Understanding Farmers' Indicators in Climate-Smart Agriculture Prioritization

in Nwoya District, Northern Uganda

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Contents

Figures

Abstract

In order to increase the uptake of climate-smart agricultural innovations, it is important to move beyond adoption claims and understand the contexts in which farmers operate. Farmers use different indicators to decide whether or not to implement, what to implement, and where to implement specific innovations. Understanding and using such indicators to prioritize agricultural innovations can be helpful in scaling out adoption.

The purpose of this study was to understand the indicators that farmers use to prioritize agricultural innovations, in general, and climate-smart agriculture (CSA), in particular. It specifically addresses the following objectives:

1. Assess the gap between awareness and use of agricultural practices.
2. Develop a list of agricultural practices that farmers prioritize across different agro-ecological zones (AEZ) designated and described by farmers themselves.
3. Identify the indicators that farmers use to rank/prioritize the different practices in the respective AEZ.
4. Compare the indicators that farmers use to prioritize CSA with indicators used by experts.
5. Identify existing demonstration plots.
6. Develop a prioritized list of climate-smart agricultural practices that farmers would like to implement in demonstration plots.
7. Establish suitable geographic locations of CSA demonstration plots.

Participatory workshops, in the form of focus group discussions, were conducted in four subcounties (Alero, Anaka, Koch-Goma, and Purongo) of Nwoya District in Northern Uganda. Separate workshops were held with farmers and experts to explore differences between stakeholders and across the district. Characterization of the AEZ, prioritization of practices, identification of indicators for prioritizing CSA, and selection of practices for demonstration as well as sites for the demonstration plots were gender disaggregated.

Results show that, across the district, farmers perceive the soil to be fertile. The majority of farmers practice burning. Farmers reported that burning saves labor for clearing land before ploughing and that, for groundnuts, the yield is higher in burned fields. Farmers, however, also stated that when burning is used, in the long term, it has negative effects on soil health and fertility. Results further show that awareness differs by practice. Although farmers are generally aware of crop management practices, such as improved varieties, early planting, intercropping, and crop rotation, awareness on land and water management practices is low. A noticeable gap was also observed between the proportions of farmers who are aware of CSA practices versus those who actually implement the practices. Several factors were attributed to this, including labor and financial constraints as well as lack of knowledge and skills.

Among important indicators that farmers reported to use in prioritizing agricultural practices are yield, income, availability of labor, cost of chemicals, availability of equipment, human health, soil fertility, time saving, access to markets, price of products, and knowledge. Generally, there were a lot of similarities in the ranking of the indicators in terms of importance. There were, however, a few noticeable differences across the AEZ and gender. Weed control, for example, was ranked as a very important indicator by the men's group in the forested zone of Koch-Goma, while their female counterparts ranked this indicator as least important. In Anaka, men ranked soil fertility as not important (2), while women said that soil fertility was a very important (5) indicator. Similarly, men said that capital was an important (4) indicator, while women said that it was least important (1). In Alero, men ranked availability of land as a very important indicator in the forested zone, while women reported that land availability was least important. Such indicators might be important in quantifying the trade-offs and synergies associated with CSA. Taking such trade-offs and synergies into consideration, when designing strategies to promote the uptake of CSA, is necessary for successful out-scaling.

There were similarities as well as differences in the ranking of practices across the district, AEZ, and gender. The most prioritized practices in Koch-Goma by men in the grassland zone were row planting, improved varieties, timely planting, broadcasting, mulching, and intercropping, respectively, in their order of ranking. Women, however, prioritized timely planting, crop rotation, seed selection, intercropping, and row planting, respectively. In the forested zone, whereas men prioritized deworming of livestock, improved breeds, and paddocking; women ranked seed selection, timely harvesting, correct spacing, and improved varieties as the most important.

In the grassland zone in Alero, men ranked selection of varieties according to AEZ, timely planting, timely weeding, timely harvesting, crop rotation, and agroforestry as the most relevant. Women, on the other hand, ranked selection of seeds, timely planting, herbicide application, zero grazing, and irrigation higher.

In the forested zone, men ranked early land preparation, seed selection, early planting, timely weeding, and crop rotation as the most important in the respective order. Their women counterparts ranked seed selection, timely planting, fallowing, pesticide application, and fertilizer application, respectively, in order.

In Anaka, men and women in the grassland zone ranked the practices in different order. In particular, men ranked silvopastoral systems, seed selection, timely planting, improved varieties, and broadcasting in that order, whereas women ranked improved varieties, timely planting, stop burning, crop rotation, and intercropping in that order. In the forested zone, men ranked timely planting, correct spacing, conservation of wetlands, improved varieties, intercropping, and agroforestry in that order; whereas women ranked agroforestry, seed selection, timely planting, improved breeds, and crop rotation in the respective order. Men in Purongo's grassland zone ranked timely weeding, early land preparation, conservation of wetlands, pesticide application, spraying for external parasites, and tethering, in that order; whereas the women ranked timely planting, fallowing, seed selection, crop rotation, improved varieties, and intercropping, in the respective order. Men in the forested zone ranked timely weeding, fallowing, crop rotation, intercropping, contour ploughing, minimum tillage, pesticide application, seed selection, and improved varieties, in that order. The women ranked early land preparation, intercropping, burning, crop rotation, mulching, tethering, residue retention, fallowing, and farmyard manure, in the respective order.

Together, these results contribute to the existing evidence collected by a climate-smart agriculture rapid appraisal (Mwongera et al. 2014) and land health surveys at the study site (Winowiecki et al. 2015) and will be used to establish gender-specific demonstration plots across Nwoya District.

Key words: Prioritization, climate-smart agriculture, farmers' indicators, Northern Uganda.

Introduction

Several agricultural technologies exist that can be classified as climate smart based on their potential to increase food security, develop and enhance resilience to climate risks, and reduce or remove greenhouse gases (GHG). Climate-smart agricultural technologies, however, present both trade-offs and synergies, depending on the specific context in which they are implemented. This makes it necessary to recognize the different actors, incentives, and constraints to adoption in order to identify locally appropriate practices. Prioritization of climate-smart agricultural technologies is a fundamental first step toward minimizing trade-offs and maximizing synergies. Different indicators can be used to identify the trade-offs associated with climate-smart agriculture (CSA), including, for example, time and risk preferences as well as the availability of resources. However, the indicators that farmers and experts use to prioritize agricultural technologies in general and CSA practices in particular are not well known. This is partly because CSA is very context specific, implying that indicators used to prioritize CSA in one context might not be relevant in another. Yet, an individual farmer's choice of a technology and ultimate use will depend on the attributes that farmers favor or disfavor about the technology.

The International Center for Tropical Agriculture (CIAT) in collaboration with the International Institute of Tropical Agriculture (IITA) conducted the current study with the purpose of gathering and documenting the indicators that farmers and experts use to prioritize CSA technologies. This study is within the IFAD-funded project titled "Increasing food security and resilience of farming systems and livelihoods to climate change in East Africa through wide-scale adoption of climate-smart agricultural practices." The specific objectives of the study were:

1. Understand the criteria that farmers use to prioritize agricultural practices in general and CSA in particular.

2. Understand the gap between awareness and use of various agricultural practices.

3. Identify and assess existing demonstration plots.

4. Develop a prioritized list of CSA practices that farmers would like to implement in demonstration plots.

5. Establish suitable geographic locations for future CSA demonstration plots, including the CSA practices to highlight.

Methodology

Site selection

The study was conducted in Nwoya District of Northern Uganda and is a follow-up to a recent Climate-Smart Agriculture Rapid Appraisal (CSA-RA) exercise at the study site (Mwongera et al. 2014) and an intra-household gender survey (Figure 1). Mwongera et al. (2014) provide a detailed description of the study site, including farming systems; constraints to agricultural production; perceptions on climate variability; and crop, land, soil, and water management practices. Participatory farmers and experts workshops were conducted and took the form of focus group discussions. A total of five farmers workshops (one in each of the four subcounties in Nwoya and one co-located in villages within the soil and land health sampling) and one experts workshop were conducted. Each farmers workshop had approximately 40 participants (including both men and women).

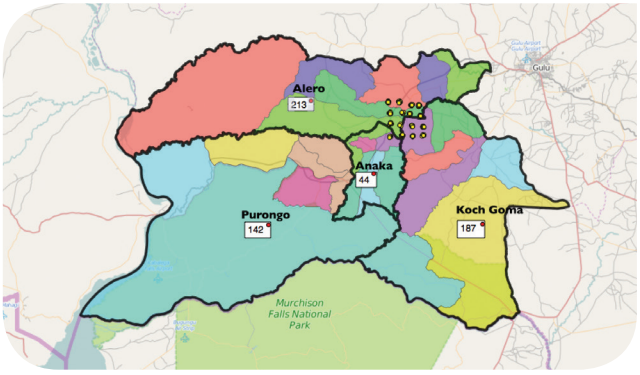


Figure 1. Map of Nwoya District.

Icebreaker

Farmers workshops began with an icebreaker on farmers' perceptions of soil fertility as well as perceptions and reasons for burning. Each participant was provided with a blue card and a yellow card. Farmers who perceived their soil to be good were asked to raise the blue card. Similarly, farmers raised the yellow card to show that the soil on their farms was not good. This activity was done separately for men and women participants. A count of the raised cards was then made. A follow-up question asked farmers for the reasons why they perceived their soils to be good or not depending on the card raised. Subsequent questions asked farmers to indicate by a show of hands whether they practiced burning, the reasons why they practiced burning, and to explain what they observed with burning.

The icebreaker was followed by a mapping exercise. In this activity, farmers were asked to show the location of the different parishes in their respective subcounties and to characterize their subcounty into different zones based on the variability in vegetation, soil, climate, and other distinct features. These farmer-derived AEZ were used for the remainder of the workshops.

Prioritization of practices

Prioritization of CSA technologies began by asking farmers to name and briefly describe agricultural practices that they had heard about. For each of the mentioned practices, farmers were asked to raise their hand if they had heard about the practice. A quick count by gender of the participants was then made. Similarly, farmers were asked to show by hand how many were currently (present and last season) using the practice. A follow-up question asked about the benefits associated with each practice that farmers indicated they were using. Participants were also asked about any practices that they had abandoned. A facilitator then probed for the reasons why the practice had been abandoned. In cases for which the gap between awareness and use was noticeable, farmers were asked for the reasons why many people were aware of but were not using the practice. To make sure that the list of practices was exhaustive, a pre-prepared list of agricultural practices was compared with the farmers' list to check for any missing practices. In case of any, the missing practice was described, a photo was shown to the farmers, and a question was asked to confirm that they were not aware of the practice. The practices were then added to the list generated by farmers and the proportion of awareness indicated as zero upon confirming that indeed farmers were not aware of the practice. Finally, farmers were asked about the factors that they considered when deciding whether or not to use each of the practices that they were aware of and were using.

Farmers were later grouped into smaller groups based on the identified AEZ and by gender. Starting with the master list generated in the plenary, farmers were asked

to identify specific practices that were relevant for their respective AEZ. This exercise generated a short list of practices. Farmers were then asked for the benefits of such practices or the reasons why they selected the practices as the most relevant for their AEZ. Follow-up questions asked about constraints to implementation and what farmers would need in order to implement the practices. A pairwise matrix was created to compare a single practice with another for ranking. Finally, each farmer was provided with five seeds for scoring of the indicators that they used to prioritize agricultural practices. A facilitator explained how the seeds were to be used: assigning one seed would mean that the indicator was least important, while five seeds would mean that the indicator was most important. A brief discussion followed to understand why farmers chose a particular score for an indicator.

Results and discussion

Farmers' perception of soil fertility

Figure 2 shows farmers' perception of soil fertility by subcounty. As shown, across all the subcounties, more than 95% of the farmers perceived their soils to be good. Table 1 presents the indicators farmers used for good soils.

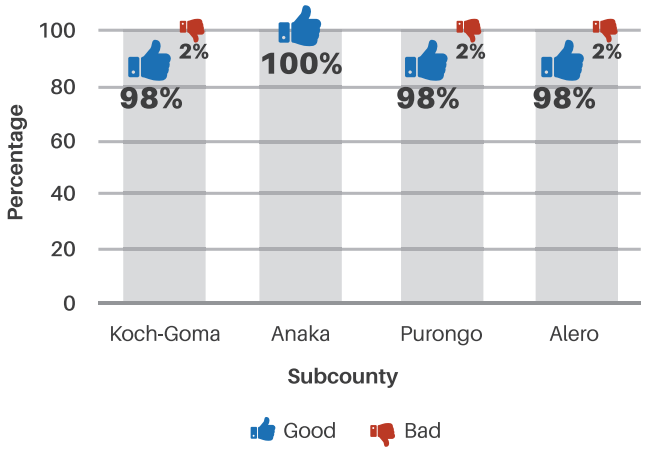


Figure 2. Farmers' perception of soil quality.

The few farmers who reported poor soil gave the following reasons. In Purongo Subcounty, sandy soil did not retain moisture, and the farm had a lot of stones. In Anaka, farmers who reported poor soil said that they had observed poor crop growth with yellowish coloring on the leaves, that the soil was sandy with low moisture retention, and that the soil gave poor yields. In Koch-Goma, farmers reported weed infestations, lower and declining yields, and poor seed germination as indicators of poor soil fertility.

Farmers' perceptions of burning

Burning is common and widely practiced in Nwoya District. In fact, the land health survey conducted in 2014 indicated that more than 85% of the 160 sampled plots were influenced by burning. Furthermore, all farmers in Koch-Goma, Alero, Anaka, and Purongo reported that they practiced burning. Table 2 presents the reasons for burning, while Table 3 presents what farmers observe as the effects of burning.

Mapping and characterization of the agro-ecological zones (AEZ)

Koch-Goma Subcounty

Participants from Koch-Goma identified and marked the following parishes on the map: Kal, Agonga, Orum, Amar, Lii, and Coo-rom. A discussion with farmers revealed that there were differences in vegetation cover across Koch-Goma Subcounty. Farmers characterized the subcounty into two AEZ: the forested zone and the grassland zone (Figure 3).

Figure 3. A farmer classifying Koch-Goma Subcounty into AEZ.

Table 1. Indicators that farmers used to rate soil fertility as good, by subcounty.

Koch-Goma	Alero	Anaka	Purongo
High crop yield	Fewer weeds	Crops yield well even without fertilizer	High yields without applying fertilizer
The soil is soft and easy to till	Crops grow fast without use of fertilizer	Fertile loamy soils	The soil has humus
The soil supports many different types of crops	High yields without use of fertilizer	Soils are soft and noncompacted	The soils are dark (black) in color
Fast crop growth	The soil is soft and easy to plough	Their land is flat; thus, no surface runoff/erosion	Fewer weeds
High moisture retention	The soil has a deep layer of humus material; can plough over and over again without exhaustion		Requires only one ploughing before planting
	Fewer pests and diseases		The soil has high moisture retention
	Plants have many tillers, e.g., bananas and millet		The soil smells good when ploughing
	Good moisture retention		The soil is well aerated
			They use a hand hoe for ploughing and obtaining a good harvest

Table 2. Reasons why farmers practice burning, by subcounty.

Koch-Goma	Alero	Anaka	Purongo
To remove crop residues left after harvesting	To destroy weeds	Burning reduces or clears the bush for easy ploughing	To destroy weeds and weed seeds
Some seeds such as sesame seeds require a very clean field	To kill pests	To kill stubborn weeds and weed seeds, e.g., black jack	To destroy pests
To kill pests and disease-causing organisms	To hunt for the edible rat "anyeri"	To clear debris from the field	For easy ploughing by both hand hoe and tractor
Crops yield higher in the burned areas	To remove or clear crop residues	Crops such as groundnut grow very well in burned spots	Improves soil condition
	To make cultivation easier by reducing vegetation size	Burning kills pests and their cycle is inhibited from going to the subsequent season. It even kills nematodes	To avoid transfer of diseases from previous cropping season
		Others burn to look for "anyeri," an edible rat	Limited labor during land preparation
		Burning allows for faster decomposition of grass roots	

Forested zone

Farmers in the forested zone mostly grow sesame and banana. Sesame is reportedly grown because it is not loved by the elephants, which are very destructive of other crops. The soil is loamy. Farmers further reported faster growth of crops in the forested zone than in the grassland zone. Attacks by elephants and monkeys and destruction of crops are a major challenge coupled with difficulty in ploughing. Poor roads in this zone constrain access to markets. Farmers also walk long distances between their farms and homesteads. Deforestation is high in the forested zone. Farmers also reported that rainfall was also increasingly unpredictable.

Grassland zone

Farmers in the grassland zone mostly grow rice, pigeon pea, sorghum, and beans. The soil in the grassland is sandy. In this zone, farmers reported problematic weed infestations, drying of the soil, crop pests, and declining soil fertility because of over-cultivation, which results in lower yields. Farmers said that they are now using tractors in order to expand cultivated area. They are also introducing new crops such as onions. Crop rotation with sorghum and cassava is also common. Furthermore, expansion into new valleys has increased because the water table has gone down in other areas.

Table 3. Effects that farmers observe after burning.

Koch-Goma	Alero	Anaka	Purongo
Burning reduces soil fertility, especially if you burn for several years continuously	Crops grow faster in the burned spots	Burning hardens the soil by exposing it to sunlight, thus making it hard to plough	Burning destroys weeds and weed seeds
	There are fewer weeds after burning	Increases productivity in burned spots, e.g., groundnut yield is higher in burned spots	Destroys pests
	Burning reduces soil fertility; crops grow vigorously but yield is low	Reduces moisture retention of the soil	Makes ploughing easy by both hand hoe and tractor
	The ash from burning is harmful to crops	Reduces yield of crops because of excessive/ frequent burning	Improves soil condition
		Kills microorganisms, thus lowering soil fertility	Avoids transfer of diseases from previous cropping season
		Increases compactness of the soil, thus making it hard to plough	Limited labor during land preparation
		Increases soil erosion since grasses are not there to reduce surface runoff	

Alero Subcounty

In Alero Subcounty, participants identified the following parishes from the printed Google Earth map: Bwobonam, Panyabono, Pangu, Panokrac, Kal, and Paibwor. Farmers characterized the parishes into three zones: forested, grassland, and stony.

Forested zone

This zone covers the western part of Pangu, Paibwor, Panokrac, and a small part of Panyabono. The zone is characterized by the following: high tree densities and high yields of a diversity of crops (e.g., groundnut, sesame, rice, bananas, and some fruit trees). The challenges faced in the forested zone are similar to those in Koch-Goma and include destruction of crops by wild animals, difficulty in ploughing because of tree stumps and roots, and poor road infrastructure. In

addition, farmers reported that destruction of crops by termites is prevalent in this zone. Farmers also reported that charcoal burning has increased, thus further exacerbating deforestation. Rainfall is also becoming unpredictable, and wells and boreholes are drying.

Grassland zone

The grassland zone covers Bwobonam, Kal, and the eastern part of Paibwor. This zone is dominated by short grasses and sandy soil, and the crops that grow well are maize, millet, rice, groundnut, and beans. In this zone, farmers reported low soil water-holding capacity and hence wilting of crops during the dry season. Farmers also reported a need for deep ploughing and said that rainfall was becoming unpredictable and the wind was very strong. The frequency of droughts has increased, the water table has gone down, and wells are drying up.

Stony (rocky) zone

The stony (rocky) zone covers Pangu parish. The crops mainly grown are maize, cassava, and groundnut. The zone suffers several challenges related to destruction of crops by baboons, high soil erosion, limited land for agricultural production, and difficulty with transportation. In the rocky zone, flooding has increased. Wild animals are also increasingly destroying people's crops.

Anaka Subcounty

Upon seeing the Google Earth map, participants from Anaka Subcounty identified the following parishes: Pabali, Todora, Ywaya, and Pangura. Farmers classified the subcounty into two AEZ: forested and grassland.

Forested zone

This zone covers the southwestern part of Ywaya, the northern part of Todora, and a small section of Pangura. In this zone, grasses are tall and healthy, and farmers mainly grow sesame, maize, beans, groundnut, and rice. Farmers mostly plough using hand hoes. The area is cold, and the soil has good texture and is well aerated. Farmers said that crop yield is relatively high across this zone. The main challenges are small farm sizes because farmers rely on hand hoes, high weed infestations, destruction of crops by wildlife such as monkeys, too cold during the rainy season, and finally good vegetative growth of crops but low yield. Among the changes that farmers perceive have taken place in the forested zone are an increase in weed prevalence, delayed rains, deforestation, tsetse-fly infestation, and expanded area under cultivation.

Grassland zone

This zone covers Pabali, the northeastern part of Ywaya, and the southern part of Todora and Pangura. In this zone, farmers use tractors for ploughing, grasses are short, the area is flat, all crops grow well, rainfall distribution is uneven, wind destroys people's crops, and the soil dries up during the dry season, making it difficult to cultivate. The main challenges in the grassland zone are that it is difficult to cultivate using hand hoes, soil erosion is common because of few trees, there is no timber for drying sesame, and droughts occur frequently.

Purongo Subcounty

Farmers in Purongo marked five parishes on their map: Latooro, Pabit, Paromo, Patira, and Pawatomero. Using farmers' own classification, the subcounty was characterized into two AEZ: forested and grassland zones (Figure 4).

Figure 4. Mapping exercise in Purongo Subcounty.

Forested zone

Pabit and Paromo are mostly forested. The forested zone has dark (black) soil and receives high rainfall. Farmers reported that the main challenge in the forested zone is that it is difficult to use a tractor for ploughing because of tree stumps. As a consequence, farmers are able to cultivate only small areas of land. Farmers also complained of wildlife such as monkeys because they destroy crops. In addition, the high moisture content in the forested zone affects the growth of some crops. Several changes have occurred in this zone. The faster growth rate of weeds is attributed to the increase in deforestation. Other changes are the late commencement of rain and changes in the rainfall patterns.

Grassland zone

Pawatomero, Patira, and Latooro are mostly covered by grassland. The grassland zone has sandy soils, receives less rainfall, and farmers in the zone grow mainly rice. The challenges faced by farmers in this zone are too much sunshine, floods, strong wind, wilting of crops, heavy weed infestation, fast drying up of the soil, and invasion by elephants. Several changes have occurred in this zone. Farmers indicated that nowadays if you plant late, the crops will fail, and yields will decline compared with earlier days when they were able to harvest, even when planting was delayed. It was further noted that, in the grassland, there is a lot of soil erosion and siltation of wells, and the water table has gone down.

Awareness and use of agricultural technologies

Awareness is a fundamental first step toward the adoption of climate-smart agriculture. In this study, participants were asked to name all the agricultural practices that they had heard about. For the practices that farmers were aware of, they were asked to show by hand how many were currently using the practice (current or previous season). Table 4 presents the results of awareness and use for the men, by subcounty, whereas Table 5 presents the results for the women. Among both men and women and across the subcounties, the gap between awareness and use is highest in relation to soil, land, and water management practices, such as the use of farmyard manure, compost manure, chemical fertilizer, mulching, digging of trenches, drainage channels, row planting (especially in Anaka and Alero), improved varieties, irrigation, rainwater harvesting, paddocking, and improved breeds. Farmers' perception that the soil is good partly explains why soil fertility improvement practices are not being used. Farmers, however, also mentioned labor constraints that hinder the use of compost and farmyard manure. The lack of equipment and availability of water could explain why farmers are not practicing irrigation, while the lack of knowledge and poor quality of seed explain why farmers are not using improved varieties. The high cost of purchase and management of improved breeds was reported as the main reason why adoption of the practice is very low. Lack of knowledge and grass-thatched houses were explained as the reasons why farmers find it difficult to practice rainwater harvesting although they might be aware of the technology.

Table 4. Awareness and use of agricultural technologies for the men in each subcounty.

Practice	Koch-Goma		Anaka		Alero		Purongo	
	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Controlled burning			79	87	85	68		
Fallowing	45	80	100	89	88	97	81	82
Agroforestry	30	80	53	70				
Crop rotation	61	55	79	100	91	90	86	83
Intercropping	67	50	47	100	61	65	90	89
Residue retention	58	63	53	60	85	39	86	89
Farmyard manure	55	33	63	17	79	31	90	26
Compost manure	58	32						

Practice	Koch-Goma		Anaka		Alero		Purongo	
	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Digging trenches			74	64				
Contour ploughing	64	90	63	100	85	43	81	82
Fertilizer use	42	29	79	0	94	19	100	33
Mulching	52	47	47	67	79	15	71	60
Timely planting			100	68	88	59		
Timely weeding			95	72			100	71
Timely harvesting	82	67			79	50		
Row planting			79	47	61	45	90	89
Seed selection			89	94	70	39		
Deep ploughing	42	79	68	69	70	61		
Selection of crops based on AEZ			68	100	70	78		
Avoid shading			84	100				
Crop monitoring			84	100				
Phytosanitation	76	72	89	82				
Fungicide use			95	33				
Improved varieties	64	43	95	89	64	62		
Pesticide use	82	67	89	41	67	73		
Proper seed storage			95	83	64	100		
Irrigation			89	18	91	20		
Broadcasting			84	100				
Stall feeding/zero grazing	73	38	100	84	61	40		
Improved feeding	64	24	95	89	82	22	81	24
Rotational grazing			95	100	67	0	90	100
Disease treatment			89	88				
Pasture agronomy			89	6				
Cut and carry			89	6			76	0
Beekeeping			105	45				
Aquaculture			105	0				
Humidity control during incubation			63	2				
Silvopastoral systems	73	13	0	0				
Digging drainage channels			95	18	55	22	71	93
Rainwater harvesting	61	0	100	3				
Water storage			116	6	76	16	67	29
Conservation of wetlands	36	50	89	17			95	85
Bunding (e.g., using banana stems)	36	50			79	69		
Early land preparation	82	70			124	66	95	95
Correct spacing	82	78			85	61	76	94
Tethering	70	93			64	91		
Paddocking	64	0			70	0		
Routine animal spraying	82	67						
Improved breeds	73	38						
Deworming	73	46			85	36	81	47
Avoid planting eucalyptus in swamps							76	88
Mixed cropping	61	55			61	50	86	67

Notes (Table 4):

1. *Awareness* is computed as a percentage of those participants that have heard about a practice. *Use* is computed as the proportion of those who use a practice given that they are aware. For example, 63% of the participants in Alero were aware of "Farmyard manure," while only 17% of those who were aware had actually used the practice.

2. Numbers presented are percentages. The total number of men participants for each subcounty were the following: Koch-Goma, 33; Anaka, 19; Alero, 33; and Purongo, 21.

Table 5. Awareness and use of agricultural technologies for the women in each subcounty.

Practice	Koch-Goma		Anaka		Alero		Purongo	
	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Stop burning			63	33	74	64	0	
Fallowing	70	84	83	75	100	100	63	100
Agroforestry	22	83	54	54	0		71	24
Crop rotation	55	100	79	89	100	100	92	95
Intercropping	61	100	92	91	74	93	67	88
Residue retention	63	53	71	88	95	61	58	93
Farmyard manure	45	27	63	60	63	67	25	0
Compost manure	70	32	0		0		33	25
Digging trenches			79	63	37	57	0	
Contour ploughing	44	75	79	68	84	56	58	57
Fertilizer use	33	22	54	0	95	11	75	11
Mulching	44	40	88	33	79	13	42	30
Timely planting			104	84	95	72	0	
Timely weeding			92	95	0		88	90
Timely harvesting	81	82			84	81	0	
Row planting			83	90	79	60	75	78
Seed selection			96	96	84	100	0	
Deep ploughing	0.04	100	92	95	100	89	0	
Selection of crops based on AEZ			88	100	100	100	0	
Avoid shading			92	84	0		0	
Crop monitoring			100	96	0		0	
Phytosanitation	92	48	92	68	0		0	
Fungicide use			75	28	0		0	
Improved varieties	33	11	96	83	84	63	0	
Pesticide use	63	2	96	0	95	39	0	
Proper seed storage			92	100	84	100	0	
Irrigation			96	83	89	35	0	
Broadcasting			92	91	0		0	
Stall feeding/zero grazing	63	12	79	84	89	47	54	15
Improved feeding	30	38	83	85	84	44	38	78
Rotational grazing			88	100	79	0.07	67	56
Disease treatment			92	77	0		0	
Pasture agronomy			75	0	0		0	
Cut and carry			88	0	0		54	15
Beekeeping			88	33	0		0	
Aquaculture			88	0	0		0	

Practice	Koch-Goma		Anaka		Alero		Purongo	
	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Humidity control during incubation			79	95	0		0	
Silvopastoral systems	11	0	0		0		0	
Digging drainage channels			100	88	95	22	0	
Rainwater harvesting	56	0	92	86	0		0	
Water storage			92	100	95	100	50	75
Conservation of wetlands	33	100	58	71	0		33	63
Bunding (e.g., using banana stems)	0.07	0	0		58	91	0	
Early land preparation	78	43	0		100	100	83	100
Correct spacing	56	73	0		105	75	67	75
Tethering	67	78	0		95	83	0	
Paddocking	19	0	0		89	0	0	
Routine animal spraying	67	11	0		0		0	
Improved breeds	30	25	0		0		0	
Deworming	70	42	0		58	45	29	100
Avoid planting eucalyptus in swamps			0		0		58	71
Mixed cropping	74	65	0		95	94	71	100

Notes:

1. *Awareness* is computed as a percentage of those participants that have heard about a practice. *Use* is computed as the proportion of those who use a practice given that they are aware. For example, 71% of the participants in Purongo were aware of "Agroforestry," while only 24% of those who were aware had actually used the practice.

2. Numbers presented are percentages. The total number of women participants for each subcounty were the following: Koch-Goma, 27; Anaka, 24; Alero, 19; and Purongo, 24.

Selected practices by AEZ and gender

Alero Subcounty

Figure 5 shows the practices that were selected by farmers (men and women) in the different AEZ in Alero Subcounty. In the grassland zone, the women gave several reasons for selecting the practices: increased income, increased productivity, reducing soil erosion and controlling weeds by growing cover crops, diversified production through intercropping, pest control, protecting the soil from direct sunlight, decreased workload, increased soil fertility, improved varieties ensuring food security and producing good-quality produce, and zero-grazing controlling diseases and reducing theft.

In the women's group from the grassland zone, farmers also had reasons why some practices were not used. They reported that they do not apply chemical fertilizers because they are expensive, they lack skills on how to apply them, and their soil is good. It was further indicated that rainwater harvesting is not practiced because most farmers have grass-thatched houses and also lack storage facilities. Farmyard manure is not applied because it is time-wasting for those with large farms. Similarly, compost manure was reported to increase the workload for those with large farms, and their already fertile soil makes the practice irrelevant. In this zone, women expressed concern about the high cost of pesticides and also said that they feared using chemicals because they were poisonous. Farmers further perceive minimum tillage as a practice that decreases the harvest and is expensive. On what farmers would need to implement the practices, the following were mentioned: capital to purchase pesticides, herbicides, and fertilizers; water storage facilities so that they can

harvest rainwater; equipment such as sprayers and wheelbarrows to enable them to apply compost manure and herbicides; and training on how to implement minimum tillage. Among the constraints identified by female farmers in this zone were low demand for some produce; variability in weather, which affects spraying; the soil is mostly sticky and hard and hence affects some crops; and scarcity of labor.

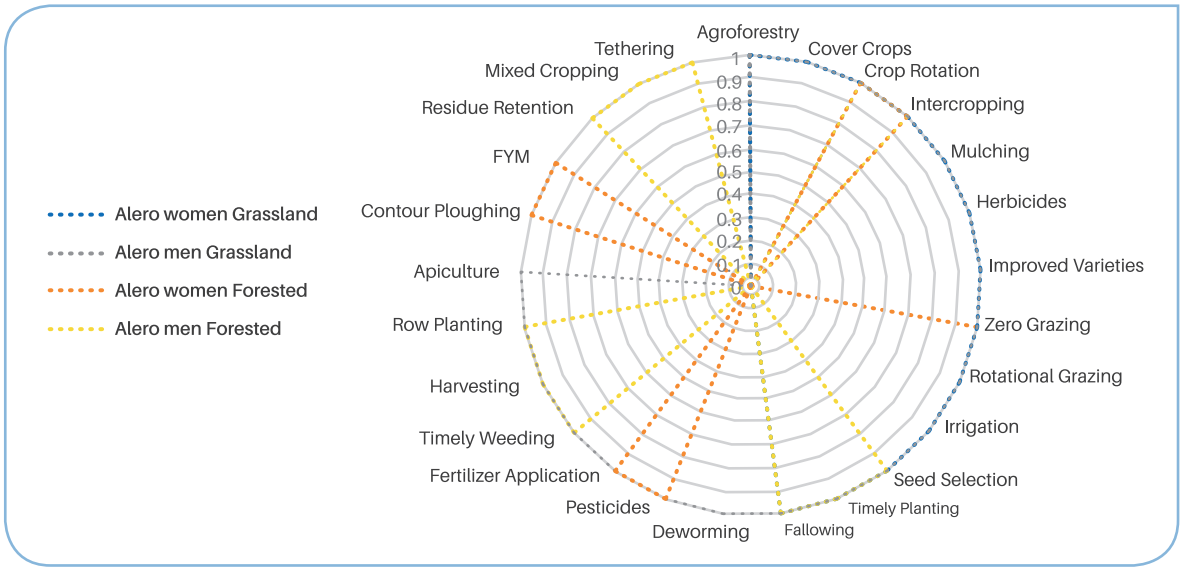


Figure 5. Selected practices in Alero by gender and AEZ.

Several benefits were associated with the practices that men farmers in the grassland zone selected: income generation; increased yield and good quality of produce; improvement of soil fertility; time saving; improvement of plant growth; improvement of health conditions by producing and eating enough and nutritious food; irrigation will allow for cultivation even during the off-season; improvement in rainfall distribution because of agroforestry; and controlling pests by using pesticides. The following constraints were mentioned that hinder the implementation of some practices in the zone: insufficient knowledge or skills; lack of capital; lack of tools; the presence of many trees and tree stumps, which hinder mechanization (such as the use of tractors); poor road infrastructure; land conflicts; tsetse flies; and lack of inputs such as fertilizer. Farmers said that, in order to implement the practices, they would need tools and equipment; knowledge; follow-up on the practices; capital; a market for their produce; good roads for transportation; good storage facilities; inputs such as pesticides, herbicides, and fertilizers; field visits to demonstration plots or to model farmers; cooperation among farmers; and interest toward a given practice. They identified the following constraints: climate change, land conflicts, civil wars, jealousy among farmers, drunkenness, theft, being involved in criminal cases (jailed), conservation of local traditions/knowledge, the problem of stray animals such as elephants, selling off of available equipment, and government policies, for example, there is a fear that the government will take land when minerals such as oil are discovered in an area.

Table 6 presents the benefits associated with the practices selected by women farmers in the forested zone of Alero Subcounty as the most relevant. In this group, participants indicated that herbicide application is a relevant but expensive practice and that they lack knowledge on how to apply the herbicides. Other identified relevant practices that were not being used were (1) fertilizer use because it is expensive; (2) agroforestry due to the lack of tree seedlings; (3) improved breeds because of the high purchase cost; (4) organic farming because of the lack of technical know-how; (5) beekeeping due to the lack of knowledge on apiculture; and (6) improved varieties because of the lack of seeds and lack of knowledge. In order to implement these practices, farmers reported that they would need to be provided with training, fertilizers, herbicides, tree seedlings, improved breeds of livestock, beehives, and improved varieties of crops.

Table 6. Practices selected by women farmers from the forested zone of Alero Subcounty.

Practice	Benefit
Agroforestry	Limited available land; hence, the practice ensures maximum use; windbreaks are provided for crops and houses
Contour ploughing	Reduces soil erosion; reduces the effect of wind on crops such as sesame and maize
Crop rotation	Ensures high yields for subsequent crops; ensures maximum use of soil nutrients
Intercropping	Diversified crop production, reduces risk in case of crop failure, makes weeding easy
Pesticide application	Kills pests rapidly
Farmyard manure	Vigorous growth, high yield of fruit trees, increased soil fertility
Zero grazing	Ensures proper feeding for high milk production
Timely planting	Early maturity, high yield
Fallowing	Allows land to regain fertility, kills weeds
Fertilizer use	Ensures faster growth of crops, high yields, and increased soil fertility
Seed selection	Increases germination; minimizes abnormal growth, e.g., shrinkage of groundnuts

The men from the forested zone of Alero reported the following reasons for their selection of the practices (see Figure 5): to control weeds or make it easier to weed (e.g., row planting), obtain good yield, increase soil fertility, control soil erosion, control diseases and pests, ensure complete decomposition of residues, avoid competition of crops for nutrients, and to make it easy to harvest. They also gave the following reasons why some practices perceived as relevant were not being used: high labor demand, lack of knowledge, lack of equipment and funds, the type of crops that they grow do not favor practices such as mulching, their large sizes of land also make mulching a difficult practice, and many fake companies are producing fake herbicides and seeds that discourage farmers. For farmers to implement the relevant practices in the forested zone of Alero, they reported that they would need proper training on the different practices, access to markets, capital to purchase the required equipment, improved transportation and communication infrastructure, availability of affordable inputs, and availability of storage infrastructure. The major constraints identified to implementation of the practices were variability in weather, pests, and diseases, the use of rudimentary tools, fake inputs, and price volatility.

Table 7 presents the selected practices by farmers in the rocky zone of Alero. Results are presented for both men and women because the number of farmers from this zone was too small to allow separation by gender.

Farmers in this zone also reported that proper spacing and stall feeding were relevant practices that were not currently being implemented. For proper spacing, farmers said that they did not have adequate training, they did not know the benefits associated with the practice, and they were constrained by the shortage of labor. Farmers also said that the reasons why they did not implement stall feeding were financial constraints, lack of training, and poor management. Farmers, therefore, said that they would need training and tools such as measuring tapes in order to implement proper spacing. To practice stall feeding, they would need capital, training, and support from NGOs and the government. Laziness among farmers, lack of interest, and pests were also mentioned as barriers to the implementation of proper spacing.

Table 7. Practices selected by farmers from the rocky zone of Alero Subcounty.

Practice	Benefit
Farmyard manure	Improves soil fertility and hence results in higher yield
Fallowing	Improves soil fertility and hence yield; reduces soil erosion
No burning	Allows the soil to regain fertility; adds soil humus; retains soil moisture
Bunding	Prevents soil erosion; ensures good yield; prevents soil erosion
Contour ploughing	Helps to prevent soil erosion; ensures good harvest
Crop rotation	Guarantees food security; enables higher yield
Deep ploughing	Enables soil moisture and thus soil fertility; brings out weed seeds
Inorganic fertilizer	Although they are not practicing this, they said that they know it gives higher yield and increased income
Early land preparation	Higher yield; ensures early planting; food security
Irrigation	Maintains good soil; allows easy harvesting
Timely weeding	Prevents stunted growth of crops; higher yield; moisture retention
Timely planting	Products sold at a high price; enables higher yield; food security is guaranteed
Row planting	Easy weeding; vigorous plant growth; prevents pest damage
Pesticides	Vigorous plant growth; prevents pest damage
Seed selection	Good yield; vigorous growth; prevents pest damage
Timely harvest	Prevents pests; reduces postharvest losses; good quality of produce
Intercropping	Easy weeding; insurance; more harvest; prevents crop destruction
Zero grazing	Prevents destruction; increases income because of high milk production
Seed selection according to AEZ	Good harvest
Seed storage	Saves money; enables early planting
Tethering	Prevents conflicts in the community; does not require a lot of land; allows pasture growth; is time-saving

Koch-Goma Subcounty

Table 8 presents the practices that were selected by the women from the forested zone of Koch-Goma. The zone covers Kal, Lii, Orum, and Agonga parishes. It also shows the benefits that farmers associate with each of the selected practices. Table 9 presents the practices that farmers were not using but perceived to be relevant for the forested zone of Koch-Goma. Women in this group gave reasons why the practices were not being used and what they would need to implement the practices (Table 10).

Table 8. Selected practices and associated benefits for women from the Koch-Goma forested zone.

Practice	Importance
Crop rotation	Good harvest; helps to control weeds; generates income
Fallowing	Kills weeds; fallowed land allows faster crop growth; allows land to gain fertility; allows higher yield
Crop residue retention	Kills weed life cycle; land regains fertility; higher yield
Agroforestry	Cultivation of crops helps to maintain trees; good harvest; income
Bunding with banana stems	Enhances soil fertility; protects the soil during floods; prevents soil erosion
Fertilizer use	Improves soil fertility; allows higher yield
Deep ploughing	Ensures retention of soil moisture; allows good till and soil conditions
Mulching	Ensures moisture retention; allows higher yield
Contour ploughing	Prevents soil erosion; moisture retention within the soil furrow; reduces runoff; prevents wind erosion
Timely weeding	Controls weeds; boosts plant vigor; good harvest
Improved varieties	High germination rate; uniform harvest; prevents alternate germination
Row planting	Adequate growth; good and quality harvests; controls storage pests; prevents spreading of diseases
Seed selection	High germination rate; uniform harvest
Correct spacing	Vigorous growth; good harvest; prevents spreading of diseases
Pesticides application	Kills pests; improves plant health
Timely harvesting	Prevents rotting; prevents infiltration of pests in the field; quality harvest
Mixed farming	One crop grows faster than the other, thus ensuring food security; decreases the workload on the farm; guaranteed food security
Paddocking	Prevents diseases; pasture growth and regeneration; reduction of workload such as tethering daily
Deworming	Treats diseases; good-quality products, hence high income
Improved breeds	High income

Table 9. Relevant but not currently used practices in the forested zone of Koch-Goma.

Practice	Reasons	What will farmers need to implement the practices?	Constraints to implementation
Paddocking	Prefer tethering; lack of capital; livestock are expensive, especially improved breeds	Training on the practice, including proper stock rates; materials for constructing the paddocks	Products are not accepted by the community; poor veterinary services; low conception rates after artificial insemination
Spraying	It is expensive; lack of knowledge; dangerous for children	Training	Lack of spare parts for the equipment; lack of market; fear of health hazards
Improved breeds	Costs; inadequate knowledge; labor and time constraints	Knowledge/training	Poor management of stored seeds; laziness; distance
Correct spacing	Lack of knowledge on the recommended spacing; lack of labor; lack of tools	Training; spraying equipment; extension workers	Laziness and waste of time; scarcity of labor; low prices of products
Seed selection	Lack of knowledge; it is a waste of time		It is costly and hard to maintain the breeds

Table 10. Selected short list of practices by women: forested zone of Koch-Goma.

Practice	Importance
Crop rotation	Good harvest; helps also to control weeds
Fallowing	Kills weed life cycle; fallowed land allows faster growth of crops; allows the soil to regain fertility
Agroforestry	Good crop harvest; it is good for beekeeping
Deep ploughing	Ensures moisture retention in the soil; allows good till and soil conditions
Early planting	Plants escape droughts and unreliable rains; plants use good soil conditions
Contour ploughing and planting	Prevents soil erosion; moisture retention within the soil furrows; reduces runoff; prevents strong winds from blowing off soil particles
Timely weeding	Prevents weeds from killing plants; boosts plant vigor; good harvest; prevents weed multiplication in the field
Seed selection	High germination rate; uniform harvest; prevents alternate germination
Pest control	Kills pests; improves plant health and vigor
Timely harvesting	Prevents wastage; good and quality harvest; prevents infiltration of storage pests from the field; prevents rotting
Correcting spacing	Allows for proper aeration; good harvest; rigorous growth; prevents spread of diseases

Practice	Importance
Intercropping	One crop matures before the other; hence, the practice spreads the harvest; reduces workload, e.g., labor for weeding, more than one harvest from the same field
Avoid draining wetlands	Wetlands provide drinking water; provides water for irrigation; helps to conserve water; maintains water cycle; prevents fast drying of the soil
Rainwater harvesting	Income through sale of off-season cultivation, i.e., dry seasons; allows continuous farming in a year; ensures water availability for domestic purposes; allows irrigation to be practiced
Paddocking	Ensures disease prevention, i.e., its spread; pasture growth or regeneration; allows equal distribution of forage; reduces workload
Spraying/deworming	Treats diseases; increases products such as milk yield; healthy animals; increased income
Improved breeds	Increased income through sale of products such as milk

Similar to their female counterparts, the men identified some practices that they perceive as relevant but that they are not using. Table 11 presents these practices, the reasons why they are not used, what farmers would need in order to implement the practices, and the constraints they perceive to implementation.

From a master list of practices, the men farmers in the grassland zone of Koch-Goma selected the following practices as the most relevant for their zone: intercropping, timely planting, use of improved varieties, broadcasting, row planting, mixed farming, stall feeding, rotational grazing, deworming and spraying of animals, agroforestry, aquaculture, minimum tillage, apiculture, mulching, farmyard manure, irrigation, stop deforestation, conservation of wetlands, fallowing, no burning, and bunding. Several reasons were given for their selection, including to earn income; food security; higher yields; to improve soil fertility, for example, mulching for moisture retention; fear of damage that might be caused by animals such as pigs; hence, stall feeding; health improvement through quality food/yield; saving time; water conservation; medicinal values of trees; and to attract rainfall, for example, agroforestry. In the same vein, the following factors were identified as reasons why some practices are not implemented by farmers in the grassland zone of Koch-Goma: lack of machines or tools, seasonal wetlands prevent the use of irrigation, wetlands are used as borders because of land conflicts, labor scarcity, the lack of livestock makes it difficult to use an ox-plough, lack of knowledge and reliance on traditional knowledge, poor breeds of fish hinder aquaculture, pests such as birds, and lack of interest from farmers. Farmers, therefore, indicated that they would need training, demonstration of the practices, access to markets, provision of tools and equipment, agricultural extension service providers, and on-farm visits and tours by the farmers. Finally, the constraints that were identified by men in the grassland zone of Koch-Goma were related to climate change, civil wars, fluctuations in prices of agricultural produce, an increase in taxes on agricultural products, land conflicts, pests and diseases, theft, poor road network, lack of a market for products, poor postharvest management, and jealousy from other people such as neighbors.

Table 12 shows the practices that were selected as relevant by women farmers from the grassland zone of Koch-Goma. This zone covers Amar and Coo-rom parishes.

Farmers in this group, however, reported that, although fertilizer and herbicides are relevant, the lack of purchasing power hinders use. Moreover, the lack of equipment (sprayer) is a barrier to the use of herbicides. Women in this group therefore indicated that they would need money to buy fertilizer and herbicides, equipment such as a knapsack sprayer, and training on efficient use of fertilizer and herbicides. Lack of knowledge was identified as a major constraint.

Table 11. Relevant, but not used, practices for the forested zone of Koch-Goma by men.

Practice	Reasons	What is needed to implement the practices	Constraints to implementation
Paddocking	They prefer tethering; lack of money to buy wires to paddock the grazing area; high cost of improved breeds	Training on how to construct the paddocks using readily available materials; training on stocking rates; provision of materials such as wires; sensitize farmers with large sizes of land on the importance of paddocking	Products unaccepted by local people; lack of incentives; quarantine in case of disease outbreak, hence, they will not sell their products; poor veterinary services; low conception rates after artificial insemination
Rainwater harvesting	Lack of collecting tanks; they have huts so gutters cannot be installed; lack of knowledge on rainwater harvesting; collected water can form breeding ground for mosquitoes	Knowledge on rainwater harvesting; chemicals to control breeding of mosquitoes; loans to facilitate installation of the system	Unreliable rainfall; droughts; breeding of disease-causing organisms; changes in climate and weather patterns, especially late rains when all water is used up
Correct spacing	Lack of knowledge of recommended spacing; labor intensive; lack of tools such as tape measure and rope	Training; tools at affordable prices; extension staff and service for monitoring correct spacing.	Laziness; lack of labor at household level; illness; low prices of products in local market over time; many responsibilities and work render practice time wasting
Pest control using pesticides	Lack of knowledge; people use pesticides to commit suicide	Training and sensitization on how to use pesticides to avoid cases of suicide; pesticides at affordable costs; affordable and durable sprayers; reduced tax on agro-inputs; sprayers of different calibrations made available since the 15–20-liter sprayers are heavy for most farmers	Lack of spare parts for sprayers; market for products, i.e., prices are low; health problems and side effects
Seed selection	Lack of knowledge	Training on better methods of selecting specific seeds; local seed store for farmers' saved seeds	Poor management of stored seeds; laziness during seed selection; distance of travel to local stores; theft of selected seeds; use of the stored seeds for food in periods of scarcity
Agroforestry	Lack of agroforestry tree species; lack of knowledge on planting and use of trees	Farmers' field day to train about the practice; provide seedlings at affordable prices; monitor growth of the tree species over time	Poor extension service to monitor; some tree species may not grow in the area; poor attitude toward the practice
Improved breeds of livestock	Lack of suitable sources of breeds; taking care of improved livestock is labor intensive	Provide knowledge on improved breeds; accessible sources of the breeds; provide management requirements for about 3 months so that farmers can acquaint themselves with keeping the animals, e.g., vaccines and other drugs	Lack of interest from local people; they are often bred in a different area and may not perform well/adapt in their local conditions; people's perceptions about improved breeds, e.g., products, may not be acceptable to local people, hence, a disincentive to the farmers

Table 12. Practices selected by women from the grassland zone of Koch-Goma.

Practice	Reasons
Crop rotation	Diversification; improves soil fertility; full nutrient use; monoculture leads to soil exhaustion
Timely planting	Early maturity; high yield
Rotational grazing	Reduces pasture exhaustion
Routine deworming	For the health of the animals; reduces cost of disease treatment
Fertilizer use	Increases soil fertility
Farmyard manure	Very high yield; faster maturity; it is cheap
Improved feeding, e.g., silage and elephant grass	High milk yield
Intercropping	Full nutrient use; limited labor
Row planting	Easy weeding; higher yield than broadcasting
Seed selection	To remove seeds that are unlikely to germinate
Mulching	Increased soil fertility because, when the residues decompose, soil erosion decreases

Anaka Subcounty

Table 13 presents the practices that the men from the grassland zone of Anaka selected as the most relevant for the zone. It further shows what farmers perceive as the benefits of the practices.

Men farmers of the grassland zone of Anaka also reported that improved breeds, strip cropping, silvopastoral systems, minimum tillage, and agroforestry are relevant for the zone but that they were not implementing them. Several reasons were given for not implementing these practices. Table 14 presents the reasons that farmers gave and what they would need in order to implement the practices.

Table 15 lists the practices that were selected by the women in the grassland zone of Anaka Subcounty. It also presents the benefits that farmers in this zone associate with the practices.

Table 13. Most relevant practices in Anaka Subcounty's grassland zone as selected by the men.

Practice	Benefits
Intercropping	Risk insurance; nutrients for crops; diversified income; reduced cost of operation
Fallowing	Allows the soil to regain fertility; kills weeds
Agroforestry	Trees provide shade for some crops
Crop rotation	Disease prevention; higher yield; addition of nutrients
Timely planting	Early harvest; good harvest; food security; plants grow faster
Timely weeding	Faster plant growth; higher yield; prevents pests; avoids competition with weeds
Contour ploughing	Controls soil erosion
Seed selection	Good germination; good and quality harvest; high income
Pesticide use	Reduces damage by pests; reduces loss
Minimum tillage	Reduces workload; reduces costs; does not waste time
Improved breeds of cattle	High income; provide nutrient-rich milk
Silvopastoral systems	Reduce animal movement; increase pasture availability; conserve the soil; provide shade for the animals
Strip cropping	Prevents strong winds (e.g., cassava and beans); prevents over-shading other crops; diversified production; prevents spreading of diseases
Mulching	Retains soil moisture; reduces erosion; kills weeds; avoids soil pests/worms; increases soil fertility; good harvest (e.g., in tomatoes)

Table 14. Practices that are relevant but not implemented, reasons for not implementing them, and what would be needed by the men of the grassland zone of Anaka to implement them.

Practice	Reasons	What they would need to implement the practice	Constraints that would hinder implementation
Improved breeds	No animals; high cost of purchase; veterinary services are expensive; lack of proper knowledge on keeping improved breeds	Training and knowledge; capital to invest; reliable veterinary services; pasture establishment for cattle	Laziness, especially because cutting grass is tedious; limited pasture land; high cost of veterinary services
Strip cropping	Lack of knowledge; the method requires crops that yield higher; much workload	Training through demonstration; required crop species; observe the benefits	Low yield; wrong mix of crops for the practice
Silvopastoral systems	Lack of knowledge on suitable tree species; lack of capacity to keep animals	Animal breeds; tree species	Land conflicts; high cost of veterinary services
Minimum tillage	Lack of awareness; the practice requires use of herbicides	Training on spraying and practice; cheap and affordable herbicides; spraying equipment	Effects of herbicides on the soil; in case of low yield, farmers become discouraged; high cost of herbicides; farmers' perceptions about the practice
Agroforestry	Lack of knowledge on tree species; tree species not available in the area	Tree species (e.g., *Caliandra*)	Tree species might host crop diseases; low economic value of the tree species

Women farmers in this zone also reported that herbicides, fertilizer, as well as cut and carry were relevant technologies that were not currently being used because of some constraints. Such constraints include the high cost and unavailability of herbicides, the high cost of fertilizer and the perception that the practice reduces soil fertility, and the lack of improved breeds of livestock. In order to implement these practices, farmers said that they would need training, equipment such as sprayers, and chemicals.

Figure 6 shows the selected practices as relevant in the forested zone of Anaka by gender, while Table 16 presents the benefits that women farmers associate with the most relevant practices.

Table 15. Benefits associated with the practices selected from the grassland zone by women in Anaka Subcounty.

Practice	Benefits
Agroforestry	Trees act as windbreakers; they are easy to weed; and they provide timber
Terracing	Reduces soil erosion; prevents washing away of crops
Contour ploughing	Prevents soil erosion
Crop rotation	Ensures higher productivity; ensures food security; higher income
Intercropping	Easy weeding; easy harvesting of the intercropped crops; time and labor saving
Mulching	Prevents rotting of fruits such as watermelon; controls weeds; improves soil fertility; ensures moisture retention
Pesticides	Kill pests
Fallowing	Regains soil fertility; controls weeds
Timely planting	Faster maturity, hence early harvesting; higher yield; ensures availability of labor; higher income
Stop burning	Higher soil fertility
Improved varieties	Early maturity; disease resistance; higher yield; drought tolerant

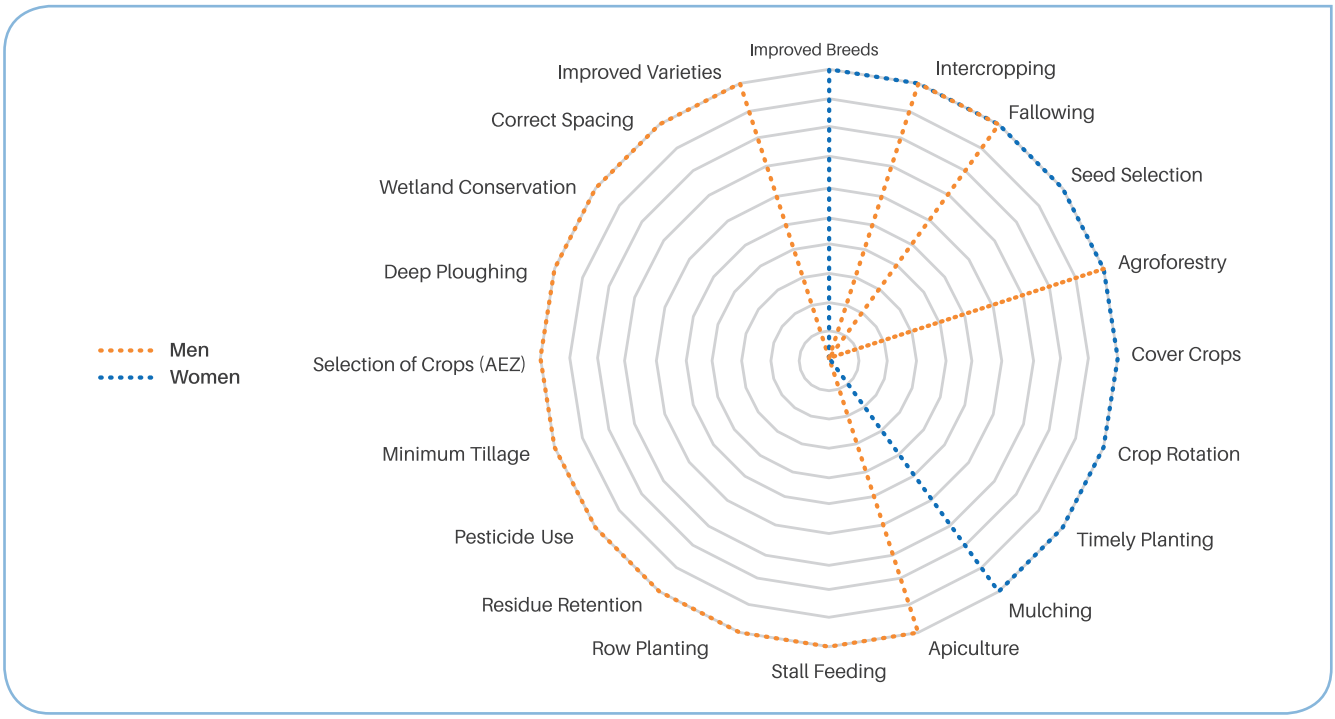


Figure 6. Practices selected by farmers in the forested zone of Anaka.

Table 16. Benefits associated with the practices selected by women from Anaka.

Practice	Benefits
Improved breeds	Increased income because of high milk production; improved standard of living
Intercropping (e.g., groundnuts and maize)	Food security, reduced workload, higher price of products and hence higher income, improved germination
Fallowing	The soil regains fertility
Seed selection	Higher prices of products and higher yield after sorting seeds; it is an improved farming method
Agroforestry	It is an insurance for the future (children); increase in capital; it is a method of saving; attracts rainfall
Cover crop	Pest control; higher yield; food security
Crop rotation	Higher yield; food security; the soil regains its fertility
Timely planting	Higher prices/income; labor saving since there will be less weeding; the quality of produce is excellent
Mulching	Prevents plants from rotting

In addition to the practices in Table 16, women in the forested zone of Anaka reported that fertilizer, improved breeds, agroforestry, and minimum tillage are relevant practices for the zone but were currently not being implemented. They cited the following reasons for not implementing the practices: fertilizer is expensive and it is not available, and they lack training on how to apply the input; improved breeds are not only expensive but also difficult to take care of; agroforestry is expensive and farmers lack knowledge of the practice; there is a shortage of land and land conflicts occur; and there is a lack of awareness on minimum tillage. Together, farmers reported that they would need an ox-plough, training, herbicides, and tree seedlings in order to implement the practices. Specific constraints to the application of fertilizer include lack of training, the fear that fertilizer will damage the soil, the perception that fertilizer will kill useful organisms in the soil, and that chemical fertilizers pose a health hazard, especially to children. With respect to herbicides, farmers said that they are difficult to apply, they are selective on weeds, the farmers lack training, and that herbicides increase their workload. They reiterated that improved breeds are expensive to buy and difficult to manage.

Men in the forested zone of Anaka Subcounty mentioned the following benefits that they associate with the selected practices: high yield, provision of income, food security, the use of herbicides in minimum tillage saves time, improved health, apiculture helps to keep away elephants, improvement of soil fertility, improved varieties are adapted to the changing climate, wetlands conservation reduces climate change, vigorous growth of crops due to correct spacing, and zero grazing could help to install biogas systems in the agro-ecological zone. Implementation of the practices is, however, not without constraints. Farmers mentioned the following as reasons why some practices were not being used despite being relevant for the zone: financial constraints; lack of knowledge; lack of inputs such as pesticides, improved seeds, and fungicides; lack of markets for their produce; tree stumps make it difficult to plough using tractors; poor road networks; price fluctuations; limited land as most of it is forested; and limited labor supply. With these constraints, farmers said that they would need the following in order to implement the practices:

- Provision of inputs such as improved seeds
- Availability of equipment such as sprayers
- Oxen to pull the ox-plough
- Training on how to implement the practice

- Capital to finance implementation
- Access to output markets
- Improved transportation infrastructure
- Formation of cooperatives
- Incentives such as loans
- Sufficient labor supply

In addition to the already mentioned barriers, farmers listed the following factors that hinder implementation of the practices: land conflicts, jealousy among farmers, unpredictable rainfall, domestic violence, civil wars, lack of interest/laziness of the farmers toward a particular practice, and drunkenness of the farmers.

Purongo Subcounty

For the men farmers from the forested zone of Purongo Subcounty, the following practices were selected from the master list: agroforestry, minimum tillage, contour ploughing, crop rotation, intercropping, silvopastoral systems, pesticides, improved crop varieties, improved animal breeds, seed selection, fallowing, crop diversification, timely weeding, and beekeeping. Table 17 presents some practices that farmers in this zone perceive as relevant but that they are currently not implementing. Table 18 presents what farmers would need in order to implement the practices in the forested zone of Purongo, as explained by the men.

Table 17. Practices perceived to be relevant but not currently implemented in the forested zone by men.

Practice	Reasons
Beekeeping	Tree species not suitable for beekeeping; swamps dry out during the dry season and hence bees have limited water; harvest only once a year; lack of knowledge on profitable apiary management
Fish farming	Do not know how to construct dams; lack of fingerlings; water dries out during dry seasons; lack of knowledge on fish feeds; lack of tools
Improved breeds of cattle	Difficult pasture establishment; lack of knowledge on management requirements; expensive sources of improved breeds of cattle; expensive veterinary services
Minimum tillage	Lack of awareness about the practice

Table 18. What would farmers need in order to implement these practices in the zone?

Practice	Required for implementation
Beekeeping	Hives (improved), suitable tree species, training
Fish farming	Training on how to construct dams, good fish breeds, knowledge on locally available fish breeds, knowledge on fish pests and diseases and their management
Improved breeds of cattle	Training on management, nearby and accessible veterinary services, materials and tools for constructing paddocks, sources of forage seeds (grasses or legumes)
Minimum tillage	Training on types of herbicides, tools such as sprayers, knowledge on application

The women from the forested zone of Purongo Subcounty listed the following practices as the most relevant: early land preparation, row planting, intercropping, crop rotation, fallowing, farmyard manure, crop residue retention, burning, mulching, and tethering. The following practices, however, were perceived to be relevant but not currently being used: beekeeping, improved breeds of livestock, minimum tillage, agroforestry, and fish farming. For beekeeping, farmers said that the tree species in the zone are not suitable for beekeeping, that most farms dry out during the dry season and hence there is no water for bees, and that the harvest is low since it is once a year. For improved breeds, women farmers in this zone said that the breeds are very expensive, that they lack knowledge on the practice, and that culturally the practice is considered as a men's activity. Table 19 presents the benefits of the relevant practices that the farmers were using while Table 20 presents the constraints associated with the practices.

Table 19. Benefits of the relevant practices as perceived by women in the grassland zone of Purongo.

Practice	Benefits
Early land preparation	Ensures higher yield; enables early planting; ensures good harvest and food security; ensures higher profits; fewer weeds
Row planting	Enables higher yield, good harvest, penetration of sunlight; makes weeding easy
Intercropping	Food security; time-saving; good harvest; cost friendly; diversified production
Crop rotation	Higher yield; good harvest; improved soil fertility; less weeding; food security; improved standard of living; adds on plant nutrients
Fallowing	Kills weeds; especially black jack; higher yield; cheaper than fertilizers
Farmyard manure	Improves soil fertility; higher yield; allows good harvest
Residue retention	Prevents hardening of the soil; improves soil fertility; increased soil moisture retention; higher yield; easy harvesting, especially beans; prevents weed germination
Burning	Easy opening of the land; it is easy to kill weeds; certain crops such as sorghum require burning
Mulching	Soil moisture conservation, especially in cultivation of horticultural crops such as tomatoes and egg plants; higher yield
Tethering	Reduces the destruction done by animals; reduces theft of animals

Table 20. Constraints associated with the practices perceived as relevant by women in the grassland zone of Purongo.

Practice	Constraints
Early land preparation	Labor intensive and hence costly; laziness among men
Row planting	Shortage of labor; requires teamwork (group)
Intercropping	Waste of land; shortage of labor; shortage of land; inadequate seeds for planting
Fallowing	Shortage of land
Farmyard manure	Not everyone has animals and hence no manure; labor intensive
Residue retention	Harbors pests that destroy crops; existence of anthills
Burning	Low yield of plants

Figure 7 shows the selected relevant practices of farmers from the grassland zone of Purongo Subcounty.

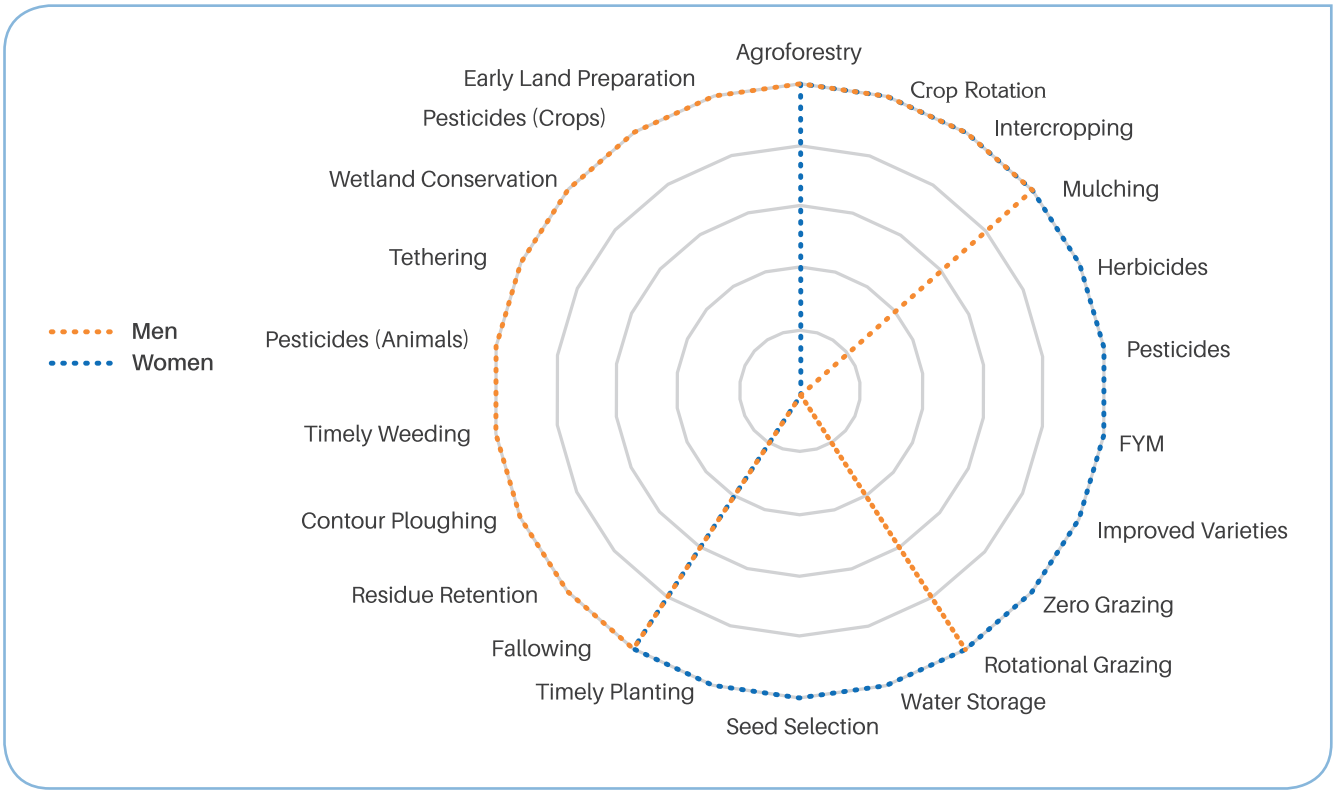


Figure 7. Practices selected as relevant by farmers from the grassland zone of Purongo.

The women gave several reasons for the selection: increased yield, increased income, increased nutrients, easy weeding, diversified harvest, preventing rotting of crops, and retaining soil moisture (e.g., by practicing mulching), reduced workload, faster maturity (e.g., by using improved varieties), reduced loss of livestock, proper feeding and reduced disease prevalence (e.g., through zero grazing), healthy growth due to seed selection, high price of produce because of good quality, fallowing increases soil fertility, and herbicides and pesticides help to kill weeds and diseases.

For the men from the grassland zone, the reasons given for the selection of relevant practices were high yield, control of pests, control of weeds, improved soil fertility, saving of time, trees purify the air in agroforestry systems, conserving wetlands provides water for livestock and irrigation water for crops, food security, tethering prevents conflicts caused when animals destroy neighbors' crops, improved health, and control of soil erosion. Lack of knowledge, lack of capital, limited access to required inputs such as pesticides, stray wild animals, land disputes, climate change, lack of markets for products, locusts, hailstones, and crop diseases were the major challenges that farmers face. Farmers, therefore, indicated that they would need training on relevant skills, farm equipment, capital, access to markets, storage facilities, a good transportation network, and available and affordable fertilizers in order to implement the practices.

The women in the grassland zone of Purongo gave several reasons for not implementing certain practices and the reasons for not implementing them Table 21.

Table 21. Practices relevant but not implemented, reasons for not implementing them, and what would be needed to implement them for women in the grassland zone of Purongo.

Practice	Reasons	What they would need to implement the practices	Constraints that would hinder implementation
Agroforestry	Lack of enough land because trees take a long time in the field; lack of seedlings and they are expensive	Be provided with seedlings	Diseases
Herbicides	Lack of knowledge; they are expensive	Be provided with herbicides; training on how to apply the chemicals	Herbicides are poisonous; application is affected by weather (e.g., windy weather reduces the efficiency)
Pesticides	High cost of pesticides	Be provided with pesticides	They are poisonous
Farmyard manure	Tiresome for those with large farms; lack of enough material	Substitute with fertilizer because obtaining enough material is difficult	Tiresome; increases workload
Zero grazing	Lack of enough capital; no animals	Improved breeds of cattle	Land constraints; increases workload

Pairwise ranking of the selected practices by agro-ecological zone and gender

Prioritized practices by subcounty, gender, and AEZ

Farmers prioritize the different practices differently by both agro-ecological zone and gender. Figure 8 shows the most prioritized practices in Koch-Goma by men in the grassland zone. These include row planting, improved varieties, timely planting, broadcasting, mulching, and intercropping, respectively, in their order of ranking. Women, however, prioritized timely planting, crop rotation, seed selection, intercropping, and row planting, respectively. In the forested zone, whereas men prioritized deworming of livestock, improved breeds, and paddocking, women ranked seed selection, timely harvesting, correct spacing, and improved varieties as the most important.

In the grassland zone in Alero, men ranked selection of varieties according to AEZ, timely planting, timely weeding, timely harvesting, crop rotation, and agroforestry as the most relevant (Figure 9). Women, on the other hand, ranked selection of seeds, timely planting, herbicide application, zero grazing, and irrigation as the most relevant. In the forested zone, men ranked early land preparation, seed selection, early planting, timely weeding, and crop rotation as the most important in the respective order. Their women counterparts ranked seed selection, timely planting, fallowing, pesticide application, and fertilizer application, respectively, in order.

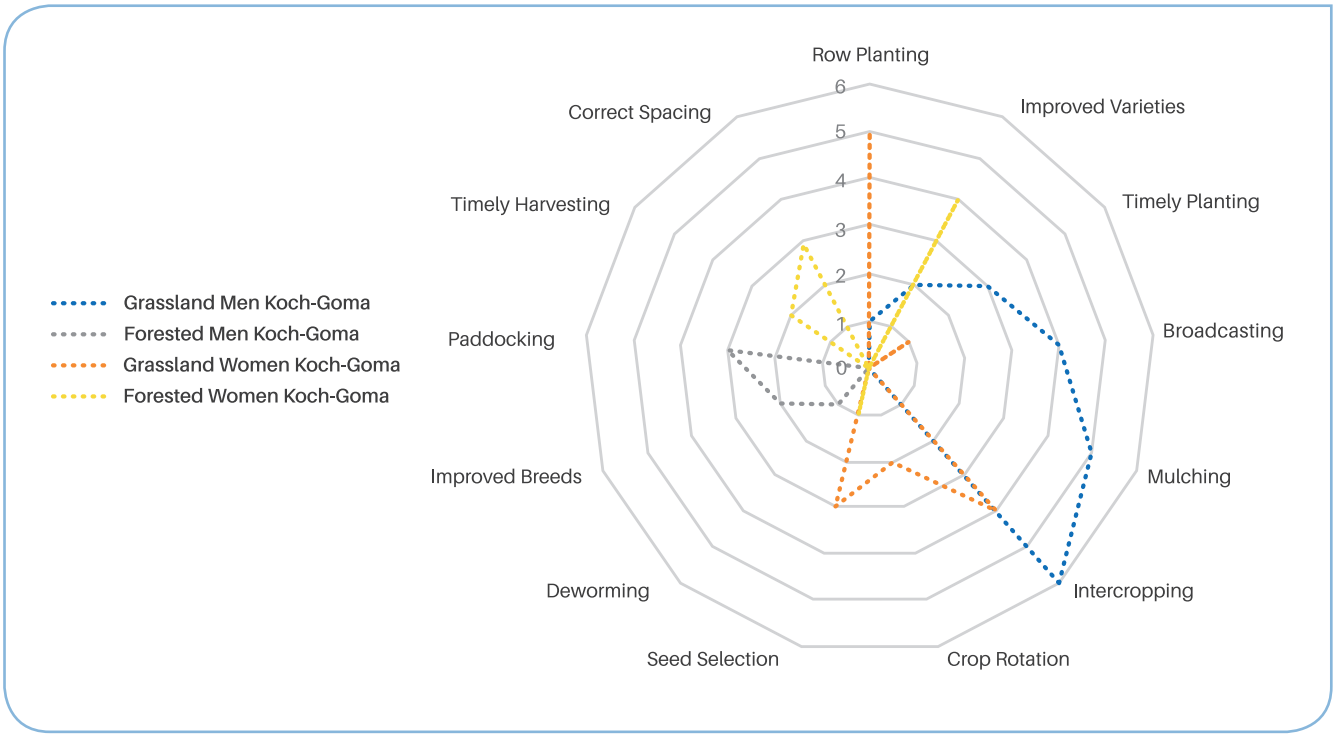


Figure 8. Practices prioritized in Koch-Goma by gender and AEZ.

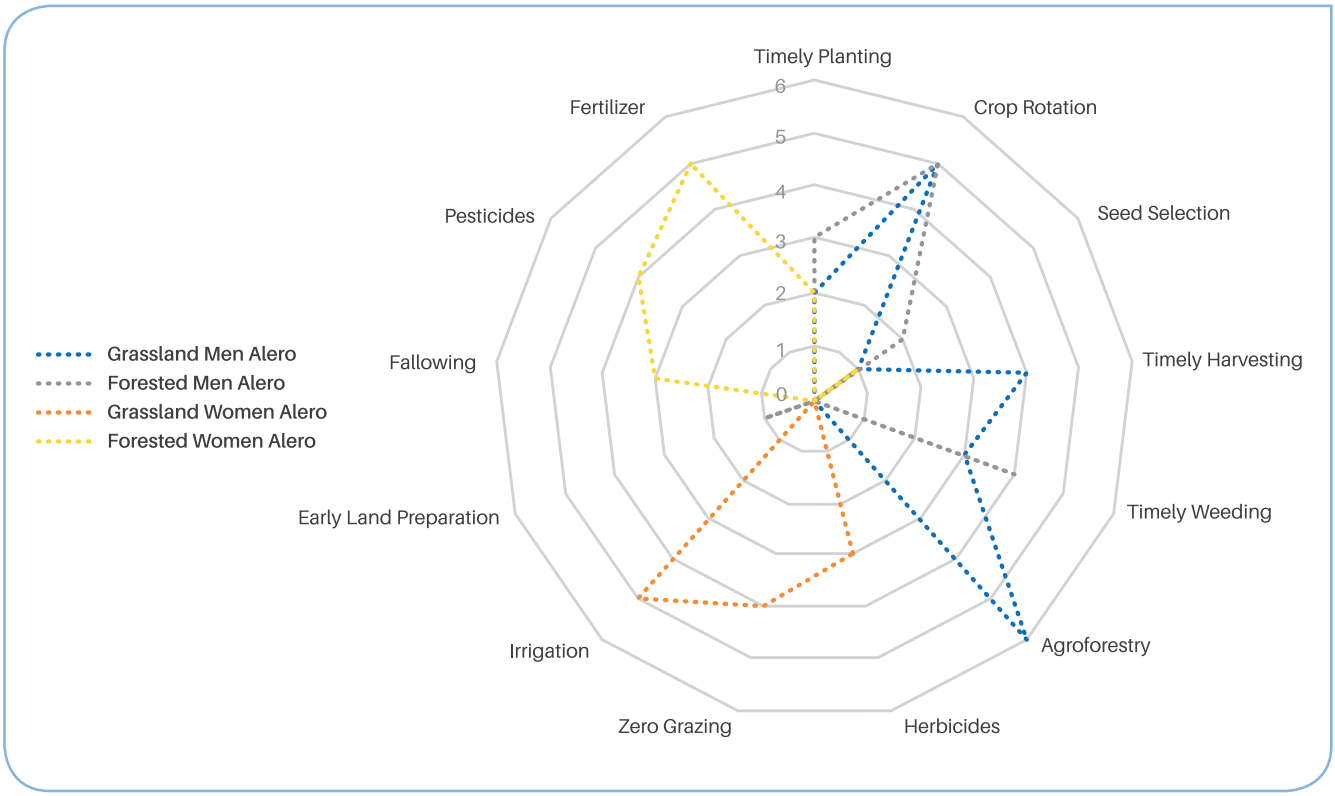


Figure 9. Practices prioritized in Alero by gender and AEZ.

In Anaka, men and women in the grassland zone had different rankings of the practices (Figure 10). In particular, men ranked silvopastoral systems, seed selection, timely planting, improved varieties, and broadcasting in the respective order, while women ranked improved varieties, timely planting, controlled burning, crop rotation, and intercropping, respectively, in order. In the forested zone, men ranked timely planting, correct spacing, conservation of wetlands, improved varieties, intercropping, and agroforestry while women ranked agroforestry, seed selection, timely planting, improved breeds, and crop rotation in the respective order.

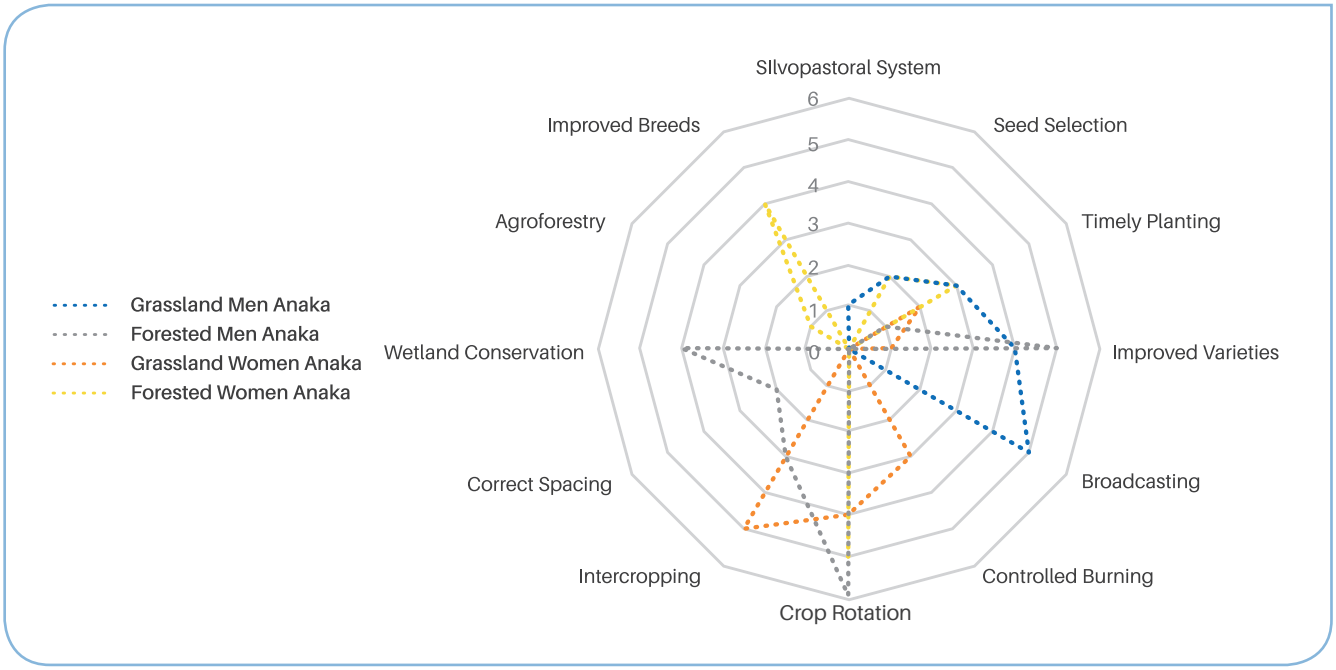


Figure 10. Practices prioritized in Anaka by gender and AEZ.

Lastly, men in Purongo's grassland zone ranked timely weeding, early land preparation, conservation of wetlands, pesticide application, spraying for external parasites, and tethering while the women ranked timely planting, fallowing, seed selection, crop rotation, improved varieties, and intercropping in the respective order (Figure 11). Men in the forested zone ranked timely weeding, fallowing, crop rotation, intercropping, contour ploughing, minimum tillage, pesticide application, seed selection, and improved varieties in that order. The women ranked early land preparation, intercropping, burning, crop rotation, mulching, tethering, residue retention, fallowing, and farmyard manure in the respective order. Figures 12, 13, 14, 15, 16, and 17 summarize the ranking of practices across the AEZs and by gender.

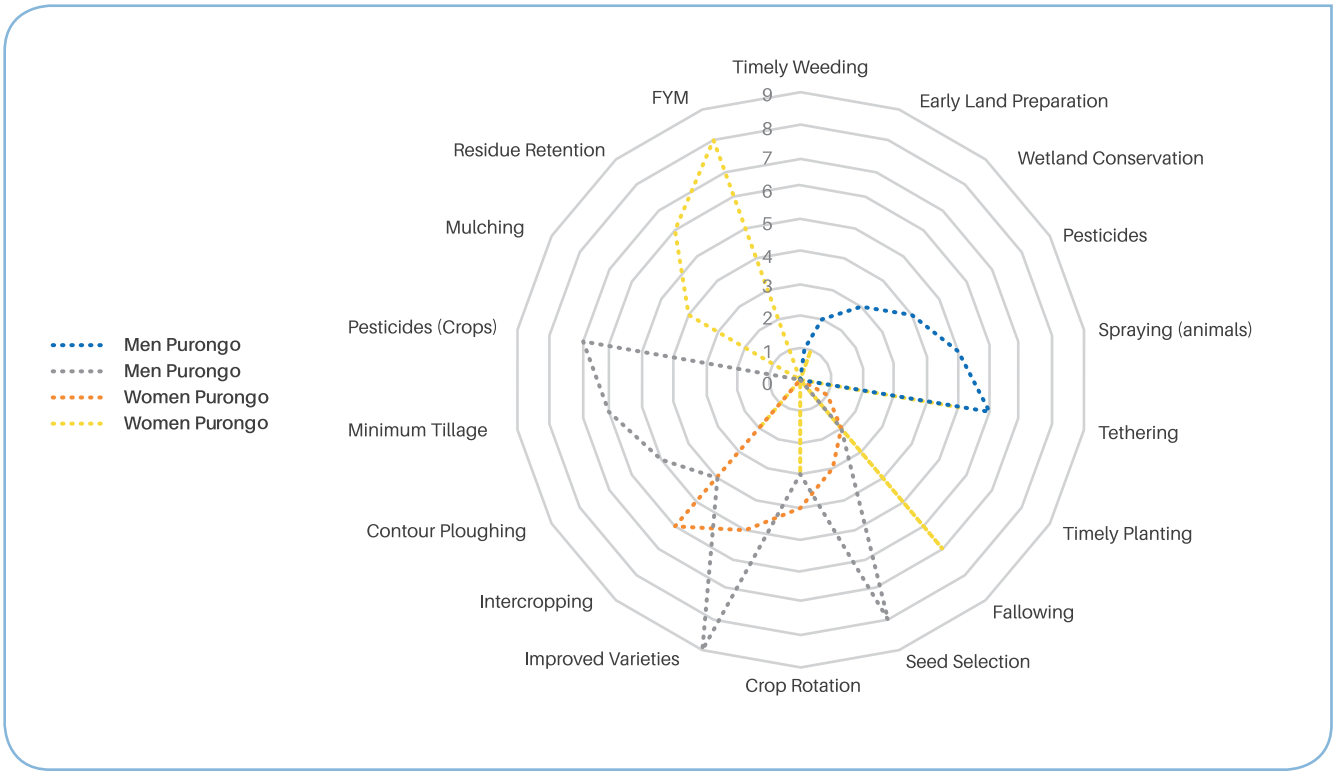


Figure 11. Practices prioritized in Purongo by gender and AEZ.

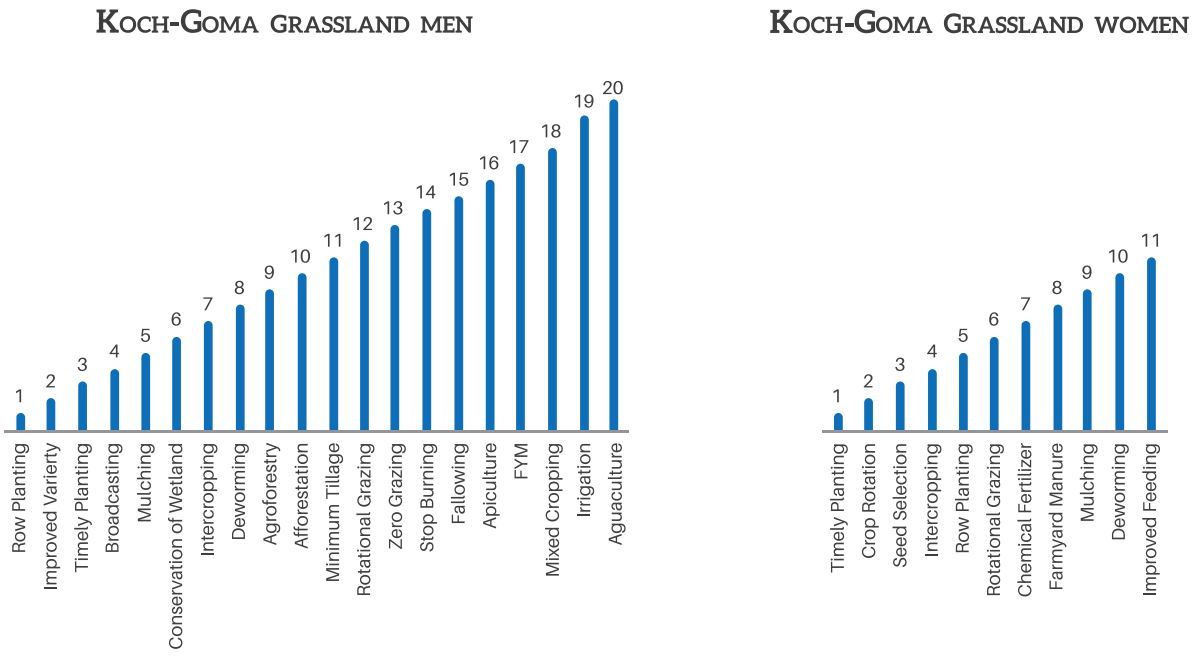


Figure 12. Ranking of practices in Koch-Goma by AEZ and gender (continues).

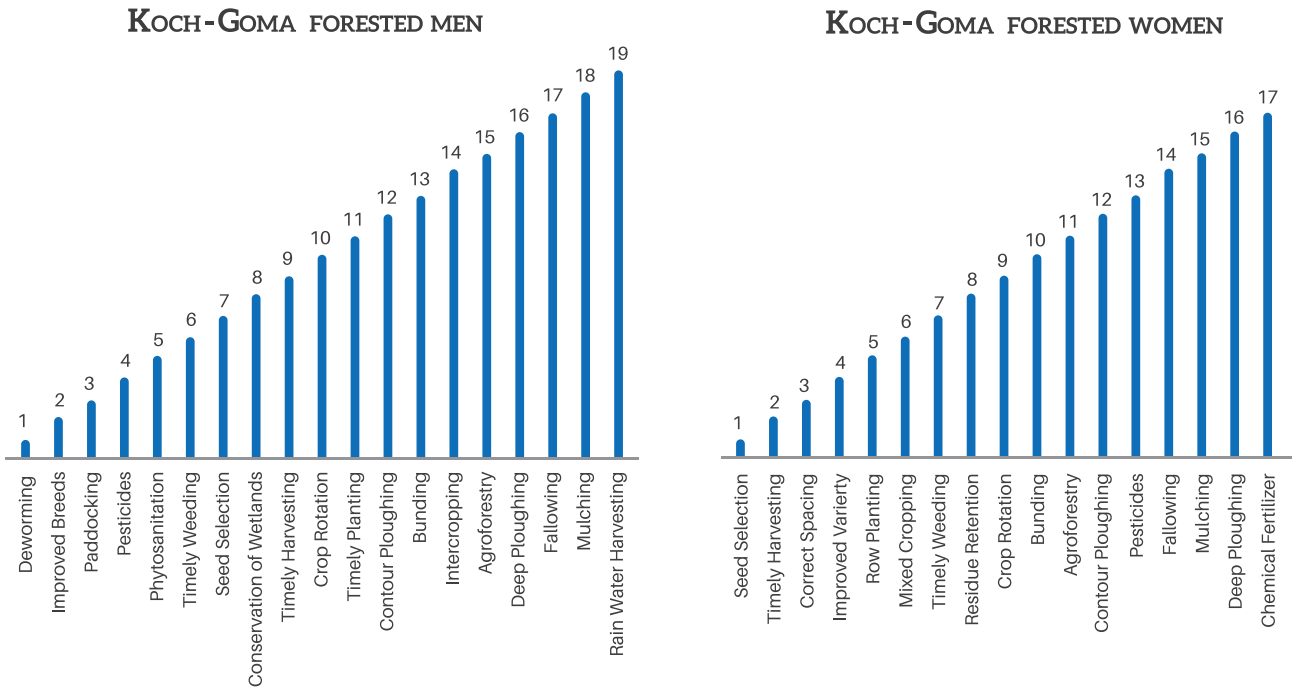


Figure 12 (continued). Ranking of practices in Koch-Goma by AEZ and gender.

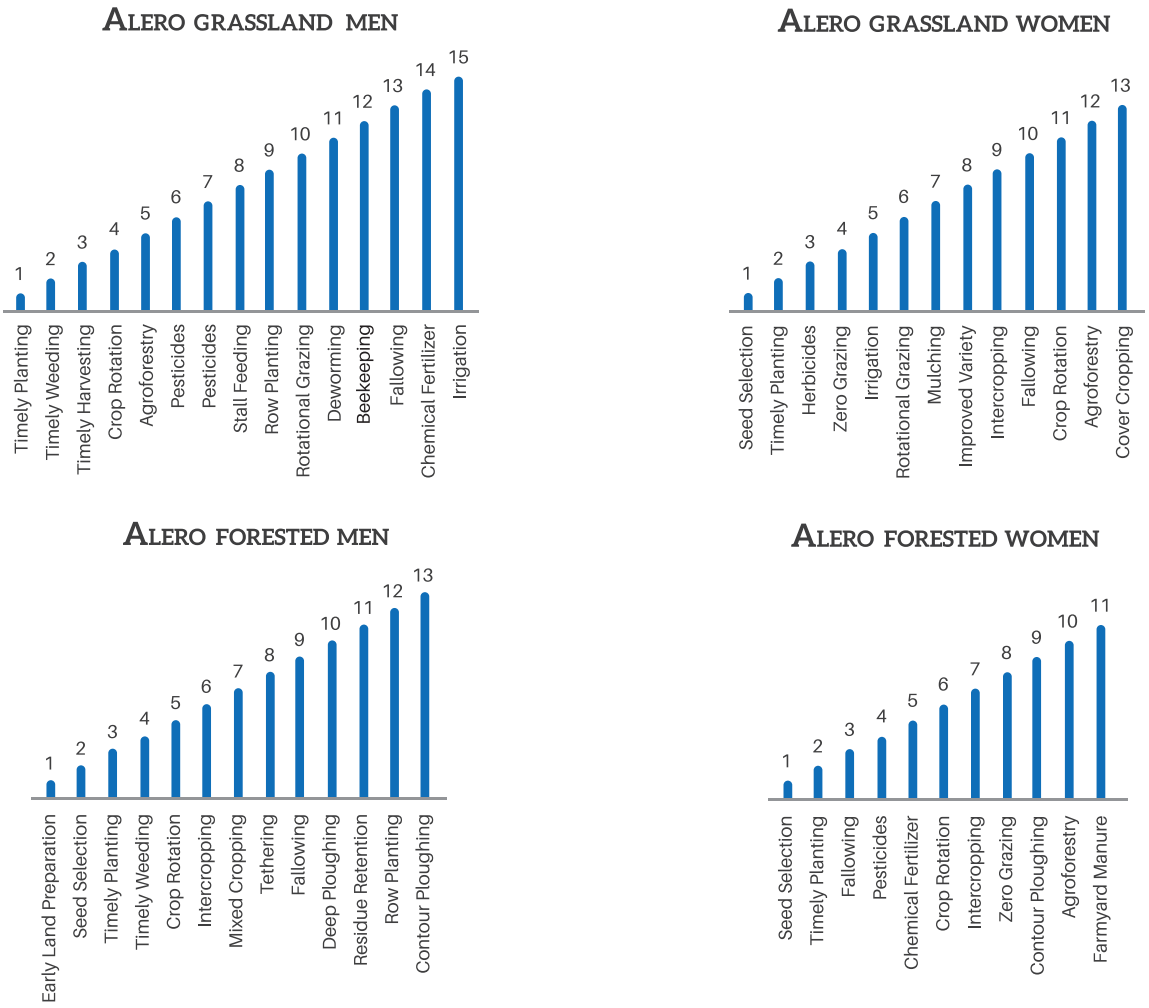


Figure 13. Ranking of practices in the grassland and forested zone of Alero.

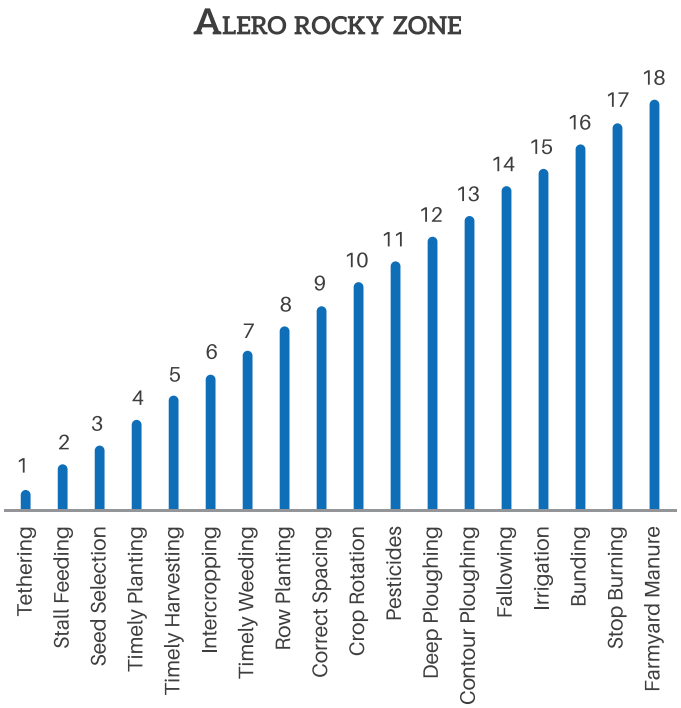


Figure 14. Ranking of practices in the rocky zone of Alero.

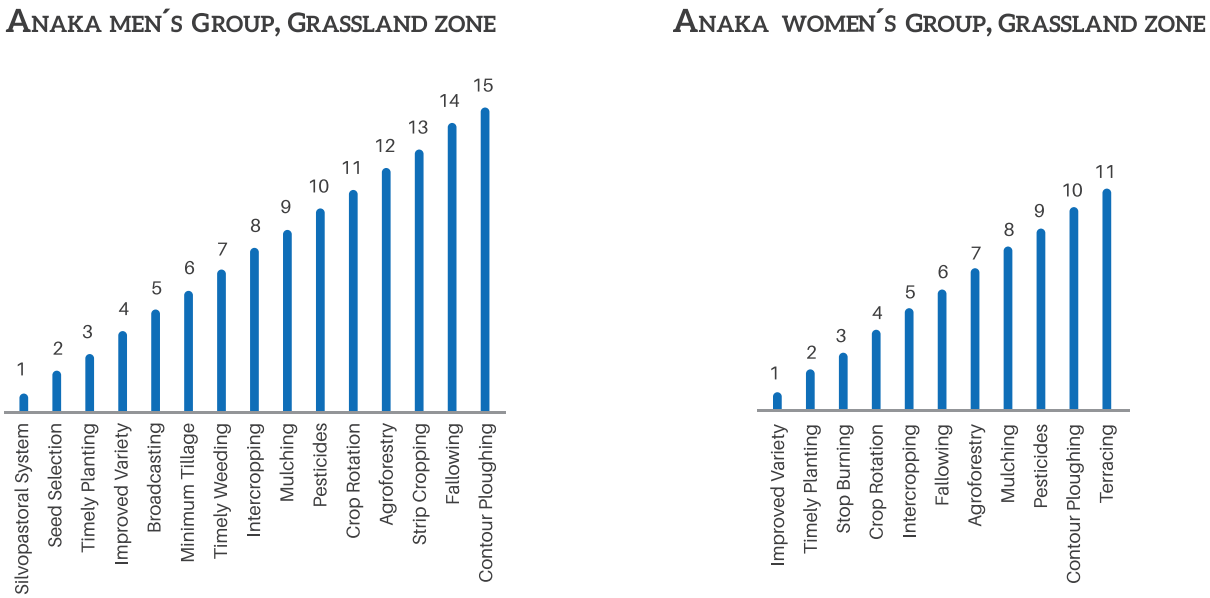
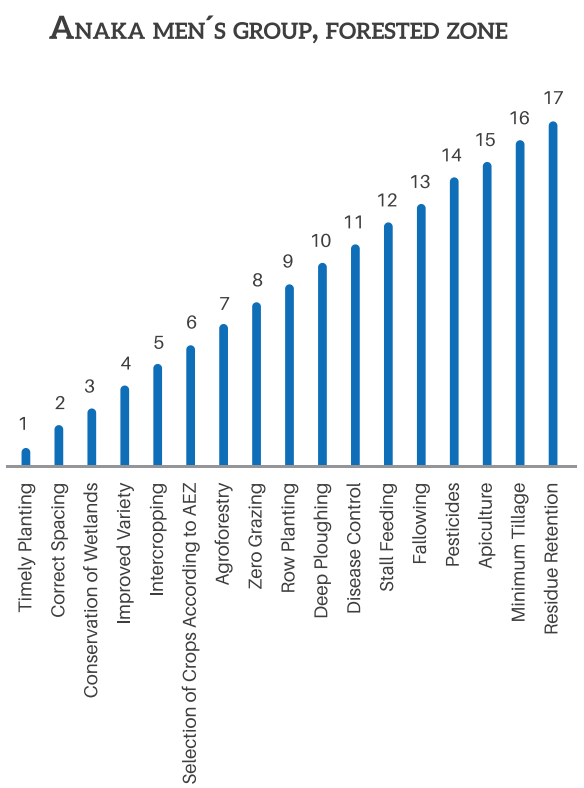


Figure 15. Ranking of practices in Anaka – grassland zone.



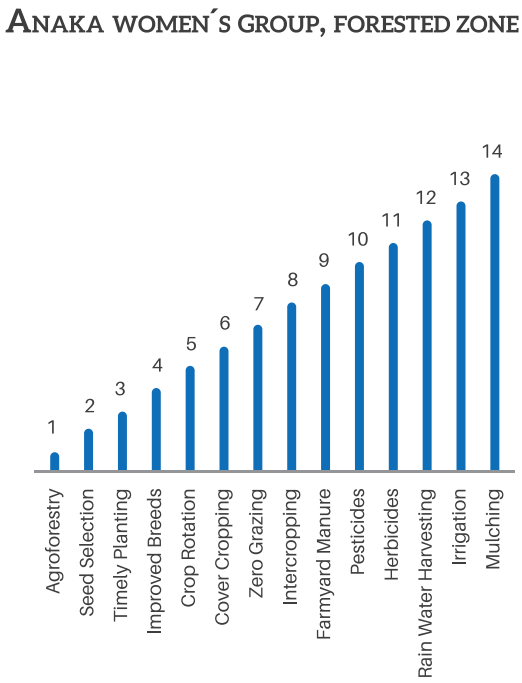
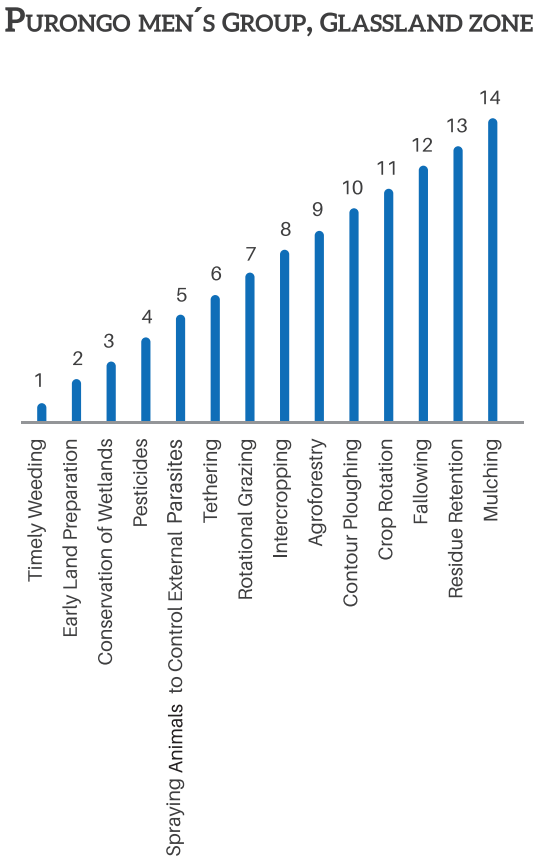


Figure 16. Ranking of practices in Anaka – forested zone.



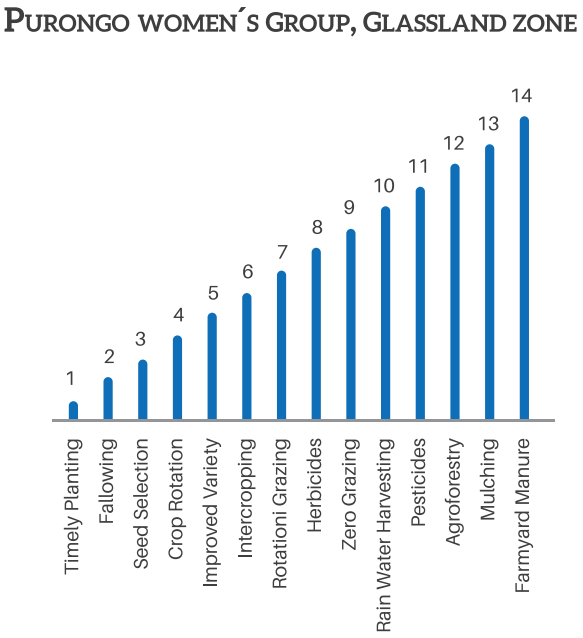


Figure 17. Ranking of practices in Purongo – grassland and forested zones (continues).

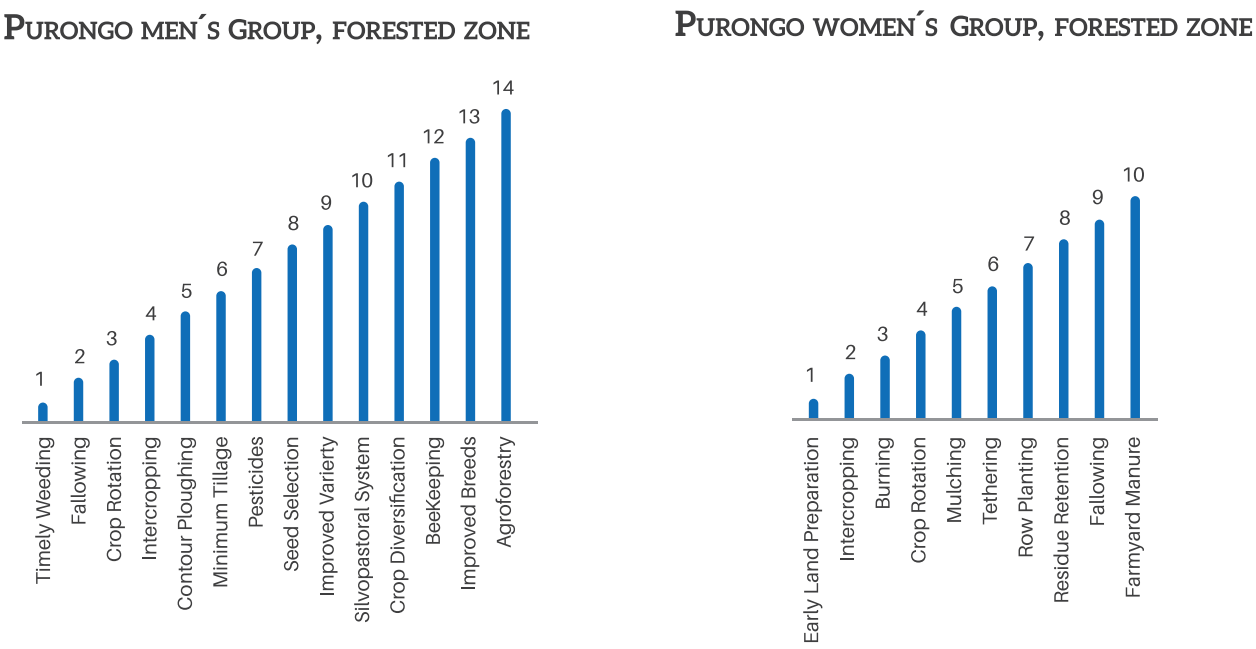


Figure 17. (continued) Ranking of practices in Purongo – grassland and forested zones.

Indicators that farmers use to prioritize agricultural technologies and their importance

Table 22 presents the different indicators that farmers use to prioritize agricultural practices across AEZ and by gender. As shown, there are similarities as well as differences in the indicators used. In the forested zone of Koch-Goma, for example, the men ranked weed control as a very important indicator, in complete contrast to the women's perception that weed control is least important. Similarly, men and women from the grassland zone of Koch-Goma contrasted in their ranking of prestige as an important indicator for selecting an agricultural practice. Specifically, men ranked prestige as least important (1) whereas women ranked it as important (4). In Anaka Subcounty, differences in the ranking of the indicators used to prioritize agricultural practices were observed in soil fertility. Men ranked soil fertility as not important (2) while women said that soil fertility was a very important (5) indicator. Other significant differences in Anaka were observed in the ranking of capital/cost, pest and disease control, and availability of equipment. Men said that capital was an important (4) indicator while women said that it was least important (1). Similarly, whereas men ranked disease and pest control as very important, women felt that the indicator was not important.
In Alero, men ranked availability of land as a very important indicator in the forested zone while women reported that land availability was least important. Generally, there was similarity in the ranking of yield, income, food security, and technical knowledge across the four subcounties. There was also general agreement about the importance of capital/cost except among women from the grassland zone of Anaka and men in the forested zone of Purongo, who ranked the indicator as not important.

Table 22. Ranking of the indicators that farmers use to prioritize agricultural innovations.

	Koch-Goma				Anaka				Alero					Purongo			
	Forested		Grassland		Forested		Grassland		Forested		Grassland		Rocky	Forested		Grassland	
	M	F	M	F	M	F	M	F	M	F	M	F	Both	M	F	M	F
Yield	5	5	5	5	5	5	5	5	5		5	3	4	5	4	5	5
Income	5	5		2	5	5	4	5	5	5		5		5	3	5	5
Food security		5	5	4	5	5	5	3						5	4	5	4
Weed control	5	1	5	5	5	5	5	5									
Soil fertility	5	4	5	5	2	5	1	5									
Health	5	4	5	3	5	5	5	5						5	5	5	5
Moisture retention	5	5	5	3	4	4	2	2									
Prestige	2	1	1	4													
Employment	5	3	5	3													
Technical knowledge	5	5	5	5	5	5	3	5	5	3	5	5	5	5	4	5	1
Climate change	3	5	3	5										5	5	3	5
Availability of labor	5	4	5	5	2		5	2	3	4		3	5				
Indigenous knowledge	5	3	5	5										2	5	3	5
Capital/cost	5	5		4	5	4	4	1	5	4	5	5	4	2	4	4	
Pest and disease control					2	2	5	1									
Quality of produce					5	5	5	5									
Availability of equipment					3	5	3	1	5	5		5	5	3		5	5
Availability of land									5	1	5	1	4	5	5	5	3
Landscape/elevation									1	2	4	1	4	5	2	1	5
Access to market																	
Access to roads																	
Availability of inputs																	
Type of soil									5	3	3	5	5				
Availability of water									1	1	1	5	5				
Trees														2	4	3	2
Improved germination					5	5		5									
Rainfall						5		4									

Note: The numbers indicate a Likert scale, with 1 = least important and 5 = most important.

Demonstration plots

The women in the forested zone of Koch-Goma did not identify any existing demonstration plots in their area. They prefer, however, the following practices for demonstration: crop rotation, improved variety, mulching, row planting, and spraying pesticides. Similar to the women, the men also did not identify any existing demonstration plot in the zone. Their choice of practices to be tried in a demonstration plot was different from that of the women. The following were selected for trial: agroforestry, correct spacing, contour ploughing, improved livestock breeds, and rainwater harvesting. The men group recommended that management of the demonstration plots should be done by a group. They further suggested that the location should be in a central place so that all farmers can access the demonstration site. Kal Parish was chosen as the most suitable place by the men group. Participants in this group of men suggested that the community should own the demonstration plots and members of the formed groups should elect leaders and contact farmers. They recommended that the demonstration plot should be visited once every week.

Men in the grassland zone of Koch-Goma recommended Amar, Amar Kalang, and Akil as suitable locations for demonstration plots.

Women from the grassland zone in Alero selected the following practices for trial in a demonstration plot: agroforestry, intercropping, mulching, chemical fertilizers, contour ploughing, and minimum tillage. They reported that there were already existing demonstration plots of ZOA and CARITAS, which are managed by community members. The plots demonstrate preparation of nursery beds, row planting and correct spacing, and transplanting. For the new demonstration plots to be established, the group recommended Bwobonam-Station A as a suitable location. The women would like to own the demonstration plots themselves for ease of management. They, however, would like to work with men in groups. The men recommended Oyinya and Parido in addition to Bwobonam as suitable locations for the demonstration plots.

The women in the forested zone of Alero Subcounty selected the following practices for trial in a demonstration plot: compost manure, integrated pest management, strip cropping, bunds/ridges, and minimum tillage. They said that there has never been a demonstration plot in their zone, which covers Panyabono, Kal, and Paibwor parishes. They indicated that, for a new demonstration plot, any area close to the subcounty headquarters would be appropriate. They recommended management by farmers themselves in partnership with community officers and subcounty production officers. For the men from the forested zone of Alero, three sites from different parishes were selected as suitable for demonstration plots: Kal parish in Atocon Village, Panokrac parish in Pamin rut Village, and Paibwor parish in Kinene Village.

In the stony/rocky zone of Alero, farmers selected stall feeding, proper spacing, and crops adapted to the agro-ecological zone as the practices that they would like to try in the demonstration plots. They did not identify any existing demonstration plots but recommended Panguu parish in Langol Village as a suitable location for a new demonstration plot. They further indicated that the demonstration plot should be managed by farmers themselves in groups with the

involvement of the community development officer and radio stations such as Mega FM.

In the forested zone of Anaka, the men farmers recommended Labyei, Todora (Te-Olam), and Gok A. The women in this zone recommended agroforestry, stall feeding, and cover crops for trial in the demonstration plots. They identified an existing demonstration plot of ZOA on maize and groundnut seeds in Pabali of Lapono Village. They recommended the same location for a new demonstration plot managed by farmers organized in groups. They said, however, that both men and women should be involved in management.

Men in the grassland zone of Anaka Subcounty said that they would like to try the following practices in a demonstration plot: minimum tillage, strip cropping, row planting, and silvopastoral systems. They did not identify any existing demonstration plots in the zone and suggested that new demonstration plots should be located in Ywaya parish of Onyomtil Village. They recommended that farmers should come together to form a group, that members should volunteer to provide a demonstration garden, that members should elect their leaders, and that government authorities should be involved (e.g., the Rwot Kweri, LC1, parish chief, and institutions such as Gulu University). Women farmers from the same zone selected agroforestry, pesticide and fertilizer application, and terracing for trial in a demonstration plot. They did not identify any currently existing demonstration plot but said that one existed in 2010 on tomato production. The women recommended that new demonstration plots should be set up in Lamoki primary school in Ywaya parish and Gok, the subcounty headquarters for Todora and Pangora parishes. Farmers would like to manage the demonstration plots themselves with assistance from the implementing organization. They suggested, however, that subcounty production officers and the Rwot Kweris should be involved.

The men in the forested zone of Purongo Subcounty indicated that there is a demonstration plot in Paromo of a private grain company called Amatheon Agri, which is testing maize varieties. The demonstration plot is located in Bel-Kec Village on one of the participant farmer's land. Farmers suggested the following practices for trial in a demonstration plot: minimum tillage, improved livestock breeds, and agroforestry. The preferred location is Bel-Kec Village because it is a central location and is along the main road used by many people in the zone. The farmers said that management of the demonstration plot should be by a group and that farmers should visit it every fortnight. They further suggested that members should elect contact farmers who will provide a garden as well as lead the rest of the farmers. The women said that they would like to try row planting, intercropping, mulching, agroforestry, and improved varieties in the demonstration plots. They recommended Pawatomero parish in Pawatomero East Village and Paromo parish in Bel Kec Village. They said that management should be left to women.

The women from the grassland zone of Purongo said that there were no existing demonstration plots. They suggested Pabit-Kibar as the best site for a new demonstration plot. They further recommended that farmers should own the demonstration plots themselves and also suggested that women should be involved. The men from the same zone recommended Patira East, Pawatomero West, and Pabit East as suitable locations for the demonstration plots.

Women farmers of the grassland zone of Alero Subcounty selected the following practices for trial in the demonstration plot: agroforestry, minimum tillage, pasture agronomy, paddocking, improved feeding, and fertilizer use. Farmers further reported that, although they were not aware of silvopastoral systems, integrated pest management, and cover crops, they would like to see them tried in the demonstration plot. Farmers also identified an existing demo in Kamguru on onion production in Corner Nwoya. ZOA created a demonstration plot for bean production in 2013 in Agweng A near Nwoya primary school. The demonstration plots were managed by farmers in farmer groups. For new plots, farmers suggested Nwoya primary school because the place is accessible by all the people. They recommended that the demonstration plots should be managed by group leaders of the different farmers' groups to ensure proper management of the demos together with the implementing body. For partners, farmers recommended subcounty and parish production officers to be involved as well.

Together, this information will be used to set up demonstration plots for CSA in Nwoya District.

Results of experts workshop

Experts' perception of soil fertility and burning

Similar to farmers, experts unanimously said that the soil is fertile. The reasons given for the good soil follow:

1. Farmers do not apply fertilizers, yet they always obtain a good harvest
2. There is no serious flooding
3. The soil supports mechanization, especially ploughing using a tractor
4. There is faster and rigorous crop growth
5. The soil color is black
6. The soil supports a variety of crops

These reasons given by experts are similar to those given by farmers, suggesting that both farmers and experts hold the same view that the soil is fertile. The results also show that both farmers and experts use the same indicators to determine whether their soil is good or not.

Results of a previous soil analysis were shown to the experts and a discussion was held about whether they agreed or not with the results. Experts disagreed with the findings and asked questions related to how the sampling was done. They seemed to agree, however, that crops that require a lot of nitrogen might not yield well but maintained that other crops would yield very well. They tended to suggest that, maybe in the future, the soil might decline in fertility but that at the moment the soil is still very fertile.

Again, consistent with what farmers said, experts reported that the main reasons why burning is practiced is to open the field for ploughing for clearance of vegetation around the homestead, because some crops cannot be grown when there are a lot of residues, and that ashes add nutrients to the soil. The experts indicated, however, that burning affects soil fertility in several ways, including destruction of useful soil microbes, exposure of the soil to soil erosion, removal of plant residues that are supposed to enhance soil fertility, and hardening of the soil, thus making ploughing difficult.

Mapping activity

Experts classified Nwoya District into three AEZs based on vegetation type: woodland, grassland, and mixed woodland plus grassland. Purongo and part of Alero Subcounty are generally grassland up to River Nile. Koch-Goma and part of Alero are generally forested while Anaka Subcounty has a mix of grassland and woodland. The following were given as the characteristics of the woodland zone: crops grown include sesame, beans, groundnuts, bananas, and cassava; the zone receives more rainfall than other locations; the soil is loamy but some parts have sandy soil; farmers in this zone mainly practice mixed cropping; it has two cropping seasons; it is not very hot; and the soil retains moisture for a long time. The grassland zone is characterized by rice, groundnuts, maize, and cassava as the main crops; farming is more mechanized, especially the use of a tractor for ploughing; the area receives less rainfall; monoculture is a common practice; severe drought occurs, particularly in mid-June compared to the woodland zone; and the area is very hot and streams normally dry up frequently in mid-June and in December-March.

In the woodland, there is an increase in deforestation as farmers extend their production. Charcoal burning is also a major driver of deforestation. In the grasslands, soil erosion is a problem. In addition, some crops (such as cassava) are being abandoned because they attract elephants. There are also frequent droughts. Compared with the other two zones, the problem of food insecurity is more severe in the grassland zone.

Table 23 shows the practices that experts prioritized and Table 24 shows the different indicators that experts use when deciding whether or not a practice should be used. Again, the indicators used by experts are consistent with what farmers mentioned. When asked what they think farmers would need in order to implement the practices they mentioned as relevant, experts listed the following:

- Training
- Demonstration
- Subsidized inputs such as fertilizer, pesticides, and herbicides
- Farmers should form groups
- Agricultural trips
- Training of subcounty extension staff and strengthening of extension services
- Tools and equipment
- Development partners to work alongside subcounty extension staff

Finally, experts selected the following practices for demonstration: pesticide application, minimum tillage, mulching, contour ploughing, aquaculture, cover cropping, fertilizer application, farmyard manure and composting, and apiculture. They recommended that management should be done by farmers through farmer groups. Such groups should then work with development partners such as ZOA.

Table 23. Practices selected by experts.

Soil management practices	Crop management practices	Water conservation measures
Crop rotation	Timely planting	Furrow irrigation
Fallowing	Timely weeding	Rainwater harvesting
Mulching	Intercropping	Fencing of water sources
Agroforestry	Pruning	
Intercropping	Thinning	
Cover crops	Pesticides	
Contour ploughing	Row planting	
Ridging	Proper spacing	
Farmyard manure	Seed selection	
Compost manure	Improved varieties	
Inorganic fertilizer		
Swamp reclamation		
Herbicides		

Table 24. Indicators used by experts to rank agricultural innovations.

Indicator	Woodland	Grassland
Agro-ecology	2	3
Tools and equipment	4	5
Capital/costs	4	5
Availability of markets	5	5
Knowledge and skills	5	5
Storage	4	5
Availability of raw materials	3	3
Availability of land	5	5
Soil fertility	4	5
Topography/landscape	1	1
Type of crop	2	1
Yield	5	5

Conclusions and recommendations

Understanding the indicators that farmers use to select agricultural practices for implementation is a necessary first step toward prioritizing CSA. Participatory approaches can be useful to elicit such information. We conducted participatory workshops in the form of focus group discussions with farmers and experts in Nwoya District of Northern Uganda to gather information on important indicators that farmers use to prioritize agricultural practices.

The study proceeded in a series of steps involving assessing the gap between awareness and use of practices among farmers, assessing perceptions on soil fertility and burning, generating a prioritized list of agricultural practices, identifying important indicators that farmers consider in prioritizing the practices, and identifying suitable geographic locations for demonstration plots of CSA. Results show that both among men and women and across the subcounties, the gap between awareness and use is highest in relation to soil, land, and water management practices, including the application of farmyard manure, compost manure, and chemical fertilizers; mulching; digging of trenches or drainage channels; row planting (especially in Anaka and Alero); improved varieties; irrigation; rainwater harvesting; paddocking; and improved breeds.

Farmers' perceptions that the soil is good partly explains why soil fertility improvement practices are not being used. Farmers, however, also mentioned labor constraints that hinder the use of compost and farmyard manure. The lack of equipment and availability of water could explain why farmers are not practicing irrigation, while the lack of knowledge and poor quality of seed explain why farmers are not using improved varieties. The high cost of purchase and management of improved breeds was reported as the main reason why adoption of the practice is very low. Lack of knowledge and the grass-thatched houses were explained as the reasons why farmers find it difficult to practice rainwater harvesting although they might be aware of the technology.

The most prioritized practices in Koch-Goma by men in the grassland zone were row planting, improved varieties, timely planting, broadcasting, mulching, and intercropping, respectively, in their order of ranking. Women, however, prioritized timely planting, crop rotation, seed selection, intercropping, and row planting, respectively. In the forested zone, while men prioritized deworming of livestock, improved breeds, and paddocking; women ranked seed selection, timely harvesting, correct spacing, and improved varieties as the most important. In the grassland zone in Alero, men ranked selection of varieties according to agro-ecological zone, timely planting, timely weeding, timely harvesting, crop rotation, and agroforestry as the most relevant. Women, on the other hand, ranked selection of seeds, timely planting, herbicide application, zero grazing, and irrigation as the most relevant. In the forested zone, men ranked early land preparation, seed selection, early planting, timely weeding, and crop rotation as the most important, respectively. Their women counterparts ranked seed selection, timely planting, fallowing, pesticide application, and fertilizer application, respectively. In Anaka, men and women in the grassland zone had different rankings of the practices. In particular, men ranked silvopastoral systems, seed selection, timely planting, improved

varieties, and broadcasting in the respective order, while women ranked improved varieties, timely planting, stopping burning, crop rotation, and intercropping in that order. In the forested zone, men ranked timely planting, correct spacing, conservation of wetlands, improved varieties, intercropping, and agroforestry, while women ranked agroforestry, seed selection, timely planting, improved breeds, and crop rotation in the respective order. Men in Purongo's grassland zone ranked timely weeding, early land preparation, conservation of wetlands, pesticide application, spraying for external parasites, and tethering while the women ranked timely planting, fallowing, seed selection, crop rotation, improved varieties, and intercropping in the respective order. Men in the forested zone ranked timely weeding, fallowing, crop rotation, intercropping, contour ploughing, minimum tillage, pesticide application, seed selection, and improved varieties. The women ranked early land preparation, intercropping, burning, crop rotation, mulching, tethering, residue retention, fallowing, and farmyard manure in the respective order.

The most important indicators used by farmers to rank agricultural innovations included in CSA are yield, income, availability of labor, cost of chemicals, availability of equipment, health, soil fertility, time-saving, access to markets and price of products, type of soil, and knowledge. Although similarities existed in the importance of the indicators, there were also differences across the AEZ and by gender. Weed control, for example, was ranked as a very important indicator by men in the forested zone of Koch-Goma, while their female counterparts ranked this indicator as least important. In Anaka, men ranked soil fertility as not important (2); while women said that soil fertility was a very important (5) indicator. Similarly, men said that capital was an important (4) indicator, while women said that it was least important (1). In Alero, men ranked availability of land as a very important indicator in the forested zone, while women reported that land availability was least important.

The findings of this study suggest the need to develop participatory approaches that can help to understand how farmers prioritize agricultural innovations. The findings further show that, across the zones, farmers mostly prioritize crop management practices perhaps with immediate or short-term benefits and with less cost of implementation. These findings reiterate the importance of understanding the contexts in which farmers operate. Only when a critical understanding takes place of the constraints that farmers associate with the different practices and what they perceive as the appropriate ways to reduce the bottlenecks, can locally appropriate measures be designed to scale up adoption.

In conclusion, the results show great variability both in AEZ and in the prioritization of agricultural practices. We, therefore, recommend that studies aiming to understand ways in which CSA can be prioritized to conduct participatory research take into consideration such variability. Conducting several workshops with participants from the different AEZs and with both men and women can be helpful. Finally, our findings can be used to inform targeted investment by donors and development partners such as IFAD and USAID to reduce the factors identified as barriers to the implementation of CSA.

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