Inter Aide has been promoting *Cajanus cajan* in association with fodder grasses along anti-erosive structures since 10 years. However, as the available cultivars were not suited for highlands agro-system, other legumes forage trees/shrubs have been introduced: *Sesbania sesban* and *Chamaecytisus proliferus* (tree Lucerne). Other species have been introduced more recently.

The choice of a legume species not only depends on the ecosystem but also on a particular strategy: 1) Natural pasture improvement, 2) Fodder diversification; 3) Abandoned land rehabilitation; 4) Diversified live fencing using perennial plants on farm boundaries such as *Sesbania*, tree Lucerne 5) Green manure... The integration of fodder grass production helps increasing food quantity and quality, especially during the dry season. However, legumes fodder plantation is still at an early stage of diffusion.

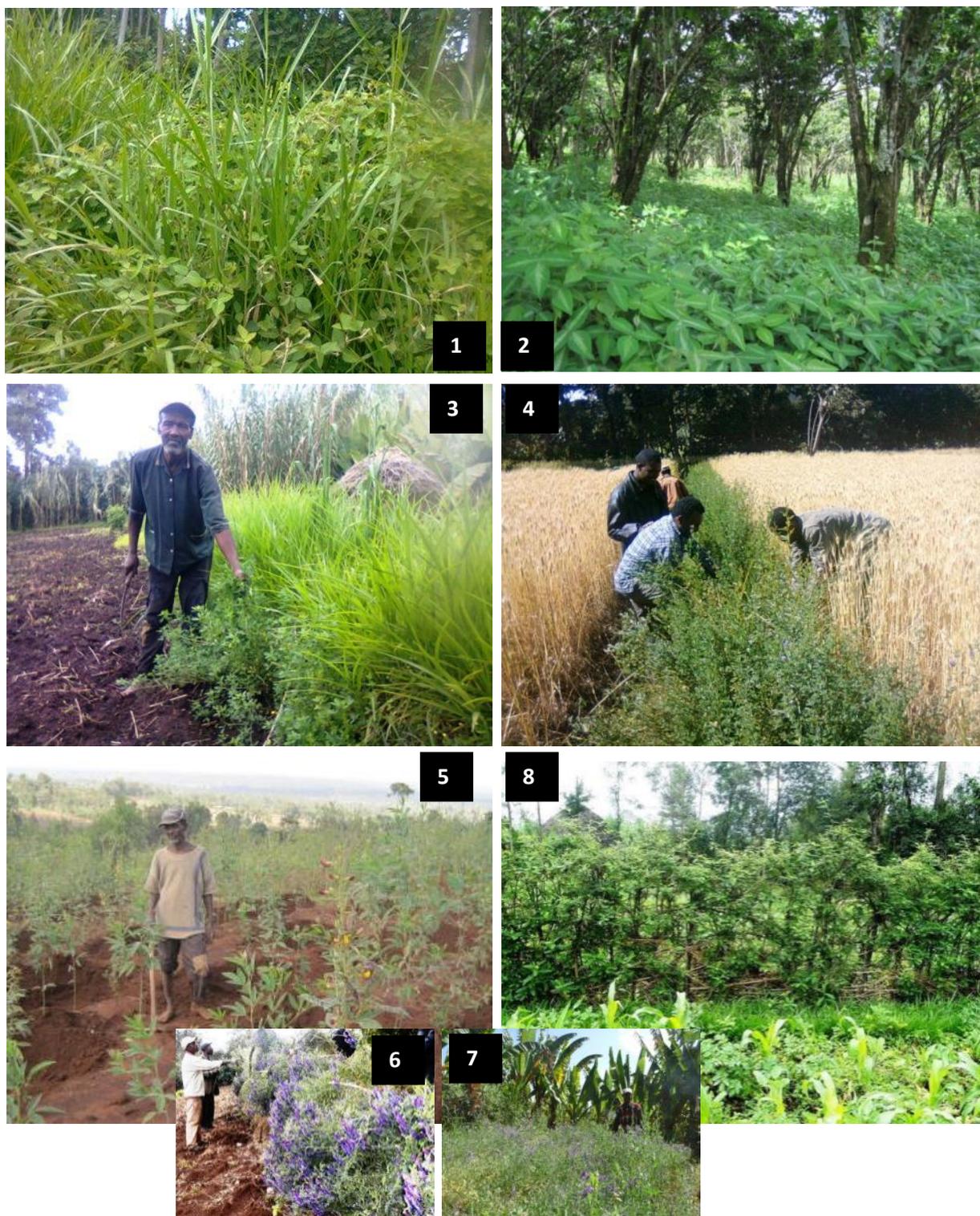
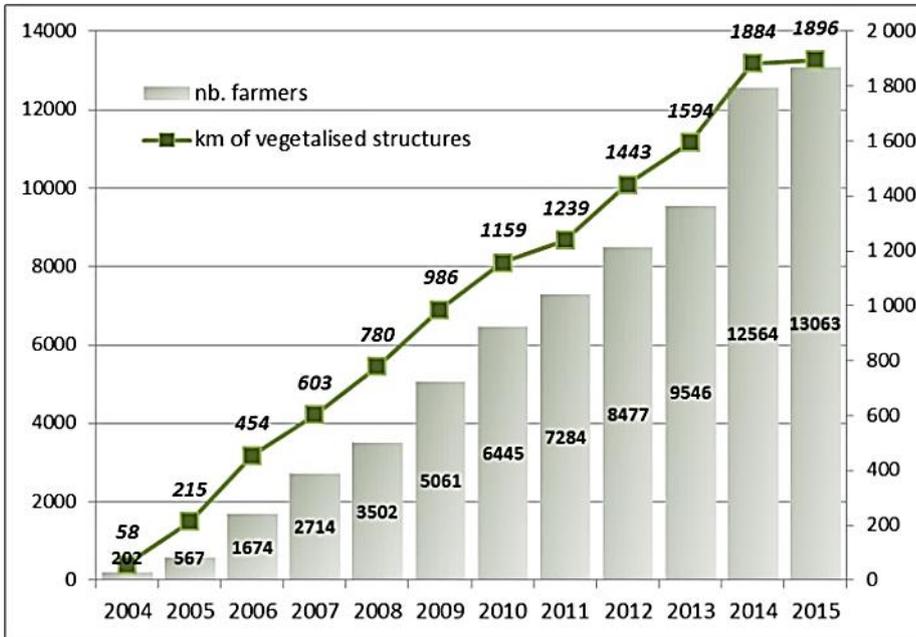


Figure 25: 1: *Desmodium* associated with Bana grass on permanent forage cultivation plot; 2: *Desmodium* under coffee tree; 3 and 4: integration of alfalfa in association with *P. Riparium* on soil bunds; 5: rehabilitation of degraded land with *C.cajan*; 6: Vetch seeds production on anti-erosive structure for 7: green manure; 8: hedge of *Sesbania sesban* with *P. riparium*

D. Adoption

Cumulated number of farmers having integrating soil conservation and fodder production in their farm

The first interventions combining soil conservation and fodder production started in 2005 in 2 districts of the Southern Region of Ethiopia. In 2012, the activities have been extended to 2 new districts, and the Ethiopian organization Rural Community Based Development Initiative Associations, replicated a similar approach in 2 other new districts respectively in 2012 and 2013. **In 10 years, 13063 farmers have adopted the practice. They have constructed and vegetalized a total of 1 896 km anti-erosive structures.** More soil bunds and fanya juu structures have been built but only those that have been vegetalized with fodder production (grass and legume) have been taken into account.



Note: since 2013, a partner Ethiopian NGO (RCBDIA) has been replicating similar activities in 2 additional districts. It has contributed to increase the number of benefiting families.

Figure 26: Evolution of the number of families involved in project activities and cumulative length of anti-erosive structures built between 2004 and April 2015

Durability of the changes

In order to evaluate the durability of the adoption, an exhaustive assessment has been conducted within the frame of this study in 4 sub-watersheds of intervention where the project intervened at different periods. In these communities, the objective was to compare the number of structures recorded at the end of the project presence and the current situation in order to evaluate if the farmers have maintained or not the practices. The obtained results were encouraging. For instance, in the village of Ajacho, where Inter Aide intervened between 2005 and 2008, 93% of the villagers have conserved their structures.

District / Kebele / village	Starting year / ending year	total nb of families	% farmers with vegetalized struct. at project end	% farmers with vegetalized struct. in 2015	Main reasons for not adopting
Kacha Bira / Burchana / Ajacho	2005 / 2008	72	99%	93%	migration, death
Kacha Bira / HobiChaka / Yayama	2007 / 2008	80	93%	93%	new comers
Hadero / Hachacho / Geshame	2011 / 2012	102	75%	90%	
Boloso Sore / Gununo / Dagecho	2012 / 2014	127	72%	80%	Farms located in flat areas



Figure 27: Village of Ajacho in Kacha Bira (April 2015), at the peak of the dry seasons. Ten years after the construction & vegetalisation of the first structures, the effect of the soil bunds counter-planted with grass (the ditches have now been refilled) on the terracing is visible.

Favoring and limiting factors of adoption

In order to determine factors that represent catalyzers, or at the opposite bottlenecks, for the adoption of this new practice in the concerned area, the following paragraph confronts the innovation with a theory established by Everett Rogers⁶ on the diffusion of innovation. Everett Rogers identified five factors that determine the success variation of the diffusion of an innovation:

Factors (Definition)	Innovation: integrating fodder production on anti-erosive structures in South Ethiopia
Relative Advantage <i>(perception of the level of improvements and effectiveness of the innovation as compared to existing solutions)</i>	The incomes generated by the fodder production and its impact on animal feeding, health and Enset consumption (limiting the use of Enset leaves for fodder) are clear advantages. The link with soil and water conservation (consolidation and durability of the anti-erosive structures, reduction of run-offs, moisture conservation...) is another relative advantage as compare to the more conventional models, which usually do not consider the integration of fodder production as an option to better conserve soil fertility.
	The proposed grasses (such as <i>Pennisetum riparium</i>) are highly productive, including in dry season when fodder is scarce
Compatibility <i>(the adequacy with the values and the practices of the farmers)</i>	The farmers are used to cut and carry systems for animal feeding. A main innovation is now to crop fodder, but without really entering in competition with the traditional cropping system. An important risk is related to over-grazing. The integration of grass and legume in the fields must be linked with clear rules and practices to prevent open grazing (applied by the traditional "Iddir" associations for instance). For the moment, the introduced varieties are not compatible with pasture improvement but only used for cut-and carry practices.
	Very good palatability as fodder, no problem of adaptation in animal diet
Simplicity or Complexity <i>(If the innovation is perceived as complicated or difficult to use, an individual is unlikely to adopt it.)</i>	The proposed varieties are easy to multiply by seedlings, to transplant and to crop, to use as cut and carry. The fodder can be harvested when needed by the farmers.
	The introduction of fodder on micro nurseries and antierosive structures is not complex (as soon as the system of "backyard nursery" is understood for on-farm multiplication).
The possibility to try <i>(How easily an innovation may be experimented. If a user is able to test an innovation, the individual will be more likely to adopt it.)</i>	The vegetative multiplication and the production can easily be tested on small plots by the farmers all year long.
	The introduction of <i>small quantities of fodder</i> in family backyard nurseries facilitate its "triability"
	However, the access to a few quantity of initial planting material, to be then multiplied, is a prerequisite
The visibility of the results <i>(The extent that an innovation is visible to others. An innovation that is more visible will drive communication among the individual's peers and will in turn create more positive or negative reactions.)</i>	Easily observable among more and more farmers' fields in the area.
	This innovation is more and more visible. Fodder grasses are now widely sold in the markets at a good price.
	No negative reactions observed yet

This indicative table provides an idea of the potential for the adoption and diffusion of combining fodder production and soil and water conservation (benefits, compatibility with traditional norms and practices, a low level of complexity, a high possibility to try and observe the new practice). **A fundamental necessary condition is the control of open-grazing as most of the fodder introduced do not tolerate open-grazing (picture below of an overgrazed structure).** Another condition concerns the availability of small quantities of vegetative material in the area and, of course, the possibility for the farmers to access it.

Figure 28: Uncontrolled goat and calf grazing freely fodder produced on bunds, deteriorating the structures and preventing a good regrowth



⁶<http://www.spreadingscience.com/our-approach/diffusion-of-innovations-in-a-community/> and http://en.wikipedia.org/wiki/Diffusion_of_innovations

E. Impact

Impact generated on highly vulnerable families

Income and gross value: the following economic calculation shows that the production of biomass on anti-erosive structures allows to significantly increase the gross value of the fields production:

- 1/4 of hectare (50m x 50m) planted with wheat and potatoes, generates an annual gross income equivalent to 2000 ETB⁷ (Cheveau & Hoornaert, 2011)
- 2 lines of erosion control structures of 50m long by 2m wide (50 cm to 1m width for the ditch and 1m for the earthen bund) represent a loss of 6 to 8% of the cultivated land plot, or an economic loss in production equivalent to 160 ETB.
- The production of fodder on these 2 earthen bund lines will generate an average annual income close to 1100 ETB, when sold directly on foot or on the market (3 cuttings per year, 2 in the rainy season and 1 during the dry season).
- The accepted reference for the economical yearly value of fodder production is therefore set at 22 ETB per m² (1 €) or 11 ETB per linear meter (0.5 €). **The role of fodder as cash crop is blatant for the vulnerable and highly vulnerable families, who are much more likely than others to sell fodder**
- This means that the integration of vegetalized anti-erosive allows a 45% increase of the plot gross value, and much more in case of vulnerable families plots, that are usually less productive.

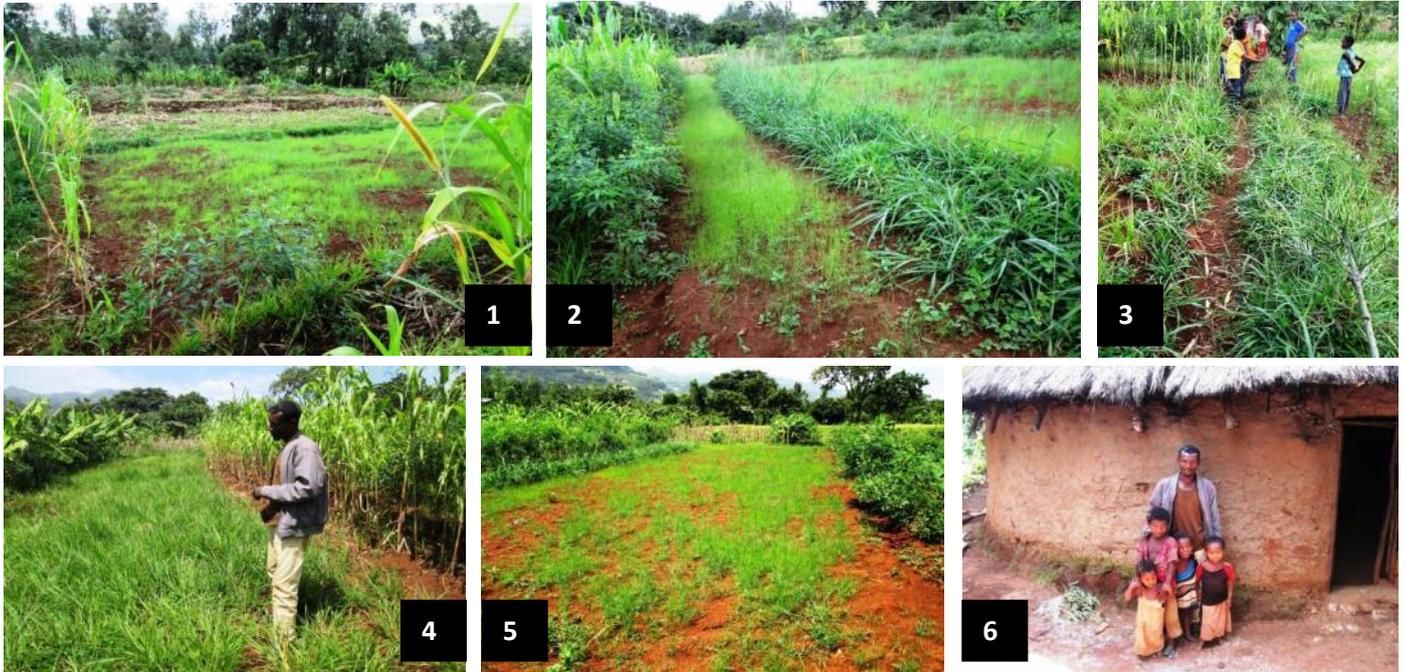


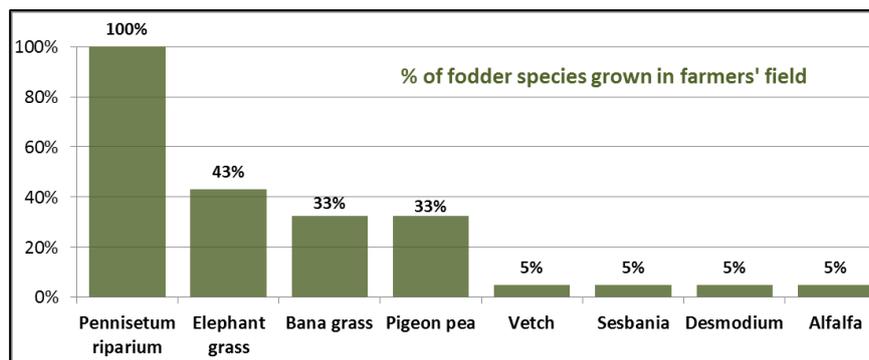
Figure 29: The example of M. Feleke Dalecho (6), a farmer in a precarious situation due to a sickness of 5 years, is quite indicative. Several structures to control erosion have been done by the farmer. Different fodder species (Bana grass, Pennisetum riparium, Cajanus cajan, Desmodium) have been integrated in the farm: 1 on the anti-erosive structures; 2 directly as pure fodder hedge; 3 along the paths surrounding the fields; 4 as permanent fodder production plot. Usually, due to the lack of animals and biomass, the soil fertility of these types of farms is relatively poor. Looking at the picture 4 and 5 taken in adjacent plots, it illustrates quite well the additional benefit fodder integration can represent as compared to cereals on degraded soils (here teff on picture 5 and P riparium associated with Desmodium on picture 4).

The average linear length of structures built by the most vulnerable families is 95m⁸ after 2 years of project support. The corresponding central cash value is about 1050 ETB, as a low assumption, and may be estimated at 30% of the survival threshold (Cheveau Aurelie et Hoornaert Camille, 2011). Fodder production is therefore a quick and important source of cash for the poorest, with the comparative advantage of an almost **permanent availability**.

⁷ 1€ = 25 ETB

⁸ Data from a survey among every farmers from 3 village units (253 households)

Biodiversity: the introduction of fodder species contributes mechanically to increase the farm biodiversity. As shown in the table below, 4 species have been widely adopted by the farmers. Associated to different Pennisetum varieties, the project strongly promotes Pigeon Pea (*Cajanus Cajan*) on the embankments as nitrogen-fixing, additional forage and a source of human food: **100 linear meters of structure bearing pigeon pea produces annually 35 kg of peas on average.**



Access to vegetative material: the establishment of backyards nurseries is a very important step in the vulnerable families' awareness creation. The absence of vegetative material conservation (sweet potatoes vines, tubers of taro) in the home garden is a marker of poverty. The management of short cycle planting material in family practices is an undeniable progress in the ability to respond to climate changes and food crises, resulting in strengthening resilience.

Enset is widely used as staple food in Wolayta and Kembatta. However, fresh Enset leaves and corms are also part of animal diet. Enset leaves are cut and mixed with straw or other fodder sources, usually between October and May. Enset depletion is a strong poverty marker. The usage of Enset to feed animal compete with the available food for family consumption. **With the introduction of cultivated fodder, 48% of interviewed farmers highlight the improvement of their Enset plot,** as the uses of leaves and corms for animal feeding decreased. On average, the size of Enset plot has increased by 10% after project implementation.

Productive capital: a short survey targeting the highly vulnerable families⁹ has revealed that two years after installing anti-erosive structures and fodder production, a majority (69%) of farmers had established animals sharing agreements. Producing fodder initially allows families to share an animal: the owner puts the animal in the family who has the responsibility to feed it but benefits dairy products, organic manure and draft power. The survey also revealed that **vulnerable families not included in the project support were in a final position deteriorated as opposed to baseline** in terms of access to livestock.



Figure 30: Integration of *P. riparium* and *Cajanus cajan*

More information on the activities conducted with highly vulnerable families is available here (in French only): <http://www.interaide.org/pratiques/sites/default/files/famillestrespauvres.pdf>

⁹This qualitative study is based on a limited sample of 15 farmers. Therefore the confidence interval is important: [46 – 94%] but even the lower limit would testify of a significant change.

Obtained effects on the broadest segment of the farming population

All elements presented above remain relevant when higher socio-economic strata are considered among the population of farmers, but the deficit in biodiversity and vegetative material conservation are specific attributes of the most vulnerable. The section below emphasizes the obtained effects on the broadest segment of the farming population.

Potential direct income: as seen above, the introduction of fodder production represents a new income source, which in turn may facilitate farmers' access to improved seeds and fertilizer and enables livestock restocking. On the total sample, 28% of the 254 interviewed farmers¹⁰ are selling fodder, from which 29% are "better-off" or "intermediary" farmers, whereas 71% are vulnerable or highly vulnerable families.

The trend clearly shows a contrasted attitude directly linked with the social status: the vulnerable families represent a large majority among the sellers, leading to think that the breeding usage of fodder becomes more important as we move up in farmers' social rank.

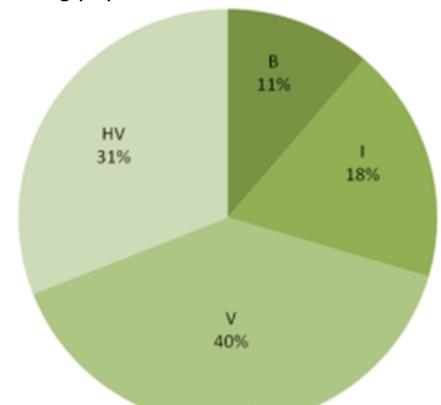


Figure 31: Proportion of each social class among farmers selling fodder

The table below displays different aspects of fodder management reality:

- All surveyed farmers have built more than 120m of structures with vegetative production. This means that **fodder production is meaningful for all types of farmers** from the better off to the most vulnerable.
- They devote at least another plot of their land to produce fodder, which counts for 40% of the total fodder production of the farm. **This reflects the efforts of the farmers to increase their own production, besides the physical support of anti-erosive structures.**
- **The calculated value of fodder shows the impressive financial return that is expected from sale, which counts for respectively:**
 - **148% of the total farming income** (Cheveau & Hoornaert, 2011) of highly vulnerable families
 - **64% of the total farming income**¹¹ of intermediate families
 - **43% of the total farming income** of better off farmers.

Type	Sample	Antierosive structures (m ²)	Other: hedge, plots, around field... (m ²)	Total (m ²) (%)	Estimated value
Better-off	34	230	176	406 (43%)	8936 ETB (388€)
Intermediate	44	162	117	279 (42%)	6141 ETB (267€)
Vulnerable	32	126	106	232 (46%)	5110 ETB (222€)
Highly Vulnerable	8	127	67	194 (34%)	4263 ETB (185€)



"I am working as a Development Agent since 14 years. I was surprised when I first arrived in Daguecho 6 month ago to see how soil and water conservation measures were well implemented. I was also surprised to see the impact on family standard of living: there are more improved breed among farmers, improved seeds are more widely used, farmers produce their own fodder,..."

If Farmers Training Center could be established next to this type of demonstration site, it could be a good example to show other farmers the results. It could ease exchange visits."

Interview with DA from Areka FTC, April 2015

¹⁰ According to a survey conducted among every farmer in 3 different village units

¹¹ The total farming income has been calculated in 2011, therefore there are many reasons to believe that it has increased since then. However, it gives a quite accurate idea of the economic situation.

Savings on animal feeding: with the introduction of cultivated fodder, farmers experience and report a decrease of the money spent to feed animals, but also a raise in family food availability thanks to the reduction of the pressure on onset plot. Even with cultivated fodder implementation, **41% of the farmers are still buying supplementary sources of fodder to bridge the animal hunger gap, to diversify animal feeding and to maintain balanced diet as much as possible.**

- Among farmers still buying supplementary forage, 68% purchase Frushka¹²:
 - Mainly during the dry season or at the beginning of the Belg, (that is to say between January and March), when fodder availability is getting scarce.
 - To feed preferentially cows while they are in lactation or oxen at the ploughing season
- Natural grass is the second type of fodder most commonly bought by farmers (59%) at the beginning or at the end of the rainy season (May-June or October-December), even if some households get bundles during the entire rainy season.
- A short ad hoc survey reveals that 300 ETB per animal are yearly saved for food, including 230 ETB for frushka and 55 ETB for natural grasses.

With 100 m of cultivated fodder, a farmer can properly feed 2 animals for 2,5 month on average¹³.

Animal health and by-products

▪ **Access to improved animal:** a survey conducted among every farmer of four different villages¹⁴ reveals that, on average, 21 % of the families have purchased at least one improved breed. In villages where cultivated fodder has been introduced 10 years ago, half of the families have invested on improved animal breeds. Milk production from Jersey or Holstein is on average 3 times higher than from traditional breed, however, those animals require a higher quantity and quality feeding management than traditional breed.

▪ **Animal fattening:** With fodder availability, animal fattening (mainly oxen) is getting much more common: 39% of the farmers were involved in animal fattening before producing fodder, whereas **they are 57%¹⁵ after.**

Cows and oxen are kept around 4 months; **the average gross added value per animal is about 2135 ETB and 2810 ETB respectively (93 and 121 €).**

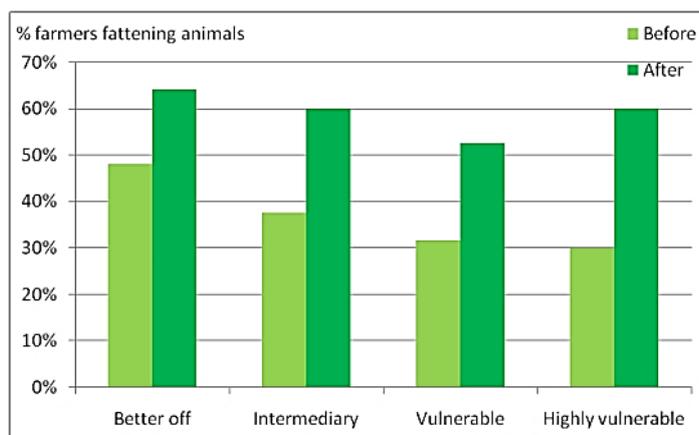


Figure 32: Proportion of farmers from different social classes fattening animals

Milk production:

The improvement of herd management coupled with the diversification of feeding sources presents various positive impacts on the farm economy:

- **67% of farmers state that their animals are getting fatter**
- **65% also highlight the increase of milk quantity from traditional breed** since cultivated fodder is available: an increase of 50 L per year on average can be noticed, reaching 900 L per year.

¹² A mix of various cereals such as barley, maize, wheat made into powder¹² Survey conducted among 20 farmers; considering that the same plot is harvested twice during the rainy season and once at the dry/belg season

¹³ Survey conducted among 20 farmers; considering that the same plot is harvested twice during the rainy season and once at the dry/belg season

¹⁴ Survey conducted in July-August 2015 among 381 farmers, involved in the project at different stage (from 2005 until 2012)

¹⁵ Difference between the two percentages highly significant, with p<0.001

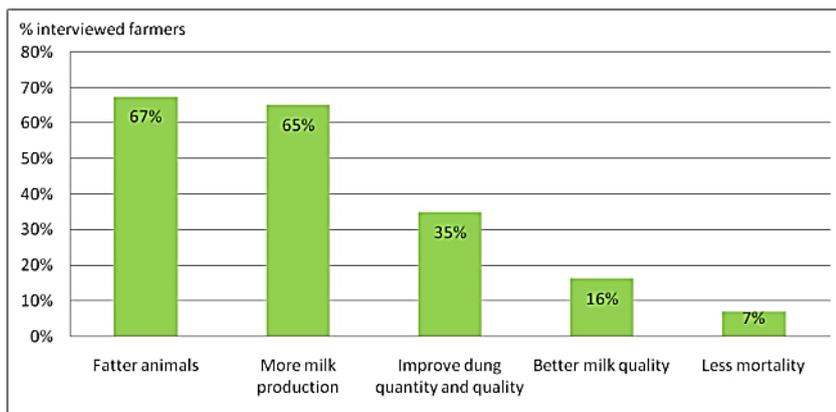


Figure 33: Farmers' appreciation on improved fodder effects on health and by products

However, this increase of milk production is not necessarily directly linked with the integration of cultivated fodder in animal feeding. Indeed, since fodder production is getting part of the agrarian system, it seems that farmers also pay more attention to animal management, through the cut and carry practice.

The increase of milk quantity and quality contributes to households' food security improvement: there is enough production to feed every family member, and women also increase their butter production for home consumption and to sell at the market.

Yearly milk production (L)	Traditional breed		Improved breed (Jersey / Holstein)
	With no cultivated fodder	With cultivated fodder	
Average	850	900	2850
Minimum	110	180	1825
Maximum	1460	2190	4015

Figure 34: Average yearly milk production of improved breed and traditional breed fed with and without cultivated fodder

Impact on fodder harvest burden: a relief for women and children

Women and children are mainly responsible for animal feeding and fodder harvest. Harvesting natural grass is a physically demanding and time-consuming task: the average time spent during the rainy season reach 4 hours per week, with a maximum of 12 hours per week. With the introduction of fodder within farmland, the average time spent to harvest natural grass comes close to 3 hours per week, with a maximum of 7 hours/week.

Highly vulnerable families who have 1 shared cow or calf generally don't have enough fodder resources within their farm to feed their animals. Some women have to work in other farmland to prepare Kocho (mainly in August) and get enset leaves from those better off families as a payment, to feed their animal. The husband, daily worker in neighbouring farms, harvest wheat or teff and get bundle of straw as a payment.

With the introduction of cultivated fodder, those families spend less time working in other farmland just to get animal feeding. They pay more attention in the management of their land, improving their food security.

BELG	Natural grass		Fodder
	Before	After	
Time spent (minutes per week)			
Average	77,3	40,8	36,7
Maximum	360	360	120
Minimum	0	0	0

MEHER	Natural grass		Fodder
	Before	After	
Time spent (minutes per week)			
Average	236,8	170,1	101,9
Maximum	720	420	210
Minimum	30	0	0

Figure 35: Time spent to harvest natural grass before and after project implementation and cultivated fodder during the Belg and Meher respectively

The present innovation has led to a sum of effects which contribute to reinforce family resilience to climate change:

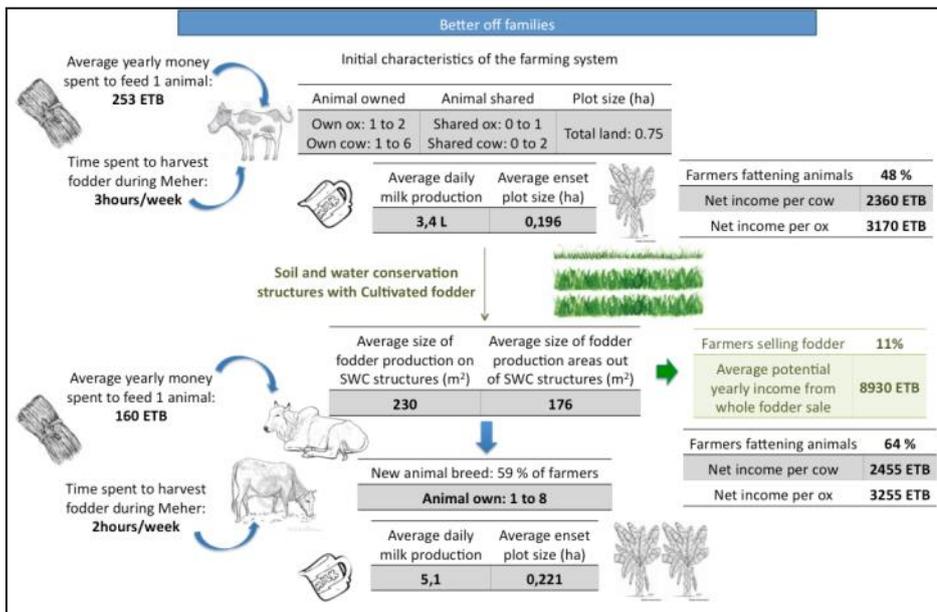
- Vegetalized anti-erosive structures help **decreasing soil exposure to erosion caused by recurrent heavy rains**, maintaining its fertility, and thus, maintaining yields
- Thanks to their **capacity to retain water and ease its infiltration**, anti-erosive structures planted with fodder also **optimize the use of the rains**, which are getting scarcer during the dry season (Belg)
- The introduction of cultivated fodder within the farms **contributes to partially overcome the "feed and fodder gap" which is becoming longer due to the late arrival of rains during the dry season**. Indeed, Enset plot are restored, as its uses to feed animals has decreased, providing food for family consumption. Moreover, good quality fodder can be harvested at a period when other fodder sources are extremely scarce.
- The intensification and diversification of the production in small farms (<0.5ha) enables **a better risk management in case of erratic climatic hazards**. The introduction of cultivated fodder in underused area provides a new income source spread along the year.

Farmers' strategies according to their social class

Note: it is important to clarify the terms used in the social classification presented below: the heading "better off" for instance should not be misinterpreted. It refers to farmers who possess only 0.75ha of land, which in any context would pass for a tiny exploitable area, just sufficient to meet the basic food needs of a family. The reader may refer to the indicators provided in the graphs proposed to capture this misleading reality

a. "Better-off" families

Usually, better off families own the entire yoke equipment for ploughing and when they don't, they get into partnership contracts to complete it. These farmers have their own cattle: several cows or calf, sheep, goat, donkey and on average bigger farms (0.75 ha). As they rarely have enough land to fully use their yoke equipment, they cultivate other farmers' field under sharecropping contract. They sometimes employ external labour and entrust part of their cattle to other farmers under share-breeding contract. They usually fatten 1 or 2 animals per year.



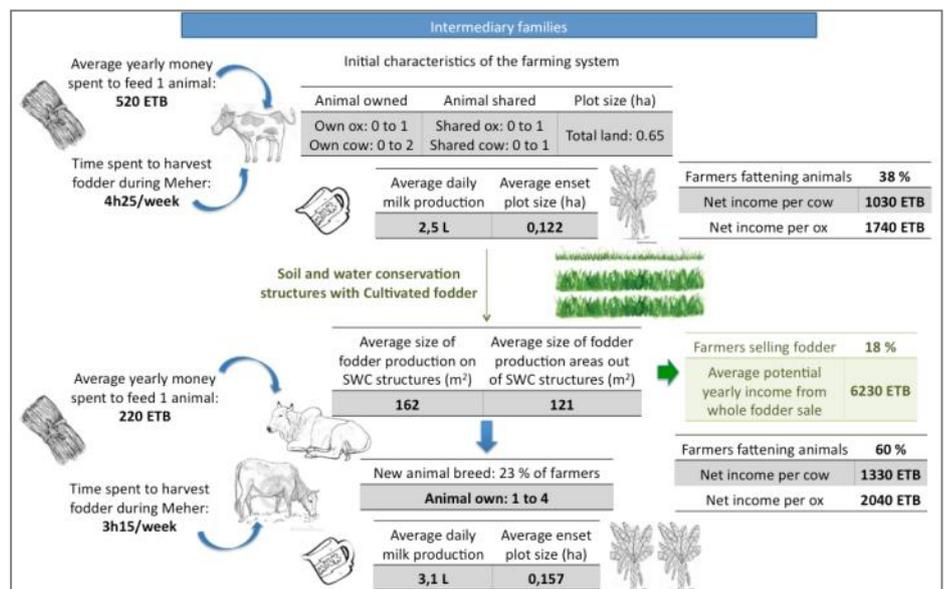
They are fully busy with their agriculture activities, so they rarely have any external job, except trading or handicraft. **Those families mainly use cultivated fodder to feed their cattle.** Thanks to the decrease of time and money spent to feed animals, and the punctual sale of fodder, they purchase improved seeds and fertilizer, and invest on better animal breeds (Jersey or Holstein). Animal feeding improvement coupled with productive breed enables a significant increase of milk quantity and quality. Moreover, the pressure on Enset plots is decreasing, enhancing households' food availability.

b. "Intermediate" farming families

Those families own one ox or half an ox, which means this ox is co-owned by two farmers. The access to ploughing oxen enables them to exploit larger surface, although the agrarian context prevents any type of land concentration. This type of farm stands in an intermediary situation, with regards to capital, to work organisation, as well as economical results:

- Even in limited quantity, they have their own animals
- They punctually work as daily labourers or salaried workers during the dry season
- They have the potential to accumulate capital, and thus can evolve towards a better situation. With the introduction of anti-erosive structures and cultivated fodder, those families invest promptly on improved seeds and fertilizer.

Instead of increasing their herd, they generally prefer to invest on improved animal breed, resulting on an increase of milk production,... but also of fodder needs. The on-farm fodder resources (crop residues, weeds, enset,...) being insufficient, their expenses to maintain an acceptable production (for milking cow or ox) remain high, as well as the time spent to collect natural grass during the rainy season. The increase of enset plot is however a positive sign of standard of living improvement.



c. "Vulnerable" families

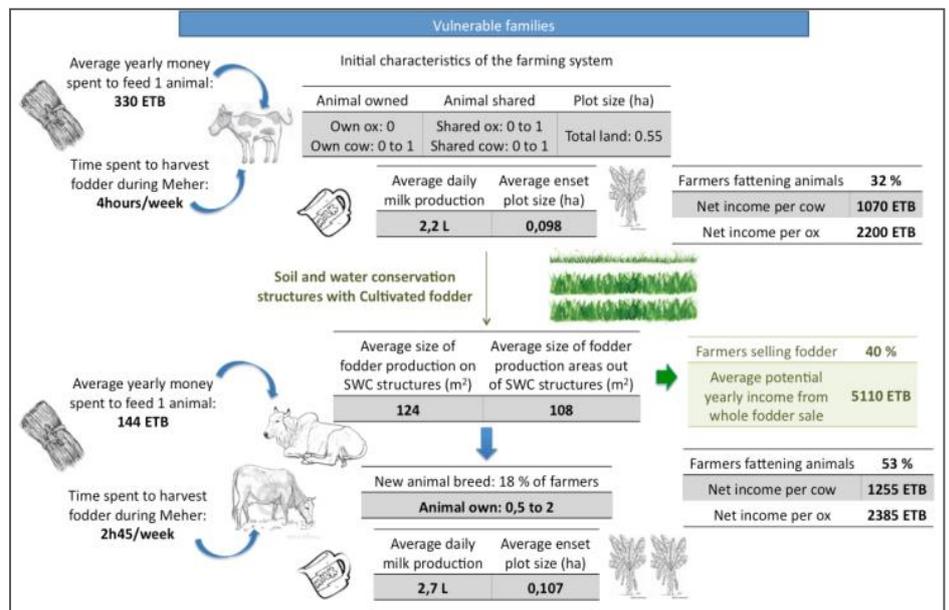
This social class includes farming families

- with limited land access,
- with limited working force: widows, disabled or old people,
- with limited investment capacity

- **These farmers do not own any ox**, and rarely a cow. However, they sometimes keep one cow, one ox or one ewe on a share-breeding contract base. They can benefit from the manure and from part of the breeding products.
- **These farmers exploit small superficies and prioritize enset plantation and home garden**, which receive the whole manure, to the prejudice of cereals.
- **Their very low investment capacity prevents them for buying inputs**: seeds or fertilizers.
- **Some of them who own bigger land lend part of their fields to other farmers** under a share-cropping contract: they benefit from half of the total harvest minus the repayment of inputs.

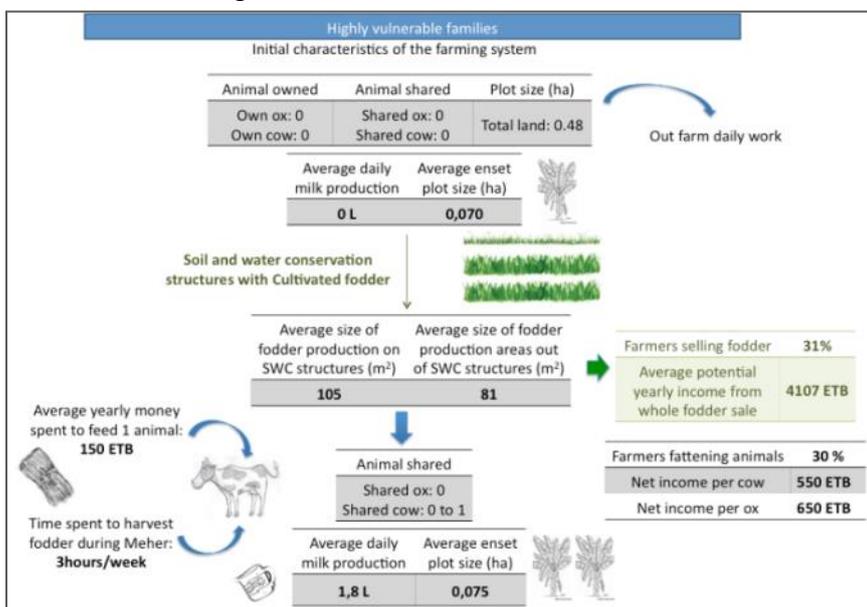
The agricultural income being very low, the heads of the families have to get off-farm occupation. They look for seasonal jobs in neighbouring regions (frequently in national farms) during the slack work season, or work as labourer during the work peak (harvests, weeding).

Cultivated fodder production being higher than the herd's need, vulnerable families usually sell their surplus by line to neighbours, and punctually by bundle at the market. The priority of vulnerable families is to purchase agricultural inputs, and, when they get enough capital after 2 to 3 years, to purchase their own cow or ox. 18 % have invested on improved animal breed. However, as they still have difficulties to feed properly their animals, milk production remains low.



d. Highly vulnerable families

- **These farmers do not have any animals, not even under share-breeding contracts.**
- **They have no mean of production**, and have a very limited access to manure to fertilize their enset plot or home garden.
- **Consequently, most of their land is under a sharecropping contract**, and the head of the family is **mainly working out of the farm.**



With the introduction of anti-erosive structure coupled with fodder production, those families get a new income source through the sale of fodder. Their first expenditure is generally to purchase agricultural inputs and food to feed the family. The family head tries to spend more time working on his farm, decreasing the size of the sharecropped plot. Once they have enough capital, that is to say after 2 to 3 years, they get an animal under share cropping contract so they can benefit from milk and dung.

Even if the average number of highly vulnerable families has dropped in our study, they remain in a fragile situation, with low resilience in case of important drought and threatened food insecurity.

F. Perspective and scalability

1/ Moving to scale can be defined as a change of dimension in the implementation of an action and therefore the massive expansion of its operational scope. In itself, moving indicates a transforming modality rather than a one-time jump. We can *therefore* consider that scaling up can be defined by the gradual gathering of a number of conditions. Among these conditions:

- ⇒ *Reproducibility* is obviously a key condition and refers to the possibility of transposing action from one area to another without any significant loss of effectiveness or relevance. This reproducibility is first based on the adequacy of the proposed solution with the expectations and needs of farming families, then on the accuracy of the methodology, the stability of the system of actors involved and the existence of diffusion tools and spreading mechanisms. These will ensure local ownership by the stakeholders, paving the way for integrating innovation into local policies. **The fact that more than 13000 farmers have adopted the technique in 6 different zones shows the potential for extension.**
- ⇒ *The efficiency* of the action is measured by the resources consumed by unit of outcome. Any operational scaling up must be accompanied by a reduction of units costs. This is generally based on the mobilization of relay actors instead of project operators and on the selection of the most conducive operational features to spreading. This leads to the issue of transferability.
- ⇒ *The transferability of methods* is seeking "relay effects", a form of "horizontal" spread of innovations through external agents. Proven mechanisms of transfer to relay actors should be tested. The ability of the methods to be assimilated and applied by stakeholders, public or private, is an essential attribute of scalability. The today methodology is based on mobilization of local traditional group Iddirs, Peer farmers and Agents from the Ministry of Agriculture as **resource actors, permitting to minimize the input from the project while reaching more farmers.**
- ⇒ *The possibility of operating leverage effects*, allowing a "vertical" information dissemination and thus access to a wider target audience. **In Ethiopia, this effect is borne by institutional agents (MoA) and dissemination structures (Farmer Training Centers),** because ownership of innovations by institutions represents the preferred route for moving to scale. These levers can also be searched effects in target populations where influential actors have a strong audience.

2/ In its perspectives, the project aims at strengthening the ownership by institutional stakeholders on technical (the integration of solutions that allow both diversifying production and conserving soil and fertility in a context of climate change) and organizational (recognition of Iddirs as players able to coordinate natural resource management mechanisms at the level of a micro watershed) features. The geographical extensions recently carried out were made with deliberately reduced staff in order to rely on institutional agents as relay actors. An example of a rapid adoption by MoA stakeholders was a pilot experience developed in Boloso Sore on rehabilitation of communal land. This experience was a "showcase" that promoted the visibility of the results (demonstrability and visibility). It seems promising to work on a system combining showcase sites, organizing exchanges visits between MoA actors, anticipating spreading mechanisms and vegetative material production, creating synergies between Farmer Training Centers, drafting and publicizing an article giving voice to some MOA agents on environmental and social issues.

In terms of leverage effects, it seems therefore essential to continue supporting Farmer Training Centres, through the establishment of fodder demonstration & multiplication plots, the development of educational tools for MoA agents as well as a technical and didactic documentation. We will assess to which extent the establishment of a network of relay farmers actually contributes to the spread of certain types of planting material. Another area of concern will be to continue improving the visibility of innovations by increasing exchange visits, supporting knowledge dissemination mechanisms, arousing the interest of the highest number of stakeholders, valuing the showcase sites and promoting integration within the Farmer Training Centers.

