Strengthening Drought Resilience in the (agro)Pastoral Lowlands of Ethiopia

Proposed drought resilient livelihood development interventions in the resources conserved sites of the Afar Region

(PN 16.0123.6-001.00)

1. Background

The programme "Strengthening Drought Resilience in Pastoral and Agro-pastoral Areas of Ethipia" (SDR) was launched as a support to the Ethiopian Government in the implementation of its economic development strategies. It is closely linked to the Country Programming Paper (CPP) to End Drought Emergencies in the Horn of Africa and anchored in the over-arching Growth and Transformation Plan (GTP). The programme is implemented jointly by the Ethiopian Ministry Livestock and Fisheries Development (MoLF), the Ethiopian Ministry of Agriculture and Natural Resources (MoANR), their respective decentralised bureaus and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), mandated by the German Federal Ministry of Economic Cooperation and Development (BMZ). The programme with its different projects aims overall at strengthening the capacities of communities and responsible institutions in the Afar and Somali Region to implement drought resilience measures within a legal, political and institutional framework reflecting the concerns of pastoralists and agro-pastoralists. The project has been designed to respond to the needs and priorities of pastoralists and agro-pastoralists in the Afar and Somali Regions and to the key problems in the management of the natural resources, they are facing. The measures will be focusing on the adaptation of Natural Resource Management (NRM) to the local situation by pilot-interventions on community level, the improvement of livelihoods based on income generating activities and the development of capacities of major stakeholders at village, community, regional and national level.

Overall Objectives for the Assignment

Field visit together with the six woreda focal persons (Chifra, Uwa, Awra, Teru, Gulina and Yallo) trained in the recent Waterboxx Ecological Water Saving Technology (EWST) in order to assist in the identification of implementation sites for EWST.

Develop a planting strategy for both the waterboxxes and the different physical structures; Water Spreading Weirs (WSWs) and Drystone Measures (DSMs) that have been constructed in Afar region. This will encompass also methods of riverbank stabilization.

Specific objectives for the assignment including all tasks comprise

- Advice on implementation of Waterboxxes in nations and nationalities park Semera (see separate report).
- Follow-up ToT Waterboxx participants for planning and formulate proposals for implementation of Waterboxxes.
- Identify suitable species for planting around WSWs, DSMs and riverbanks and develop planting patterns for identified species as well as propose sourcing possibilities for the identified species

Deliverables

- Concise report, defining options for practical implementation of the stated objectives. Report should focus on quick-win options and win-win crops (food & forage).
- Concrete recommendations in, separate report, for optimal implementation of Waterboxxes in Nation and Nationalities Park Semera. Including implementation modalities

2. Biophysical conditions and livelihood dynamics

Variation in biophysical conditions of the intervention sites

The biophysical parameters of the intervention sites include elevation, air temperature, rainfall, soil types, and seasonal/perennial rivers/wadis were recorded and displayed from secondary sources (Annex 1).

The study districts of are characterized by high temperature and erratic rainfall and occasion runoff/on of water from within and the neighboring western highlands. Hydrologically, the Chifra-Yallo landscape is rated as moderately to highly productive aquifer (UNICEF-UNESCO, 2015). These might be due to the runoff/on of water from the western highlands through the seasonal and perennial rivers of Mille, Awra, Uwa, and Teru. The variation in elevation of the study sites are suitable for runoff/on of water, ranging from 500 to 1500m above sea level. Moreover, the runoff/on collecting rivers/wadis/gullies are highly concentrated around the study sites. On the other hand, the annual rainfall is highly variable across the study sites and within seasons, roughly ranges from 250 mm in the lowlands to 600 mm in the peak western highlands. The rainfall is received as torrential within maximum span of two months, usually in July and August. The study sites are also characterized by hot average day and night temperature, ranging from 21 to 30^{o}C. The soil types of the study sites are variable in their texture and deep according to the elevation of the lands, shallow and less fertilize soils in the high and steep slopes, and deep fertile soils in the valley bottoms.

Livelihood dynamics of the pastoral community

Traditionally, the main livelihood of the Afar community is livestock dependent. There is seasonal movement in search of feed and water for livestock to areas where there is recent (re)growth of fresh vegetation following rainfall. With increasing population and recurrent drought, the pressure on natural resources intensified and the vegetation cover-abundance in the Afar region reduced gradually. According to the Afar elders, the canopy cover-abundance of the highly palatable vegetation has been lost or substantially reduced in the last decades. Subsequently, the livestock population in the study sites decreased. Also there is shift in livestock composition to cope with the prevailing dynamics of the cover-abundance palatable vegetation. The Afar elders indicated that the cattle and camel population substantially reduced in the last decades. On the other hand, the small ruminate population (goats and sheep) relatively remained as key livelihood support to the Afar community. Interesting to note that between competing browsers (camel and goat) and grazers (cattle and sheep), the larger livestock population are reduced. Elders also noted that the livestock productivity (milk and meat/head) reduced considerably in the last decades. The shift in livestock population and composition, and associated reduction in livestock productivity also triggered shifts in food habit and nutrition of the Afar community. The food habits largely shifted from use of nutritious animal products to less nutritious highlander type foods ‘bread and sauces such as *shiro*’. That means the pastoral Afar community has to purchase the highlander type foods from the market that needs cash. The skill of Afar community is largely pastorals

with limited skills and experience to be employed as skilled laborers in the mushrooming nearby towns compared to the highlanders, implying that the livelihoods options of the Afar community is limited.

The shifts in vegetation cover-abundance, and livestock composition and food habits are indicators of the increased uncertainty of rainfall pattern or drought, land degradation and shortage of feed and food. This led to food insecurity of the Afar Community. The food security status of the districts in Ethiopia was rated based on a five point scale: generally food secure, moderately food insecure, highly food insecure, extremely food insecure and famine (Food security, 2010). The intervention districts of Chifra, Uwa, Awra, Gulina, Teru and Yallo was rated as moderately to highly food insecure areas of Ethiopia (Fig. 1). The results further indicate that livelihood under recurrent drought conditions is extremely difficult for the pastoral Afar community.

Some of the Afar community close to the seasonal and perennial rivers exercise limited sedentary irrigated faming around the rivers Mille and Awra, and rainfed crop husbandry around the seasonal big rivers. In most cases, the cultivation of most of the irrigated farming is based on 50% share cropping with the highlanders. The Afar contributed land, protection and sometimes oxen for plowing the field. The highlanders contributed other farm inputs and labor for the irrigated crops. Maize is the main cultivated crop in irrigated fields, perhaps purposely chosen to serve the food-feed value badly needed in the Afar community. More recently, some Afar settlers started to farm their own plots by their own or employ the highlanders as laborers particularly in irrigated scheme of Awra district. The Awra irrigation scheme is established by the Strengthening Sustainable Development (SSD) project about a decade ago. The move is appeared to be a process of gradual change from pastoral to sedentary farming by learning. Initially, the share cropping with the highlanders may help as a sharing of skill and knowledge on the cultivation of irrigated crops. Thereafter, the pastorals learn to employee the highlanders as laborers and finally the Afar pastorals move to manage their irrigated farms by themselves.

Comparatively, the irrigated fields are limited to the Mille and Awra river banks and the number of beneficiary pastorals is limited. A large number of the Afar community are still without access to irrigated or reliable rainfed crops. The livelihood of the pastorals is still traditional despite the tremendous changes in recurrent drought occurrence, rainfall uncertainty, and associated changes in vegetation cover-abundance and livestock population and composition. The traditional pastoral livelihood is no more a viable option under the recurrent drought conditions. Alternatively, GIZ in collaboration with regional partners introduced natural resources conservation technologies-the weir spreading structures and dry stone measures. The newly introduced resource conservation interventions are aimed to enhance the drought resilient livelihood development of the pastoral community in the six districts of the Afar region.

3. Resource conservation interventions

In the western portion of the Afar districts, rain drops as torrential rainfall associated with heavy runoff in the valley bottoms, gullies and rivers. The runoff is lived short without substantial contribution to groundwater and (re)growth of vegetation or crop cultivation. GIZ in collaboration with the local partners mainly the Bureau of Pastoral Agriculture Development (BoPAD) introduced weir water spreading structures and dry stone measures around the gullies and water running spots. The structures are constructed to slow down runoff, increase run-on and infiltration in a wider area around the water running bottoms. The water spreading structures has been introduced in six districts of the Afar region: Chifra, Uwa, Awra, Teru, Gulina and Yallo. The construction of the water spreading structures in Teru and Uwa districts is on progress. The focus of the current visit and report is on the other four districts where the water spreading structures are fully functional for some time (Table 1).

The water spreading structures effectively stabilized runoff-conserving water above and below the structures. Fertile soils and water widely distributed across the command fields below and above the structures. The conserved resources (water and soils) effectively support the (re)growth of annual and perennial plants with vigorous foliage growth and canopy cover compared to the sites without structures.The increased canopy cover around the water spreads become a valuable source of fresh leaves and pods-nutritious feed for livestock. The excessive foliage or canopy cover also serves as shade to livestock (particularly to newly born) during the intense sun heat of the day). Most importantly the ponded water above and below the water spreading structures serves as drinking water to both human and livestock. The pastorals mentioned that the presence of drinking water around the structures reduced the daily movement of women and the livestock to far distant watering points. That means the daily energy lost in search of water is conserved. The Afar women may have more time to do other works including farm activities. In restricted movements, the livestock needs less feed than under long distance daily movement. Moreover, the cultivation of maize and some high value crops (mango and vegetables) started in the constructed water spreading structures of Chifra, Awra and Yallo districts.

Table 1. Number of functional water spreading structures in the four districts of the Afar region.

District	**Intervention watershed**	**Number of visited weir structures and dry stone measures**	
		Water spreading weirs	**Dry stone measures**
Chifra	Geriro-Taboi	4	4
Awra	Lekora	4	-
	Kelkelsa	3	6
Gulina	Tbia-Dera	4	-
Yallo	Kebi-Agolo	3	-

It is clearly observed that the conserved resources offer tremendous ecosystem services and benefits to the pastoral Afar community. In most water spreading structures, the residence of the pastorals increased after the intervention as compared to before the intervention. Moreover, the conserved resources can be effectively and efficiently used to enhance the drought resilient livelihood of the pastoral community. To enhance the productive use of the conserved resources (water and fertile soils), there is a need to integrated the conserved resources with livestock and cropping patterns along the drought resilient livelihood intervention pathways and intervention approaches.

Relative potential of the sites for drought resilient interventions

In order to propose context specific drought resilient livelihood interventions in the resources conserved sites, the relative potential of the water spreading structures sites within a watershed was evaluated based on:

- Visible area of the runoff sources
- Amount of surface water retained above and below the water spreading structure
- (Re)growth performance (foliage canopy cover and abundance) of annual and perennial vegetation
- Current use of the conserved resources for food-feed crop production

Based on the above observations and discussion with knowledgeable experts and pastorals in the site, the relative potential of the sites in soil moisture and fertility status in supporting drought resilient livelihood development is aggregately classified into relatively less moist and fertile, moderately moist and fertile, moist and fertile and extremely moist and fertile fields.

4. Proposed drought resilient livelihood development interventions

Drought resilient livelihood intervention approaches

The livelihood intervention approaches focus on win-win situations whereby intervention will start in relatively well functional conservation structures where the Afar community can take responsibility to implement the livelihood interventions voluntarily. The successful intervention sites may serve as a live field school for sharing experiences to other similar domains or watersheds. Moreover, the livelihood intervention could be tested in a cluster approaches along the conserved resource gradients of the watershed. This is useful to ensure agreed community based livestock protection and willingness to participate in drought resilient livelihood supporting interventions. The livelihood approach may also focus on enhancing the productive use of conserved resources. Biological and economic benefits should be ensured per unit of conserved resources such as water (enhancing physical and economic water productivity). The proposed interventions may also follow the pastorals centered approach where the interventions could diversify and intensify based on the existing livelihood system of the community: Securing access to water and food-feed crops, and beyond. Most importantly the proposed livelihood

interventions should be context specific and process based whereby the processes and results could be scaled out to similar domain areas.

Based on the aforementioned livelihood approaches, the integrated drought resilient livelihoods development pathways could be defined to address the systemic challenges and opportunities in improving the drought resilient livelihood of pastorals.

Drought resilient livelihood intervention pathways

The framework for drought resilient livelihood development pathways may serve as indicator of the key entry and end points of the proposed interventions. Defining the livelihood pathways may also assist to proactively fine-tune key interventions in a systemic way to a complex drought resilient livelihood development in the pastoral community. In transforming towards drought resilient livelihoods of the pastoral community, the livelihood pathways proposed: resource conservation---development of input supply and services---productive use of conserved resources---marketing access and linkages (Fig. 1).

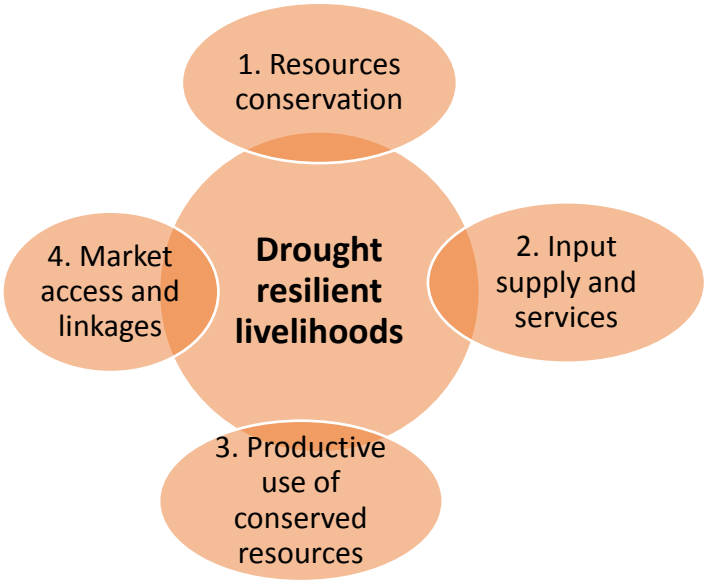

Figure 1. Drought resilient livelihood intervention pathways for the pastoral areas of the Afar region.

Resource conservation

Resource conservation is the key entry point to enhance drought resilient livelihood development in the dryland areas of the pastoral community. The resource conservation using the water spreading structures is effectively demonstrated with tangible and observed ecosystem impacts in the selected GIZ intervention sites. The resource conservation efforts using water spreading technologies may continue in other similar domains as an entry point to the drought resilient livelihood development interventions.

Development of input supply and support services

The input supply potential for livelihood development interventions were assessed in the interventions watersheds and adjacent areas within the Afar region. The input supply mainly refers to the source of planting materials to be used in the intervention structures. These include food-feed annual crops (maize, pearl millet, sorghum, cow pea and groundnut), perennial high value trees (*Balanites aegyptiaca* and *Zeziphus spp.*), high value fruits (mango, orange, citron, lemon, guava and grape vine) and vegetables (onion, tomato, and leafy vegetables). The supply of inputs also include planting materials of livestock feeds including Napier and Rhodes grasses, and legume shrubs (*Leucaena* and *Sesbania*). The Werer Research Center in the southern part of the Afar region and the BoPAD nursery in Dubti might be the source of planting materials for some of the proposed livelihood interventions. The sugar and Napier farms in Dubti may also serve as sources of planting materials of sugar and Napier grass splits for the intervention sites. There is no fruit nursery in the intervention districts and most likely in the whole Afar region.

In the study districts, there was no input supply facilities owned by public and private sector. The Afar Agricultural Research Institute (APARI) located in Awra district do have little nursery facilities to supply planting materials of high value food-feed trees and fruits, and feeds. In this regard the establishment and strengthening of the new/initiated nurseries are necessary for reliable supply of planting materials of high value food-feed trees, fruits and feeds.

While transforming towards drought resilient livelihood development, the agricultural support services are crucial elements in the intervention. The agricultural support services include the extension and research service providers relevant for the development of drought resilient livelihood interventions. The APARI has an agricultural center in Awra district but unable to check the facilities and manpower status to support the livelihood intervention through the research for development concept. Credit and saving services could be part of the drought resilient livelihood development interventions. In good rainfall seasons, pastorals may learn saving of money from the sale of the produce and credit could be available to them in bad rainfall seasons.

Productive use of conserved resources

For the productive use of conserved resources there is a need to integrate the food-feed crops and feed development with livestock keeping in a systemic way. In this regard, the ecological water saving technology (EWST) known as the Groasis Waterboxx has been introduced in the intervention districts (Fig. 3). The EWST assisted the productive use of conserved water in establishing high value fruits and food-feed trees seedlings in the dry areas of the pastoral sites. The details of the technical use and field implementation of the Waterboxx is demonstrated for 24 focal persons and experts working in the intervention districts of GIZ, 23-24 August 2017. The effective use of EWST in the establishment of food-feed trees, fruits and other feed seedlings will be treated case by case in the specific intervention watersheds. The proposed productive use of conserved resources include the effective use of resources

down the soil profile: annual crops use resources of the upper 0-40 cm soil layers and perennials may use resources of the lower depth of the soil profile. Effective use resources also include planting patterns that effectively use the spread of resources across the fields: high resources deposition close to the gully beds and banks, and low resource conservation away from the center of the gullies.

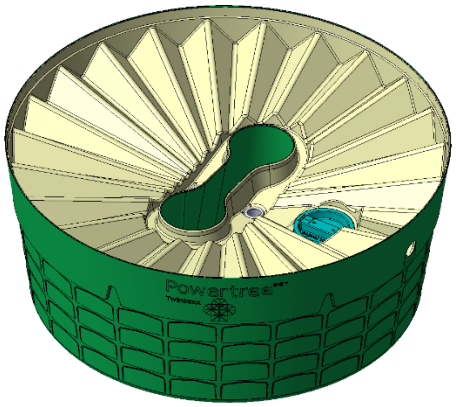

Figure 2. Groasis Waterboxx ecological water saving technology

Market access and linkages

In the long term, the access to and linkage to livestock and crop outputs is one of the key elements in the successful transformation towards drought resilient livelihood development. In effect, the conserved resources should be wisely translated into cash. In this way, pastoral may get more cash associated to good rainy seasons and could compensate and support livelihoods in drought seasons when the rainfall is low.

Support should be provided for access to market information and linkages in short and long distance marketing of agricultural products. This is crucial element in the success of the livelihood interventions. In the short distance pre-urban and urban sites, individual weekly markets can be developed for exchange of livestock and other products. Green feed and feed block, and live animal marketing can be enhanced in the open weekly market. In the long distance marketing, marketing and linkages can be established or strengthened to the nearby big towns of Wello, Mekele and other key market centers (e.g., the universities) for group marketing of live animals and other products. At the same time, individual and cooperative rural shops can be strengthened in the intervention sites on competitive price basis. The linkage of conserved resources with high water productivity of food-feed trees, feed and high value fruits and further linkage with selective livestock feeding most likely enhance the livelihood of the pastoral community. At the same time, the community may be encouraged to exercise partial or full permanent settlement. While exercising market oriented commodity development on the conserved resources, the community may shift towards marketable animal types and breeds, a means to downsize less marketable or valued livestock types, a reduction for carry capacity to the environment. Gradually the community may shift towards more drought resilient livelihood mechanisms than the pastoral subsistence farming which are more prone to the recurrent drought occurrences.

Within the livelihood development paths, the focus of this report is on development of effective input supply and support services and productive use of conserved resources. The proposed productive use of conserved resources and development of effective input supply and support services is integrated with the relative potential of the water spreading structures in the intervention watersheds.

5 Proposed drought resilient livelihood development interventions

Geriro-Taboi intervention watershed

The Geriro-Taboi intervention watershed is located in the Chifra district surrounding the Chifra town. In the upper course of the Geriro-Taboi watershed consists of two sub-watersheds: Geriro and Taboi. Both sub-watersheds received runoff water from the western Geriro hills. The Taboi sub-watershed channeled towards the lower gully on right side of the Geriro hills and the Geriro sub-watershed channeled towards the left lower gully. The gullies getting wider and wider as we move from the hills and the gullies meet below the Chifra town. The wider gully funneled to the WaEma River before they joined the Mille perennial River.

In the last few years, GIZ in collaboration with the local public offices and the community has introduced natural resources conservation measures mainly dry stone and weir water spreading structures were constructed mostly to reduce runoff and spread the water that flow through the concentrated gullies. As a result soil and water conservation has been improved along the watershed: DSMs stabilized soil and water in the upper sides. The drought resilient development approaches could be operational following the variation in conserved resource gradient along the watershed continuum-from the western Geriro hills down to the valley bottoms.

Following the implementation of resource conservation measures, a variation in relative soil moisture and fertility gradient has been established particularly along the gullies within the watershed continuum (Table 2). The relative variation in soil moisture and fertility can be classified based on water spreading structure type, and land type and location.

Dry stone structures: The dry stone structures has been constructed on the upper sites of the watershed close to the foothills. The dry stone has been constructed on two types of landscapes: on surface lands without gullies to check rills and slow down gully formation and runoff, and across the gullies. The relative soil moisture and fertility status of the dry stone constructed without gullies were rated as less moist and fertile, and the soils across the gullies as moderately moist and fertile (Table 2).

Weir structures: Down the dry stone structures, series of weirs has been constructed across the gullies in the valley bottoms of the watershed. A clear variation in the relative soil moisture and fertility status was observed in the fields with weir structures. Most fields in the middle of the gully (above or adjacent to the Chifra town) was rated as moist and fertile. On the other hand, the fields with weirs in the lower portion of

the gully were rated as extremely moist and fertile (Table 2). The gully beds and banks also groups under this category.

Groundwater beneficiaries: The lands between the two sub-watersheds with water spreading structures are assumed to be beneficiaries of the groundwater enrichment due the GIZ resource conservation interventions. The area between the two sub-watersheds is the Chifra town and the pastoral settlements. In the town, the lands are either private residences or public sites. The pre-urban and urban private residences, public lands (e.g., schools, clinic, and administration spots) and settlement areas are direct or indirect beneficiaries of the resource conservation structures. Pastoral and pre-urban residents indicated that tree survival and performance in improved in the last few years. This might be associated groundwater enrichment. Accordingly, the soil moisture of the buffer area is assumed to be improved and can be included in the drought resilient livelihood development interventions (Table 2).

Table 2. Variation in soil moisture and fertility status of the fields across the water spreading structures along the Geriro-Taboi watershed continuum.

Structure type	**Constructed land scape type**	**Relative soil moisture and fertility status**
Dry stone	Dry stone without gullies	Less moist and fertile soils
	Dry stone across gullies	Moderately moist and fertile soils
Weirs	Weirs across the relatively upper part of the gullies	Moderately moist and fertile soils
	Weirs across the middle portion of the gullies	Moist and fertile soils
	Gully beds and banks, and lower portion of the gully weir	Extremely moist and fertile soils
Groundwater beneficiaries: Peripheral sites of weirs	Pastoral settlements	Groundwater assumed to enriched
	Urban and pre-urban residence and public places	Groundwater assumed to enriched

The variation in soil moisture and fertility across the different water spreading structures and landscapes along the watershed continuum is a base for developing drought resilient livelihood development interventions (Table 3). The proposed interventions follow the drought resilient livelihood development interventions approaches. The proposed interventions are context specific that include the relative soil moisture and fertility status of the specific intervention fields. For instance, the drought tolerant CAM plants (Crussilian Acid Metabolism)-Cactus spear and Agave sp., are proposed to be planted in the dry stone structures in sites relatively less moist and fertile fields of the foothills (Table 3). On the contrary, the less drought tolerant fruits, legume crops and sugar cane is proposed to be planted in the extremely moist and fertile fields, lower portion of the weir structured gully. In between the upper and lower portion of the gullies, planting of the relatively productive and water productivity efficient C_4 plants (Pearl millet, sorghum, maize, Napier grass) is proposed. The intervention approach is also center around the pastoral community-food-feed crops and feeds including legume shrubs get special emphasis in the intervention (Table 3). This is because the pastoral community has to get balance feed to their livestock and at the same time get food for household consumption. The integration of food-feed trees and food-feed crops in the same fields is purposeful. In good rainfall seasons, the pastorals can harvest both food and feed. In

bad rainfall seasons, the pastorals can harvest feed. In both cases, the strategy of the intervention is to get more biomass early in the season with early canopy cover. The early canopy cover of fast growing plants is advantageous in reducing direct loss of water by evaporation and productive use of conserved water before it loss to the atmosphere or drained beyond the root zones.

Moreover, technologies that help the productive use of conserved resources is included in the proposal. Fruits, high value food-feed trees and legume shrubs is proposed to be planted with Waterboxx EWST. The scale of the proposed intervention is the Geriro-Taboi whole watershed. These included the water source hills, dry stone and weir spreading fields and other settlement and residential areas in cluster approach. Within this cluster, pastoral community should agree on the drought resilient livelihood development interventions and contribute to the protection of the watershed through established rules and bylaws.

With successful establishment of the fruits, pumping water supply from shallow wells might be necessary. Reliable pumps with spare parts supply should be purchased of the sustainable supply of water.

Table 3. Proposed drought resilient interventions in the Geriro-Taboi watershed, Chifra district.

	Moisture status	**Proposed interventions**			
		High value fruits and food-feed trees*	**Food-feed crops**	**Feed**	**Others**
DSM	Dry stone outside gullies: Less moist and fertile	*Cactus* spear, high value food-feed trees	-	Salt bush and Leucaena sp.*	Agave sp.
	Dry stone across gullies: Moderately moist and fertile	high value food-feed tree crops,	In good season, Pearl millet, early maturing sorghum and maize can be planted with improved agronomic practices[1]	Napier grass across the gullies	Agave sp., and Cactus spear above the structured gullies
WSW	Moderately moist: Upper portion of the gullies	Rows of high value food-feed tree crops,	Pearl millet, early maturing sorghum and maize can be planted with improved agronomic practices[1].	Napier grass across the gullies, Leucaena sp., in the gully banks	
	Moist and fertile: Middle portion of the gullies	Fruits (mango and citrus) around the gully banks and high value food-feed tree crops and legume shrubs	Pearl millet and early maturing sorghum and groundnut can be planted with improved agronomic practices[1].	Napier and Rhodes grasses across the gullies, Leucaena sp., in the gully banks.	
	Extremely moist: lower portion of the gully and most gully beds and banks	Rows of fruits (mango and citrus), Sugar cane around the banks.	Early maturing maize, cowpea and ground nut can be planted with improved agronomic practices[2].	Napier and Rhodes grasses across the gullies, Leucaena sp., in the gully banks.	
Peripheral sites WSW	Pastoral settlements	Rows of fruits (mango and citrus) and high value food-feed trees		Leucaena sp.,	
	Urban and pre-urban residence and public places	Fruits (grape vine, mango and citrus) and high value food-feed tree	Napier grass	Leucaena sp.,	

Fruits: Mango, citrus and grape vine; high value trees: *B. egyptiaca* and *Zeziphus* spp., *Moringa* sp.; forage crops: Napier and Rhodes grasses, and legume shrubs; food-feed crops: Maize, sorghum, pearl millet, sugar cane, cow pea and groundnut. Both fruits, high value trees and legume shrubs will be planted with the support of Waterboxx EWST.

Lekora intervention watershed

The Lekora watershed is located in the pleasant and attractive plain of Awra district. Unlike the hills of Geriro, the Lekora water has no major runoff sources hills. The relatively small gully collects water and soil from the surrounding gentle slope fields. Three weirs have been constructed across the gully and manage to spread water and fertile soils across the fields. Annual and perennial plants performs well around the structures compared to the other unstructured sites. Ponding water above and below the weir structure is serving as drinking water for human and livestock. Unlike the Geriro-Taboi watershed, variation in soil moisture and fertility status across the weir sites and gully is less visible. Perhaps the area was wet and green during the field visit. This may obscure the visible surface moisture difference across the sites or the spreading weirs constructed in 2016 and too early to see the changes in the first two or three showers of rain. However, the amount of ponding water gradually increased towards the lower portion of the weirs. Also pastorals grow maize in the lower portion of the gully, perhaps as sign of improved moisture availability towards the lower portion of the gully or weirs.

Based on the performance of the perennial trees, the groundwater of the site might be within the shallow depth reach. Boreholes were sampled close to the sites, to measure the groundwater potential perhaps for irrigated development but the information is on groundwater status is not available. In the absence of the groundwater information, three drought resilient livelihood intervention options are suggested: Planting of high value fruits, high value food-feed trees, and a mixture of both (Table 4).

Option 1: Rows of mango planting

Assuming that the groundwater is very close to the surface, then the planting of rows of grafted mango seedlings is advisable with the support of Waterboxx EWST (Table 4). The mango orchards can be fenced using live plants of high value food-feed trees, Napier grass and legume shrubs to protect from wind and animals. Between the mango rows, food-feed annual crops can be sown: pearl millet in the upper weir, early sorghum in the middle, maize and cow pea in the lower weir command field. Following the successfully establishment of the mango seedlings, supplemental irrigation can be applied from shallow wells. In this regard, the selection of shallow well sites and pumps is essential element of the intervention. If this approach is successful, the whole Awra plain can be a mango belt in the future.

Option 2: Rows of high value food-feed tree planting

Assuming that the groundwater is deep enough to be accessible by fruits, then the planting of high value food-feed trees might be the best option. The establishment of the high value food-feed trees could assisted using the Waterboxx EWST (Table 4). This is relatively easy intervention where rows of *Zeziphus* spp, *Balanites*, *Moringa* sp., or *Leucaena* sp., can be cultivated in rows aligned with the wind

direction so that plants can protect each other. Wind prone *Moringa* sp., may be planted in the middle of other species to get enough wind protection. Between the rows of the high food-feed trees, annual food-feed crops can be sown in the same sequence as in option 1.

Option 3. Mixture of mango and high value food-feed trees

This option might be useful to plant rows of mango orchards close to the gully banks and high value food-feed trees on the peripheral sites of the water spreading structures. The high value food-feed trees may also serve as wind protection to mango orchards. Alternatively, mango rows can be planted in the lower end of the gully (the lower third weir commanding field) and high value food-feed trees in domain fields supplied by the upper two weirs (Table 4). Between the rows of the high food-feed trees, annual food-feed crops can be sown in the same sequence as in option 1.

The APARI research staff in Awra district can make close follow up and collect information to evaluate the performance of the three options. The information collected from the Lekora drought resilient livelihood support will be useful to develop the livelihoods of the Awra plain.

Use of supplemental irrigation from shallow well water can be coordinated to irrigate the established mango and food-feed trees during the extended dry season. The shallow well can be dug in spots where trees perform well.

Table 4. Proposed drought resilient interventions in the Lekora intervention watershed, Awra district.

Intervention options	Water spreading structure	Moisture status	High value fruits	High value food-feed trees	Food-feed crops	Feed
Option 1: Planting of mango rows.	Weirs 1-3	Moist to extremely moist and fertile soil	Planting rows of mango	High value trees to be planted as mango fences	Pearl millet, sorghum and maize/cow pea will be planted between mango rows using improved agronomic practices[1].	Napier grass and legume shrubs to be planted as mango fence
Option 2: Planting of rows of high value food-feed trees.	Weirs 1-3	Moist to extremely moist and fertile soil	-	Planting rows of high value food-feed trees	Pearl millet, sorghum and maize/cow pea will be planted between food-feed tree rows using improved agronomic practices[1].	Napier grass and legume shrubs to be planted as food-feed fence
Option 3: Planting of rows of high value food-feed trees in upper two weirs and mango in the lower weir.	Weirs 1 and 2	Moist and fertile soils	-	Planting rows of high value food-feed trees	Pearl millet and will be planted between food-feed tree rows using improved agronomic practices[1].	Napier grass and legume shrubs to be planted as food-feed fence
	Weirs 3	Extremely moist and fertile soils	Planting rows of Mango	High value trees to be planted as mango fences	Maize/cow pea will be planted between food-feed tree rows using improved agronomic practices[1].	Napier grass and legume shrubs to be planted as food-feed fence
Pastoral settlements	-	Moderately moist and fertile soils	-	Planting rows of high value food-feed trees	-	-

Fruits: Mango, citrus and grape vine; high value trees: *B. egyptiaca* and *Zeziphus* spp., *Moringa* sp. Both fruits and high value trees to be planted with the support of Waterboxx.

Kelkelsa intervention watershed

The Kelkelsa intervention watershed is located on the lower portion of the Awra district. In the Kelkelsa seasonal river two major weirs constructed across the gully. Moreover, many dry stone water spreading structures constructed in the upper gullies close to the eastern hills. In the lower end of the weir 'islands of lake water' created. The surface water can stay from 8 to 12 months depending on the amount of seasonal rainfall and runoff. The deposited soils around the surface water is so deep and fertile, suitable for the cultivation of tropical fruits, vegetables, food-feed trees and feed. Unlike Lekora watershed, the Kelkelsa weir site is located deep in the valley bottom with less risk to wind damage to high value plants. The second water spreading weir structure is constructed at higher elevation than the first lower weir. The soil moisture and fertility status is relatively lower than the first lake weir. Up the weir water spreading structures, series of dry stone water spreading structures constructed. The soil moisture and fertility status of the dry stone water spreading structures is relatively much lower than the weir structures.

In the Kelkelsa intervention sites, variation in soil moisture and fertility gradient created along the watershed continuum: extremely moist (with water lake) and fertile soils in the lower weir to less moist and fertile soils in the dry stone structures towards the foothills (Table 5). This variation in conserved resources is useful to develop and propose context specific drought resilient livelihood options (Table 5) according to the drought resilient livelihood development approaches stated above. The lower portion of the watershed (weir 1) is highly suitable for mango orchards. Perhaps the Kent grafted mango produced in the Hamedo plain of the Mereb Leke district of Tigray might be suitable for this area. Private and Relief Society of Tigray (REST) produce and supply grafted seedlings of improved mango from the Hamedo plain. Between the rows of mango, different vegetables can be produced both for household consumptions and market. Last season, the pastoral women mange to grow and harvest onion through hand watering in the lower portion of the gully.

Most importantly, the huge surface water created in the lower portion of the watershed (weir 1) should be protected from siltation. In this regard, series of silt trapping measures has to be implemented up in the gullies: Napier and Rhodes grass planting across the relatively moist gullies; Cactus spear and agave across the dry gullies (Table 5).

Table 5. Proposed drought resilient interventions in the Kelkelsa intervention watershed, Awra district.

Water spreading structure	Moisture status	Proposed interventions				
		High value fruits	Vegetables	Food-feed trees	Feed	Others
Dry stones: towards upper portion of the watershed	Dry stone outside gullies: Less moist and fertile	high value food-feed trees	-	*Cactus* spear, high value food-feed trees	-	Agave sp.
	Dry stone across gullies: Less moist and fertile	high value food-feed trees	-	Cactus spear above the structured gullies	Napier grass up in the selected moist gullies;	
Weir 2: Middle portion of the watershed	Moderately moist to moist and fertile soils	Rows of mango in the moist spots	-	Rows of high value food-feed trees	Napier grass across the gullies	
Weir 1: Lower portion of the watershed	Extremely moist and fertile soils with surface water lasting 8 to 12 months	Rows of fruits (mango and citrus), Sugar cane around the banks	Leafy vegetables, onion and tomato, water melon with improved agronomic practices[2].	-	Napier and Rhodes grasses across the gullies.	
Peripheral sites of water spreading structures	Pastoral settlements			Rows of high value food-feed trees		

Fruits: Mango, citrus and grape vine; high value trees: *B. egyptiaca* and *Zeziphus* spp., *Moringa* sp. Both fruits and high value trees to be planted with the support of Waterboxx.

Tabiadora watershed

The Tabiadora watershed is located in Gulina district at the outskirt of the Kelwan zonal town. Ecologically, the the Tabiadora watershed is similar to the Lekora intervention watershed. In the Tabiadora watershed, there are four constructed water spreading weirs across the main gully. The Tabiadora watershed is generally in a gentle flat surface without hills as major sources of runoff. The intervention gully is with deep fertile soil supporting healthy looking natural vegetation. The four weirs stabilized and conserved surface water and fertile soils below and above the structures. The cover-abundance and green foliage or canopy cover of the annual and perennial trees were exceptional good. This may indicate the intervention watershed is moist and fertile enough to support the (re)growth annual herbage and foliage of perennial trees. This may further imply that the Tabiadora watershed can support drought resilient livelihood development according to the stated livelihood development approaches.

Though the weirs across the gully exceptionally holds high level of moisture and fertile soils, the relative water and fertility level of the weirs increased towards the lower portion of the gully (lowest in the upper weir 4 and highest in the lowest weir 1). The perceived gradient in resource conservation are useful to proposed drought resilient livelihood interventions (Table 6).

Table 6. Proposed drought resilient interventions in the Tabiadora watershed, Gulina district.

Water spreading structure	Moisture status	Proposed interventions			
		High value fruits	High value food-feed trees	Feed	Others
Weir 1: Upper portion of the gully	Moderately moist and fertile	-	Planting rows of high value food-feed trees	Napier and legume shrubs across the gully	Cactus and Agave planting across the upper portion of the gully to protect siltation
Weir 2 and 3: Middle portion of the gully	Moist and fertile	Guava and citrus	Planting rows of high value food-feed trees as fence to fruits	Napier and legume shrubs across the gully	
Weir 4: Lower portion of the gully	Extremely moist and fertile	Rows of mango	Planting rows of high value food-feed trees as fence to fruits	Napier and legume shrubs across the gully	
Peripheral sites of water spreading structures	Urban and pre-urban residence and public places	Fruits (grape vine, mango, citrus and guava) and high value food-feed trees			

Fruits: Mango, citrus and grape vine; high value trees: *B. egyptiaca* and *Zeziphus* spp., *Moringa* sp. Both fruits and high value trees to be planted with the support of Waterboxx.

Kebi-Agolo intervention watershed

The Kebi-Agolo intervention watershed is found in the Yallo district of the Afar region. The intervention watershed has unique topography compared to the other visited watersheds. The intervention watershed is surrounded by the Kebi-Agolo Mountains; potential sources of runoff water for the valley bottom weir structures. The Kebi-Agolo intervention watershed has three constructed water spreading weirs. All the weirs maintained surface water and fertile soils during the visit. The two weirs were constructed across the two different gullies and the third constructed between the two gullies. The first weir is constructed close to the foothills (weir 1), the second water spreading weir captures runoff water from the extended hills (weir 2) without a major gully, and the third weir is constructed across the gully that capture runoff of water from the mountains. The spatial positioning of the constructed water spreading weirs has created difference in soil moisture and fertility level around the command area. The third weir is extremely moist and fertile, suitable for the cultivation of high value food-feed trees, fruits and other feed sources. The weir holds surface water and currently serving as drinking water to human and livestock as well as for high value food-feed trees and mango seedlings planted below the weir structure. The second moist and fertile weir (weir 1) is capturing surface water and fertile soils below and above the weir structure. The conserved water is serving as drinking water to humans and livestock, and food-feed trees. The luxuriously grown food-feed trees below the weir structure also serves shade to newly born animals during the intense heat of the day, fallen leaves and pods are also valuable feed sources. The second weir is capturing water and fertile soil but lower than weir site 1 and 3. Based on the variation in conserved resources (moisture and soil), different drought resilient livelihood interventions proposed (Table 7).

In the first water spreading weir, rows of high value food-feed trees can be planted using the conserved resources. Cactus and Napier grass can be planted up the weir water spreading structure and across the gully to protect siltation and as food and feed sources. The planting of the food-feed crops should be supported with the Waterboxx EWST. In good rainfall seasons, pearl millet or early sorghum can be planted between the high value food-feed trees. In the second water spreading weir, rows of high value food-feed trees can be planted using the Waterboxx EWST. Up the weir structure, cactus can be planted as sources of food and feed crop. In the third spreading weir, fruits and high value food-feed trees as fence can be developed. Up the gully and weir site, series of Napier and legume shrubs planting rows can be planted for silt protection and livestock feed.

The planting of high value food-feed trees might be successful because the pastorals critically need water and feed/d for their livestock and the household consumption. Moreover, the supply of supplementation irrigation for mango fruits is needed during the extended dry period. Shallow well sources can be established around weir 3 and pumped to supplement the established mango orchards.

Table 7. Proposed drought resilient interventions in the Kebi-Agolo intervention watershed, Yallo district.

Water spreading structure	**Moisture status**	**Proposed interventions**			
		High value fruits	**High value food-feed trees**	**Feed**	**Others**
Weir 1: Constructed across the gully close to the foothills	Moist and fertile	-	Planting rows of high value food-feed trees	Napier and legume shrubs across the gully	Cactus planting up the weir and across the gully
Weir 2: Between weir 1 and 3 without a gully	Moderately moist and fertile	-	Planting rows of high value food-feed trees including cactus.	Napier and legume shrubs planting up the weir to protect siltation	
Weir 3: Constructed across the relatively big gully	Extremely moist and fertile	Rows of mango seedlings	Planting rows of high value food-feed trees as fence to mango	Napier and legume shrubs planting up the weir to protect siltation	
Peripheral sites of water spreading structures	Pastoral settlements		Planting of rows of high value food-feed trees		

Fruits: Mango, citrus and grape vine; high value trees: *B. egyptiaca* and *Zeziphus* spp., *Moringa* sp. Both fruits and high value trees to be planted with the support of Waterboxx.

6 Possible sources of planting materials

The list of possible sources of planting materials for fruit seedlings, high value food-feed trees and crops, and feeds is given in Table 8. Some of the sources of planting materials is communicated and their availability is confirmed.

Table 8. Possible sources of planting materials within and outside the Afar region.

High value fruit seedlings		
1	Mango	Public nurseries (Alamata) and similar ecology of Merebleke (Rama)-REST and certified private mango seedling producers. Seedlings from the Rama ecology might be more relevant for the intervention site.
2	Orange	Public and the upper Awash areas including Melkassa Research Center
3	Lemon	Public and the upper Awash areas including Melkassa Agricultural Research Center
4	Grape vine	Debrezeit Agricultural Research center and private seedling suppliers around Zewi
5	Guava	Found on many private and public nurseries (Alamata?)

High value food-feed trees and crops		
1	Cactus spear	Planting leaves of cactus can be collected from Raya-Azebo cactus sites. The cactus types most likely adapt to the proposed planting site.
2	*Zeziphus mourtania*	Available at Melkassa Research Center
3	*Zeziphus spina-christi*	Locally available
4	*Balanites aegyptica*	Locally available
5	Maize	Stay green maize from Melkassa RC and CIMMYT. Stay green forage maize could be an option for low moisture sites, source to be searched at ILRI.
6	Stay green forage sorghum	To be checked at Melkassa RC and ILRI
7	Cow pea	Werer RC and Melkassa RC, ILRI
8	Pearl millet	Melkassa RC
9	Groundnut	Werer RC, Mereb Leke district
10	Sugar cane	Cane planting can be easily collected from sugar cane farms in the Awash valley
Feed crops		
1	Napier grass	Werer RC, Tendaho/Mille farm for splits, and virus free materials from ILRI
2	*Salt bush (Atriplex)*	Helvatas Ethiopia, Mekele Branch and GIZ sites
3	*Leucaena leceacophola*	Werer RC
4	*Rhodes grass (Chloris gayana)*	Werer RC
5	*Lablab purpureus* cultivar Rongai	Werer RC, ILRI
6	*Sesbania sesban*	Werer RC

7 Improved agronomic interventions and cropping patterns

Agronomic practices: Different proven agronomic practices can be applied in the production high value fruits, food-feed trees and feeds. Seedlings of high value fruits and trees will be planted with Waterboxx EWST to improve sustainable seedling establishment and enhance water productivity. To implement the use of the Waterboox technology, 24 experts of relevant partners and GIZ staff in the intervention sites were trained on the technical use of Waterboxx EWST in Chifra, 23-24 August 2017. Moreover, improved agronomic practices that enhance early growth and effective use of conserved soil moisture will be introduced in the intervention sites particularly for plants growing without Waterboxx technology. The agronomic practices include seed priming (maize, sorghum and cow pea), transplanting of seedlings (maize, sorghum, Napier grass, Sugar cane and Rhodes grass).

For fast and early canopy cover and growth of primed seeds or transplanting seedlings, about 100 kg DAP will be side dressed. The DAP will be drilled into the planting furrows early in the morning and immediately covered with soil.

Improved cropping pattern and use of food-feed crops: In the field, maize and cowpea can be planted in land-use ratio of 4:1. That means in every four rows of maize there will be one row of cowpea. The maize can be planted in high population level than the normal plant population, about 40% higher than the normal maize population. About 40% of the maize plants can be thinned and fed to livestock in the first 6-10 weeks. In the next 10-12 weeks, the community can defoliate lower maize leaves selectively, up to 30-40% of the total leaves depending on the development stage of maize and soil moisture status. In case of moisture shortage, possibility of supplemental irrigation from the weir sites or other ponding water should be practices using motor pumps. Towards the end of the season, natural grasses could be an

option for livestock feed and the remaining maize stover and cowpea harvests can be stored in shades for the critical dry season feed. Similarly, Pearl millet and sorghum stovers can be harvested and stored in shades for the critical dry season feed.

The cutting of Napier and Rhodes grasses, and legume shrubs needs special attention. Following the establishment of the grasses and legumes, feeds can be harvested regularly. Depending on the supply of moisture and healthy growth of grasses and legumes, green feed can be harvested monthly. The harvested green fodder can be feed to milking cow or goat or camel. The remaining green feed should be dried under shade and stored for the dry season as feed supplement particularly to milking and fattened animals. In this way, the growth forage plants can be kept continuously at exponential growth pattern without wastage of carbohydrates for the maintenance of photosynthetically less active plant parts. The harvesting of forage at the end of the exponential growth period is also the maximizing of digestible portion of the feed.

In extreme drought cases, the pollarding of food-feed trees including *Zeziphus* spp., *B. aegyptiaca* and *Cactus* leaves might be an option to feed livestock. The cutting and pruning of perennial trees needs skill and knowledge of the users. Only newly grown leaves and twigs should be removed carefully not to affect the physiology of the trees or shrubs. For this purpose special cutting and pruning tools are required. The twigs should be remove from its mother tree in a slash manner against the sun. In this case healthy regrowth of browsing trees can be regulated in a sustainable manner.

Intervention in transition periods: While establishing the planting materials as food-feed and feed crops, there might be a need to have a transition livestock feed based on business model. In the Sugar farm of Tendaho, the leaves of Sugar cane are easily burned in the field. On the other hand, the leaves of sugar cane can be harvested, chopped and mixed with molasses to prepared feed-blocks. This could be a good job opportunity for youth in the area. The feed-blocks usually rich in energy can be sold at reasonable price to the pastorals in the intervention site. The intervention site is well connected to the sugar farms by asphalt roads. The implementation of this intervention needs the collaboration work of the BoPAD and decision makers.

8 Socio-economic interventions

Establishment of community bylaws and rules on protection and use of resources: The community should be willing and agreed to protect and use the communal resources properly. Agreed bylaws and rules should be developed by the community perhaps with the facilitation of the local administrators and extension service providers. The agreed community bylaws and rules should be approved and rectified by the district cabinet to have acceptance under the local legal system.

Strengthening and establishment of input supply and services: In the resources conserved sites, moisture may support crop growth for short. That means the supply of inputs is as urgent as possible

more than any agricultural systems in the intervention watersheds. Timely supply of inputs and associated services is essential for full exploitation of the conserved resources in support of drought resilient livelihood development of the community. Establishment of one main large nursery at the Awra irrigation schemes is proposed as main suppliers of grafted fruit seedlings, high value food-feed trees and feed planting materials. The water supply of the Awra irrigation scheme is gravity fed and year round water is supply is secured. In the nursery site pest and virus free planting materials can be introduced from reliable sources. For instance, reliable virus free Napier grass planting materials are found in the Forage Genetic Unit of ILRI. On the other hand, mother trees of fruit that could serve as sources of scion could be planted in the main nursery. For instance, disease free mango mother trees can be established in the nursery. The mother tree mango can serve as sources of scion for grafted mango seedling development. Until the mango mother tree is mature enough to be used as source of scion, grafted mango seedlings and citrus can be transported from other sources including from Alamata and the Mereb Leke districts. In addition to the main nursery at Awra, the strengthening and establishment of two supporting nurseries is proposed at Mille and Yallo. At Mille, there is small existing nursery located close to the perennial Mille River. The position the nursery is in the valley bottom suitable for protection of seedlings and planting materials from winds. The nursery has gravity fed constructed facilities which might need minor maintenance. The nursery is well fenced using Gabion. The nursery can be expanded to the lower side of fields to include the development of planting materials: fruits, high value food-feed trees and feeds.

The Yallo nursery can be established around the Meles Green Park site (or could be other unvisited better sites). The nursery should be based on reliable sources of groundwater and the Meles Green Park looks promising based on the lush green performance of the vegetation and sources of runoff. In the valley bottoms of the runoff or in the run-on Green Park, surface water is observed during the rainy season in some low lying spots, reflecting that shallow well development is possible. Using the shallow well, nursery development looks feasible. In the nursery suitable seedlings of high value food-feed trees and feeds can be developed. Perhaps water demanding high value fruit seedlings can be transported from the neighboring Alamata district.

Establishment and strengthening of rural credit and saving cooperatives is one of the essential elements to enhance the shift from subsistence to market oriented farming. The establishment of the credit and saving services could also enhance group marketing of input and output marketing of the community.

9 Targeting of beneficiaries

Targeting of the household types and household members is essential for speedy uptake of the drought resilient livelihood interventions. The targeting of beneficiaries should consider the culture and norms of the community and the productive working members in the households. In most cases, the women play a

decisive role in the Afar community. Similarly, the household composition is gradually shifted into relatively educated youth. In this case, targeting the women both women headed households and women in male headed households as well as the youth might be an option for speedy uptake of drought resilient livelihood interventions in the resource conserved watersheds. In cultures where targeting the women is not suitable, the husband and wife targeting might be an option in the drought resilient livelihood interventions.

10 Capacity development and knowledge management

For the successful transformation of the pastorals into drought resilient livelihood development in the resource conserved watersheds, the capacity development and follow up is critically useful element in the intervention. The mindset and attitude of the targeted beneficiaries should be won while introducing the livelihood interventions. Moreover, new drought resilient livelihood interventions will be introduced in a new environment (the pastoral community), the proper practice of the new livelihood intervention will take some time. Thus the close follow up and supervision of the support service providers is an important component of the intervention. In capacity development, priority should be given to women and youth, perhaps the husband and wife joint training might be an option. Training should not be class based teaching, 'business as usual'. Rather training should focus on the field work, learning by doing approach. While on training, clear communication between the trainer and trainees should be established. Often, inexperienced trainers or new graduate showed to use English words for non-English speaker pastorals. This type of training usually dilute the essence of the message and uptake of the proposed drought resilient livelihoods interventions may be delayed or become unsuccessful.

After practical field training, there should be continuous field follow up to support the practice of improved drought resilient livelihood interventions in the pastoral community. This is in fact training while doing. Encouraging awards to the best extension experts or agents, the pastorals or community could boost the uptake of the new livelihood interventions. The farmers to famer or community to community training can be continued as part of the training-follow up pathway. Simultaneously, within season interactive decision making power of actors and service providers should be strengthened. The uptake of the practical field training should be monitored, and the results should be used to modify and rectify within season and immediate capacity development actions and follow up measures should be taken.

Knowledge management: Agricultural development in the drought prone areas is incremental. New opportunities and challenges continuously emerged in response to market signals and demands. Accordingly, the actors and service providers of the livelihood interventions need to understand the dynamic changes in the drought prone agriculture. This is necessary to arrange proactive measures to use emerging opportunities and reduce emerging challenges. This part of the drought resilient actions to improve the livelihood of the pastoral community. Knowledge of the actors and service providers is key to

launch proactive measures in improving drought resilient livelihoods of the community. Knowledge management can be arranged at the expert and the pastoral levels. At the pastoral level, knowledge sharing events including field visits and tours, community to community sharing of ideas using platforms is necessary to adapt the new livelihood interventions. The pastoral community are culturally and traditionally excellent communicators in sharing information. This tradition of information sharing can be used for sharing of best practices and achievements in livelihood development; perhaps one of the best way even to shift further towards market oriented farming in using the conserved resources efficiently and effectively.

At the expert or service providers level (DAs and Subject Matter Experts), knowledge management is about proactive understanding of the dynamics of the recurrent drought and their impact on the community. Knowledge management is also about proactive measures to lesson drought impacts a head and plan drought resilient livelihood development interventions. This is the most challenging and knowledge demanding: the contribution to proactive drought resilient measures. In this regard, the knowledge of experts can be improved through increasing access to off-line and on-line information about drought resilient agriculture. Moreover, e-readers with thousands of literatures can be a handy access to information on drought resilient livelihood development. Accordingly, Agricultural Knowledge centers (AKCs) can be established at the Pastoral Agriculture Development Offices (PADO) of the districts and the BoPAD burea in Semera. The AKC can consist of relevant on-line and offline access materials, e-readers, relevant videos and TV screens. The experts may also visit successful drought resilient livelihoods within and outside the interventions for improved sharing of knowledge. After every visit, experts should review and compared the best knowledge gained with their own context specific conditions. Accordingly, modifications or improvement should be introduced immediately in the livelihood intervention sites. The dynamics of the changes and associated outcomes should be documented timely.

11 Prioritizing drought resilient livelihood intervention watersheds

Intervention watersheds can be prioritized for drought resilient livelihood development interventions following the stated livelihood development approaches, possibility for scaling out to other domain watersheds, access facilities and relative potential of the watershed and collaboration tendency of pastorals to implement and use the proposed interventions. Accordingly, the visited and described drought resilient livelihood development intervention watersheds were prioritized in two cycles. Within each cycle, the livelihood interventions watersheds also prioritized based on the above criteria and best educated guess of the evaluators (Table 9).

First cycle livelihood intervention watersheds	Ranking	Remark
Geriro-Taboi	1	Big watershed consists of dry stone and weir structures with clear conserved resource gradient along the watershed continuum; suitable for sharing achievements in a relatively good access in a high population area.
Kelkelsa	2	A high potential watershed for mango development in the valley bottoms where the concentration of water and fertile soil is prevalent.
Kebi-Agolo	3	A unique ecology with high variation in rainfall uncertainty, and high run-on opportunity to develop high value fruits and food-feed trees and feeds using the Waterboxx EWST.
Second cycle livelihood intervention watersheds	**Ranking**	**Remark**
Lekora	1	Perhaps the best testing site for livelihood development with a high uptake of achievements to scale out in the majority of the Awra plain.
Tabiadora	2	A unique watershed close to the zonal town and might be useful to test options for livelihood support in a disturbed outskirt of the urban and peri-urban towns.

References

FAO. 2013. Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Security Framework Programme. Emergency and Rehabilitation Division. Food and Agriculture Organization of the United Nations

Annex 1.
Field visit schedules and persons contacted

The field visit will take place from 4-10 September 2017 (Table 9). The visit will include discussion with Gerben van Ek, coordinator xxx and administrative matters in Addis, flowed by field visits and discussion with GIZ focal persons and staff in the GIZ intervention five districts in the Afar region.

Table 9. Time schedule for field visits to the GIZ intervention Afar region, 4-10 September 2017.

Date	Activity to be accomplished	Person(s) to be contacted
4 Sept 2017	Departure from Mekele to Addis and discuss with Gerben van Ek about the details of the program and finalize administrative issues in the GIZ HQ, Addis.	Gerben van Ek, Senior Expert-NRM/Project Manager IFTAR
5 Sept 2017	Departure to Semera, visit the Nation and Nationality Park. Discuss with Park coordinators about the design and intention of the Park; suggest on the use of Waterboxx EWST and planting pattern for attractive greening the Park scenery.	Jemal, GIZ Regional Coordinator and Park Coordinators
6 Sept 2017	Visit Chifra and Uwa districts and GIZ intervention sites; seedlings planted with Waterboxx.	With GIZ focal person and GIZ staff
7 Sept 2017	Visit Gulina and Awra districts and GIZ intervention sites; seedlings planted with Waterboxx.	With GIZ focal person and GIZ staff
8 Sept 2017	Visit Yallo district and GIZ intervention sites; seedlings planted with Waterboxx.	With GIZ focal person and GIZ staff
9 Sept 2017	Final wrap discussion with GIZ and BoPAD focal staff-most likely at Semera	
10 Sept 2017	Departure to Addis and Mekele	
14 Sept 2017	Draft report will be sent to the Project Manager IFTAR	Gerben van Ek