Local knowledge of land degradation and restoration influences the adoption and success of restoration options for dryland systems: the case of Samre

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April, 2017

1. RESEARCH METHODOLOGY

Research Hypothesis

Farmers' understanding and perceptions of land degradation and restoration has a strong effect on the adoption and success of restoration options

Research Questions

1. What is farmers' knowledge on the drivers of land degradation?
2. What are farmer's perceptions and definitions of land degradation and land restoration (and indicators)?
3. Which are the contextual factors that influence the adoption and success of land restoration interventions? (Options by Context matrices)
4. What is the current status of tree diversity, and what are future
5. What are the implications of farmers' local knowledge about land restoration on scaling up and out different land restoration options?

2.2 Data Collection and Analysis Methodology

This local knowledge study applied the Agro-ecological Knowledge Toolkit (AKT5) and methodological framework (Sinclair & Walker, 1998; Walker & Sinclair, 1998). Local knowledge was elicited by using knowledge-based methodologies and semi-structured interviews, which were conducted on farmers willing to participate in the exercise and who had detailed knowledge of the study topic. The knowledge elicited was then represented using the AKT5 software (Dixon et al., 2001).

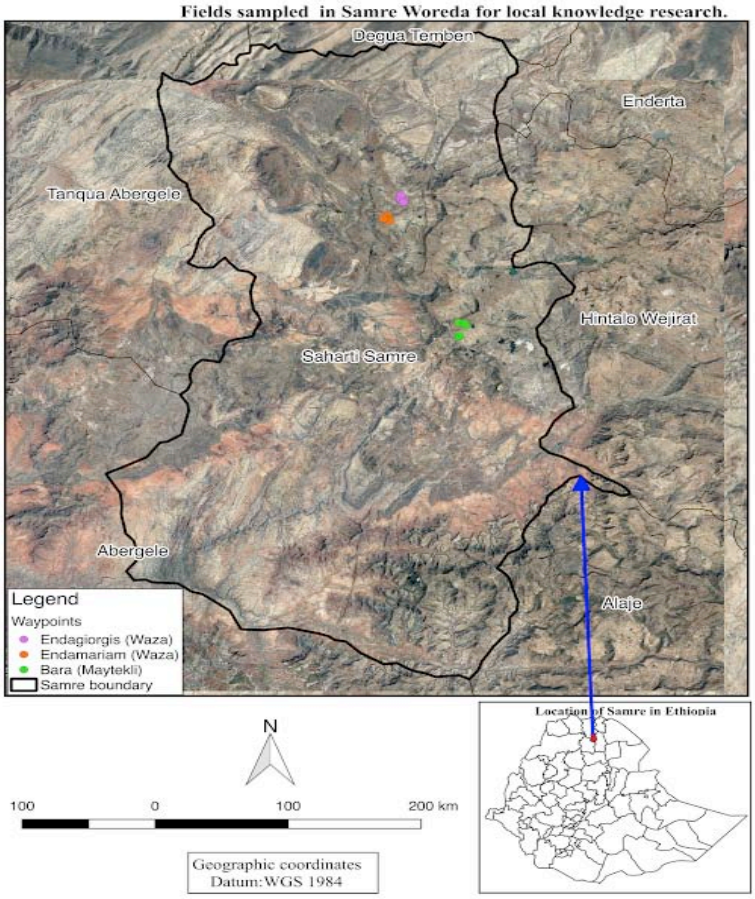


Figure 1: Map of Samre sites where local knowledge research was carried out

Sampling strategy

Stratified random sampling technique was applied to select informants based on: watershed, sub-catchment and slope location of fields. In addition, gender, land size, age, land tenure were also employed to select informants in each stratum.

Table 1: Sample size

	Ranking exercise		Individual Interviews	
Location	Male	Female	Male	Female
Maytekli	15	10	6	4
Endagiorgis	13	5	5	5
Endamariam	7	5	6	4
Total	35	20	17	13

1. RESULTS

1.1 Farmers' knowledge on the drivers of land degradation?

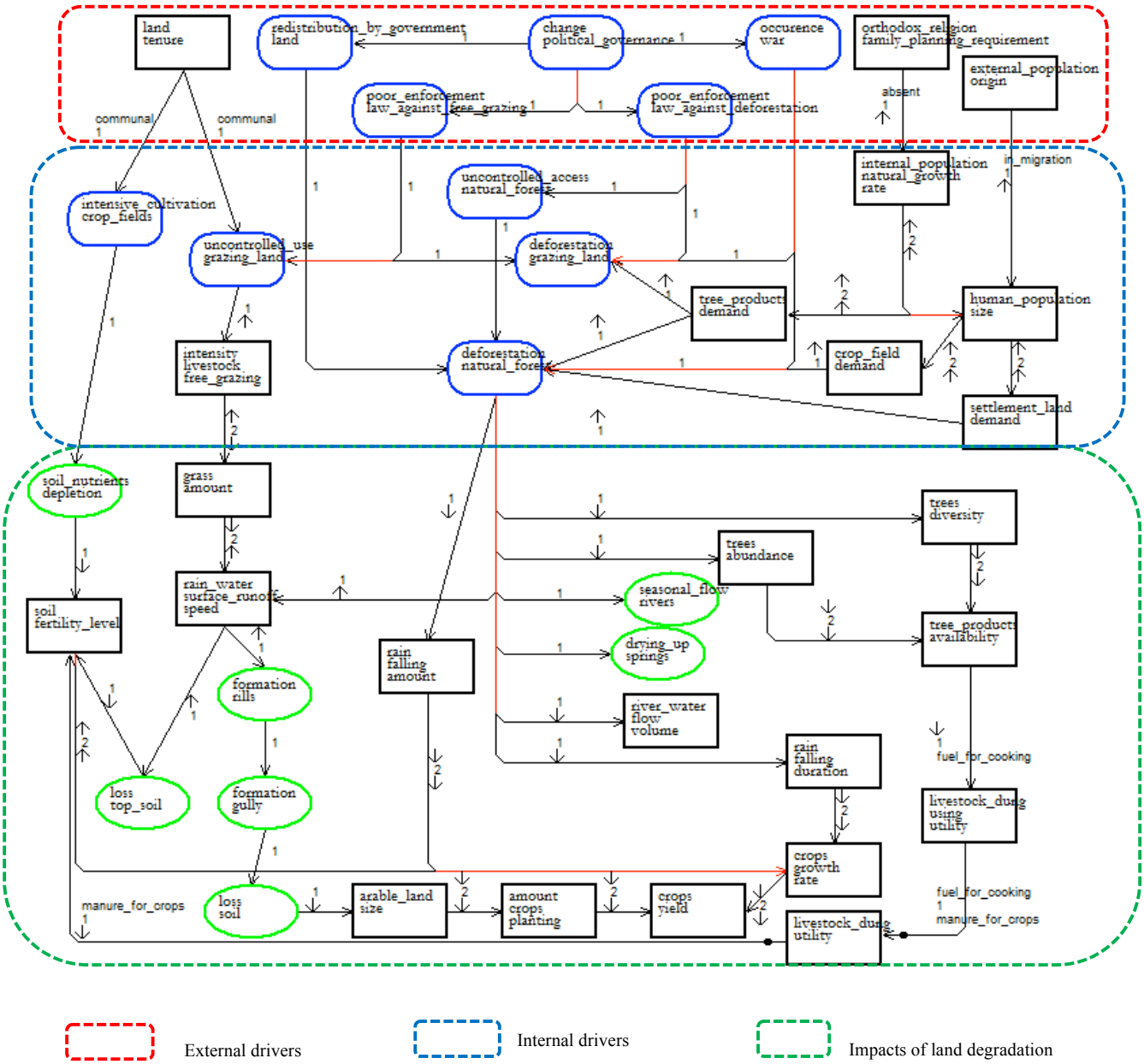
Soils

The 2 dominant soil types identified by farmers were the Mekeyih (luvisols) and Baekel (cambisols). Mekeyih was identified as the most fertile but highly erodible compared to other soils. However, the rate of soil erosion and land degradation was also dependent on other physical factors such as slope gradient of land, amount of vegetation cover and rainfall intensity. Soil types differed by sub-catchment.

Table 2: Soil types and description

Local Soil Taxonomy	Farmers' Description	Scientific Equivalent	Maytekli	Endamariam	Endagiorgis
Baekel	Light brown to yellow colour, Silty, loose particles, well drained, mostly found on sloped areas	Cambisols	x	x	
Mekeyih (Keyih)	Reddish-brown medium mixture of clay and silt, well drained. Mostly found downslope. It is more erodible than andelewetay and Baekel soils because it has fine particles. It is more fertile than other soils.	Luvisols	x		x
Walka	Dark brown to dark grey/ red, Clayey, cracks when dry, susceptible to waterlogging, normally on downslope flat areas, highly erodible as water seeps through and big chunks of soil cuts off	Vertisols	x	x	
Hutsa	Reddish brown, sandy -loam, loose particles, found on flat areas	Leptosols	x		x
Edelewetay (Ede)	Mixed clay and silt and gravel, less fertile than mekey, deposited by flowing water	Alluvial		x	
Adigrat	Blackish rocky or gravel, found on the steep slopes		x	x	x

Two major land use types where land restoration interventions have been implemented namely cropland and exclosures came out strongly during the scoping phase of local knowledge elicitation. Farmers also focused on these 2 land use types while talking about the drivers and effects of land degradation, that is, the grazing land (currently called exclosures) and cropland. The results are presented in Figures 2 and 3 below demonstrate the external and internal drivers of land degradation and also subsequent ecological and livelihood effects.



KEY: Nodes represent: human actions (blue boxes with rounded corners) or processes (green boxes with rounded edges) or attributes of objects or actions or processes (black boxes with straight edges). Arrows connecting nodes denote the direction of causal influence. The upper small arrow on a link indicates either an increase (↑) or decrease (↓) in the causal node, and the lower arrow on a link refers to an increase (↑) or decrease (↓) in the effect node. Numbers between small arrows indicate whether the relationship is two-way (2), in which case ↑A causing ↓B also implies ↓A causing ↑B, or one-way (1), which indicates that this reversibility does not apply. Words instead of small arrows denote a value of the node other than increase or decrease. Black dots along the arrow represent lack of or absence of human action.

Figure 2: AKT5 Causal diagram of drivers of land degradation in Waza watershed, Samre

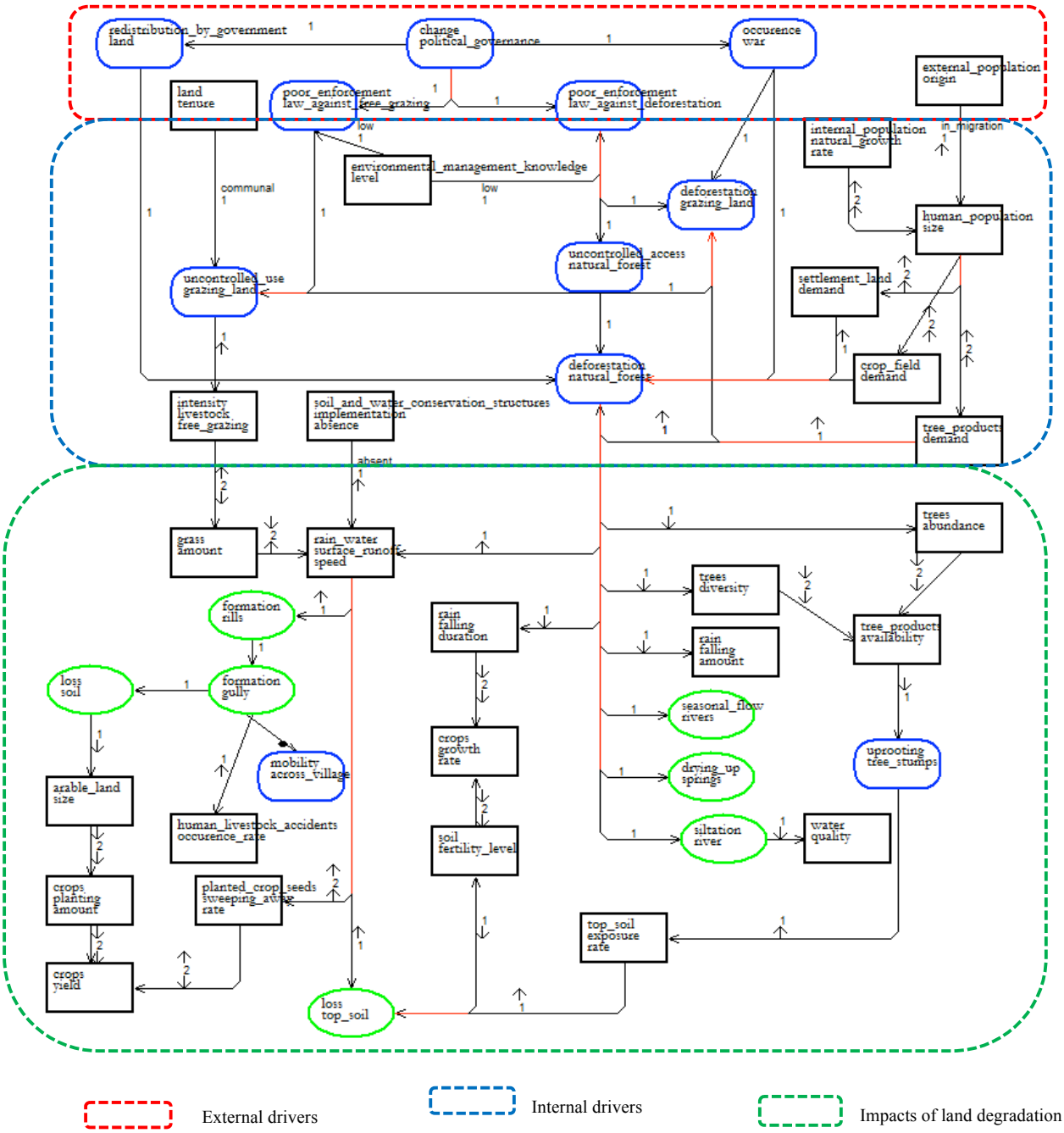


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Figure 3: AKT5 Causal diagram of drivers of land degradation in Bara sub-catchment, Maytekli watershed, Samre

2.2 Different farmers' perception and definition of land degradation and indicators
Different farmers described land degradation differently, with the definitions focusing on vegetation cover, soil productivity, water, spatial and seasonal elements.

- ✓ Decreasing productivity due to loss of fertile top soil through water or wind erosion
- ✓ Loss of vegetation cover- diversity and abundance
- ✓ Not being able to produce enough food to last all year round
- ✓ Land degradation begins upslope
- ✓ The local landscape is not homogeneous- you cannot define an entire landscape as degraded
- ✓ Water scarcity
- ✓ Land degradation is "seasonal"- more severe in more times than others
- ✓ Loss of arable land surface area through gullies
- ✓ Hazards to livestock and children

Land degradation manifested differently to different stakeholders.

- **Men**
- Not being able to sustain their family, hence looking for supplementary livelihood strategies including out-migration, selling livestock, trees
- Loss of livestock through falling into gullies
- Lack of fodder
- Out migration

Landless youths

- Resource use conflicts
- Lack of income as a result of lack low food production in rented fields, and lack of paid labour opportunities leading to food insecurity and outmigration to towns
- Increased crimes
- Poor nutrition
- Lack of fodder
- Lack of livelihood alternatives hence out-migration in search of survival

- **Women**
- Long walking distances in search of water and firewood
- Less fodder hence less use of cow-dung 'kubet' for cooking
- Poor nutrition for children

- **Children**
- Poor nutrition
- Increased diseases
- Poor performance in school
- School abandonment- children missing school to look after livestock over long distances
- Accidents and lack of mobility across gullies during the rainy season

2.3 Options by Context matrices: Contextual factors that influence the adoption and success of land restoration interventions

This section focuses on 2 main land-use categories namely cropland and exclosures. Table 4 and 5 below presents farmers' knowledge on biophysical contextual requirements for the various land restoration options in Samre.

TABLE 4: BIOPHYSICAL CONTEXTUAL REQUIREMENTS

Land Restoration Option	Land Use Type	Land degradation level and Soil erosion type	Soil type	Soil depth	Location along the slope, slope gradient	Field size
Deep trenches	Onfarm	Suitable for areas experiencing surface run-off and sheet erosion including. Deep trenches trap and retain water and intercept soil and sediments from being lost	Suitable for well-drained soils eg Baekel soil. Farmers especially in Maytekli where clayey 'Walka' soils is common reported a challenge of water-logging around the mouth of the trench leading to crops rotting. In such soils, it may require modifications eg draining channels	Suitable for deep soils	On flat land or gentle slope and should be located at the base of the field in order to trap surface run-off and intercept and retain the soil carried being carried downslope	Not suitable for small field sizes as farmers, especially in Maytekli reported that they occupy a lot of space especially in Maytekli watershed. Farmers with small land preferred narrow trenches
Bench terraces	Onfarm	Suitable for areas with sheet erosion or rills beginning to form	Is applicable to diverse soil types except sandy or stony soils	Very deep soils	Steep and very steep slopes	Any land size is appropriate as no land is wasted. It is suitable for converting un-arable steep slopes to arable land
Stone bunds	Onfarm	Sheet erosion, rill erosion. Stone bunds are used to not only control surface runoff and trap sediment but also convert steep slopes into flat arable land	Suitable for stony soils	Shallow soils, areas with no or minimal soil, rocky land surfaces.	Constructed across steep slopes, usually in the upper and mid slope location in gently sloped areas	Appropriate for all field sizes including small fields. It does not consume space because stones are gradually arranges in a vertical direction in a strip and gradual addition of stones upwards as the bund takes shape

Soil bunds	Onfarm	Constructed in areas with no stones. Consructed along a contour across the slope, they reduce the speed and empact of surface run-off	Mostly suitable for loamy or clayey soils because the particles easily stick together	Deep or moderately deep soils. Farmers especially in Endamariam watershed planted grasses or allowed natural regeneration to stabilize the soil bunds	Gentle slope to flat areas. Soil bunds are best suited for the midslopes because they slow the speed ot surface runoff downhill	Suitable for larger fields, however, farmers with small fields utilize the bund to plant fodder and trees in order to maximize on the space
Sesbania sesban	Onfarm	Mostly planted to control soil erosion, but also for other benefits such as fodder. They are planted in micro-basins to conserve moisture needed for growth and survival	and wide variety of soils, including Mekeyih, Baekel and Walka soils. Further, this was mostly planted in micro-basins and mostly mulched in order to retain soil moisture	Planted in moderately deep soils for root establishment. An ideal location is along soil bunds and at the edges of stone bunds and bench terraces because soils tend to be deeper, and the Sesbania stabilizes the soil	Suitable on any slope location	Farmers who owned small fields felt it was consuming space. Farmers in Endagiorgis watershed mentioned that since it is seen as a more permanent intervention, some were not willing to plant Sesbania in their cropfields as this would be incompartible with their practice of crop rotation on limited land
Apiculture	Exclosures	Degraded exclosure land but with already regenerating diverse natural vegetation	All soil types as long as they can support a high diversity of bee forage vegetation	All	Any slope location. Exclosures are the most ideal habitat for bees because they prefer a quiet and uninterupted environment away from the human activity disturbances	It is most suitable for exclosures due to the expansive land, which provides a wide acreage of natural vegetation

Check dams and gully treatment using gabions	Exclosures	Normally implemented across gullies. It may comprise of a series of gabions, loose-stone and rock-filled checkdams to intercept and reduce the flow of water downslope	All soil types. However, gully treatment requires gully bank treatment using vegetative measures such as planting of *Pennisetum purpureum*, *Arundo donax*, vertiver grass etc	Constructed along gullies, which could be deep rocky landforms or deep soils. Checkdams are then constructed in the lower part of the treated gully to harvest water. Checkdams are also harvesting points for the ground water recharged from exclosures through interventions such as percoration channels and ponds	All slope locations, this depends on the direction of the gully.	Gullies are inevitable occurences and not pre-designed. Infact farmers reported that the gullies eat away chunks of arable land. Checkdams

The table below presents socio-economic requirements for the various land restoration options.

TABLE 5: SOCIO-ECONOMIC CONTEXTUAL REQUIREMENTS

Land Restoration Option	Livestock management system	Land tenure	Labour and Gender	Inputs/ Technology	Policy, institutional and enabling environment, Knowledge/ Skills
Deep trenches	It is non-vegetative hence not affected by the free- grazing system.	Are semi-permanent structures hence land tenure was not a restricting factor	Are labour intensive, especially excavation and maintenance eg silt removal, Women especially found them cumbersome to manage	Farmers reported lack of tools and equipment for excavating soil	Most farmers, including non-project dfarmers lacked prior training on the design and measurements
Bench terraces	Livestock may affect planted grass before it establishes	This is a permanent intervention and thus not applicable to landless farmers or those who have rented land	Was found to be highly labour intensive and requires communal work approach. Also,	Shortage of appropriate tools and equipment for digging benches discouraged farmers from initiating terraces	Prior training on the design and measurements

Stone bunds	Are structural hence contact with livestock has no major impact	This is a permanent intervention and thus not applicable to landless farmers or those who have rented land	Labor intensive during the initial stage of laying out the stones, but refilling of stones Refilling with stones, trimming grass to increase the height of the bunds is easier as the bunds mature.	Uses locally available materials (stones) and does not require many external tools .	Prior skills are required when setting up the initial stone bund from the ground level
Soil bunds	Are structural hence contact with livestock has no major impact	Soil bunds are semi-permanent, hence can be removed or relocated to suit the land-users' preference	Labor intensive during the initial stage of constructing soil bunds. Maintennace such as refilling soil is less labour intensive	Farmers lacked tools for construction and maintenance of soil bunds	Prior skills are required when constructing the initial sil bunds
Sesbania sesban	During the early seedling establishment, farmers from all watersheds viewed Sesbania as unsuitable for free-grazing livestock managemnet practice due to heavy browsing. Guards were employed , especially in Endamariam and Endagiorgis watersheds to guard the farms.	This is not a viable option for farmers who are renting land as trees are viewed as a permanent and long-term investment	Initial stages of seedling establishment was viewed as labour intensive due to the need seedling protection in areas with free grazing system. Also, regular watering and mulching to prevent loss of moisture. Before the rainy season- "mkuskas"- which means scooping out the soil around the Sesbania trees is required before the rainy season; weeding	Access to seeds was a challenge to many farmers due to cost of buying the seeds	Farmers had knowledge and training in seedling production due to centralized seed and seedling sytsem whereby BOARD (Bureau of Agriculture and Rural Development) is the mainl distributor of the seeds.

Apiculture	According to farmers, apiculture is not negatively influenced by livestock management systems	For the landless youths	Not labour intensive except whenestablishing the colony and harvesting honey, which is mostly done by male. However, benefits are shared equally between the landless men and women	Bee keeping require water source, which the farmers reported was becoming avaiable with the ground water recharge. Farmers attributed the success of bee keeping to the high diversity of native tree species that provide bee forage especially: *Becium grandiflorum, Opuntia ficus-indica, Leucas abyssinica (Benth.) Briq., Euphorbia candelabrum, Acacia ethaica* . Bee harvesting equipment and tools; improved bee hives	Most female farmers felt that they lacked skills in bee keeping including colony selection and reproduction and harvesting timing and processing methods because it is men who were involved in these activities. There was also limited market for honey
Check dams and gully treatment using gambions	Free-grazing livestock pose a threat to vegetative gully treatment	Appropriate for all farmers including land-less / renting since it is the water that is used to irrigate crops	vegetative gully treatment requires close monintoring and regular watering and maintenance	This requires trechnological assistance such as generators, pumps and distribution pipes. Benefis depend on the the location of the fiel along the slope and the location of the checkdam. Fields upslope need technological support eg generators and pumps.	Requires communal action and ownership because although checkdams cut across fields, they are considered as past of exclosures which are communally managed

- Management and maintenance of exclosures was through watershed committees who organized farmers to undertake the various activities such as watering of vegetative interventions along gully banks and excavation of structural interventions. On the other hand, individual farmers were responsible for the everyday maintenance of land restoration interventions in their individual farms.
- Maintenance of onfarm land restoration interventions was mainly integrated within everyday land management activities.
- In addition to contextual factors that influence the type and performance of land restoration interventions discussed in the 2 tables above, **the intensity and frequency of maintenance of land restoration interventions was further influenced by other contextual factors as highlighted below:**

✓ Distance of fields from home compound: Interventions in fields that were next to or near the homestead received more regular and intense maintenance compared to far ones.
✓ Production potential of land: On their own initiative, majority of farmers gave more regular attention to fields with more production potential, or fields already in the process of restoration, in order to maximize on immediate increase in crop production.
✓ Level of land degradation or restoration:
✓ Age of intervention: Farmers managed newer land restoration interventions more frequently compared to those that were older and more established.
✓ Crop being planted- Unlike for other crops which undergo the first ploughing (Nekla), second plough (Degma/ Kolkal) and sometime third ploughing (Teslas/ Gemsa), when farmers were planning to plant teff, soil is ploughed for the 4th time (Zeri), to soften and break down the soil into very fine particles. During each ploughing activity, the existing interventions are maintained in the process.
✓ Nature/ type of LR intervention: Maintenance also depended on the nature and type of the intervention. Structural interventions require continuous maintenance while vegetative ones require less maintenance once they have established
✓ Knowledge level/level of training of the farmer: Farmers with no training were found to have limited or no knowledge of maintaining interventions eg some farmers were not excavating soil from deep trenches once they got filled up
✓ Availability of labour- Depending on the , especially women and the old farmers who faced limited labour attended to interventions less frequently.
✓ Prevailing weather conditions- when it is the dry season, less maintenance is done especially for the soil-based structural interventions. Only stone bunds. Majority of the maintenance activities are carried out during ploughing, planting and weeding periods.
✓ Resource endowment: farmers who lacked tools such as hoes maintained interventions less frequently

2.4 Current status of tree diversity in Samre and farmers' future priorities

- 60 tree species encountered in Samre , with 58 being identified upto botanical level (Table 6)
- 39 Native and 21 Exotic tree species
- 33 families were encountered, with the dominant families being: Fabaceae (11 species), Euphorbiaceae (4 species) and Myrtaceae (4 species)

Dominant tree niches were**:** Church compound where most native tree species were found

- Homestead: Live fence- *Euphorbia candelabrum, E. tirucalli';* native Fruit species- *Carissa spinarum, Ziziphus spina-christi,* Ornamental, Income- *Rhamnus prinoides,* fruits
- Along soil and stone bunds- Sesbania sesban, *Rumex nervosus, Euclea schimperi, Acacia etbaica*
- Woodlots- *Eucalyptus camaldulensis, E. globulus*
- Exclosures under restoration- *Acacia abyssinica, A.etbaica, A. albida*, *Euclea schimperi, E. candelabrum*

Table 6: Current tree diversity species encountered in different niches on farms and in landscapes and tree utilities as reported by farmers in Samre

1						STUDY AREA			PRODUCTS															ECOLOGICAL SERVICES								NICHES								
2	Scientific Name	Tigrinya Name	Amharic Name	Family	Origin	Bara Sub-catchment (Mayickli Watershed)	Endagiorgis Sub-catchment (Waza Watershed)	Endamariam Sub-catchment (Waza watershed)	Income	Fruits	Other Foods	Firewood	Charcoal	Timmber for furniture	Timber for construction	Farm tools	Household tools	Medicine	Fodder	Bee forage	Tannins/Dye stuff	Gums/Resins	Fibre/Ropes	Ornamental	Live fence	Dead fence	Shade	Soil Erosion control	Soil fertility improvement	Riverbank stabilization	Wind break	Scatterd in homestead	Homestead boundary/live	Woodlot	Along soil bunds	Along Bench Terraces/ Stone bunds	Along Gullies	Along Rivers	Church compound	Exclosures
3	*Acacia abyssinica*	Che-a	Cheba, wachu, bazra girar	Fabaceae	Native	x	x	x				x	x		x	x	x		x		x	x				x	x	x		x	x					x	x		x	x
4	*Acacia brevispica*	Qonteftefte	Qontir/ Kentefa, Kontevl, Mezazign	Fabaceae	Native	x	x	x				x						x	x						x								x			x			x	
5	*Acacia ethaica*	Seraw		Fabaceae	Native	x	x	x				x	x		x	x		x		x					x	x	x	x				x				x	x		x	x
6	*Acacia oerfota*	Gomero		Fabaceae	Native			x				x	x		x	x			x				x		x		x				x								x	
7	*Acacia polyacantha*	Gumero/ Ghomoro		Fabaceae	Native			x							x	x			x								x				x								x	
8	*Acacia saligna*	Akacha	Akacha saligna	Fabaceae	Exotic	x	x	x	x			x			x				x			x			x		x	x	x		x						x	x		x
9	*Albizia schimperiana*	Sassa	Sassa, Imasa, Sembaru	Fabaceae	Native	x			x			x	x		x		x		x	x							x	x											x	
10	*Aloe Barbadensis*	Ere		Asphodelaceae	Native	x		x										x		x								x					x				x		x	
11	*Argemone mexicana L.*	Medafe tilian		Papaveraceae	Exotic		x	x																																
12	*Arundo donax*	Shamboko		Poaceae	Exotic		x	x																				x									x			
13	*Azadirachta indica*	Nim/Limo	Kinin	Meliaceae	Exotic	x	x	x			x	x	x		x			x	x	x				x			x				x	x								
14	*Becium grandiflorum*	Tebeb		Lamiaceae	Native	x	x	x				x								x												x				x	x	x	x	
15	*Calpurnia aurea*	H'tsawts	Digita	Papilionoideae	Native	x			x			x			x	x		x		x				x	x		x	x			x	x	x				x		x	
16	*Carica papaya*	Papayo/ Papaye	Papaya	Caricaceae	Exotic		x	x	x	x										x												x								
17	*Carissa spinarum*	Agam	Agam	Apocynaceae	Native	x	x			x		x	x		x	x	x	x	x					x	x	x	x	x		x	x					x	x	x	x	
18	*Casuarina cunninghamiana*	Shewshewe	Shewshewe, Arzelibanos	Casuarinaceae	Exotic	x						x	x		x				x					x			x	x			x									
19	*Cirsium dender*	Dander		Asteraceae	Native	x																															x	x	x	
20	*Cordia africana*	Awh'i / Ekhi	Wanza/ Anu: Urogu	Boraginaceae	Native	x	x	x	x	x		x	x	x	x	x	x	x	x	x				x	x		x	x	x	x	x	x							x	
21	*Croton macrostachyus*	Tambuk	Bisana	Euphorbiaceae	Native	x	x	x	x	x		x	x		x	x	x	x	x	x				x	x		x	x		x	x								x	
22	*Dodonaea angustifolia*	Tahses	Kitkita	Sapindaceae	Native	x						x				x		x	x	x				x			x	x									x		x	
23	*Eucalyptus camaldulensis*	Keyih Qelamitos	Key bahir zaf	Myrtaceae	Exotic	x	x	x	x			x	x		x	x	x			x				x	x	x	x	x			x	x								x
24	*Eucalyptus globulus*	Tseada Qelamitos	Nech bahir zaf	Myrtaceae	Exotic	x	x	x	x			x	x	x	x	x		x		x				x	x	x	x	x			x	x								x
25	*Euclea schimperi*	Kulea-o/ Kuliew		Ebenaceae	Native	x	x	x				x								x								x		x		x	x		x	x	x	x	x	x
26	*Euphorbia candelabrum*	Kulkual	Kulkual	Euphorbiaceae	Native	x		x							x					x					x								x						x	x
27	*Euphorbia tirucalli*	Kinchib	Kinchib	Euphorbiaceae	Native		x	x	x									x				x			x								x						x	
28	*Faidherbia (Acacia) albida*	Momona	Grar	Fabaceae	Native	x	x	x				x			x	x	x	x	x							x	x	x	x	x	x	x				x	x		x	x
29	*Ficus vasta*	Da'ro/ Da'ero	Warka	Moraceae	Native			x		x		x	x		x	x	x		x					x			x	x	x		x								x	
30	*Grevillea robusta*	Grevillea	Grevila	Proteaceae	Exotic	x			x			x	x	x	x	x			x	x				x			x	x	x		x									x
31	*Helianthus annuus*	Shof bahari		Asteraceae	Exotic		x	x			x									x																				
32	*Hypoestes forskaolii*	Girbia		Acanthaceae	Native		x												x	x																x			x	

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33	*Jasminum abyssinicum*	Habbi-tselim		Bignoniaceae	Exotic	x						x			x	x				x				x			x											x	x	
34	*Juniperus procera*	Tsihdi/ Tsehedi	Yehabesha Tid	Cupressaceae	Native	x						x		x	x			x						x	x		x	x			x	x						x		
35	*Justicia schimperiana (Hochst ex. Nees)*	Smieja		Acanthaceae	Native			x										x																						
36	*Lepidium sativum L.*	Shenfa/ Shanfa		Brassicaceae	Exotic	x		x																														x		
37	*Leucas abyssinica (Benth.) Briq.*	Sewa Kemi/ Swa kami		Lamiaceae	Native	x		x												x					x			x								x	x	x	x	
38	*Malus domestica*	Apple		Rosaceae	Exotic	x	x	x	x	x																						x								
39	*Mangifera indica*	Mangus	Mango	Anacardiaceae	Exotic	x		x	x	x		x								x				x			x				x	x								
40	*Maytenus arbutifolia*	Atat	Atat	Celastraceae	Native			x				x				x			x						x	x												x	
41	*Maytenus senegalensis*	Kebkeb/ Qebqeb	Nech atat, Qoqoba, Yedega	Celastraceae	Native	x	x	x				x	x					x	x	x					x	x	x	x				x	x			x	x		x	
42	*Myrsine africana L.*	Kechemo	Kechemo	Myrsinaceae	Native	x		x																															x	
43	*Nicotiana glauca R. Graham*	Tenbish/cherged/Tambush / menhateto/ mengededo		Solanaceae	Exotic		x	x				x																x									x		x	x
44	*Olea africana/ europaaea subsp. cuspidata*	Awuli-e	Weira	Oleaceae	Native	x	x	x				x	x	x	x	x	x	x	x	x				x	x		x	x		x	x	x							x	
45	*Opuntia ficus-indica*	Beles	Ashewa Qurqual	Cactaceae	Native	x	x	x		x									x						x			x					x						x	
46	*Parkinsonia aculeata*	Shewit Hagay		Fabaceae	Exotic			x												x								x											x	
47	*Pennisetum purpureum*	Saeri harmaz		Poaceae	Native		x												x									x												
48	*Persea americana*	Avocado	Avocado	Lauraceae	Exotic	x			x	x									x												x	x								
49	*Psidium guajava*	Zeitun	Zeituna	Myrtaceae	Exotic		x			x		x				x	x										x					x								
50	*Rhamnus prinoides*	Gesho	Gesho	Rhamnaceae	Native	x	x	x	x		x							x														x		x						
51	*Rhus natalensis*	TeTa'lo	Embus, Qamo, chakema, takuma, qundo berbere	Anacardiaceae	Native		x	x				x	x			x	x		x									x											x	
52	*Ricinus communis*	Gulei	Gulo/ Bulqa	Euphorbiaceae	Native		x	x	x		x							x							x						x	x								
53	*Rumex nervosus*	H'eh'ot		Polygonaceae	Native	x	x	x																				x					x		x	x	x	x	x	x
54	*Schinus molle*	Tikur Berbere	Qundo berbere	Anacardiaceae	Exotic	x		x	x		x	x	x		x	x	x	x	x	x				x	x		x	x			x	x							x	
55	*Senna singueana*	Hambo hambo		Fabaceae	Native	x	x	x				x													x			x		x		x	x				x	x	x	
56	*Sesbania sesban*	Sasbanya	Girangire	Fabaceae	Native	x	x	x				x			x	x			x									x	x						x	x	x			
57	*Syzygium guineense*	Li'ham	Dokma	Myrtaceae	Native	x		x	x	x		x	x	x	x	x		x		x	x	x			x		x	x			x	x	x				x		x	
58	*Terminalia brownii*	Weyba		Combretaceae	Native		x	x																															x	
59	*Ziziphus spina-christi*	Giba/Geba/ Gaba	Qurqura	Rhamnaceae	Native	x	x	x	x	x		x			x	x		x							x	x		x	x			x				x	x		x	

Table 7: Farmer ranking of priority tree species and preferred utilities

Tree Products	Endamariam	Endagiorgis	Maytekli	Ecological Services	Endamariam	Endagiorgis	Maytekli
Fruits/ Income	**1** Mango, orange, banana, papaya, avocado	**1** Orange, Zeitun, Lemin, Ananasi	**1** Apple, Gesho (income), Papaya, Zeitun, Avocado	**Live fence**	**1** Kontefetefe, Shehoko, Beles, Kinchip, Agam	**2** Giba, Kebkeb, Seraw, Andel, Kontefetefe, Kinchib	
Bee forage	**3** Tebeb, Beles, Suwa kerni, Kulkual, Seraw, Tambuk		**4** Tebeb, Suwa ekrni, Grbia, Awh'i, Shof bahari	**Soil erosion control**	**2** Saeri hamaz, Ere, Akacha, Gasa grass, H'tsawts	**4** Akacha, Tahses, Ere, Chea	**3** Shamboko, Shehoko, Saeri harmaz, Tsaeda ere, Akacha
Fodder	**4** Leucaena, Sesbania, Momona, Limo, Giba	**5** Sesbania, Leucaena, Kancha harmaz/ Saeri harmaz, Tehag	**3** Tehag, Saeri harmaz, Sesbania, Mugya, Beles	**Dead fence**	**3** Giba, Kelamitos, Kuleau, Kebkeb, Chea	**3** Chea, Giba, Agam, Andel, Bnii	
Charcoal		2 Seraw, Tet'aalo, Awuli-e, Kebkeb		**Soil fertility improvement**		**5** Momona, Giba	**1** Momona, Leucaena, Akacha, Giba
Medicine	**2** Atch, Moringa, Tsaeda Kelamitos, Awh'i, Agol			**Aesthetic/ Ornamental**		**1** Shagla, Daero, Awhi, Kelamitos, Tambuk	**2** Grevillea, Limo, Shweshewe, Awuli-e, Key kelamitos
Timber for house construction		**3** Kelamitos, Tsehidi, Awh'i, Giba					
Poles for farm implements		**4** Awuli-e, Giba, Tahses, Weyba	**2** Awuli-e, Tsaeda kelamitos, Keyih kelamitos, Awh'i, Tahses				

Key: Numerals represent the order of importance of the tree product/service, with number 1 being farmers' most important/ priority future tree product/ service

The scientific names of these tree species and their details are provided in the tables above

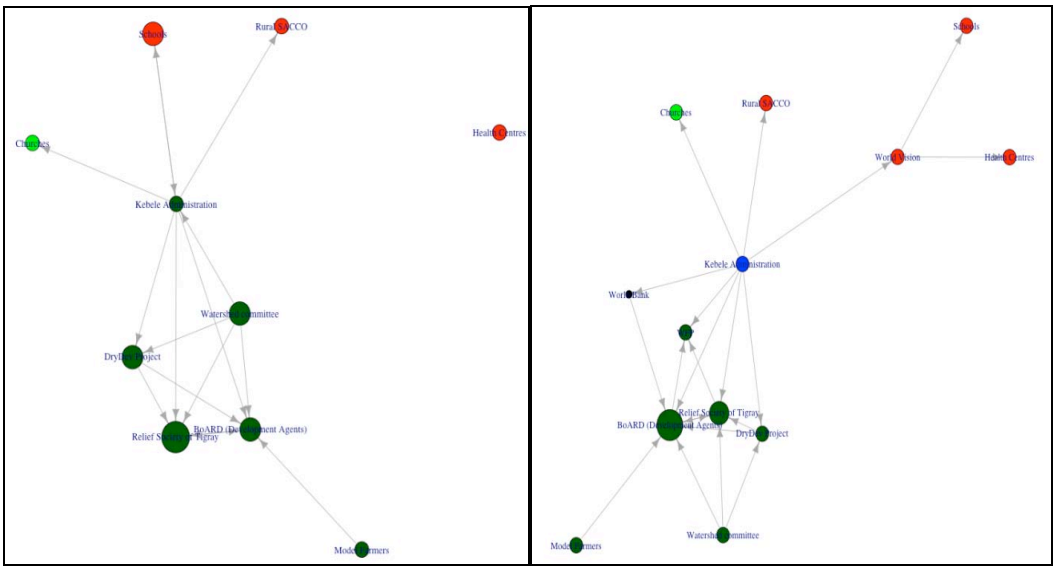
2.5 Implications of local knowledge about land restoration on scaling land restoration options

2.5.1 Lessons Learnt: Farmers' assessment of what has contributed to the success of past restoration interventions:

1. Community involvement and representation at all stages- For instance, there were numerous consultation and negotiation meetings with the local community starting from the selection of intervention sites, to the design, implementation and management of the interventions. Also the use of local labour
2. 'Social' boundaries- the presence of and strict enforcement of the by-laws such as against free grazing of livestock and instead farmers practicing 'cut and carry' system
3. According to farmers in Maytekli, because land is owned by the government, this has played a key role in ensuring that land restoration interventions are successful. This is because it is the government that sets aside and determines which land should be restored. Therefore there is effective and uniform implementation of interventions which reduces conflicts amongst farmers as everyone's land has to be involved
4. Intensive awareness creation on the nature, functions and importance of the different land restoration interventions, before and during implementation phases
5. Farmers working together in close cooperation, which also includes the communal labour sharing. Farmers are also eager to learn from each other and to share knowledge
6. Holistic watershed rehabilitation especially by DryDev project and Productive Safety Net programme- land restoration interventions were not only implemented in exclosures but also on the cropland- hence farmers also had immediate tangible benefits
7. Some form of 'food compensation' and motivation to farmers for providing labour for implementation activities, but this was only provided for exclosure activities

2.5.2 An overview of challenges encountered during the design, planning and implementation phases of land restoration interventions in both exclosures and cropland

1. The key challenge that was being faced by the Watershed Committees was that during the design, planning and implementation phase of interventions, some farmers resisted the idea of exclosures. This is because they were the main grazing areas hence a key source of fodder. But through community sensitization and implementing by-laws, most community members have now embraced the land restoration interventions.
2. Delayed timing for implementation of interventions: Delayed activities and delivery of required materials and tools. According to farmers, when interventions are implemented during the rainy season, farmers experience various challenges: farmers are busy in their fields and they have to abandon their crop production activities to participate; some farmers step on and destroy crops while implementing these activities. Also, it becomes too late to capture and maximize on the loss of rain (for water harvesting) and it is difficult to intercept rain before it destroys crops.
3. Failure to customize technologies and interventions based on slope- lack of adequate equipment and tools: some farmers lack water pumps to pump water to the upper slope locations of land where waterways and water channels cannot work
4. Weak collaboration between key government and NGO stakeholders (as highlighted in Maytekli)



Key: -Size of circle represents the importance of a stakeholder to farmers with regards to land restoration;
-Arrows represents stakeholders that farmers reported working in collaboration;
-Dark green represents stakeholders that farmers viewed as being strongly aligned to land restoration agenda, light green- some level of alignment to land restoration, blue- low alignment, red- no relation with land restoration agenda

Figure 4: Social Network Analysis for Waza (left) and Maytekli (right)

5. Organizations only focus on the 'experiment' farmers- Non-intervention area farmers reported not receiving training on land restoration and SLM, hence they felt marginalized.
6. Lack of incentives to implement the restoration interventions such as food allowances to cater for the days that famers give their free labour towards land restoration on the cropland.
7. Lack of financial capacities to expand land restoration interventions to other needy areas of the watershed

Key Recommendations

- Land restoration activities should be implemented before the onset of rains
- Need for more close collaboration and involvement of the key stakeholders for instance the government
- Implementation of interventions should always be followed by monitoring and follow-up by the implementing organizations so that farmers can continually share their experiences and challenges can be addressed on time
- Sensitization should begin in the early stages of planning for interventions to ensure farmers are on-board and any conflicts resolved to ensure smooth implementation of interventions
- Training should as much as possible also include non-project farmers. This is especially key for scaling up the interventions as some farmers were interested in replicating the technologies on their individual farms.
- Need to customize interventions to local context such as slope dynamics.

2.5.3 Farmers ranking of challenges that they directly encountered in their everyday implementation and maintenance of land restoration interventions:

At the end of the local knowledge exercise, during the feedback session, farmers deliberated and ranked challenges that had been identified throughout the study and ranked them according to their level of seriousness.

Table 8: Farmer ranking of challenges affecting land restoration interventions in the cropland

Nature of Challenge	Mayte kli	Endagi orgis	Endama riam
Lack of training skills on restoration skills for the different context eg slope gradient, soil type: project farmers are trained based on intervention location and non-project farmers aren't trained	1	1	3
Lack of implements and tools for implementation and maintenance of interventions	2	2	1
Low tree survival due to post-harvest free-grazing of livestock	3	3	10
Lack of water pumps and generators for pumping water to farms upslope or further from checkdams	4		2
Water shortage due to inadequate water harvesting structures (check-dams) and storage tanks		7	4
Lack of regular follow-ups and monitoring of interventions	6	9	
Low skills and resources in livestock production	7		9
Low knowledge in tree utilities	8		
Lack of quality and diversity of tree seedlings	9		
Un-cooperative farmers	10	6	7
Lack of awareness by some farmers on the full benefits of land restoration	11		
Some interventions already implemented are not suited for the local context and farmers lack the freedom and skills to modify, eg flooding of deep trenches, failure to combine biological and physical structures makes interventions less effective	5		11
Surface runoff from untreated/ poorly restored upslope exclosures destroys downslope onfarm interventions.	12	4	8
Ineffective gully treatment upstream leads to gully expansion downslope, including failure to combine vegetative and structural interventions		5	
Land shortage discourages some farmers from implementing interventions that occupy space	13		6
Labour shortage	14	8	5
Theft and uprooting of seedlings	15		

Challenges encountered by farmers in efforts to integration more trees on their fields

- Post-harvest free grazing of livestock
- Land shortage- this discourages farmers from planting trees as they are perceived as competing for space with crops
- Water shortage
- Insecurity of tenure acts as a disincentive to farmers planting trees
- Low knowledge of tree uses especially ecological functions
- Lack of tree seedlings and diversity
- Lack of skills on tree propagation especially for fruit trees
- Labour shortage
- Theft of tree seedlings

According to farmers, below are important Pre-requisites for successful and effective land restoration interventions in the cropland:

- Provide incentives during implementation such as food for work
- Timely implementation of LR activities -before onset of rains
- Utilizing watershed committees- as communities of practice facilitators and oversee everyday maintenance of the LR interventions (communities of practice)
- Model farmers and farmer demonstrations eg Farmer Training Centres (FTCs)
- Increase collaboration between the key stakeholders (government and NGOs)
- Customize interventions to local context and farmer circumstances
- Provide context-specific LR training and skills on different local context eg slope location, soil type- including modification
- Training and sensitization to both project and non-project farmers before project implementation
- Utilizing watershed committees- as communities of practice facilitators and oversee everyday maintenance of the LR interventions (communities of practice)
- Model farmers and farmer demonstrations eg Farmer Training Centres (FTCs)
- Increase collaboration between the key stakeholders (government and NGOs)
- Full treatment of all upslope exclosures because will reduce the amount and speed of surface run-off into the cropland
- Regular monitoring of the performance of exclosures
- Efficient use of harvested water to reduce wastage- explore other forms of irrigation apart from sheet erosion, provide water storage structures
- Regular monitoring and follow-ups to ensure proper restoration and sustainability of interventions
- Assess the compatibility of different landuses with LR interventions such as control post-harvest grazing
- Exploring diverse tree species and niches that farmers are interested in and addressing constraints to adoption of trees onfarm
- Train farmers in integrated livelihood strategies including livestock production