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Building Adaptation Strategies to Moisture Deficit on Farmer's Experience: Lessons from Rural Communities of Kobo District, Northeastern Ethiopia

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Abstract

The study endeavors to explore the response of farmers to subsequent soil moisture stress on cultivated fields in Northeastern highlands of Ethiopia in general and Kobo wereda in particular. A microcosm of drought prone areas, Kobo wereda of North Wollo Zone, was selected for the study. The socio-economic as well as the biophysical data that have relevance to the study were collected and both the local adaptive mechanisms and the external interventions were explored using questionnaire surveys, focus group discussions, key informant interview and field observations. For purpose of household survey, 180 households were taken from the selected Kebeles. Seen in this way, the study divulges into the pool of local adaptive practices, backed up by 'megabytes' of information, are /were practiced by farmers of the study Kebeles. These are agronomic, physical and biological measures. The measures are well adapted to local conditions and widely practiced by farmers. These on-farm adaptive mechanisms such as traditional ditches (feses), adjusting cropping calendar (early sowing, late sowing and response farming), weed heaping have been practiced and/or managed by the household. Other indigenous practices such as traditional waterways, traditional cutoff drain, flood diversion and others are also important adaptive mechanisms.From the study it has also been unpacked that farmers' decision to invest on adaptive activities and their choice of measures are challenged by several factors. Finally, the way forward of the study is that further studies should focus on adaptive mechanisms in the study area.

Keywords: Local Adaptive mechanisms, Soil Moisture Stress, Kobo Wereda.

1. INTRODUCTION

Rural Communities have varying degrees to cope with and adapt to environmental changes and variability for centuries (IPCC, 2008). For societies directly utilizing natural resources within livelihoods, changes in environmental elements (particularly climate) imposes significant disturbances and threats. This is modest of especially where changes may be significant and pervasive compounded by elements of surprise through the occurrence of extreme events. Most developing countries are particularly vulnerable to climate change impacts, especially changes in rainfall.

Embedded in this context, Nigist (2007) attested that Africa has more climate sensitive economies/ livelihood than other continents. It is characterized by a high number of rural dwellers who are directly dependent on natural resources by way of rain fed agriculture. Having a greater know-how in which technologies are embodied, communities (local farmers) in African countries widely appreciated to adapt to long-term changes in climate and other abiotic stresses. However, such changes like increased seasonal temperatures and altered pattern of precipitation make agriculture a risk enterprise. To the extent that the current and future environmental problems can be reversed, research on ways to increase local adaptation is valuable.

Owing to the long history of early settlement and agricultural cultivation, areas of northeastern Ethiopia are suffering from an extreme degree of land degradation and variable rainfall at different spatial and temporal scale (Ataklite, 2002). In essence, the combined effect of biophysical elements and socio-economic dimensions result in soil moisture deficit which are chronic problems of agricultural production in the area. Moreover, weed competition, pests and diseases are momentous constraints in dry land areas of Ethiopia in general and in Northeastern Ethiopia in particular (Kidane et al, 2001). In this regard, there is no exception for Kobo wereda which is one of the drought prone areas in Ethiopia.

Thus, in response to this urgency, the trust of this study is unpacking the local adaptive mechanisms to moisture stress and external interventions as well as assessing the interface between these, focusing on cultivated fields in Kobo area, which is typical of most dry spell and moisture stress areas of Ethiopia.

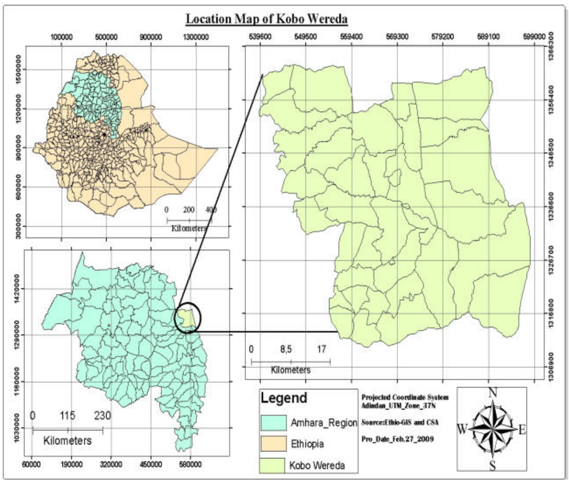
The objectives of the study are, therefore, (a)To investigate local people's perceptions on soil moisture stress (b)To explore local adaptive mechanisms by the local people to the dry spell and moisture stress

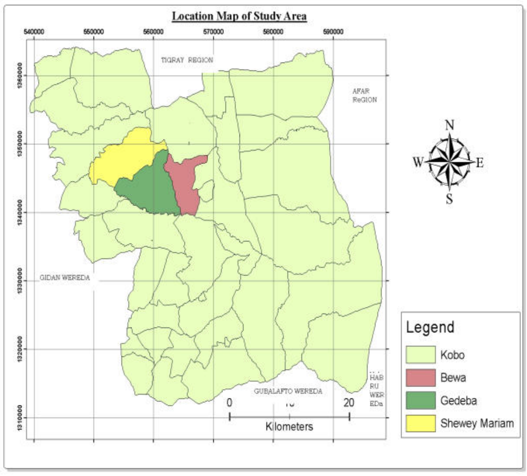
2. Materials and Methods

2.1 Description of the Study Area

The study area at hand is located in northeastern tip of Amhara region, Kobo Wereda. It is hemmed in Tigray region in the north and northeast, Afar region in east, Gidan Weoreda in the west, Gubalafto wereda in the south. It is about 570 Kilometers northeast from Addis Ababa astride on the high way from Addis Ababa to Mekele.

Map 3.1 Location map of Kobo wereda in Ethiopia





Map 3.1 Location of the study kebeles in Kobo wereda.

Rivers draining in the study area originate in the western mountains and most of them flow to the east across the plain, and finally to the Afar depression through a number of narrow outlets (KGVDP, 2002).The main rivers are Diqala, Hormat and Gobu. There are also several intermittent streams. Due to lower physiographic position and high run off as well as escarpments, the low lands receive fresh sediment regularly and suffer from frequent seasonal flooding and water lodging (Teshale, 2003). Moreover, seasonal streams are the dominant drainage elements in the study area and enhance potential for development under flood irrigation

According to the geology report of KGVDP (2000), the study area is mainly constituted by basalt and recent sediments. Basaltic rocks of different formations in the escarpment Zone (upland part of the study area) are dominant rock types. This may be due to the extensive faulting and rifting during the development of the Great East Africa rift system.

Furthermore, among the different factors that affect type and distribution of soil climate, vegetation geomorphic processes and geology of a region are the prominent ones (Biru, 2003). Accordingly, soils of the study area developed on recent alluvial sediments derived from the adjacent mountain ranges in the low- lying parts of the catchments.

2.1.4 Climate and agro- ecology of the study area

The study area has two main climatic (KGVDP, 2002). These are Warm temperate rainy and hot dry climate. The rainfall is usually bi-modal i.e summer main rainy season and winter small rainy season (but not usually as well as sufficient). The rain fall amount varies spatially from 600 mm around Kobo (eastern part of the study area) to 850 mm at Shaway (western part). The same report indicated that the average number of days per year in which the wereda gets rainfall is about 59 in summer season (that is based on 18 years climatic data).

Closely related to this, Kobo wereda in general is found in the woina dega and moist qolla agro-ecological zones. In this vein, the kebeles under study are located in the lowland agro-ecological zones (Bewa) and woina dega (Gedeba and Shaway). In the woina agro-ecology zone, population density is very high and shortage of land is critical. Moisture stress is the major agricultural production constraint (KGVDP, 2002).

Table 3.1 Area coverage of agro-ecological zones of Kobo Wereda

No.	Agro-ecological zone	Elevation (m)	Area(sq.km)	Area coverage (%)
1	Dega	2300-3169	147.87	5.74
2	Woina dega	1500-2300	1720.94	66.79
3	Qolla	960-1500	707.64	27.47
Total			2576.0	100

Source: KGVDP, 2002

2.2 Research Methodology

2.2.1 Nature and sources of data

Keeping in view the intent of the study discussed at length above, both quantitative and qualitative information have been collected using Participatory Research Approach (PRA) tools as the main techniques of data collection. Virtually, research in adaptation is actor oriented (Adger et al, 2007).Thus, information on perception and experience of different groups (past and present) and external interventions are gathered and examined. In connection to this, responding strategies to soil moisture stress by rural households have been assessed through household survey.

In sum, both data of primary and secondary nature are collected from public and private, collective and individual as well as governmental and non-governmental actors of rural livelihood in the study area.

2.2.2 Methods of primary data collection

The use of various sources of data and methods of data collection (interview, FGD and observation) ensures the necessary rigor and reliability to the finding of the study. In essence, some of the key means and sources of primary data collection are highlighted as follows.

I. In-depth interview- This was carried out with various segments and members of community, Development Agents, heads of local institutions, and other resource persons were interviewed to generate historical information about coping strategies to drought and famine. It was conducted in order to obtain aggregate data on local adaptive mechanisms by farmers. All the interviewees are taken with their own consent.

II. Focus Group Discussion-This was held to gather information pertaining to controversial perceptions on practices and constraints as far as local adaptive mechanisms is concerning. As described earlier, the study area comprises three *Kebeles* of the wereda namely *Shaway, Gedeba and Bewa.* In line with this, three groups were organized for the discussion purpose. In addition, a focus group discussion was organized at the wereda level which is made up of different experts and official for the issue under consideration. Thus, in each group subsequent discussions were made with the help of checklist prepared and different triangulating issues were considered. Each group had a minimum of 7 (seven) members.

III. Household interviews – This was carried out on local adaptive mechanisms (generic and case-specific) to complement the information collected by other methods. A range of issues such as socio- economic and demographic characteristics, problems and priorities as well as adaptive practices, (on and off-plot activities) aspects of livelihood induced by moisture stress were raised during interview. In doing so, structured questionnaire (which is translated into local language; *Amharic*) is used. To administer the questionnaire, enumerators were recruited from locality based on a set of criteria i.e familiarity with the sample households, educational level and willingness. Briefing and training sessions for the enumerators were held at Shaway and Kobo (administrative center of the wereda)

IV. Field observation-Plot level data such as exposure, slope, soil type, and their implications were collected. In addition, the prevailing biophysical and socio-economic contexts at local level in which the issues of the study are embedded were themes of the field observation. The study was also flexible enough to accommodate evolution of ideas and refine understanding as the research works proceed. Field observations were also backed up by snap shot photographs and informal discussions with the local dwellers.

2.2.3 Sampling procedure

Most studies associate adaptation to climate change with drought prone localities of different spatio-temporal scale. Thus, Kobo wereda, one of the most drought prone districts in the Amhara National Regional State is selected as the study area with the assumption that it would make sense in this respect. In relation to this, the main purpose of this study is to generate information about the coping strategies of smallholders to moisture stress which has versatile repercussions.

In view of this, three *Kebeles* are purposely selected among the total 36 kebeles in the wereda. This is in the wake of combination of reasons such as proximity to the wereda administrative town, prevailing adaptive activities, agro-ecological setting, and existing knowledge of the researcher. This was also possible through utilizing data about the biophysical and socio-economic contexts from different division of WARD and KGVDP offices. Therefore, Shaway (about 27km west), Gedeba (about 17km west) and Bewa (about 9km west) of the administrative town (Kobo) are selected based on the assumption that these sites will suit the intent of the study.

In that sense, Shaway and Gedeba are representatives of upland part of the wereda (which has spatial coincidence with woina dega type of agro-ecology) with an altitude of more than 2000masl.Whereas Bewa is typical of plain cropping zone which is characterized by qolla type of agro-ecology (KGVDP, 2002).

In this vein, the general sampling procedure of the study involved multistage sampling. First, the study area was stratified based on local agro- ecological zones (woina *dega* (cool sub-humid) and qolla (warm semi-arid).This was done based on the sources from the wereda Agriculture and Rural Development office. To this end, as already pointed out, three kebeles were included in the study. In order to get an access of individual household samples, the sapling procedure is stretched out by utilizing the further subdivision of the kebeles into their respective sub-kebeles (‘gots’) Thus, sample households for household and individual survey were selected based on stratified sampling. To be more specific, at the lowest levels of [[[[[[[[[

Finally, the sample size from each levels of stratification (kebeles and ‘gots’) was determined in proportion to the total number of the households dwelling there, by using systematic random sampling, on the list of farmers for levying land tax. In this fashion, from the total households of 3561, in the study area, a total sample size of 180 (about 5%) was drawn for the purpose of the study. This is the maximum possible sample size, considering the time, financial availability and the nature of the study. In addition, the subjects of key informant interviews, Focus group discussions and participant observations were selected using purposive sampling techniques. The groups included were elders' group, female household head group and community representative groups.

2.2.4 Methods of data analysis

The data that are collected from the different sources has been analyzed both qualitatively and quantitatively. In-depth case analyses and metaphors are important qualitative data analysis methods in the study. Miles and Hubberman (1984) contend that metaphors are effective qualitative data reducing, pattern making devices and ways of connecting findings to the theory. In connection to this, recognizing the relevant themes from the bulk of qualitative information and combining very important tasks in looking for meaning and interpretation is the rigor of qualitative data analysis. Embedded in this scheme, the information in the form of text, field notes (consists of metaphors, proverbs and life stories) are sorted, examined and versed under the relevant themes. To this end, emphasis is given to the information about groups and individuals understanding, feelings, and aspirations and interpretation about soil moisture stress and their response as well as external intervention. Finally, selected household stories are reported as they are pointed out in the form of extended quotation and subsequent implications have been derived.

In addition, descriptive statistics (ratio, percentage, mean, standard deviation, range) and coefficient of variation have been employed to analyze and characterize the different adaptive technologies and process with respect to the different strata of the study area and informants. Finally, softwares like Arc-GIS (Version 9.3) and excel are employed to generate processed date from the raw information.

3. RESULT AND DISCUSSION

3.1 Crop Production and the Farmers' Perception on the Impacts of Moisture stress

Crop production is one of the most important activities in the farming systems of the study area where mixed type of farming system is practiced. The major types of crops cultivated in the area include teff, sorghum, barely and pulses. The types of crops grown by sample farmers are sorghum with teff, sorghum with millet, and sorghum with oilseeds. Among the dominant crops grown both in the lowland and midland are teff and sorghum with different crop calendar. More importantly, the impacts of soil moisture stress as well as soil conservation were discussed with the sample farmers with respect to production trends for the last 5-10 years. Farmers generally have developed experience about the effects of variable rain on crop yields. In the evaluation of crop yield trends at plot levels, farmers use four major trends viz. increasing, decreasing and no change. A farmer might have observed different crop yield trends on his plots depending on the microclimate, location, soil fertility and availability of inputs. However, the trend is pertinent to only for the plot included in the sample for the study. In connection with this, in the qolla agro-climatic zones of the study area, 72% of the respondent farmers reported the decreasing of crop yields and the other 28% reported the no change trend of yield. In the midland alone, plots with a trend of yield decreasing accounts for 85 % while a no change trend was reported by 15 % as a result of soil moisture stress and related factors.

Unlike in the low-lying area a trend of high fluctuation in crop yields is experienced in the midland due to not only the erratic nature of rainfall but also to frost particularly during the last period of harvest season. The key informants also mentioned that reduced size of holdings owing to population pressure and the reduction of soil fertility are blamed for decreasing of crop yield. Intensive cultivation without SWC, non-fallow practices, due to shortage of land was reported as factors contributing to persistent crop yield decline. The effects of erosion on systems of crop production are also discussed with the sample farmers. However, assessment of the impact of erosion on crop production is further complicated by the dynamic nature of agriculture. If yields are falling, farmers are unlikely to stop growing a crop until yields drop to negligible levels. However, farmers respond to long-term decline in yields by adjusting the level of inputs used and/or by adapting the cropping system. As soil moisture stress proceeds farmers are likely to switch to growing crops that are less sensitive to the effects of moisture stress that have short growing period (e.g *Bunign teff*).

3.2 Farmers' Perceptions on Biophysical Characteristics of Plots

These are climatic extremities (particularly drought), pests and disease and in some cases flooding and water lodging. In effect, a number of informants put blame on these challenges in combination and individually for the decline in agricultural production on biophysical and socio-economic in nature. There are several reasons why the farmers' perspective is utmost importance and relevant for the study under consideration. Some of them are as follows:

First, decisions about land use and conservation activities are ultimately made by the farmers themselves and not by social planners or government agencies. Farmers decide how to use their land in light of their own objectives, production possibilities, and constraints, not on the basis of any theory of the social good

(Place, 2002). For the development and expansion of viable conservation technologies, it is indispensable to understand incentive systems and room for maneuver. Understanding the priorities and problems individual farmer faces is necessary, therefore, to understand patterns of resource use and to formulate appropriate responses to problems.

Second, natural resource use problems generally depend heavily on site-specific biophysical and socio-economic characteristics, which can vary significantly even within small areas such as plot or as large as watershed. Third, as more than 90% of the economically active population is employed in agriculture(KGVDP, 2002), farmers generally have different problems, resource endowments and socioeconomic backgrounds, their strategies for resource allocation could be different. These differences may help to design development policies and strategies best suited for different situations on the basis of the individual plot owner that takes the ultimate decision on the way the agricultural land is to use.

Therefore, a farm-level approach places the emphasis firmly on micro-level insights on farm productivity and their impacts on the livelihood of farming communities at large. In the Kobo area, where substantial proportion of people (more than 90%) depends directly on agricultural production, moisture availability dictates productivity. Hence, considering on-site adaptive mechanisms at the plot level is appropriate. Farmers decide on whethe*r* or not to invest and how much to invest, according to their objectives, resource endowments (land, labor and cash) they possess and the constraints they might face. In this vein, the land users who, through their selection of technologies, farming systems, and management practices etc., determine the rate at which technologies are profitable and/or sustainable. Moreover plots are focal points where data are usually available that allows an assessment of several biophysical and socio-economic contexts for viable production can be pointed out.

3.2.1. Perception on size and fragmentation

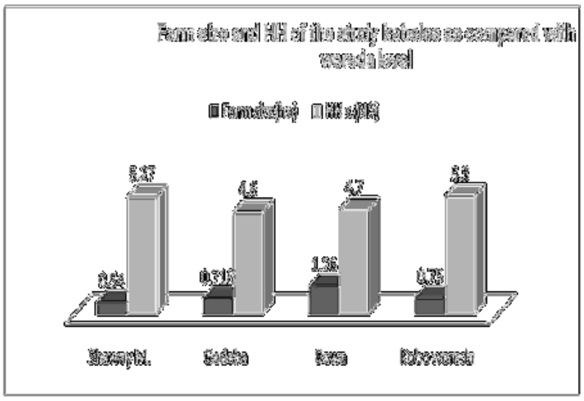
The size of land holding per household in Kobo area varies in response to different factors. Available information uncovers that the average land holding size in the plain and mountainous area is greater than one hectare and about 0.65 hectare respectively. Similarly, a study conducted by Ethio-Danish program in three Kebeles of Kobo Wereda (Kobo Zuria, Koba, and Dino) came up with the average land holding size 1.60 ha,0.50 ha and 0.61 ha per household respectively. In other words, Kobo zuria is plain and the other two kebeles are mountainous and hilly. Fore example in Koba kebele,the rugged topography is about 28%,arable land is about 12% and lastly 60% is to be hilly.

In consonance with this, the present study reveals varied pattern in land holding size. Accordingly, the average land holding size for the three kebeles is 0.76 ha which is almost similar to the average size of the wereda found out by the WARD office (0.75ha).However, variation is vividly observed between the selected kebeles accounting 0.54 ha, 0.716 ha and 1.26 ha for Shaway, Gedeba and Bewa (with plain topography) kebeles respectively.

<0.5	24	33.8	18	26.48	5	12.20
0.5-0.75	41	57.75	27	39.72	9	21.95
0.76 -1.00	6	8.45	17	25	9	21.95
>1	0	0	6	8.8	18	43.90
Total	71	100	68	100	41	100

Source: Field Survey, Kobo; January, 2014.

From the table above, it is vivid that there is no similarity of distribution of land holding size among the kebeles of different topographic make up and agro-ecological setting..In fact, most of the household particularly in the woina dega area have smaller size of land than in the qolla area as already pointed out. In essence, in Shaway and Gedeba 39.72% and 57.75% of the respondents have landholding size between 0.5 and 0.75ha ,which is less than the wereda level size) per household respectively. In the contrary, in Bewa (plain area), greater share of the respondents (43.90%) have more than one (>1) hectare. This has its own ramification on the conservation activities of households on their farmland.



Note: source for the wereda data is KWARD office, 2014.

Figure 5.3 Comparison of Farm size and HH size of the study kebeles in relation to the wereda level.

In this respect, there are bifurcated views on the relation between farm size and conservation activities. In relation to this, Aklilu and Graaff (2007) attested that households with larger farm size are able to invest more on conservation activities considering the farm size as household production asset. In addition, households with smaller holding size are found to use different moisture conservation activities under the scheme of intensification.

Land fragmentation is another variant of plot characteristics which has its own repercussion on farm operation in general and adaptive measures to moisture stress in particular.

Table 3.2 Average number of plots and average plot size of sample households by agro-ecology

Description	Shaway (n = 71)	Gedeba (n = 68)	Bewa (n = 41)
Average size(ha) (1)	0.54	0.716	1.26
Average number of plots (n) (2)	2.75	2.43	2.19
Average plot size (ha (½)	0.196	0.29	0.60

Source: Field Survey, Kobo; January, 2014..

Table 3.2 reveals that the extent of land fragmentation as one plot character in the study area. In Bewa that is in the plain Kebele the average size of a plot of a household is 0.6 ha, whereas in Shaway it is 0.196 ha and for Gedeba it accounts 0.29 ha. This implies that there is more fragmentation of plots in Shaway (in the mid land of the study area) than in Bewa. Regarding the physical setting, topography is predominant factor. The use right transfer or land inheritance and frequent redistribution amongst household heads and family members to assure equity and fairness is also major cause of land fragmentation.

Several studies take up land fragmentation in Ethiopia is a deterring factor for the improvement of land productivity particularly for management requirements of land quality. Similarly the household survey points out there are much more fragmentation of cultivated fields in kobo area. Respondents opt differently regarding the repercussions of plot fragmentation. In essence, about 29 % of the survey households contend plot fragmentation as a risk aversion strategy in times of crop failure and as a means for crop diversification since it gives the opportunities of using different micro-ecologies. For these farmers, more fragmentation implies more crop diversification, access to soil fertility improvement, better sources of available fodder, and more income generation, minimum risk of pests and diseases outbreak.

On the contrary, most of the households argued in transgress to the above views. They stated that fragmentation makes management of land resources and performing different on -farm conservation activities. In addition, because of the substantial productive time and labor lost in walking or transporting inputs, tools and yield back and from one place to another, fragmentation of plot has a negative effect. This is illustrated by the following case material.

Several repercussions can be pointed out regarding the effect of plot fragmentation. For example, I have three plots. Each of the plot farm lands are far apart about 40 minutes on foot walk each other. Owing to this, the most important problem is the utilization of agricultural inputs including labor for conservation on cultivated fields. Invariably, there is labor shortage in my household and one of my plots is located in areas in which monkeys attack the crop. Due to this, I am not in a position to manage my farm land and get the optimum return of the investment on the agricultural activities. In addition, this deters soil and water conservation activities on my plots (In-depth interview 9, Shaway, 2009)

Moreover the following table substantiates the above case material.

Table 3.3 Comparison of selected on- farm local adaptive practices to soil moisture stresses on *Yebereha meret* and on *Wejed meret* (multiple responses were given*)*.

Adaptive practices	*Yebereha meret* owners(n=90)		*Wejed meret owners*(n=90)	
	Number	%	Number	%
Late/early sowing	86	95.55	85	94.44
Weed heaping/mulching	79	87.78	23	25.56
Rain water harvesting	29	32.22	65	72.22
Flood diversion	32	35.56	58	64.44
Boy *feses*	11	12.22	47	52.22
Manuring	0	0	21	23.33
Composting	2	2.22	14	15.56

Source: Field Survey, Kobo; January, 2014.

Table 3.3 above shows comparison of selected on- farm adaptive mechanisms on *Yebereha meret* and *wejed meret*. In essence, crop adjustment adaptive mechanisms to soil moisture stress (early/late sowing) are practiced almost in equal extent on both *yebereha meret* (usually plots about 30-40 minutes walk away from the homestead) and *wejed meret* (plot that are nearby the homestead).Turning to the physical structure and fertility enhancing mechanisms, by virtue of their labour intensiveness, there is significant variation between the two categories of plots. For example, there is no respondent who use manuring in his/her yebereha *meret* but to some extent there is in the *wejed meret* (15.56%).

In sum, twofold ideas can be understood from the table and the case material. Firstly, land fragmentation determines the application and practices of adaptive mechanisms on cultivated fields. Secondly, distance of a plot from the homestead dictates on-farm SWC activities.

3.2.2 Perception on slope and soil fertility of cultivated fields

The basic resource for rural life in Ethiopia, both for crop and livestock production is land. Thus, in issues dwelling on land resource management there is urgency of proper and accurate consideration of the farm characteristics. In connection with this, in most rural Ethiopia, there is the challenge of accurate measurement of these characteristics i.e. soil fertility, slope, exposure, and stoniness, vicinity land use (up slope and down slope) (Mesfin, 1991). In response to this, one of the possible ways to deal with such matters is the farmers' perception by way of providing a scale of perceptual measurement. In consonance with this, determinant farm characteristics for production and moisture conservation activities are sorted out and provided for sample households in order to enrich the information gathered through the focus group discussion and key informant interview.

The first farm characteristics considered here is slope of the plot. Slope is by no means constraining farm characteristic of production and plot management particularly in hilly areas.In this regard, sample households were asked to state steep, medium and gentle to explain the repercussions on moisture conservation and utilization.

Table 3.4 Distribution of sample households based on perception of the slope of their farm land (plots)

Description	Shaway(n=71)		Gedeba(n=68)		Bewa(n=41)	
	No	%	No	%	No	%
Steep (>29%)	20	28.16	18	26.47	0	0
Medium ((12-30%)	42	59.15	32	47.05	12	29.26
Gentle (<12%)	9	12.6	18	26.47	29	70.73
Total	71	100	68	100	41	100

Source: Field survey, Kobo; January, 2009.

Note: *The measurement of the slope is estimation of the researcher during field observation*.

It is quite clear from table 3.2 above that variation in slope of plot across the strata(kebeles of different topographic make up).Accordingly ,majority of the respondents (59.15%) in Shaway (the midland Kebele) perceive the slope of their plot medium and significant (28.16%) of them responded their plot characterized by steep slope. A careful examination of the table above also reveals that the distribution of the respondents under each description of the slope for Gedeba is similar to that of Shaway. This is definitely due to similarity of their topographic setting. However, a remarkable difference is observed for Bewa (plain kebele).To this end, the overwhelming majority of the respondents perceive their farm land in characterized by gentle slope, and ultimately there is no one perceives their land his / her plot is steep.

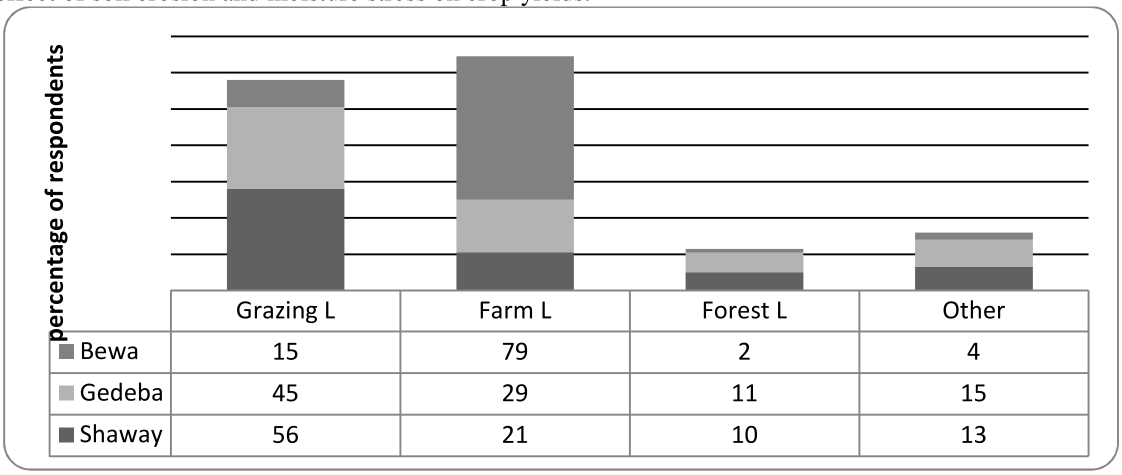
Regarding slope, when households respond to the question to the effect of slope of the upslope of their plot on their cropping pattern, they described how they select different crop types not only based on the slope of the plot but also the slope of upslope area. In that respect, it has its own repercussion on the water availability and soil formation as well as type of the plot under consideration. Slope has also proximate effect on the soil type, depth and stoniness of the plot. Therefore, farmers in the study area select certain crops depending on the type the soil they identified, the relative dampness and dryness of the soil and the slope of the land, being other things constant. This also dictates the soil type, sedimentation on the cultivated land and soil moisture availability and retention.

Table 3.5 Slope of upsland areas of sample plots in view of sample households.

Description	Shaway		Gedeba		Bewa	
	No	%*	No	%*	No	%*
Steep (>29%)	35	49.29	25	36.76	7	17.07
Medium (12-29%)	21	29.57	36	52.94	9	21.95
Flat (<12%)	15	21.12	6	8.8	25	60.97
Total	71	100	68	100	41	100

Source: Field Survey, Kobo; January, 2014.
*may not add up 100 due to rounding
Note: *The measurement of the slope is estimation of the researcher during field observation.*

It does seem safe to contend, thus, that most of the farmers are aware that the crop yields decreased rapidly if cultivated land is sloppy and used continuously for more consecutive years. This implies that farmers understand repercussion of slope that has resulted in the initiation and application of the conservation activities to mitigate the effect of soil erosion and moisture stress on crop yields.



Source : Field Survey, Kobo; January, 2014.

Figure 3.2 Land use/ cover type of the upslope area of the sample plots.

In addition, the nature of slope the upslope area coupled with the type of soil in the same site affects the nature of the soil on the cultivated land. Specifically, if the slope of the upslope area is steep and at the same time the soil type is *guzil(borebore)*[1] that plot will be affected by sedimentation of that infertile soil and the moisture availability in turn will be deficient.

There is also Farmers Training Center (FTC) used as center of disseminating and exchange of knowledge and experience. Development Agents (DAs) contact farmers on individual basis; though all farmers are not teamed up in the demonstration and dissemination of innovative technologies for adaptation to soil moisture stress (see plate 3.1)

[1] guzil(*borebore*) is local name of skeletal soils usually on the hillside area affected by serious soil erosion and land degradation.

Plate 3.1. DA from Shaway Kebele giving explanation about soil bund on cultivated fields.

The predominant areas of external intervention enriching the local adaptive activities by way of small scale irrigation, SWC activities, soil fertility management at plot level (i.e encouraging preparation of compost) mobilizing and participating in productive safety net program(plate 3.2).

Plate 3.2 Empowering traditional and small scale irrigation by development agent in Gedeba Kebele

Plate 3.2 depicts one of the entry points of blending the indigenous technology of effective utilization of soil moisture for high value variety of crops (coffee) in the one hand and the modern skill and knowledge in the other hand. Similarly, there are numerous entry points and activities in which extension service are disseminated in the arena of SWC on cultivated plot of the local people.

These are rain water harvesting, flood irrigation, river diversion, soil bund, stone bund on cultivated fields. Locally named as '*bahr sheshi'*, is an important plot of crop production after the offset of regular rain. The rain water harvesting structures are micro pond and trapezoid Geomembrane (a volume of about 60 meter cube)(see plate 3.3 below).Turning to the effectiveness of such structures these are neither effective nor sustainable. First it evaporates prior to utilization. Second, it is not much accepted by farmers, in the wake of its negative side in that animal sink and breeding ground for insects like mosquitoes. On broad count, farmers came up with the view '*danger without pleasure'* or '*fashion without function*' as far as trapezoid geomembrane is concerned in the study area. The other physical structure of soil and water conservation on cultivated crops are soil bund which are constructed by both farmers themselves and external intervention such as safety net program.

Plate3.3. Land preparation for nursery by means of potting irrigation.

As it is pointed out in the focus group discussion of the expert's soil bund construction, tie ridging, stone bund construction and improved tillage are some of the important mechanisms of moisture retention at plot level (see plate 5.5 below)

3.4 Local Adaptive Mechanisms to Moisture Stress in the Study Area

In the previous section an attempt is made to assess the external interventions in view of the local people and selected experts. This section takes up local response/ adaptive mechanisms being carried out by the local people to moisture stress. It looks into what the local people are actually doing to adapt or cope with the abiotic stress under consideration. In this vein, two key questions will be addressed. These are (i) what are these adaptive mechanisms and (ii) how effective are the existing coping strategies given the mounting problem in the study area.

In essence, traditional RWH practices including moisture conservation, flood diversion and spreading as a substantial element of the farming system, constitute a determinant factor of agricultural production in low-lying part of the study area. Therefore, agricultural production and productivity in the area is dictated by the mutual complementarities of several practices of moisture conservation.

In consonance with this, a number of key informants in the study area pointed out their indigenous adaptive practices and follow dynamic strategies based on the event of abiotic stresses. For example, farmers employ response farming in their locality when there is unexpected rain fall both spatially and temporally.

Table3.4 Predominant on-farm adaptive mechanisms to soil moisture stress

Category	Adaptive mechanisms	No	%
Adjustment in cropping calendar and pattern	Late/ early sowing*	130	72.22
	Use of resistant crops*	121	67.22
	Use of response farming*	60	33.33
	Use of early maturing varieties of crops*	97	53.88
Water management	Soil moisture control	85	47.22
	Rain water harvesting	30	16.66
	Small scale irrigation*	20	11.11
	Flood diversion*	12	6.66
Physical structures	*Kitir*	115	63.88
	*Boy feses**	89	49.44
	*Dib**	163	90.55
	*Shilshallo**	147	81.66

Source: Field Survey, Kobo; January, 2014.
*Typical local adaptive mechanisms by the respondents (=180: multiple responses were possible)

Most of the on-farm adaptive mechanisms listed in the above table are carried out by lion's share of the respondents. To point out some of them*, dip, shilshallo*, *Kitir* and soil moisture control are practiced by 90.55%, 81.66%, 63.88% and 47.22% of the respondents respectively. Coming back to the crop adjustment, particularly using crop varieties, the number of respondents is relatively small. This is because it is a function of the socio-economic status of the household to afford seeds of these varieties. This implies that, not all the households are not equally affected by the problem and they have no equal resilience.

On broad sense, due to fluctuation and uncertainty of rainfall and its uneven distribution over space and time, many of the respondents argued that improving soil moisture availability through different structures is important (see appendix IV). Respondents' experience shows that these adaptive mechanisms long existence.

However, their effectiveness is dubious.

4. CONCLUSION

Agriculture is the main stay of the rural Ethiopia. However, it is backed up by environmental degradation and stresses as well as mis-use of resources those ramifications on the food security and sustainable use of natural resources in the country. Among others, poor soil moisture conservation and erratic rainfall are the major causes of moisture deficit in Kobo area (KGVDP, 2002). Closely related to this, Temesgen et al (2008) posit moisture availability is the major determining factor for agricultural production in the Kobo wereda.

Apart from crop failure, moisture stress in Kobo area has repercussions in light of unpacking the perceptions of the local people. In essence, it negates the use of improved agricultural inputs like fertilizer. A rival substantive explanation about the consequences of moisture stress is that, it results in the occurrence of disease and pests like army worm and others. However, this needs further and independent research. Farmers have also their own way of characterizing plots and soils of their cultivated fields as well as the environs on local bases and relate to the moisture availability and retention capacity. There is pool of indigenous knowledge and practices of apt use of the available soil moisture. Farmers are aware that shortage of soil water is the most formidable challenge to the sustainable use of land resources in general and crop production in particular. Therefore, soil moisture conservation practices are coined with the survival community. In this respect, the commonest adaptive mechanisms to soil moisture stress are crop adjustment (early/late sowing, sowing moisture resistant crops), rain water harvesting practice and physical structures like *Shilshlo, boy feses, soil bund and kitir.* These local adaptive innovations to soil moisture stress constitute to be useful because they are simple, flexible and based on long experience of local conditions related to cultural and environmental components.

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