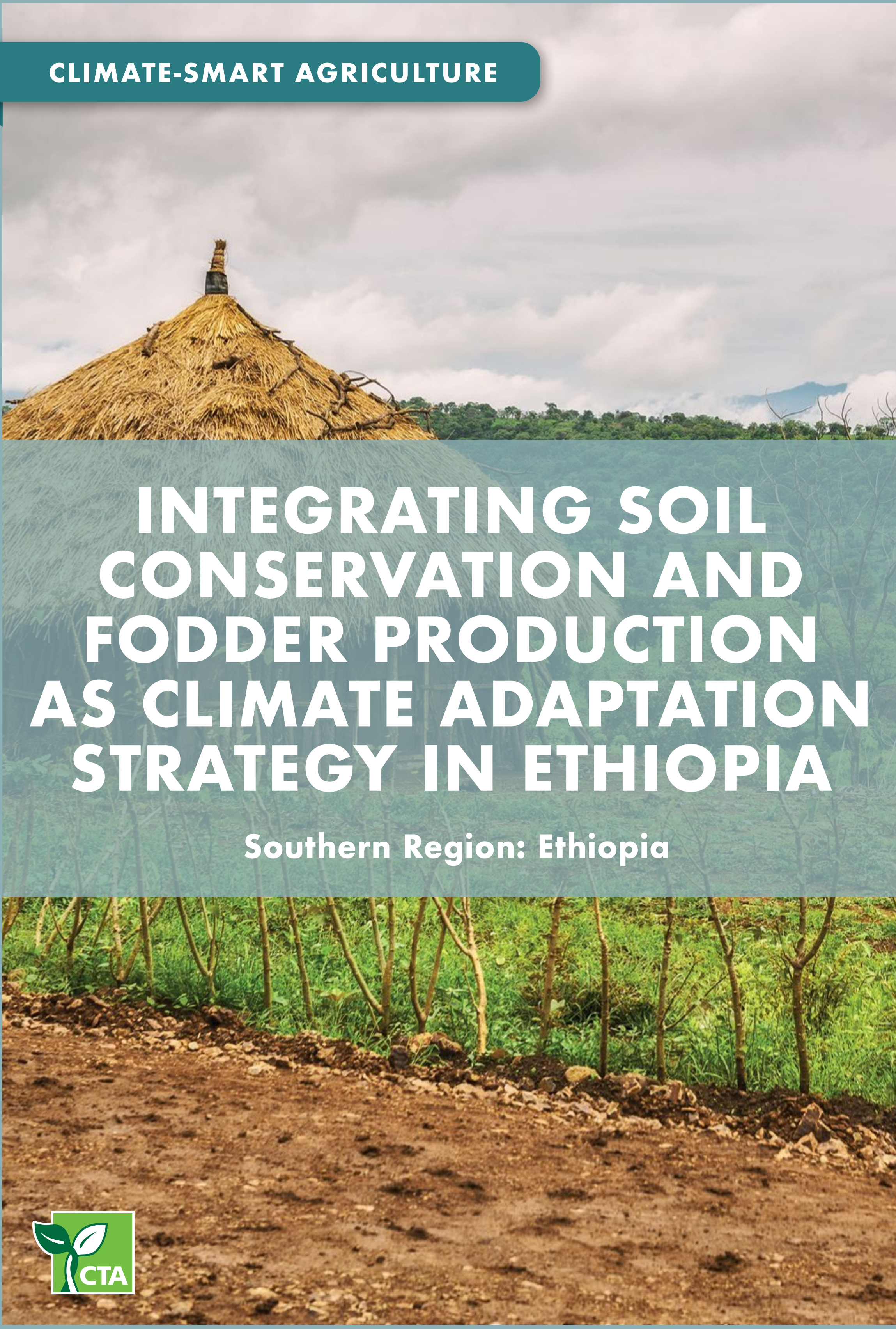
CLIMATE-SMART AGRICULTURE



INTEGRATING SOIL CONSERVATION AND FODDER PRODUCTION AS CLIMATE ADAPTATION STRATEGY IN ETHIOPIA

Southern Region: Ethiopia

ABOUT CTA

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU).
CTA operates under the framework of the Cotonou Agreement and is funded by the EU.
For more information on CTA, visit www.cta.int

ISBN 978-92-9081-633-1

INTEGRATING SOIL CONSERVATION AND FODDER PRODUCTION AS CLIMATE ADAPTATION STRATEGY IN ETHIOPIA

Southern Region: Ethiopia

Main contributors:

Lolita Guyon, Getamesay Demeke, Philippe Redon, Francois Bourgois, Tadesse Mega, Abebe Tilahun, Mesfin Desalegn, Inter Aide and RCBDIA teams

Contents

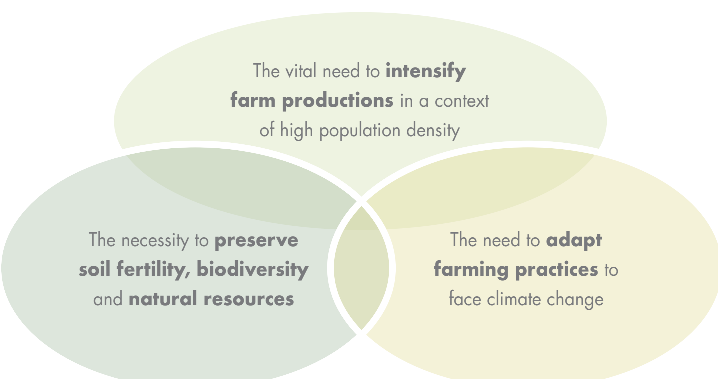
A. The idea: integrating fodder on anti-erosive structures

Presentation of the innovation

Like many smallholder farmers in Africa, the farming families of southern Ethiopia are facing three major challenges:

- The **need to intensify and diversify their farm production**, on very small areas, in a context of high population growth. In these rural areas, given the fertility rate, the population will double by 2050.
- Agricultural practices must **preserve the environment to maintain its productive capacity,** for current and future generations.
- The necessity to rapidly adapt farming practices to **cope with climate changes.**

Regarding these three challenges, Inter Aide has developed an innovative approach that consists in combining fodder production and soil and water conservation. The basic idea is simple: **to plant fodder on anti-erosive structures and in unproductive places on the farm**. This single practice allows us to address several problems: erosion and loss of fertility, fodder scarcity, and moisture and fertility conservation. But it also contributes to generating new sources of income (as well as food and wood), to reduce the burden for women of collecting fodder, and to stop open grazing.



If the innovation seems quite simple and relatively obvious, it is however the result of a long process, as several factors may influence the success and the range of adoption and diffusion of a new practice (Rogers, 1962). In this case, three elements have been decisive:

- The multiplication of vegetative material by the families themselves in **farm-based micro-nurseries**.
- The **association of grass and legumes** forages integrated on anti-erosive structures, as well as on unproductive or underused spaces, to address the crucial livestock feeding problems but without competing with traditional crops.
- The involvement of traditional organisations called '*Iddirs*' to stimulate community ownership, to ensure consistent implementation at the scale of micro watersheds and to address the critical issue of **animal open-grazing control**.

Photo: Overview of the vegetated anti-erosive structures with fodder production, Doyo Gena District.

As a result, combining fodder production and soil conservation has shown many advantages:

- **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 vegetated structures help to reduce 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* (Pigeon peas)).
- **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 especially benefits women and young girls** by reducing the burden and the time spent on collecting natural grass.
- **The decrease in pressure on *Ensete ventricosum* plantations,** usually overexploited for cattle breeding in the dry season, brings a positive effect on human food security. *Ensete* is a key crop for those smallholder farmers in terms of food reserves, shade generation or protection against wind and drying of soils. The *Ensete* plantation is an objective marker of poverty in southern Ethiopia: the poorer the family, the smaller the number of *Ensete*.

B. The context: understanding the main causes of poverty in Wolayta and Kembatta zones

The presented experience takes place in the southern region of Ethiopia, the 'SNNPR', which counts about 17 million people. The targeted districts are located in the Kembatta and Wolayta administrative zones (total population of 2.3 million) where over 85% of the population is involved in farming. Family farming is based on the culture of *Ensete* (*Ensete ventricosum*), cereals, pulses and tubers, and a fairly small home garden. While *Ensete* and garden by-products are largely consumed by the household (Bortzmeyer, 2014), cereals are the primarily sources of cash crop. The rainfall pattern is bimodal with a main rain season (*Meher*) from June to September; a short rainy season (*Belg*) from February to May, and a relatively long dry season from October to February. It usually allows two consecutive cropping seasons in the year, but any delay in the arrival of the short rains may have serious consequences for the food security of rural families from April to June. There are three main causes of this fragile situation:

- **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 has led to a splitting up process. As a clear indication: the area of arable land per family has been divided by two to three within only one generation. Today, a farm in Wolayta or Kembatta has an average area of 0.53 hectare, which makes food security a difficult objective to achieve. Rural exodus is still in its early stages in Ethiopia, as shown by the fraction of the population still living in rural areas, the highest in Africa, and is therefore not mitigating demographic growth. The progressive reduction in the size of cultivable plots induces an intensive exploitation of available land.
- **Soil erosion and the gradual loss of fertility are aggravating the situation**. From a physical point of view, the concerned areas have a mountainous profile that splits the environment into different altitudinal and agro-ecological zones from 1,300 to 2,500 m and above. In a densely populated rural area, the combination of a steep topography and high rainfall event pattern results, in the absence of adapted measures, in

intensive erosion of the open fields. This evolution negatively affects the traditional mixed cropping and breeding farming system, reduces soil fertility and compels more and more families to give up land that is becoming gradually unfit for cultivation and even pasture.

- **Southern midlands and highlands agriculture depends to a very large extent on animal traction**. However, less than 25% of rural households have presently the opportunity to own a yoke of oxen; others are forced to make arrangements, sharing animals under multiple types of contracts. Further, maintaining cattle becomes more and more difficult in a context of acute shortage of land and fodder. An agro-economic study (Cheveau *et al.*, 2011) found 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 has 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 labour and/or expenses. The expenditures on fodder now represent a substantial proportion of the tight family budget.

Repeated droughts due to the extension of dry periods, linked with the recurrent food and fodder shortages, the difficulties of extension programmes to address the root causes of food insecurity, and the continuous land fragmentation have led to a progressive weakening of the farming system and family resilience. There has been a decrease in the number of species and varieties grown (loss in biodiversity), a decrease in the biomass level in the ecosystem, reduction of livestock, depletion of *Ensete* groves and decline in soil fertility. It still appears difficult today to forecast the effects of climate changes on these local areas (Cochet, 2009). All these elements contribute to exacerbating an already fragile situation and affect smallholder families' resilience and capacities to cope with climate change and hazards in general.

C. Origin and development of an innovation process

Since its first intervention on agriculture in Ethiopia (1996), Inter Aide has focused on supporting farmers and local actors in 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 limitations: they are labour intensive (6 to 8 hours of work needed to build 10 m), they occupy up to 6–8% of the cultivated land and they need regular maintenance to avoid the leaching effect.

To fix the top soil of the structure and consolidate the soil bund with vegetation, the 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 open grazing.

A key limiting factor quickly appeared to be the quantitative availability of the vegetative material and its relatively low survival rate. Indeed, the project was mainly multiplying vetiver plantlets in a central nursery maintained by the project. But the onerous logistics and the related substantial expenses allowed the project to reach only a restricted number of farmers, 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 study commissioned by Inter Aide emphasised 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. In fact, **integrating fodder on the soil bunds** became a decisive component as access to fodder influences family vulnerability. Ten years ago, no family grew fodder and women, who were in charge of feeding animals, spent up to an hour per day to collect crop residues and weeds in order to feed livestock. In the dry season, many households would resort to *Ensete* (*Ensete ventricosum*) leaves to feed animals to the detriment of family food.

The **introduction of fodder production and its integration on anti-erosive structures** has been the triggering effect that encouraged farmers to setup vegetated soil bunds to control erosion and rapidly obtain alternative sources of fodder and/or incomes. Based on the above observations, Inter Aide identified species with appropriate rooting system and highly productive in biomass that were easy to multiply and with a good feeding value for animals (as opposed to *Vetiveria zizanioides*). *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.

Progressively, with the support of ILRI (International Livestock Research Institute) and the Ministry of Agriculture, **Inter Aide started to diversify the 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 (and to some extent also to food shortages with the production of peas [from *Cajanus cajan*] and bananas), while contributing to preserve soil and fertility in the long run.

Finally, a decisive factor was the mobilisation of traditional organisations, the *Iddirs*, as the coordinating body to manage anti-erosive master plans at micro-watersheds level and set up appropriate rules to control open grazing. *Iddirs* are traditional systems of mutual aid based on a contribution of the members in exchange for material support at the time of funerals or other adverse events. Benefiting from a strong collective recognition (Léonard, 2013), these vernacular organisations have tremendous economic importance, notably for the poorest, but had never really been integrated in the institutional frame, although identified as potential interlocutors for participative planning by the Ministry of Agriculture (ICRAF and Ministry of Agriculture, 2005).

D. Three decisive factors for project success

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

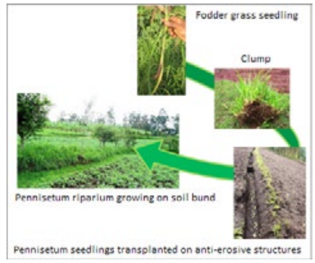
A farm-based nursery is a small plot (around 10 m^2) allocated by the farmer inside his or her farm to multiply vegetative material before transplanting it on anti-erosive structures and other places on the farm. It is an effective way to provide fast access to large quantities of fodder grasses and other vegetative material. This section discusses the introduction of this practice, its advantages and limitations in the south Ethiopian context.

The issue of distributing (new) vegetative material for a large number of families often represents a major bottleneck for organisations and institutions (Ministry of Agriculture, research centres, non-governmental organisations (NGOs). At the beginning, the project team of Inter Aide was relying on large central nurseries to multiply and supply planting material to farmers to consolidate anti-erosive soil bunds. But the cost to maintain those project nurseries, to produce and to transport the vegetative materials to farmers' field was substantial. Paradoxically, the onerous logistics and the related expenses allowed the project to reach only a restricted number of farmers who lived in accessible places close to roadsides. Furthermore, the survival rates of the seedlings after transplantation on the farms were low, sometimes below 50%.

a) Clump removed from the nursery with several seedlings; **b - c)** Division of a seedling from the clump.

Growing fodder is also not a widespread practice in southern Ethiopia. Farmers mainly rely on natural grasses and crop residues to feed their cattle, but they

never considered growing fodder as a crop in their field. There are many reasons for the limited development of fodder production, among which Duncan *et al.* (2011) emphasise 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 ILRI and the International Food Policy Research Institute (IFPRI), organised markets for quality forage are practically non-existent, both at a local level and on a larger scale.



From seedlings taken from a backyard nursery to fodder production on anti-erosive structures.

In 2006, Inter Aide tried a direct self-multiplication with some farmers using small plots in their backyard before being transplanted on the farm. Indeed, like many *Pennisetum* species, the multiplication of *Pennisetum riparium* can easily be done by cuttings. **With five clumps given as starting material for one family, and multiplied in a backyard nursery of 15 m^2, 2,000 seedlings can be obtained in less than a year, allowing coverage of 150–200 m of anti-erosive soil-bunds**. Backyard nurseries therefore give autonomy to farmers who can rapidly increase available biomass. As they directly control the multiplication process, they can also decide on the most appropriated time to move the seedlings. This has greatly improved the average survival rates, reaching more than 90%.

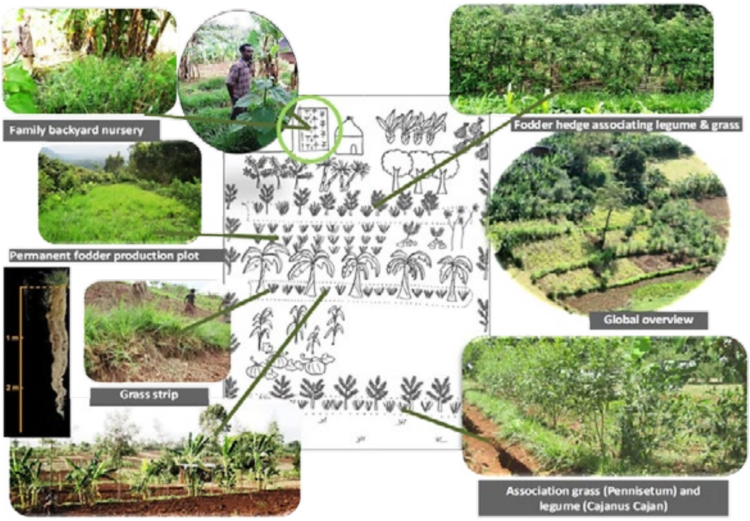
Table 1: Main advantages and the limitations of farm-based nurseries

Advantages	Limitations
Farmers are autonomous to produce their own vegetative material	Require access to initial small quantity of planting material
Some grass species (like *Pennisetum*) are easy to propagate by cuttings	The technique requires some practice to gain confidence, especially during the first year
Enable a rapid multiplication of a large number of plantlets (or seeds for some legumes) on a very reduced area	Areas formerly used for home garden production may become dedicated to fodder production, leading to a slight reduction of vegetables for self-consumption
Direct control of the transplanting time, at the most suitable moment for the farmer	Absolute necessity for the nursery to be protected from open grazing, to avoid the risk of losing all plantlets at once
Very high survival rate of the plantlets after transplantation	Slips require wet soil for seedling establishment or germination, at least during the first 2 months

From the backyard nursery to the field: illustrations

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, recognising the benefits of integrating fodder within the farm, and the given possibility to autonomously control the multiplication of the

grass, most farmers are extending fodder production into new areas: along hedges, on farms' contours and even on dedicated small areas within their farm to develop permanent fodder plots.



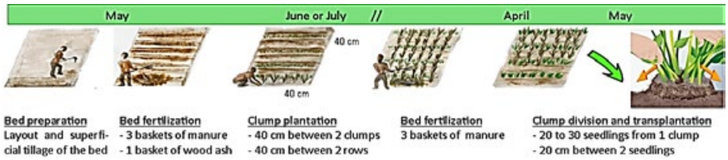
Source: Inter Aide

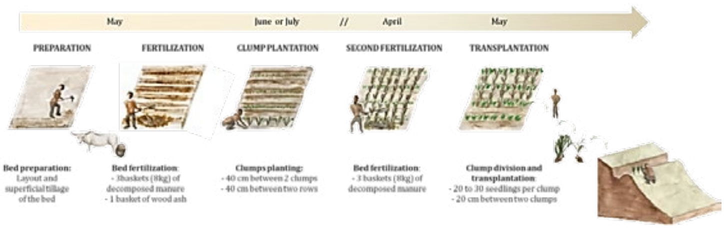
Illustration of the different possibilities for fodder integration on the farm, contributing to increased fodder resources while preserving soil and fertility. The farm-based nursery is usually setup close to the 'tukul' (house). It is represented in the green circle.

b. Building and vegetating erosion control structures with grass and legumes

The proposed solutions to physically control erosion are mainly vegetated soil bunds or *fanya juu* and/or fodder grass strips, while other possibilities are cut-off drains (upstream of the land), and simple check dams (on gullies). Using on-site material, those structures slow down the process of erosion while increasing water retention and progressively inducing a terracing of the land.

For the layout of the structures, Inter Aide relies on local referent farmers, who provide support to their peers to measure and estimate the slope range, to evaluate the number or rows needed and to level out the structures. They also





Source: Inter Aide

A representation of the farming calendar for the multiplication of planting material in backyard nurseries, before transplantation on the field, 6 to 12 months after.

advise farmers on the construction work process, and are responsible for tool distribution. Referent farmers are trained and equipped by the project with some tools (level, rope, shovel, etc.).

Technically, three people are required to measure the slope using the line level method, to determine the location of the rows, and to level out each row. More technical details can be found on the Inter Aide website (http://interaide.org/pratiques/Agriculture?language=en).

It has been estimated that 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 the type of soil. On average, **14 days are required for one farmer to construct 100 m of anti-erosive structures** and solve the problem of surface loss. Also, most of the structures require maintenance several times during the first year after construction, especially in the rainy season. Maintenance works mainly consist in scraping the trenches out and shovelling the soil up on the bunds to reinforce them. **On average, 3 hours are needed to maintain 10 m in the first year** (5 days for 100 m).

Then, for vegetating the soil bund with fodder species, farmers usually transplant their self-multiplied 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: to avoid too much maintenance of the bunds after heavy rains and to get rapid available feed for livestock. Once fodder seedlings are separated, they are planted on the top of the bund every 20 cm. **The necessary time to plant 100 m of soil bund is between 1 and 2 days**.

Diversifying fodder resources by associating grass and legumes

With the increasing pressure on land and on natural resources, providing a balanced feeding to livestock all year round remains a critical challenge for the majority of the small-scale farmers of Wolayta and Kembatta. Traditionally, during the dry season, farmers mainly rely on straw and *Ensete ventricosum* leaves. 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. **Integrating diversified fodder production within the farming system presents various advantages and is well-adapted for the cut-and-carry system**.

Inter Aide is promoting the multiplication and diversification of three main types of fodder grasses (*Pennisetum riparium*, elephant grass and bana grass), as well as seven species of legumes (*Cajanus cajan*, pigeon pea), *Sesbania sesban*, alfalfa, *Desmodium*, vetch, lupin and tree lucerne). Indeed, the association of high biomass productive grasses with nitrogen-fixing plants as high-protein forages can help to supply balanced animal feeding.

Associated with 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 metres of structure bearing pigeon pea can produce more than 35 kg of peas annually.

Illustrations

By cropping of fodder on soil bunds (here *Pennisetum riparium* and *Cajanus cajan*), with drought resistant varieties, farmers have some reserves to feed their livestock during the dry season and/or an alternative source of income. They can decide the more appropriate time to harvest the fodder, and then use it or sell it directly.

The integration of fodder grass production helps increase food quantity and quality, especially during the dry season; however, legume fodder plantation is still at an early stage of diffusion. The photos illustrate practical applications by some farming families. 1: *Desmodium* associated with bana grass at permanent forage cultivation plot; 2: *Desmodium* under coffee trees; 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*.

Cultivating fodder inside the farm, on arable lands, is a new practice in southern Ethiopia. Gradually, farmers have extended their fodder production alongside the physical support of anti-erosive structures. The photos depict a farmer who establish a perennial fodder production plot associating *Pennisetum riparium* with *Desmodium*.

February 2014:
preparation of the land and establishment of the fodder production plot.

September 2015
(19 months later): the fodder was collected 15 days before taking the picture.

October 2015:
the picture shows the fodder regrowth (1 month after the previous picture), at the end of the rainy season.

c. The key role of a traditional system *Iddir* to organise conservation measures and control open grazing

Controlling erosion in mountainous landscapes usually requires consideration of the entire watershed or at least part of it. The originality of the approach developed by Inter Aide in the south-Ethiopian context was to rely more on **coherent socio-geographical units**, according to *Iddirs'* locations, rather than purely focusing on geographic criteria.

Iddirs are one of the only forms of authentic collective organisation that can be found in rural Ethiopia, used to manage collective goods, fees and memberships, and having their own bylaws. They also benefit from a strong recognition and legitimacy: every farming family from every social class is member of an *Iddir*, and the management committee of the *Iddir* is directly selected by the members (Léonard, 2013).

On the left, this farmer in Boloso Sore district took some bana grass plants from the farm of his friend in a neighbouring village, and then multiplied them himself. On the right, a large row of Elephant grass in Damot Sore district.

For more than 10 years, *Iddirs* have proved to be able to play a crucial role in implementing a collective management system of land protection against erosion at the scale of micro-watersheds. Involved on a voluntary basis (with no incentive), they have successfully handled fundamental activities:

- Mobilise their members on the issue of soil erosion, fodder scarcity and climate change;
- Facilitate initial participative diagnosis with the farmers. Design consistent protection work adapted to their specific geographical unit and monitor its correct implementation;
- Supervise referent farmers who are trained and equipped to provide technical support to their neighbour peers;
- Identify families facing labour shortages (widow-headed houses with no assisting family members, sick and old people, young couples) and organise assistance from the community to implement protection work on their farm;
- Manage common tools provided by the project for the construction and maintenance of the structures (distribution, check, inventories, replacement);
- Represent farmers and facilitate links with other stakeholders involved on land management: agents from the Ministry of Agriculture (MoA), local authorities, neighbouring *Iddirs*;
- Negotiate and adopt specific rules in their bylaws to control open grazing.

Two elements deserve to be emphasised in the approach developed with the *Iddirs*:

- First, **the role of exchange visits to favour adoption**. It is an excellent opportunity for farmers to exchange knowledge with others, to better understand the processes and conditions of success, and to observe results in similar farming situations (farm-based nurseries, vegetated structures and fodder integration in the farm, grass/legume associations, open-grazing control, ways to support vulnerable families.
- Second, **the critical importance of rules, and their application, to control open grazing.** Many grasses, such as most of the *Pennisetum*, or legumes do not survive if they are over-grazed. Open grazing is a common


uncontrolled practice, conflicting with erosion control and fodder cropping. Animals impede grass regrowth, compete with cultivated fodder, prevent tree seedling development and can severely damage the physical and biological anti-erosive structures. To help restrict open grazing in their communities, *Iddirs* have defined, negotiated and integrated adapted regulations in their own bylaws. This goes along with the Southern-Regional (SNNPR) Land Administration and Utilisation Proclamation that stipulates that "In any type of rural land where soil and water conservation works have been undertaken, a system of free grazing shall be prohibited and a system of cut and carry feeding shall be gradually introduced".

Beyond ensuring the durability of the vegetated structures, controlling open grazing also gradually allowed the **introduction of new measures that contribute to restore soil fertility**. These measures include the reintegration of straw (wheat is cut high and straw is reincorporated in the fields, which is not possible with common grazing), the development of fodder hedges or alleys and the promising intercropping of green manure as 'improved fallow' with species such as vetch, lupin and cow-pea.

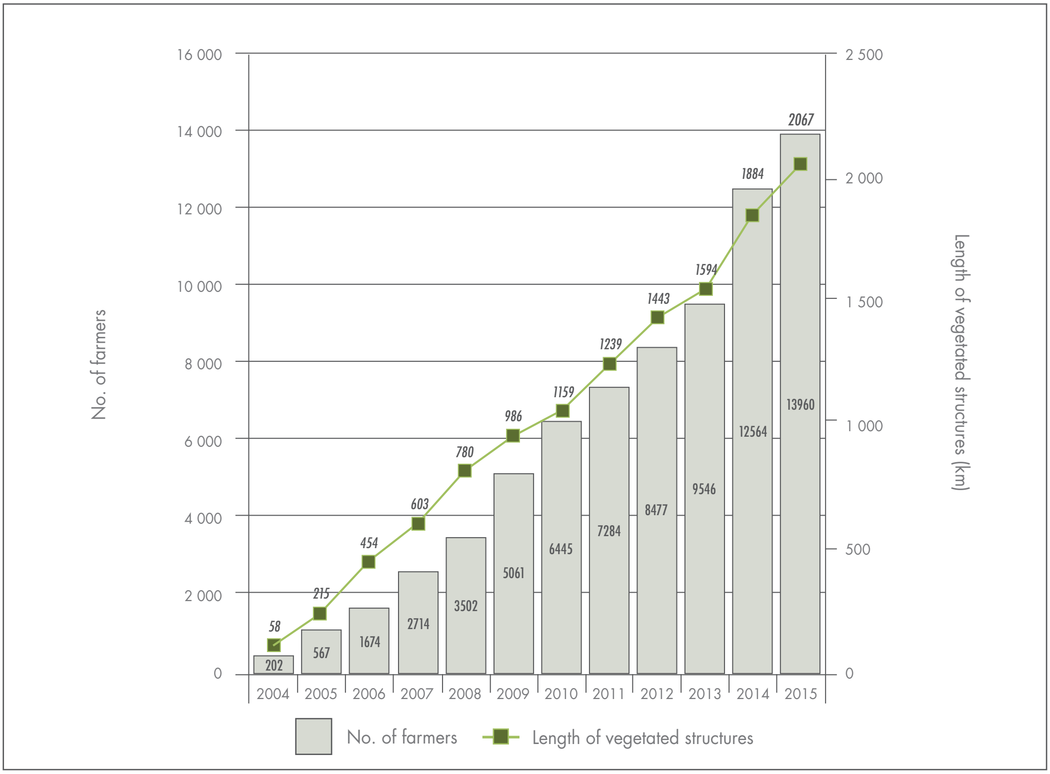
E. Adoption and durability of the changes

a. Cumulative number of farmers that adopted soil conservation structures with fodder grasses

If a number of projects have focused on soil and water conservation, in parallel to improving 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 artificial environment.

The first interventions combining soil conservation and fodder production started in 2005 in two districts of the Southern Region of Ethiopia. In 2012, the activities were extended to two new districts, and the Ethiopian organisation Rural

Figure 1: Cumulative number of farmers that adopted soil conservation structures with fodder grasses



Community Based Development Initiative Association (RCBDIA) replicated a similar approach in two other new districts, respectively, in 2012 and 2013.

In 10 years, 13,960 farmers have adopted the practice. They have constructed and vegetated a total of 2,067 km of anti-erosive structures (project database)**.** More soil bunds and *fanya juu* structures have been built but only those that have been vegetated with fodder production (grass and legume) have been taken into account.



b. 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 four old sub-watersheds of the intervention. In these communities, the objective was to compare the number of structures recorded at the end of the project with the current situation to evaluate whether the farmers have maintained 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.

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

Table 2: Durability of the changes, results of the evaluation conducted in four old project catchments

District / Kebele / village	Starting year / ending year	Total no. of families	% farmers with vegetated structure at project end	% farmers with vegetated structure in 2015
Kacha Bira / Burchana / Ajacho	2005 / 2008	72	99	93
Kacha Bira / Hobi Chaka / Yayama	2007 / 2008	80	93	93
Hadero / Hachacho / Geshame	2011 / 2012	102	75	90
Boloso Sore / Gununo / Dagecho	2012 / 2014	127	72	80

F. Impact

a. Planting grass on anti-erosive structures increases the economic value of the field

Without considering the possible effects on soil fertility, **a field equipped with vegetated anti-erosive structures provides more income than without, despite the loss of surface taken by the structures**. This simple calculation was certainly the triggering effect to stimulate many farmers to invest time and energy to build the structures and multiply grass. Indeed, producing biomass on anti-erosive structures allows farmers to significantly increase the gross value of the field:

- One-quarter of a hectare (50 m x 50 m) planted with wheat generates a gross income equivalent to Br1,600–2,000 for one season (corresponding to about €70–80 in 2015 with €1 = Br22).[2]
- Two rows of erosion control structures of 50 m long by 2 m wide (1 m width for the ditch and 1 m for the earthen bund) represent a loss of 8% of the cultivated plot, or an economic loss in production equivalent to Br128–160 (€4–5).
- The production of fodder on these two earthen bund lines generates an average annual income of Br1,100 (€33), when sold directly on foot or on the market (three cuttings per year, two in rainy season and one during

dry season – data from field measurements and prices from the local market in 2015).[3]

- Bringing this yearly production to 6 months, the increase in the plot gross value can therefore be estimated at 20% per season.
- However, during the first year, the initial investment in terms of labour is important and requires around 20 days of work (14 days to establish 100 m of soil bund + 5 days for the maintenance during the first year + 1 to 2 days to plant the grass). From the second year, the production is perennial and little labour, except for harvesting, is needed.

b. Measures of fodder production in 120 farms and estimation of its market value

To evaluate average grass fodder production per farmer, field measurements were conducted in 120 farms of three villages in 2015 (randomly selected villages within the list of the villages targeted at least 3 years after the withdrawal of Inter Aide's intervention). All the areas dedicated to fodder grass production inside the farm have been measured and recorded. For each farmer, a classification into three categories was done based on objective indicators defined within the frame of agrarian studies (Cheveau *et al.*, 2011). It mainly relies on the number of animals (own and shared) and the area of the farm. From these field measurements:

- Among the 120 farmers, three families were not producing grass fodder on their farm (2.5%).
- On average, farmers have built **171 m² of structures with vegetative production.**
- The total **average grass fodder production is 303 m²**, meaning that farmers have gradually increased their own production besides the physical support of anti-erosive structures. In total, 44% of the production comes from other plots on the farmers' land than the vegetated anti-erosive structures: on dedicated perennial fodder production plots (18%); around the field (14%); at the foot of hedges (8%) and under trees (3%).
- The last column in Table 3 indicates the financial return expected from grass sale per social category (yearly average of fodder market value for 1 m² of grass was Br22 in 2015, corresponding to €1). Not all farmers are selling fodder (essentially vulnerable families). It represents thus the market value of the production if it was fully sold on the market. **On average, the grass fodder production value of a farm is €303 per year**. For

vulnerable families, this represents €232, which is the equivalent of more than 100 days of daily work (1 day of daily seasonal work is paid locally at between €1 and €2).

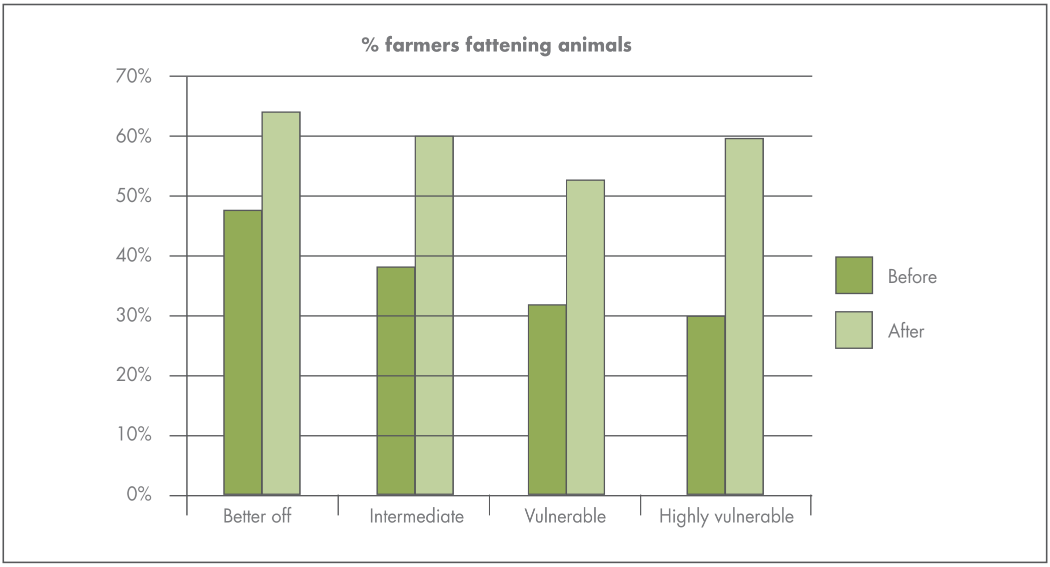
- The data were collected at least 3 years after planting the grass. All plants were thus well-established and productive.

Table 3: Measure of the fodder production on 117 farms and estimation of the production's market value

Type	Sample	Anti-erosive structures (m²)	Other: hedge, plots, around field (m2)	Total (m2) (%)	Estimated value
Better-off	34	231	176	406	Br8,937 (€406)
Intermediate	44	166	121	287	Br6,313 (€287)
Vulnerable	39	124	107	232	Br5,096 (€232)

In addition to the quantitative field measurements, surveys were exhaustively conducted in July and August 2015 among 381 farmers of four villages involved in the project at different stages (from 2005 until 2012). They underlined four main effects, which are explored in more detail below.

Figure 2: Evolution of the percentages for animal fattening per social category



c. Effect on animal health and by-products

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 57% were involved afterwards. Cows and oxen are kept for about 4 months; the average gross added value per animal was Br2,135 and Br2,810, respectively, in 2015 (€97 and €127).

Of the interviewed farmers, 67% state their animals are getting fatter and 65% also highlight an increase of milk quantity. However, the introduction of fodder cropping does not seem to have an impact on the number of animals owned but has increased the percentage of improved breed. On average, 21% of the families have purchased one (or more) improved cow(s). In villages where cultivated fodder was introduced 10 years previously, this percentage is higher with half of the families having invested in improved animal breeds. Milk production from Jersey or Holstein cows is on average three times higher than from traditional breeds (850 to 1,460 litres/year for the local breed and 2,850–4,015 litres/year for Jersey and Holstein). But those animals require a higher quantity and quality of feeding management than traditional breeds.

d. Reducing the burden for women and children to collect fodder

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

e. Attenuation of climate change effects

To find out the possible effects of climate change on precipitation during the dry and the rainy seasons, an analysis of 14 years' daily rainfall data collected by Gununo Research Center (Wolayta Zone) was performed within the frame of this study. Statistical tests (Kendall) did not confirm a significant trend in cumulative seasonal precipitation, or in the number of rainy days, or in the

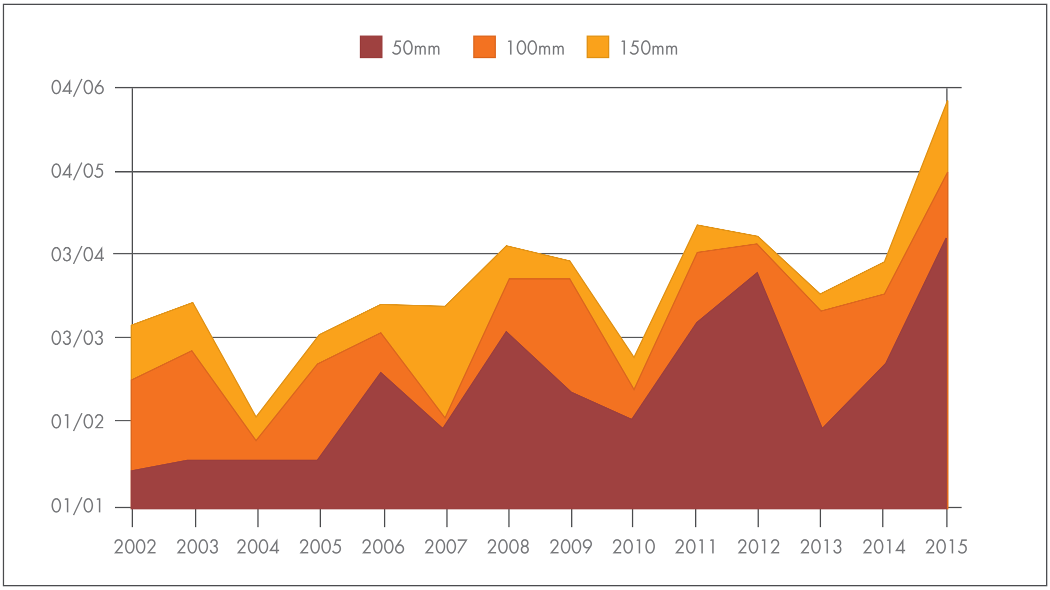
annual number of intense rainfall events (more than 20 mm of precipitation per day) over the 14 years. Those time series of data cover too short a period to reach significant variations. With available information, it is only possible to consider a progressively late arrival of the short rains in the region, without significant difference in terms of number of days or global amount of rain. This factor could confirm nevertheless that farmers are affected by climate changes mainly during the first cropping season (*Belg*), which is essential for their food security. Indeed, traditionally, the early harvests at the end of the short rainy season (*Belg*) mark the termination of the hunger and fodder gap after the dry season.

Later arrival of the short rains?

The threshold of 50 mm of cumulative rain seems to gradually occur later in the year, as indicated by Figure 3, which shows, for each year, the dates corresponding to the attainment of three cumulative thresholds of precipitation (50, 100 and 150 mm).

Measuring the impact of the vegetated structures on the soil and the moisture is beyond the scope of this study. The effects on mitigating the consequences of intense rainfall events on soil erosion or on better maintaining moisture are however well-documented in the literature (Dupriez and De Leener, 1992; Yakob *et al.*, 2015). Beyond these probable effects, the integration of drought-resistant grass and leguminous species on anti-erosive structures (such as *Pennisetum riparium*, *P. purperium*, *P. americanum* and *Cajanus cajan*) introduces new

Figure 3: Attainment of three cumulative thresholds of precipitation (50, 100 and 150 mm) for 14 consecutive years



Source: daily rainfall record, Gununo Research Center (Wolayta Zone)

fodder and food resources that are particularly critical during the critical time of the bridging period at the end of the dry season. For instance, the yearly production of 100 m of *P. riparium* corresponds to 5,700 kg of green fodder per year on average. This is the equivalent of 2 months of fodder to feed two animals of 250 kg. Letting the grass grow after the rainy season allows farmers to constitute a fodder reserve to address the dry period. Also, associating this grass with *Cajanus cajan* on the soil bunds provides an additional yearly production of peas of 35 kg on average, essentially harvested during the dry season. *Cajanus cajan* produces after 6 months and can then be pruned and maintained as perennial crop for 3 to 4 years.

In the particular context of south Ethiopia, the availability of fodder during the dry season is to be related to the reduction of the use of *Ensete ventricosum* leaves for animals, which is a crucial element for families' food security. As mentioned above, *Ensete ventricosum* is a fundamental crop used by the farmers to overcome the bridging period in south Ethiopia (Brandt *et al.*, 1997). And, as for the families, *Ensete* is one of the rare farm resources remaining on the farm during the dry season. For animal diet, the fresh leaves are cut and mixed with remaining straw, usually between October and May. The usage of *Ensete* to feed animals directly competes with the available food for family consumption, and *Ensete* depletion is a strong poverty marker (Bortzmeyer, 2014). With the introduction of cultivated fodder, 48% of interviewed farmers highlight the improvement of their *Ensete* plot, as the usage for leaves and corms for animal feeding has decreased.

f. Vulnerable families

Finally, the role of fodder as cash crop seems particularly interesting for vulnerable families, who are much more likely than others to sell fodder. With the introduction of anti-erosive structures coupled with fodder production, those families get a new income source through the sale of fodder.


1


2


3


4


5


6

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

G. Conclusion

It is most important to identify practices and innovations combining risk mitigation (soil and water conservation) and increased resilience strategies (management and storage of biomass). The promising innovations are those that improve resilience. This model is primarily based on the diffusion of a combination of practices, the promotion of biomass production, combining fodder grasses and leguminous species, on anti-erosive embankments. It provides a direct response to animal fodder scarcity while contributing to maintaining soil and fertility in the long run. Moreover, fodder production represents one of the most important sources of short-term cash for farming families. Poverty alleviation is therefore the main impact of this new practice in the south Ethiopian context; forage production generates a quick alternative income and facilitates access to livestock and organic manure. It should be stressed that income generation and economic improvement concern all categories of farmers, inclusive of the most vulnerable.

Further, improving resilience is also a strong effect of the innovation through different aspects:

- fodder plant multiplication is managed by the farmers themselves in micro, farm-based nurseries;
- 57% of the adopting farmers are involved in animal fattening as against 39% before producing fodder;
- there is an integrated approach at micro-watershed level, not only as a geographical unit, but also as a socio-economic and bio-physical unit, which aims at a complete protection of the catchment;
- the role of the traditional organisations *Iddirs* in enforcing anti-erosive measures, prohibiting open grazing and coordinating the work at micro-watershed level is fundamental for social acceptance and allows an important lever effect.

Improved resilience facilitates in turn adaptation to climatic change. Erratic rainy pattern and late arrival of the rains in *Belg* season (corresponding to the dry season) may affect food security through alternation of droughts and heavy rains. The introduction of cultivated fodder on embankments creates hedgerows which protect soil from drying. This phenomenon is also reinforced by the extension of the *Ensete ventricosum* plots, acting as a windbreak, due to reduced pressure of animal feeding. Vegetated soil bunds slow down water speed and increase infiltration, reducing the leaching effect and retaining moisture longer.

Finally, the relevance of the innovation is confirmed by the 13,960 farmers who have adopted the practice and constructed and vegetated a total of 2,067 km of anti-erosive structures. The durability of the adoption has been measured in former operational sites, where 93% of the farmers had conserved their structures established 10 years ago.

Overview of the conservation work carried out by the farmers of the sub-watershed of Lechecho, Hadero District, 2015.

References

Bortzmeyer, A. 2014. 'Etude sur les fonctionnements des jardins de case'. InterAide, Versailles. http://www.interaide.org/agri/eth/?p=61

Brandt, S.A., Spring, A., Hiebsch, C., McCabe, J.T., Tabogie, E., Diro, M., Wolde-Michael, G., Yntiso, G., Shigeta, M. and Tesfaye, S. 1997. Tree Against Hunger: Enset-Based Agricultural Systems in Ethiopia. American Association for the Advancement of Science. http://users.clas.ufl.edu/aspring/publications/enset.pdf

Cheveau, A., Hoornaert, C. and Cochet, H. 2011. Development Perspectives for an Ethiopian Agrarian system sinking into crisis: Agragrian Diagnosis carried out from March to October 2011, Doyogena Woreda, Kambatta, Southern Ethiopia. AgriParisTech/InterAide, European Union and AFD. http://interaide.org/pratiques/content/diagnostic-agraire-developement-perspectives-ethiopian-agrarian-system-sinking-crisis

Cochet, H. 2009. 'L'impact des changements climatiques en Ethiopie et dans les sociétés du sud'. Paris Institute of Technology for Life, Food and Environmental Sciences (AgroParisTech), Paris.

Duncan, A., Stur, W., Larbi, A. and Tiemann, T. 2011. 'Enhancing livelihoods of poor livestock keepers through increased use of fodder: Programme completion report'. ILRI, Nairobi, Kenya http://cgspace.cgiar.org/handle/10568/12497

Dupriez, H. and De Leener, P. 1992. *Ways of Water: Run-off, Irrigation and Drainage (Land and Life)*. Macmillan Press, London.

ICRAF and Ministry of Agriculture. 2005. Managing Land: A Practical Guidebook for Development Agents in Ethiopia: Technical Book No. 36. Regional Land Management Unit, World Agroforestry Centre and Ministry of Agriculture and Rural Development, Ethiopia, p. 39 http://www.worldagroforestry.org/downloads/Publications/PDFS/MN13598.pdf

Léonard, T. 2013. *Ethiopian Iddir Mechanisms: Case Study in Pastoral Communities of Wolayta and Kembatta*. Inter Aide, France. http://interaide.org/pratiques/sites/default/files/iddirs_wolayita-kt.pdf

Rogers, E. 1962. Diffusion of Innovations. 3rd Edition. The Free Press. New York. https://teddykw2.files.wordpress.com/2012/07/everett-m-rogers-diffusion-of-innovations.pdf

Yakob, G., Gebremicheal, A., Aklilu, A. and Melaku, E. 2015. 'Participatory evaluation of different multipurpose grass species for graded soil bund stabilization in Gimbo District, South West Ethiopia'. *Open Access Library Journal* 02**:** 1–10. doi: 10.4236/oalib.1101627

Endnotes

1. Data measured in 10,851 farms in midlands and highlands (Inter Aide project database, Damot Gale, Kacha Bira and Hadero Woreda 2006–2011).
2. Updated data from the agrarian study conducted in 2011 in Doyo Gena Woreda (Cheveau *et al.*, 2011).
3. The reference for the economical yearly value of fodder production is therefore set at Br22 per m2 (€1) or Br11 per linear metre (€0.5).
4. Difference between the two percentages is highly significant, with $p < 0.001$

Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA)

P.O. Box 380
6700 AJ Wageningen
The Netherlands
www.cta.int