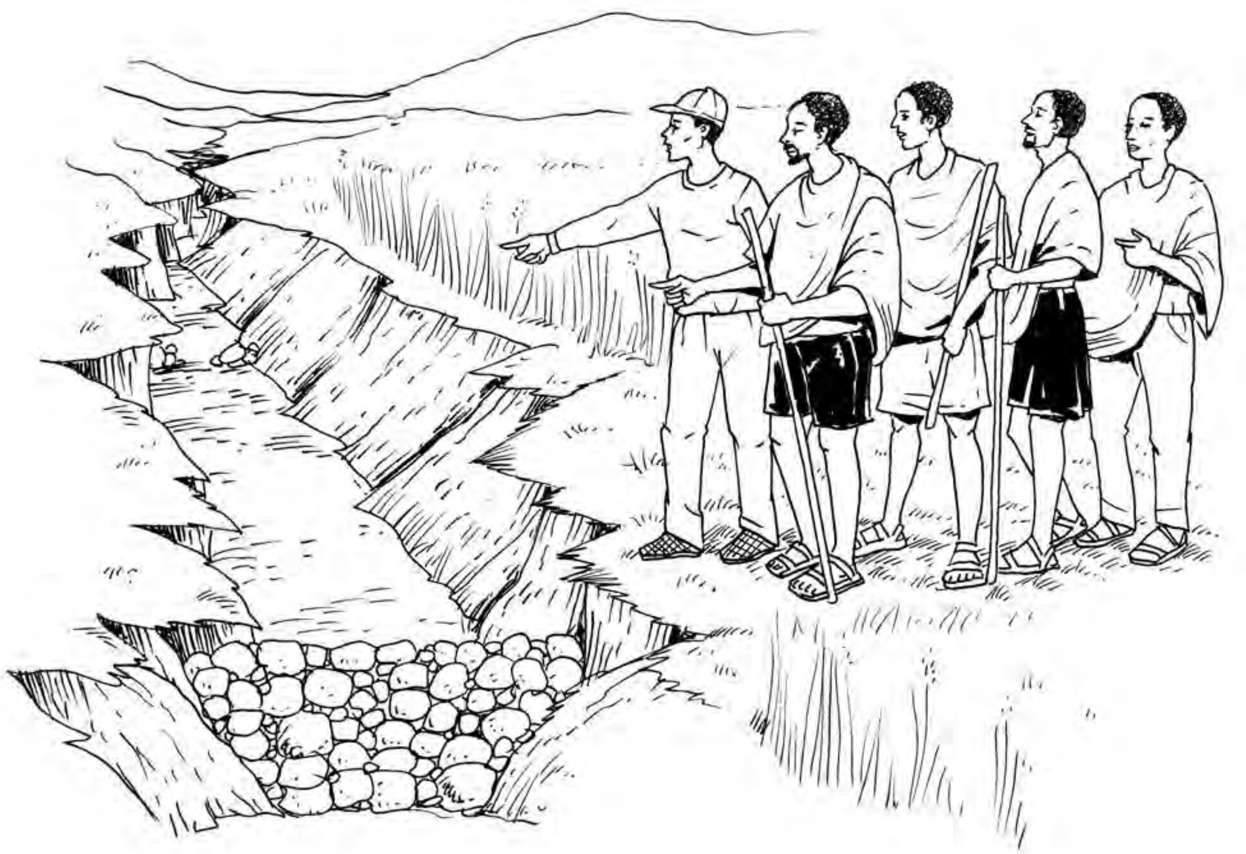
Application of a Farmer-expert Joint Learning Approach to Improve Soil Conservation: The Cases of Angereb and Enkulal Watersheds, Lake Tana Sub-basin



In the highlands of Ethiopia, where intensive agriculture is practiced, land resources are being depleted at an alarming rate. Balancing soil and water conservation (SWC) measures with the use of effective technologies and farm management practices against the current level of land degradation is a growing challenge to smallholder farmers, who are striving to meet immediate economic objectives, on the one hand, and sustainable environment, on the other. Past SWC programs focused more on land degradation and they used a top-down approach. Top-down programs tended to focus more on the symptoms of erosion through subsidized terracing rather than on the root causes of land resource degradation. There was less emphasis on integrating local knowledge of land users and planning together with farmers.

Soil conservation programs, thus, require a long-term, bottom-up, and interactive approach supporting farmers who generally have detailed knowledge of their farm. Land and water resource management demands an ongoing learning and negotiation process where high priority is given to questions of communication, sharing community and individual land user perspectives, and development of adaptive group strategies to solve problems (Pahl-Wostl 2002a; 2002b). According to Bandura (1977), social learning refers to individual learning based on observation of others and their social interactions within a group, for example, through imitation of role models. It assumes an iterative feedback between the learners and their environment, the learners changing the environment, and these changes affecting the learners.

Through such interactive exercises and iterative processes, the knowledge, which is difficult to articulate, can be made explicit. Therefore, in order to improve the efficiency of soil conservation, the present case approach aimed to articulate local soil erosion knowledge and assess the learning process and pattern of changes in attitude, skills, and knowledge of farmers by making use of local erosion indicators as learning objects. This paper provides information on the participatory learning processes through farmer-expert joint learning approaches (JLAs) and explores local knowledge of erosion and changes in soil conservation practices, taking case studies at Angereb and Enkulal watersheds in the Amhara Region.

Implementation processes and stages

Angereb (located in the Gondar Zuria District, north Gondar) and Enkulal (located in Dera District, south Gondar) watersheds were the case study areas. About 58 (from three small catchments) and 22 landowners were involved throughout the participatory learning process at Angereb and Enkulal watersheds, respectively. The following implementation stages were employed to explore and share farmers' knowledge about local soil erosion indicators and conservation practices: (1) organizing community awareness meetings; (2) conducting field visits and discussions to explore erosion indicators, causes, impacts, and their measurement; (3) identifying erosion problems and planning potential conservation measures and improvements; (4) implementing improved measures; and (5) monitoring and evaluating the performance of already implemented measures and outcomes of the learning process.

Initially, the JLA involved awareness and attitudinal change activities to motivate and increase the level of participation of farmer households during the process. This is a key step to build confidence and trust in the process and encourage individual farmers to be actively involved in the learning process. Another critical step was for well-experienced experts (who have good knowledge and communication skills) to orient, facilitate, and motivate the participants to actively participate in discussions, as well as record the changes in attitude, skills, knowledge, and practice in every process. The participating farmers themselves led the participatory process.

This approach applied frequent field visits and discussions and dialogues with farmers rather than use of empirical expert-based methods. Farmers formed groups based on the catchments and the location of their plots. Each of the groups held periodic field visits after every erosive rainstorm and held discussions in groups about the erosion processes observed in each of the participant-farmer's plot and their sources and impacts. This process gradually facilitated a collective understanding of land management practices and the associated problems and constraints with its solutions. This approach was practiced by means of consensus building through iterative procedures in order to reach a common understanding and explore local erosion indicators. Upon agreement, they described the local erosion indicators and means of verification at individual plot and landscape levels. Through continuous dialogues and discussions, the land users gained environmental knowledge that would help ensure ecosystem sustainability. Eventually, based on the knowledge of the erosion processes, farmers sat together and developed intervention plans to control the erosion processes. After implementing the controlling measures, they made regular field visits during erosive storms, collected information, and evaluated the efficiency and performance of conservation practices. In evaluating each improvement measure, participants made field observations and gathered quantitative evidence.

The outcomes of the learning process of the JLA were measured before and after each learning event. The outcomes of the JLA were measured by (i) exploring and explicitly describing more erosion indicators through the learning period, (ii) evaluating the extent of practicing improved soil conservation measures and innovations, and (iii) interviewing the learning group about their perceptions and attitudinal changes on soil erosion processes and soil conservation.

Local knowledge of erosion indicators

In the early stage of the JLA, qualitative and quantitative assessment of local erosion indicators showed that, while farmers were aware of highly visible gully erosion, landslide, flooding, damage of trees, and yield reduction, they were less aware of emerging and more frequent seasonal erosion indicators such as sheet erosion, rill erosion, ditch erosion, and tillage erosion. They hardly perceived the long-term and irreversible consequences of seasonal erosion processes, which often cause far more visible indicators like gullies. By contrast, farmers perceived those indicators that they can easily notice as being costly and beyond their capacity to reverse and control.

Later in the learning process during the first rainy season, farmers in the Angereb watershed were able to explore and come up with more erosion indicators such as rills with a depth of 15–20 cm, tree and stone mounds, exposure of plant roots, and gradual change of soil color. In the second rainy season, additional erosion indicators such as sheet and surface erosion, small rills with a depth of 5–15 cm, tillage erosion, and on-farm drainage ditches were perceived and explored. Subsequently, practicing in-depth joint learning exercises by observing the causes and effects of erosion indicators as well as the causes of the limitations of soil conservation practices were described. Similarly, in the case of Enkulal watershed, farmers identified damage to terraces, excessive traditional ditches per parcel, and excessive removal of crop residues as common local erosion indicators. Exploring a combination of different categories of indicators is, therefore, desirable to generate context-specific knowledge, both social and ecological. The different types of indicators can help to relate local knowledge to the scientific methods. The farmers learned which indicator works where, under what conditions, and why.

Change in practices

Once farmers have analyzed and understood the erosion indicator processes and problems, they implemented improved measures to address the observed problems. In the subsequent learning events, farmers gradually demonstrated changes in their practices as a result of the co-learning and knowledge sharing (Table 1).

Farm drainage ditches at Enkulal watershed

Farmers decided to reduce a significant number of ditches with lengths not more than 25 m and a gradient less than 6% each from every parcel. The participating farmers (in two groups) surveyed the number of ditches on their farms and monitored the erosion hazard of ditches. In the beginning of the learning process (in 2011), a total of 256 ditches were recorded in the agricultural fields of 22 participating farmers (a minimum of 3 and a maximum of 52 ditches per parcel). The participants noted that the average initial depth and top width of ditches was 19 cm and 38 cm, respectively. The gradient of ditches was, on average, 5-9%. After one rainy season in 2012, farmers were convinced to install bunds. As a result, the total number of ditches was reduced to about 74 ditches (an average of 2.4 ditches per parcel) (Fig. 1). Except on a few parcels, a significant number of farmers reduced ditch gradient to below 6%. None of the constructed ditches crossed the soil bunds. Measurement of sediment accumulation at the bottom of the ditches and the change in the dimension of ditches revealed that the sediment transport rate was between 0.5 cm^2 and 4.0 cm^2 per meter of the ditch. The transport

Table 1*. Changes in practices and innovations by applying JLA at the Angereb watershed.*

Initial stage of the process (1st iterative stage)	After one rainy season (2nd iterative stage)	After two rainy seasons (3rd iterative stage)
Maintenance of terraces	Constructing new terraces	Runoff disposal trench on terraces
Constructing cutoff drains	Planting along terraces	Improving cross-section of terraces
Constructing farm ditches	Fallowing	Excavating pits in the field
Constructing check dams	-	-

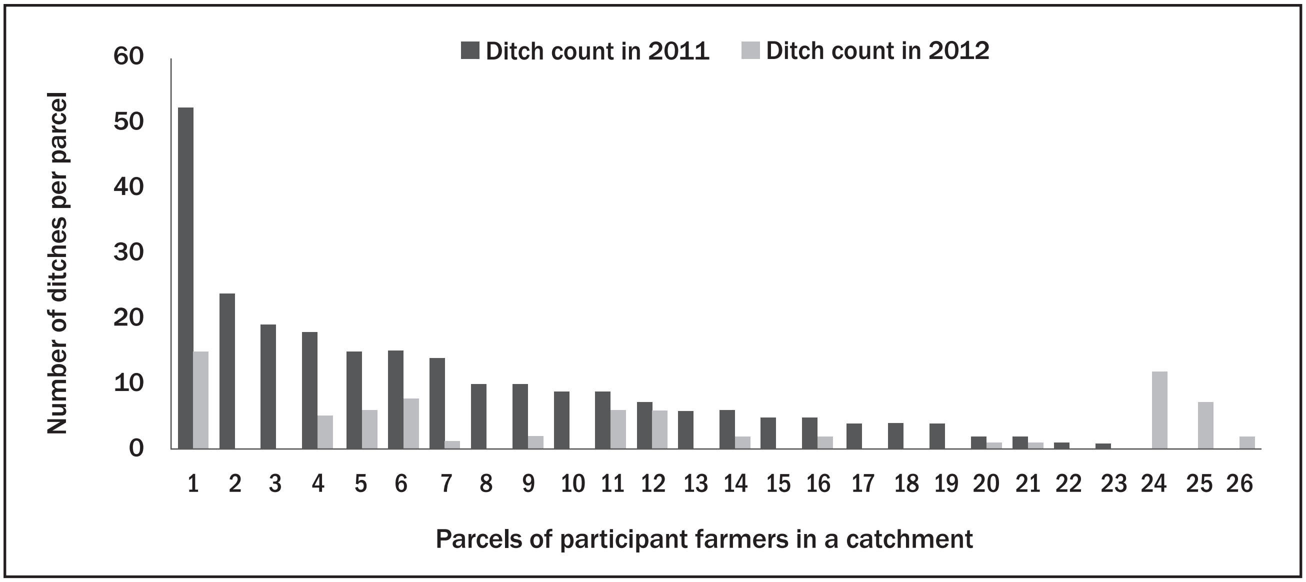


Fig. 1. *Number of ditches per parcel in 2011 and after the learning process in 2012.*

rate varied temporally and along the length. The respective rate of sediment transport at the top, middle, and bottom parts of the ditch was 0.19, 1.33, and 1.52 cm^2 per meter in July, and 0.93, 3.39, and 4.32 cm^2 per meter in August.

The average seasonal sediment transport rate was 1.27, 2.70, and 3.97 cm^2 per meter per ditch at the upper, middle, and lower sections of the ditch. This implies that the impact of the reduced number of ditches per parcel has resulted in a significant reduction of total sediment transport in a catchment. Reducing the total number of ditches in a catchment by 180 can prevent about 450 cm^2 of sediments from being eroded out of ditches.

Increased harvest height of wheat residue at Enkulal watershed

Another practice was to increase the height of crop residues left after harvest by 10 cm, 50–55 cm, 10–12 cm, 45–50 cm and 75 cm for teff; wheat and barley; millet and linseed, lupine, and niger seed, respectively. A small number of farmers harvested wheat by adding 10 cm more than the usual height. Wheat residue measurement indicated that an average height of 7–14.5 cm (equivalent to 8.5 g biomass) and 21–30 cm (equivalent to 16.6 g biomass) crop residue were recorded at the usual harvesting height and on improved height, respectively. This implies that an additional biomass of 8 g were left over the field, which, in turn, contributed to an increase in soil organic matter, gradually reducing the erodibility of the soil.

Terrace, cutoff drain, and check dam construction at Enkulal and Angereb watersheds

Farmers reached a consensus to construct new and maintain old terraces and cutoff drains in all farm plots and protect gullies together by constructing check dams. Farmers agreed to lay out structures in a toposequence in order to maintain the integration of structures and connectivity of runoff flows.

Farmers who have no bunds/terraces on their plots have been constructing terraces, cutoff drains, and check dams on cultivated lands and in gullies. At Enkulal, farmers mobilized a total of 1684 person-days (865 male and 819 female) for 34 working days. Based on the agreed specifications, a total of 6290 m (volume about 2500 m3) graded soil bunds, waterways 180 m long, more that 100 m of cutoff drains and some check dams were constructed.

At Angereb, a total of 6800 m terraces and cutoff drains and 140 check dams were constructed in the first year. In the second year, 14 new check dams were constructed while 156 old check dams were maintained. After installing the check dams, farmers regularly quantify the sediment retained by the check dams after a heavy rainstorm in order to increase the awareness of other farmers on soil erosion and nutrient loss from farm plots. For example, in Angereb, the farmers quantified 8 tons of total sediments retained in all check dams constructed during the first rainy season. Subsequently, they traced back and identified the farm plots from where the sediment was eroded and transported so that actions could be planned for the next period.

Participants' views

1. "Initially, I felt the learning process was what we already knew. Now, I realize we have learned new practices. I learned how much of our soil, drainage ditches wash away." *Fentie Mandie (male)*
2. "I learned that our tillage operation has damaged the terraces." *Dires Tebabal (male)*
3. "In the past, many were not interested in constructing terraces on their land. Now, we have learned the benefits. I learned how to divert runoff through ditches to an adjacent land. We managed to protect communal lands and pathways together. I was happy that both men and women have made equal contributions." *Birkie Zewdie (female)*
4. "The participatory process gave me an opportunity to learn from other farmers and now we can do things together." *Lakew Mesel (male)*
5. "The field visit and dialogue help individuals to take common responsibility. We understood that seeing is believing. I learned that increasing crop residue improves soil fertility." *Aragaw Muche*
6. "I learned that improved terrace construction is beneficial because our land is protected from erosion." *Manhal Ewnetu (female)*
7. "In the beginning I was reluctant to participate. But now, I've learned how to protect my land from damage and how to make decisions jointly with other farmers. I will protect terraces from animal damage and I feel responsible to protect our land." *Marie Yimam (female)*

Integrating trenches with terraces at Angereb watershed

Modified trenches were constructed to safely drain and partly retain runoff water and sediment from the terrace area. The modified trench improves efficiency of the terrace and provides multiple functions: (i) retaining excess runoff water, (ii) trapping sediment eroded from the terrace area, and iii) increasing infiltration and interflows. During the first season, one innovative farmer integrated trenches on terraces. Later, in the second year, nine other farmers implemented the innovation on a total of 557 terraces.

Improved cross-section of terraces at Angereb watershed

Damage to stone terraces due to unstable cross-sections is common. It is also difficult to maintain or improve stone terraces on steep slopes by adding more stones on top of them. Making improved cross-sections of the terraces was co-learned from an innovative farmer and practiced by other participant farmers in all of the cultivated lands. The height of structures on the top side is limited to the ground surface while the bottom riser is increased to retain as much sediment as possible. The improvement increases structural stability and is not susceptible to damage.

Change in perceptions

Twelve randomly selected participant farmers were interviewed by an independent interviewer to find out about their views on the farmer-expert JLA and their attitudinal changes on the soil erosion processes and soil conservation practices. The views of some of the participants are encouraging (see box).

Lessons learned

The farmer-expert JLA motivates farmers to explore local knowledge and adapt innovative ideas and practices. All farmers practiced certain types of soil conservation measures. The approach helped farmers to understand short-term erosion indicators and oriented them toward long-term erosion protection strategies. The JLA minimizes the sense of dependency and enhances the empowerment of farmers. In the long term, this participatory and interactive approach helps to reduce the workload and pressure of extension agents. It can be a potential tool for participatory soil conservation and useful in development research as local adoption and adaptation realities are considered toward developing sustainable technologies. It can also serve as a local platform and as an extension approach to transfer and support the adoption of sustainable soil conservation technology.

However, the approach requires well-trained experts (with skills, knowledge, and commitment) who will act as catalysts for continuous dialogue and exchange of knowledge. Facilitators need technical experience; skills of facilitation, negotiation, and conflict resolution; as well as a range of personal qualities, attitudes, and behaviors. It was observed that building a common understanding and more effective knowledge systems of sustainability takes time and patience. Scaling up this approach requires greater coordination, time, and commitment to build trust and ensure continuity.

Conclusion

If erosion processes and problems are to be understood and effective soil conservation technologies planned, economic, social, and environmental contexts that govern decisionmaking need to be considered. As context is so different from place to place and from time to time, understanding the specific local context can provide insights into the relevant issues. Therefore, in order to sustain appropriate soil conservation technology development, farmers must be involved in the process and acquire the capacity to respond to these local changing situations. The participatory learning process can be conceptualized as the interaction and integration of biophysical dimensions with the human dimensions. This determines the limits within which conservation technologies are physically possible, viable, and socially acceptable.

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