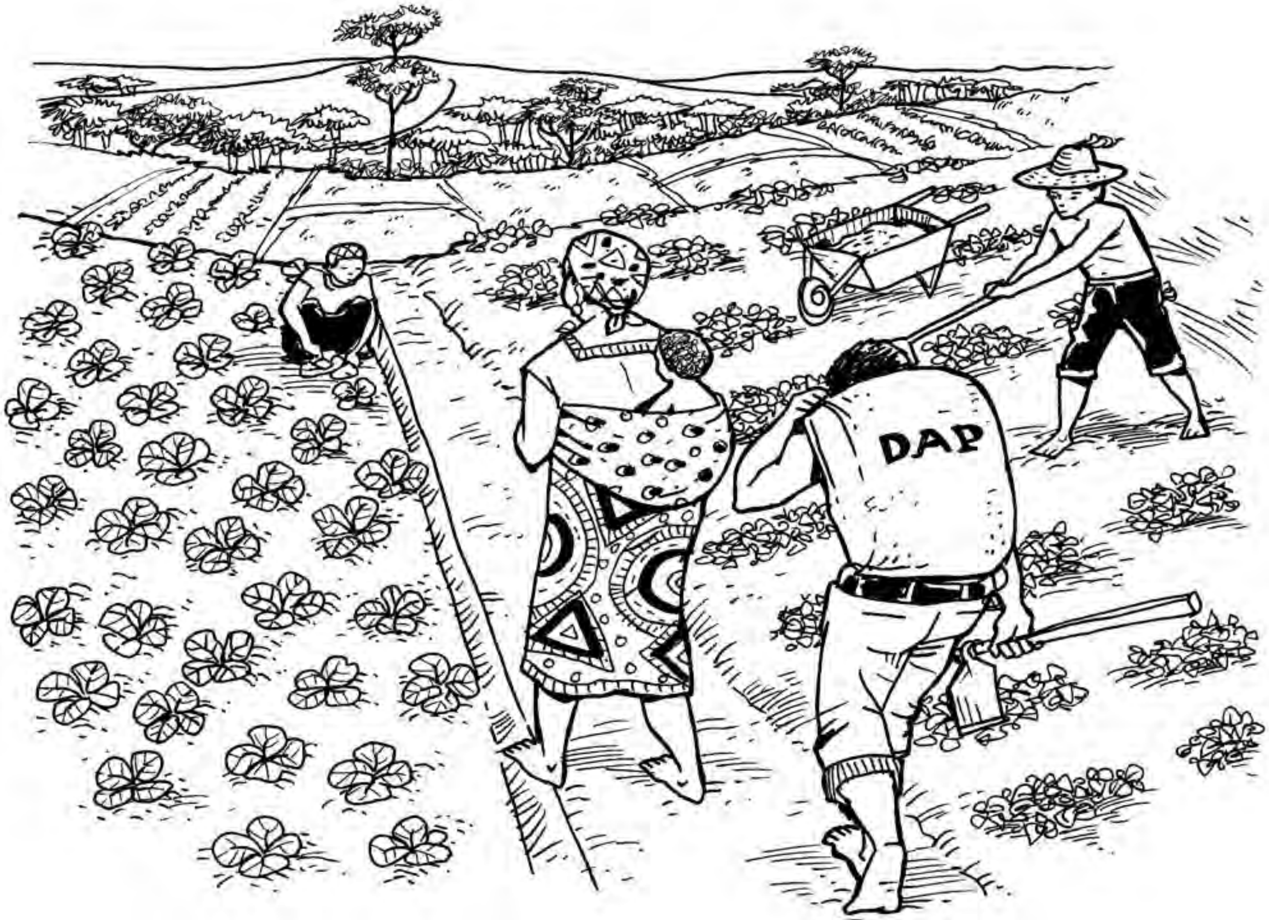
An Assessment of the Cost Effectiveness of Soil and Water Conservation Techniques in Otuke District, Uganda



An action research study was conducted by stakeholders in Otuke District under the Learning and Planning Alliance (LPA). The study aimed to increase awareness and equip farmers with knowledge and skills in using selected agricultural soil and water management practices and technologies. Otuke District is one of the districts in the Lango Subregion located in northern Uganda. Facilitated by the Global Water Initiative East Africa (GWI EA), the study identified the most cost-effective soil and water conservation (SWC) practices that can be adopted in Otuke and in similarly semiarid areas in Uganda. Working with champion farmers, demonstration plots were established to host soil and water management techniques and practices by focusing on rainwater harvesting using rooftop and runoff, construction of shallow wells for supplementary irrigation, mulching, minimum tillage (planting basins), raised planting ridges, and use of compost manure. These were complemented by growing high-value vegetable crops to demonstrate the benefits of adopting such practices by farmers.

The problem

Farmers in Uganda and in Otuke District rely on rainfed agriculture. The district receives an average annual rainfall of 1,197 mm with a unimodal distribution. Peak rainfall occurs in July/August and a secondary peak occurs in May. The period between December and February is the driest, with evaporation significantly exceeding rainfall by a factor of 10.

According to Oxfam (2008), rainfall (water supply) has become increasingly unreliable, and it is the biggest threat to food security that affects mostly small-scale farmers. Otuke farmers only realize 15–20% of potential crop yield, and the June-July dry season often results in significant crop failure (GWI EA, 2013). Extreme heat usually experienced in most semiarid areas leads to high evaporation rates. This reduces the moisture content in the soil profile available for use by the plant root systems as well as the quantity of water available for irrigation. Adversely, this increases incidences of crop failure, which, in turn, increases the vulnerability of farming households to effects of seasonal variability such as food insecurity and high risk of becoming poorer (Mubiru, 2010).

To the smallholder farmers, conventional irrigation is relatively expensive to operate and maintain and therefore uneconomical. Also, these farmers mainly grow food security crops such as cereals and tubers—these crops do not justify heavy investment in conventional irrigation. Thus, there is a need for alternative low-cost, easily adoptable agricultural water management technologies (AWM) in the semiarid regions. These enable farming households to diversify their income sources as a way of increasing household resilience to effects of changing weather patterns.

Given the above, the LPA, in collaboration with Welthungerhilfe, supported the champion farmers to promote soil and water management technologies. The results helped in identifying the most cost-effective practices that are instrumental in reducing farmer vulnerability caused by unreliable rainfall. These techniques and practices, when adopted, will improve farm productivity and result in greater food security.

Methodology

Study design and scope

An action research approach was used to execute the study. The approach is cyclic, participatory, and qualitative (Richard, 2009). More so, the study is intended to bring about action (improvement and development) as well as research knowledge and understanding as illustrated below.

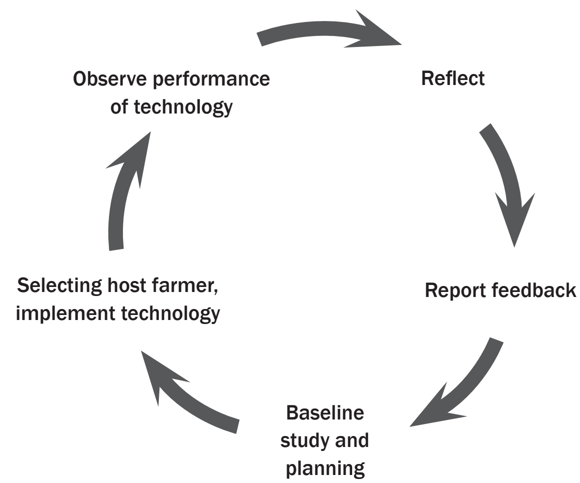


***Fig. 1**. The action research approach (Adapted from Atherton, (2009) with modifications).*

This approach supports learning by doing: jointly identifying a problem, exploring and testing solutions, and disseminating lessons of both successes and failures of an improved learning. The study was performed collaboratively with the farmers, local authorities, researchers, and other key stakeholders to test various technologies and practices on soil and water conservation.

At the onset of the study, stakeholders jointly developed the criteria for selecting champion farmers to host demonstration sites. Among the critical criteria were ability to avail of at least 2 ha of land, capacity and the will to train others, commitment of support from the spouse, readiness to invest (time and input) in demonstration plots, and consideration of women farmers.

Based on the above, eight farmers were selected from each of subcounties Olilim, Ogur, and Orum. This brings the total to 24 champion farmers (F=15, M=9). These subcounties had previously benefited from GWI phase 1, and phase 2 was built on lessons from the earlier phase.

The 24 farmers were trained and supported to prioritize and select enterprises to implement with the technologies in line with the national agriculture advisory guidelines on enterprise selection. Farmers selected tomato and onion. These are high-value crops assessed to have a ready market within the northern region. In addition, they were supported to select a third crop: cabbage, banana, or pineapple.

Onions and tomatoes were planted on two plots. On the first plot, farmers strictly applied improved agronomic practices, including soil and water management techniques and practices. On the second plot, farmers used their traditional farming practices. In this case, mulching, planting on ridges, use of permanent planting basins (PPBs), and supplementary irrigation were not applied.

The plot sizes differed according the farmers' capacity (range was from 240 to 1,000 m^2). In order to standardize this information, data were extrapolated for 1 acre.

Soil and water conservation technologies were promoted under improved practices and were used in combination. Variously, a farmer would plant tomatoes on ridges, use compost and mulch, and supplement rainfall with water harvested from surface runoff, hand-dug well, or rooftops. Maize and bananas were planted in PPBs. These basins are sunken surfaces that trap water and allow precise application of manure and inorganic fertilizers in the basins for crop utilization. The other technologies included madala terrace and kitchen gardens, conservation farming, and action research implementation approach.

The action research team under the leadership of the district agricultural officer (DAO) was composed of district technical staff, researchers from Gulu University and NARO-Ngetta (ZARDI), and the civil society (Welthungerhilfe, IUCN, ACF, and CARE International). This team developed study concepts and data collection tools, provided guidance to the implementing team, monitored the performance of the demonstration plot, analyzed the data, and produced the research report.

The project implementation process was structured in four phases: (1) studying and planning (problem identification and solutions); (2) taking action (farmer selection, profiling and citing technologies, enterprise selection, input distribution, setting up technologies, and M&E; (3) reporting on preliminary findings; and (4) reflection on challenges and coming up with remedies.

Data collection and analysis

The methods used in this assessment included questionnaires, observations, yield measurements, and focus group discussions at the subcounty level. Data were collected on households, farming systems, yields, and input-output. The collected data were processed and analyzed using SPSS and MS Excel.

Results and discussion

The cost effectiveness of a combination of SWC technologies (improved practices) was measured by the level of crop yield achievements and returns. The average yield of tomatoes produced by all the champion farmers under the improved practice was 3,079 kg/acre, the highest was 8,040 kg/acre and the lowest was 670 kg/acre.

Under control plots (farmers' practice), average yield was 1,340 kg/acre. The highest harvest was 3,788 kg/acre and the lowest was 20 kg/acre. The huge gap in the data is explained by external factors such as hailstorms, bollworms, and shrimps whose response to pesticide treatment was very poor.

Olilim farmers obtained the highest yield per acre (3,160 kg), followed by Ogor (3,138 kg) and finally, Orum (1,771 kg). The poor performance in Orum is partly explained by the delayed onset of rainfall and the effect of the short June-July dry spell, which affected the flowering and fruiting of tomato (Fig. 2).

Average yield per acre of tomatoes under farmers' practice in Otuke varied in the three subcounties. Ogor had the highest average yield (2,764 kg), followed by Olilim (2,247 kg) and lastly, Orum had 662 kg.

It must be noted that the average farmers' yields are still lower than the potential yield of 20,000–40,000 kg/acre (East Africa Seed, 2012). This was mainly because farmers were trying out the technology and the crops for the first time. More so, it was a learning process. The research team adopted a flexible approach that allowed farmers to make mistakes so as to learn from them in the second cycle. In addition, the champions had limited capacity to access and use all the recommended inputs such as pesticides and inorganic fertilizers.

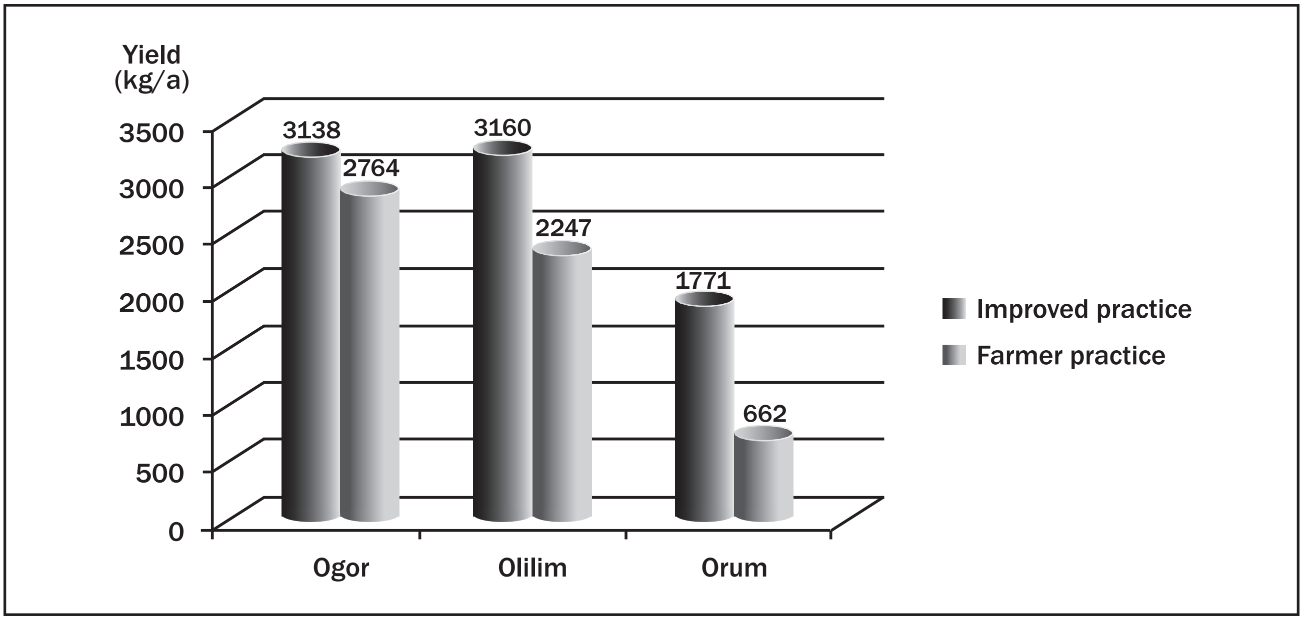


Fig. 2. Yield per acre of tomato under improved practice and farmer practice across the three subcounties.

Table 1. Establishment and maintenance cost (UGX) of each identified technology.

Technology	Labor requirement	Cost		
		Set up cost	Unit	Maintenance
Mulching	Collecting/buying the mulch Spreading the mulch	150,000	Acre	Replacing mulch that is displaced
Planting ridges	Digging of ridges	150,000	Acre	Only labor needed to heap back washed off soil
Minimum tillage (only planting hole dug)	Clearing of vegetation Spraying herbicide Digging permanent planting basins	174,000	Acre	-
Water runoff harvesting	Excavation of ponds Covering of ponds	2,690,000	35,000 liters	Cleaning of pond
Use of hand-dug shallow wells	Excavation of shallow wells	7,000,000	1 unit	Spare in case of a breakdown
Rooftop water harvesting	Procurement and installation of 11,000-liter plastic tanks	6,182,000	11,000 liters	Cleaning of tanks
Subsurface tanks	Excavation of pits Building up the tank walls	4,000,000	11,000 liters	Cleaning of tanks
Drip system	Procurement of a 1000-liter tank Procurement of drip lines	2,385,000	¼ acre (1000m^2)	Prevention of clogging (filtration system)
Treadle pump	Procurement of money maker pump and its accessories	660,000	1 unit	Routine servicing

Table 2. Champion farmers' views on water management technologies.

Variable	Response (%)				
	Strongly disagreed	Disagreed	Undecided	Agreed	Strongly agreed
1. Water harvesting is a user-friendly technology.	0	0	0	58.8	41.2
2. Farmers in Otuke can afford to harvest water.	5.9	5.9	0	70.6	17.6
3. Water harvesting can be done by all farmers in our community.	0	52.9	29.4	17.6	0
4. Water harvesting is a labor-demanding technology.	0	5.9	5.9	23.5	64.7
5. The water harvesting technology introduced to us by CARE can also be done by women.	0	5.9	11.8	52.9	29.4
6. Water harvesting technology(ies) promoted in our community is culturally acceptable.	0	5.9	0	70.6	23.5
7. Mulching gardens is useful for crop growth.	0	0	0	17.6	82.4
8. It's very easy to mulch gardens.	5.9	23.5	0	29.4	41.2
9. Getting mulch is very easy in our community.	11.8	35.3	0	29.4	23.5
10. We have always been doing mulching in our gardens.	70.6	23.5	0	0	5.9
11. Use of planting ridges for planting crops improves crop performance.	0	0	0	35.3	64.7
12. It is very easy to make planting ridges.	17.6	23.5	0	41.2	17.6
13. Construction of ridges can also be done easily by women in our community.	0	5.9	0	52.9	41.2
14. Making plant ridges is very cheap in our community.	5.9	29.4	0	23.5	41.2
15. Minimum tillage technology is very good.	0	0	11.8	76.5	11.8
16. Crops under minimum tillage yield very highly.	0	0	82.4	17.6	0
17. Treadle pumps are very easy to use (user friendly).	0	0	41.2	41.2	17.6
18. Most farmers in our community can afford to buy a treadle pump.	35.3	0	41.2	17.6	5.9
19. Even women can use a treadle pump without any difficulty.	5.9	0	41.2	41.2	11.2

Source: Primary data

Table 3. Estimated cost and gross margin analysis for tomato production on an acre of land using a combination of soil and water conservation technologies.

Subcounty	Cost to produce 1 kg of tomato (UGX)	Average yield/acre (kg)	Total sales (UGX)	Gross margin (UGX)
Olilim	272	3160	3,096,800	2,237,300
Ogor	274	3138	3,074,914	2,215,414
Orum	485	1735	1,735,254	875,754

Source: Primary data assumptions: farm gate price of tomato is 1,000 shs/kg; postharvest losses are 2%.

These results demonstrate that SWC technologies, when used in combination, are very important for farmers in Otuke as shown in the level of gross margins attained from tomato production. This concurs with the FAO argument to focus on investments (FAO, 2003) that improve food security, nutrition, and livelihood of the most vulnerable people through a combination of improved water management in rainfed agriculture and improved soil fertility management.

Lessons learned

During the first cycle, farmers were overwhelmed by the many activities on the farm and this affected their performance because they had to distribute their time to other off-project activities. The team then decided that, in the second cycle, selected technologies should focus on high-value crops (vegetables) so that the farmers can have time for the demonstrations.

Key challenges and limitations

- Fake pesticides in the market affected farmers' yields. The first batches of pesticides bought were ineffective. This affected seedlings in the nursery beds, thereby leaving farmers with fewer seedlings for transplanting.
- Hailstorm was also a challenge.

Conclusion

The results have clearly shown the benefits of using a combination of SWC technologies (improved practices) compared with farmers' practices. It is evident that further improvement can still be made in the next cycle through better crop management, e.g., pruning, maintaining optimum plant population, and introducing integrated nutrient management.

However, it is important to mention that SWC technologies must be used in combination with the right crop varieties and integrated with agronomic practices. In our study, the average cost of producing 1 kg of tomatoes in the three subcounties, for instance, in Otuke was UGX 343. According to the East Africa Seed Growers' Guide (2012), studies in Kenya show that the cost of producing tomatoes was as low as UGX 20/kg. This implies that there is room to improve yield per acre and reduce production cost per kilogram.

An action research approach with champion farmers is an appropriate method for experiential learning for both farmers and implementers. The farmers tend to own these technologies since they are developed and improved by both farmers and the action research team. For example, implementers learned from the farmers that applying salt to rocks could soften them and enable easy excavation of ponds.

Also, government needs to come out strongly to regulate activities of agro-input dealers in the private sector. The issue of fake inputs is a reality and should not be tolerated.

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