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Determinants of Adaptation to dry Spell in the Context of Agrarian Economy: Insights from Wollo Area (Kobo district), Ethiopia.

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Abstract
Climate change cannot be totally avoided. Hence, adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts is paramount importance. This is a function of processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. In this vein, the study endeavors to investigate the determinant factors of adaptive practices to dry spell in the agrarian society of wollo area (Kobo district), Ethiopia. It involves unpacking adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. In doing so, a survey of about 363 farmers has been conducted considering the issues of factors affecting adaptation to climate change in the study area. The study divulges that the external interventions that are currently introduced into the study Kebeles are SWC measures (check dams, artificial waterway and geomembrane) and artificial fertilizers are among the fertility enhancing measures. These measures are found to be incompatible to the farming system, labor intensive and high external input dependent. Concerning, the artificial fertilizers high price, lack of credit service and untimely supply are found to be the major constraints. In response to this, the complimentarity of both groups [local and 'conventional'] measures should be assessed. And then, by taking a lesson from this, the measures can be purposefully complimented for a better end.

From the study it has also been unpacked that the adaptive capacity of farmers is challenged by several factors. To be more specific, land holding size, land fragmentation, plot characteristics, land ownership security, size of livestock, labor availability and production assets availability are predominant factors affecting farmers' adaptive capacity.

Finally, the way forward of the study is that Indigenous ecological knowledge of farmers in the study area should be assessed through further studies. Besides, their complimentarity to the external interventions should be disclosed in order to exploit the opportunities provided and renovating the local adaptive mechanisms.

Key Terms: Adaptation, Agrarian economy, factors of adaptation, Wollo area

1. INTRODUCTION

Research findings in many countries of rainfed agriculture areas posit that there are possibilities to make use of area with annual rainfall of as low as 200mm for crop production (Ephram et al, 2001).In this connection, Bovin and Manger (1990) attested that, this can be achieved through application of different adaptive technologies (both processes and structures) that are ecologically sound and socially viable. To this end, in countries like Ethiopia where rain fed agriculture (that is affected by recurrent drought and dry spell) is the main stay of economy, better use of available soil moisture is crucial (MOA, 2001).[1]

In this sense, the dry land areas of Ethiopia account more than 66.6% of the total land mass ranging from arid with less than 45 days of length of growing period (LGP) to sub moist and moist zone with LGP of 60-120 days. In these areas, the major constraint to agricultural production is moisture stress (Kidane et al, 2001). The main causes of moisture stress are low and erratic rainfall, run-off losses due to poor water retention and in- filtration as well as steep slope, higher evapo-transpiration.

In response to these abiotic stresses, there are band of indigenous soil and water conservation techniques in Ethiopia that need to be reoriented to ecological, economic and social benefits as well as salient features of land management (Yohannes and Herweg, 2000). However, literature on adjustment mechanisms to resource constraints and utilizing opportunities of potentials under situations of environmental risk in Ethiopia in general and in the study area in particular is in scarce (Yohannes et al, 1993).

Several scholars attested that generations of farming communities in Ethiopia have evolved different farming technologies and innovations that can provide a basis on which to build improved land husbandry. Specifically, Ephram et al (2001) state that farming communities in risk prone areas have developed adaptive mechanisms to

[1] Ministry of Agriculture of Ethiopia is restructured into Ministry of Agriculture and Rural Development.

environmental constraints through different local technologies and adaptive socio-cultural set-up. These include the traditional soil fertility management, flood harvesting and in-situ moisture conservation. However, for a long period of time development and research institutions have failed to give due attention to the rigorous demands on risk minimization.

As a point of departure, policies and strategies of natural resource management will be meaningful to local people when there is integration of the local initiatives. Similarly, in agricultural development, local adaptation capacities can be supported by building on knowledge, interests and innovativeness of local actors (www.prolinnova.et). In this scenario, Participatory Innovation Development (PID) takes up how local people create fertile interface with the external actors such as researchers and NGOs by way of taking up leading role (rather than facilitative role). Thus, there is a need of blending the bottom up and top-down approaches to enhance the local innovations for adaptation to abiotic stresses.

In that respect, there is a call for study focusing on local levels, especially district or village levels, where actual dynamics of vulnerability of Ethiopian farmers to climate variability take place in order to recommend apt interventions and adjustment mechanism (Temesgen et al, 2008). In so doing, enhancing micro-level adaptation methods of the different stakeholders and natural resource conservation program scales-up the adaptive capacities of the farmers in increasing their resilience.

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.

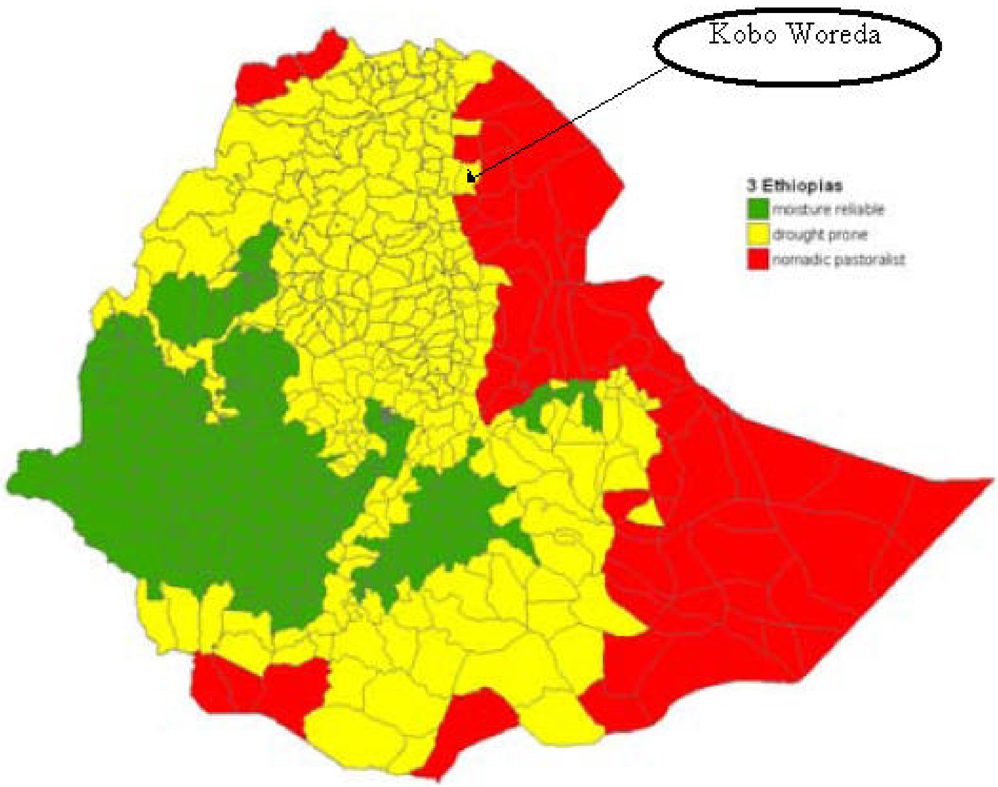
Thus, the specific objectives to which the study is striving for are; (a)To identify external interventions and their complimentarity to the local measures in the study area (b)To assess the determinants of the local adaptive mechanisms to moisture stress in relation to their effectiveness.

2. Theoretical Framework

Agriculture is the backbone of the Ethiopian economy. However, it is challenged by, among others, recurrent drought. From the perspective of development opportunities, the predominant moisture availability regimes in Ethiopia are widely perceived to present the most important dimension circumscribing agricultural potential. This makes sense, given the predominance of the rainfall reliant small holder agriculture (Alelign, 1991; Kidane and Getachew, 1991; Nigist, 2007). Even though, it is crude and embodies the 18 (eighteen) agro-climatic zones and their respective subdivisions, chamberlin et al (2006) developed the “three Ethiopia”, moisture regimes. This is developed in light of the need of a “geographically differentiated strategy” with different priorities articulated for different areas of the country with different needs. Accordingly, the “three Ethiopias” are the rainfall sufficient highlands, the drought prone area and the arid low lands. These areas are often a way out for discussing different geographical priorities (both adaptation and mitigation mechanisms for the underlying environmental constraints).

The concept of “three Ethiopias” emphasizes moisture availability, which is widely regarded as one of the major development constraints facing smallholder farming in Ethiopia. Apart from moisture availability, however, there are additional natural and man-made geographies that are widely recognized to be basic conditioning factors for rural development. For example, agricultural potential is determined by soil, topography, and demographic characters and socio-economic conditions (Mohamud and Pender, 2006).

Fig 1 Three "Ethiopias" based on moisture availability



Source: Adapted from Chamberlin et al (2006)

Note: wereda boundaries are shown in grey

Embedded in the aggregation of the three Ethiopia, most parts of the Northern weredas of Ethiopia including the study area (Kobo wereda in North Wello zone) are characterized by drought-prone moisture regime (see figure 1 above).

The concept of development domain, on broad count, denotes identifying patterns and conditions that broadly enhance or constrain different development options including adaptation options. These include the relative endowment of agricultural potentials for rain fed (and irrigated) agriculture, access to market opportunities and availability of labor relative to land (Chambelin et al, 2006). Similarly, Engida (1991) explains in light of the dependency of majority of the Ethiopian population on rain fed agriculture, the agricultural potential of the country that calls for geographically differentiated adaptive strategies should be assessed and analyzed. This would help in agricultural planning, drought monitoring and so on.

Based on this context, the study area is categorized under areas of high agricultural potential (specifically for cereal production), high market access and high labor availability and high population density (Ephram et al, 2001; KGVDP, 2002; Mohamud and Pender, 2006).

To the researcher's knowledge, no studies published to date investigated adaptation in the context of Kobo area. Thus, understanding the determinants of households' and community's choice of adaptation options can provide policy insights in order to point out target variables and then substantiate the use of adaptation measures in the agricultural sector (Nhemanchena and Hassan, 2007).

A number of interwoven factors dictate the implementation of adaptation options for moisture stress problems by farm households (Hassan et al, 2008). These factors are broadly categorized in to biophysical and socio-economic, which are emanated from the biophysical and socio-economic context of a given spatial entity of different scales (Agrawal, 2006).

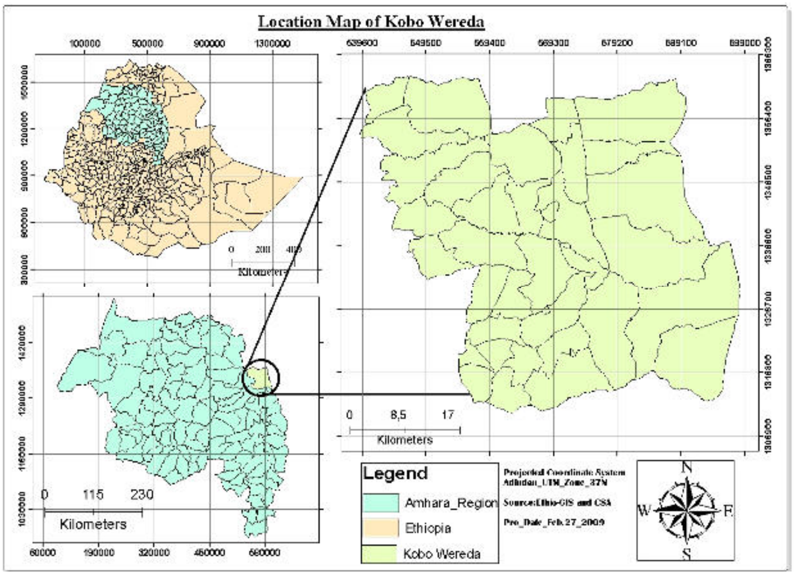
The biophysical factors are, among others, soil type, plot size, topography, and different climatic elements (rainfall, temperature). Irrigation potential, frequency of climatic extremes (e.g. drought) are also factors for adaptive activities (Temesgen et al, 2008). In addition, Nhemachena and Hassan (2007) pointed out that increasing mean annual temperature increases the probability of farmers to respond to changes in terms of changing management practices. In connection with this, less precipitation increases the arousal of farmers to farmers to efficiently use water resources and option (Ephram et al, 2001; Nhemachena and Hassan, 2008; Temessgen et al, 2008). This is a concordant idea of “vulnerability is not always bad” by Gallopin (2006).

The socio-economic factors, on the other hand, among the others, include wealth, literacy, technology, institutions and social capital etc (Nhemachena and Hassan, 2007;Temesgen et al, 2008).

3 Materials and Methods

3.1 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. Astronomically, the study area lies within a geographical coordinates of 12^0 06’- 12^0 18’ North latitude and 39^0 23’-39’ East longitudes (see map.1 below).



Map 1 Location map of Kobo wereda in Ethiopia

3.1.2 Topography and hydrology

The study area is characterized by pronounced variation in scenery. The landscape can be addressed to have two main features namely and western mountainous terrain and the eastern low lying flat plain squashed in between the two ridges. Altitude ranges between about 1468(qolla) meter above sea level at Kobo (administrative center of the wereda) and 2230 meter above sea level in Shaway (characterized by the woina dega agro climatic zone)(see map 2 below)

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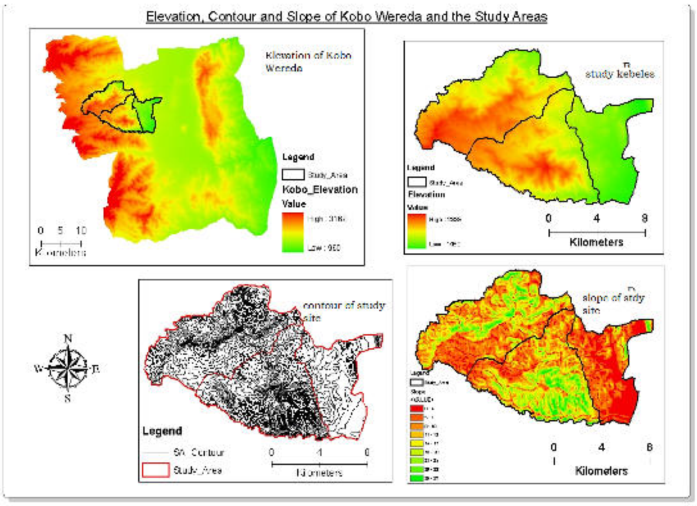

Map 2. Elevation, contour and slope map of Kobo wereda and the study kebeles
Source: Ethio-GIS.
Note: Slope (in degree); Altitude (in masl)

The study area is characterized by two main physiographic units. These are mountainous terrains and escarpments (the western part) and the lowland plain area, the eastern part (KGVDP, 2000). Under this division, the low-lying plain area[2] which is characterized by qolla type of agro ecology covers about 21.71% and the rest constitutes the upland area[3] woina dega agroecology and to some extent dega type.

In addition the low-lying plain has a general alignment along north –south direction. The western mountains rise from depressions about 1468 meter above sea level (masl henceforth) and reach to more than 2300 masl in the west before merging with the Ethiopian plateau proper. Specifically, the study area reveals a general sloping of eastward from the western escarpment of the rift valley system (see map 3 below).

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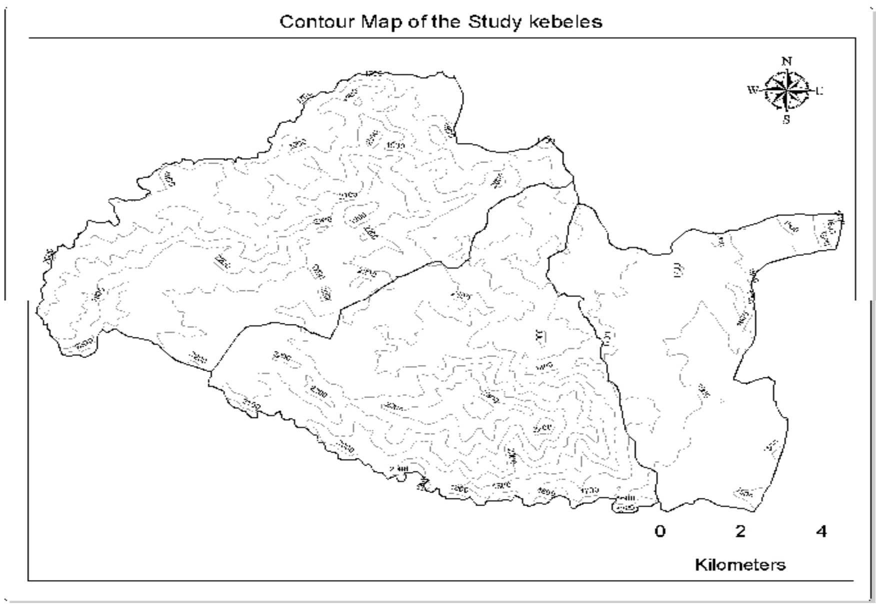

Map 3 Contour maps of the study kebeles
Source: Ethio-GIS.

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

[2] Low-lying plain area is characterized by qolla type of agro ecology in kobo wereda.
[3] Upland area is characterized by woina dega and above type of agro ecology in kobo wereda.

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.

3.2 Methods

3.2.1 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 was 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 a more insightful way, the following are the rationale for purposeful selection of these Kebeles for the study.

i. The kebeles are typical of rainfed agriculture in the wereda and they are microcosms of northeastern moisture stress areas at large.

ii. Meaningful insight of the researcher about the kebeles' biophysical and socio-economic contexts.

iii. Proximity of the Kebeles to the wereda town in hence minimizes the cost of the research.

More germane to this, the ground of justification to take two kebeles (Shaway and Gedeba) from the upland part of the wereda and only one Kebele from the plain (lower altitude) is the proportional areal coverage of each physiographic unit in the wereda. To be more specific, the upland area covers above 75% of the area of the wereda while the plain area accounts about 21.71 % (see table 3.2 in chapter three). Thus, the purposeful taking of kebeles from each physiographic unit having distinct agro-ecology accords this information.

To this end, 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'
Finally, the sample size from each levels of stratification (kebeles and 'gots') will be 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 3825, in the study area, a total sample size of 363 (about 9.4%) will be 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 (see table 1 below). Whenever the population size is known and the Standard deviation is unknown, we can use Slovin's formula to figure out what sample size we need to take, which is expressed as

$n = N / (1 + Ne^2)$ where n = Number of samples, N = Total population and e=Margin of error tolerable error (0.05)

$$n = \frac{3825}{3825 + (0.05 \times 0.05)}$$ (at 95% confidence level and this gives us margin of error is 0.05)

n= 3825

10.5625
n=363

Table 1. Summary of the sampling procedure and sample size distribution across the different levels stratification.

District	Total HH No	Total Kebeles	'kebele in the woredas		
			Name of the 'Kebele'	No of HH	Sample size
Kobo	13,617	36	Shaway	1292	123
			Gedeba	1501	142
			Bewa	1032	98
			Total	3825	363

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.

3.2.2 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 concerned. 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.

V. Case studies and narrations- This was utilized on eight (5 male and 3 female headed) house holds of purposely selected. Here, care was taken to include cases from various segments of the target population in the study area. In this fashion, in-depth investigations were made to generate data pertinent to demographic as well as socio-economic profiles and their implications on the resiliency of their livelihood to the recurrent moisture stress. On top of this, the major challenges of households and the coping and adaptive strategies were also the essence of the case studies.

In summary, all the above methods were employed to generate information about the community itself and fuel out discussions so as to make triangulation on various themes of the study. Moreover, informants and discussants were selected with the intention of representing different socio-economic characteristics such as male versus female headed households, better-off versus poor as defined by the local people and so on.

3.2.3 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.

4. RESULTS AND DISCUSSION

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, 2014)

4.1 Characterization of biophysical factors

Farmers in the study area have their own way of describing and characterizing soils on their own cultivated fields and their environs at large. To be more specific, they have a local system of classification based on their experience of potential and constraints of soils as far as moisture availability and other characteristics are concerned. Accordingly, farmers in Kobo area distinguish five different local soil types. The soils are locally known as Boda,Ashewama,Borebore , Walka and Mohlama. These soils are classified on the bases of some recognizable and easily identifiable soil and field characteristics which have their own repercussion on the soil moisture condition of their own fields. These criteria for classification are productivity, slope position, depth, color, consistency, fertility and stoniness. Each criteria/ characteristic has also implications on the soil moisture and productivity of the soil. For example concerning stoniness there is a metaphor:

"Melkam lij k funga; Tiru mirt k dinga"

When crudely versed "a beautiful girl is born from ugly women and good production from stony farm can be gained". In the same fashion, farmers in the study area have immense view point about soils of locality and their characteristics.

Table 3. Local Classification, characteristics of soils and relation to soil moisture condition in n Kobo area as farmers.

Characteristics	Local Soil type				
	Boda	Ashewama	Borebore	Walka	Mohlama
Color	black- gray	yellow	gray	black	red
Consistency	Mod-less	less	less	More sticky	sticky
Depth	deep	Average deep	shallow	Shallow-deep	shallow
Slope position	plain	plain	hillside	hillside-plain	hilly area
Fertility	Less fertile	Lesss fertile	Less fertile	more fertile	fertile
Stoniness	Not stony	moderate	stony	moderate	Very stony
*Moisture retention	moderate	low	low	high	high

Source:Field observation and FGD with elders.

The moisture content of soils also determines, among others, the workability of the soil. Certain soils are easy to work at any moisture content while other soils have a very narrow range of moisture content within which they can be worked (FAO, 1984).Similarly, the focus group discussion and field observation sustantiates this argument in light of generating the above table. For example, sand/ashewama soils are easier than clay/walka soils to work and walka soils retain more moisture but are characterized by narrow range of moisture content for workability.

Table 4.Response of sample households pertaining to causes of reduction in crop production (n=363; Multiple responses were given for the question).

Perceived causes	Woina Dega(n=265)		Qolla(n=98)	
	No	%	No	%
Lack of rain	131	94.24	41	100
Excessive rain	35	25.18	6	14.63
Insects &disease	86	61.87	27	65.85
Flood	28	20.14	17	41.46
Frost	17	12.23	1	2.43

Source: Field survey, kobo; January, 2014.

As it is depicted in the table above, the most commonly mentioned risk factor reported by sample households is lack of rain in both woina dega and qolla agro-ecology of the study area. It is mentioned by 94.24% and 100% of the respondents in woina dega and qolla agro-ecology of the study area respectively. A vivid implication from this is, soil moisture stress is a hindering factor for crop production typical in kobo area in lieu of rain fed agriculture. Next to lack of rain, insects and disease explained by 61.87% of the respondent in woina dega and 65.85% of the respondents in qolla have also paramount significance for crop failure in the study area. As a point of departure, farmers have their own anticipating as well as adjusting mechanisms to problems of the moisture stress. More importantly, farmers respond to long-term decline in yields by adjusting the level of inputs used and/or by adapting the cropping system. For example, as 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 (i.e Bunign teff) and less variable yields.

Moreover, the occurrence of some pests and crop disease is also depending on climatic condition. As it is described by one of the key informant;

> There are insects and crop disease which are directly emanated from the occurrence of moisture stress and dry spell during harvest season. For example army warm, locust smut occurs when there is subsequent dry spell within growing season. Another aspect in this regard is when there is much amount of rain in the month of May; there is the probability of the occurrence of crop diseases and pests in summer season particularly that attack pulses and oilseeds. Thus, anticipating this we reduce investing on such crop varieties to produce. (Interview from Bewa 11, 2009)

In short, this cases material enlightens us indigenous ecological knowledge embedded in farmers' know-how promotes both ecological and social resilience which shares dimensions of adaptive management at household level. In light of this, dry spell and moisture stress have their own ramifications on the occurrence of diseases and out break of pests that attack crops within the harvesting season. However, such views need further investigation and calibration.

The local people's perceptions of environmental constraints are based on their local and indigenous perceptions of reality on their immediate geographic setting(Ali, 2008).In essence, the local people's understanding and perception and plot level characteristics of their farm land need to be the focal point to have a clear insight about micro level production problems. In relation to this, during household survey, sample households were requested to uncover the main challenges of production at household and plot level.

4.2 External Intervention in Soil moisture Conservation

> The critiques of 'top down' developmen call for more 'bottom-up' or participatory approaches in natural resource management should direct us not to oppose science /scientists/ to tradition/farmers. Rather, it is to help develop collaborative methods between rural producers and scientists to identify and circulate useful knowledge (Peters, 2002: 35)

In countries like Ethiopia, where the majority of the farmers are illiterate, agricultural extension service plays significant role in assisting farmers to investigate their production problems and scale up their awareness of constraint and priorities of their farming system at large. The above explanation takes up the idea of blending external intervention and indigenous knowledge so as to increase productivity of their farming system. To this effect, the WARD office is providing several services in this respect. For example, three Development Agents (DAs) are assigned in each kebele in order to fuel out their efforts of improving their rural livelihood in general and their agricultural production in particular.
The table belowe shows predominantly delivered extension service in the study area

Table 5 Selected extension service in Kobo area (multiple responses were given)

Description	Respondents			
	Shaway&Gedeba(n=265)		Bewa(n=98)	
	Count	%	Count	%
Being visited by DA	97	69.78	36	87.8
Training on SWC	108	77.70	29	70.73
Improved seed	7	5.04	13	31.71
Pesticides and herbicides	5	3.60	6	14.63
Fertilizer	6	4.32	9	21.95
Credit service	12	8.63	4	9.76

Source: Field survey, Kobo; January, 2014.
. In this vein, many of the respondents (77.70% and 70.73%) have been trained about the various soil and water conservation activities in the upland and the lowland area respectively. Majority of the respondents (69.78% and 87.80%) are being visited by their respective development agent in the upland and the lowland area respectively. However, there is variation in the extension service between the upland and the lowland area. This reasonably emanated from difference in distance of the area from the capital town of the wereda. Other extension services listed above are meager to which farmers are needy of financial input that is beyond their economic capacity.

Improved farming inputs such as improved seed, pesticides and herbicide and fertilizer are generally lacking (KGVDP, 2001). Similarly, it is quite clear from the table above small number of sample households in the study area apply these inputs. Farmers in the study area pointed out various reasons for not using fertilizers and other inputs. Firstly, the land itself is fertile (known as '**Muq afer'**or 'hot soil') as it is supplied by fertile silt (alluvium) from the surrounding hills. In effect, if only the moisture availability is reliable it can give good production without applying fertilizer. This is typical reason of farmers in the lowland plain areas, not in midland. The other reason which is pointed out by sample household heads in both agro-ecology of the study area is, given the unreliability nature of the rainfall in the area, household heads tend to be reluctant to apply the inputs at higher cost. In other words, they tend to be free from the likely risk of crop failure which may lead to bankrupcy. On broad count, farmers relate their discouraging experience of using improved seeds and fertilizers which did not perform well under moisture stress condition. This implication is complemented by the views of a key informant as follows:

> All the extension services were important to increase crop production from my farm land. However, the problem is the price of these inputs. It is too costly to me to buy fertilizer, improved seed, pesticides and herbicides at the same time due to economic constraint. In some cases when opportunities are gained to have access to these inputs the ecological factor (dry spell in the harvesting season) lowers my confidence to use them. Therefore, another hindering factor to use these inputs (particularly fertilizer) is the unreliability of soil moisture availability in the whole harvesting season. (Interview from Bewa 12, 2009)

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.
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 1).

Plate 1 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 5.3 below).Turning to the effectiveness of such structures these are neither effective nor sustainable. First it evaporates prior to utilization.

Plate 1 Trapezoid geomembrane for harvesting rain water.

Source: Snapshot photo, January, 2014. Shaway Kebele.
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 (see plate 5.4). Landscape level management like participatory watershed management through mass mobilization and Food-for- work are also variants of conservation activities in the study area. Moreover, since 2004, community level natural resource management activities have been implemented mainly through safety net program which is funded by USAID.

Plate 2. Land preparation for nursery by means of potting irrigation.
Source: Snapshot photo, January, 2014. Bewa kebele.

As it is pointed out in the focus group discussion of the experts soil bund construction, tie ridging, stone bund construction and improved tillage are some of the important mechanisms of moisture retention at plot level.

Compost and manure preparation are also encouraged in the wereda. For example, in 2006 and 2007, about 1324 and 1860.5 quintal compost was prepared and applied to the farm plots respectively. Similarly, many of the sample household heads stated that they prepare compost and use manure in spite of shortage of material to prepare. They have also reported these organic fertilizers have significant positive effect on the moisture retention capacity of the soil. This clearly shows that the complimentarity of the local adaptive mechanisms and the external interventions.
Productive Safety net is another intervention for soil and water conservation in the study area. Basically the central intent of the program is assuring food security. However, field observation and in-depth interview came up with the significance of the program in alleviating problems of resource degradation. In this scenario, it has its own contribution for on-farm soil moisture conservation activities. According to Ayalew Belay, team leader of the safety net program in Kobo wereda, the quota allocation for each kebele in the wereda is based on the food gap[4] in a year. In consonance with this, the gap in the wereda ranges from three months to eight and more months even in a year of good harvest season. Usually, the wider gap is identified in the midland (woina dega) area due to the degraded land. Therefore, the quota ranges from 500 households to 1900 households members within a kebele.

In connection to this, farmers participating in the program were asked to point out the drawback of the program. Thus, most of them raised the issue of implementation. The overlapping of the working days with activities on their own farm (plough, weeding threshing) is one of the problem. According to the wereda safety net program team leader, an individual participating in the program must work 16 (sixteen) hours in a week. Considering this, farmers complained about labor problem in relation to their own farm activities. On broad count, owing to the above bifurcated views on the repercussion of the safety net program, it calls for further independent investigation on the issue under consideration. However, in a more profound way productive safety-net program is one of the entry points to mobilize the community to participate in soil moisture conservation and NRM at large.

4.3 Factors Affecting Local Adaptive Mechanisms to Moisture Stress in the Study Area

As stated in chapter 3 at length, the study area is characterized by fragile ecosystem which has immense repercussions on the subsistence livelihood of the local people. In relation to this, survey households and key informants were asked to point out prominent on-farm adaptive strategies currently being carried out by the local people. To this end, these on-farm adaptive mechanisms are discussed in the following subsequent paragraphs.

[4] Food gap is the period (usually within a year) when a household is under chronic food shortage.

Prevalence of moisture stress compounded by crop diseases and pests is the main constraint of crop production in Kobo area. As the result, farmers usually experience poor grain yields or sometimes they face complete crop failure(Interview 13 below).In some years, the rain comes early and in other very late, but commonly it ends too early(KGVDP, 2002).In response to this, farmers have employed different strategies including the use of rain water harvesting techniques and practices appropriate farm management methods(e.g. flood diversion, soil bund, stone bunds, contour furrows(shilshallo) and timing of tillage,…etc)(see box 5.3 below).

Box 1 local water harvesting practices for cultivated fields of Bewa Kebele

At farm level in situ and ex-tu water is spread by a series of contour furrows or basins (i.e Shilshallo /dirdaro).The process of the formation of alternative contour furrows is called shilshallo or dirdaro. These furrows pave way to the distribution and percolation of water in the field. This is done to scale up the capacity of the crop to resist moisture stress during the dry spell time of the growing season. Shilshallo is made along the contour by ox drawn equipment called 'maresha' but it is carried out on cultivated field of sorghum and maize. Bund construction is another variant of moisture conservation method on cultivated fields. The purpose of this is for management and diversion of flood water and thereby reducing the velocity of flood water and makes the flood water to retain behind the bund.

The belg-runoff, especially in plain area, is used to inundate repeatedly ploughed seedbed in winter season (between February and April).The principle is to allow flood water from the surrounding highlands to retain behind the bund and leave the water standing. This facilitates infiltration of water and suit farm operation (plough) make favorable environment for seed germination. The Kiremt-runoff, on the other hand, used to irrigate the crops (usually sorghum and maize) in July, August and September. Farmers named such plots as 'wuha geb.'

Source: Focus Group discussion from Bewa elders, January, 2014

The other unique type of water harvesting structure in the study area is Haroyee(Ella). This is typical to the plain part of the study area. It is usually constructed along the lower reaches of the main flood diversion canal and on the edge of the crop fields. Such positioning of the structure is said to be purposeful as this allows utilizing (collect) the excess water runoff.

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. A key informant from Bewa kebele reminds us this type of response in the following fashion.

> Response farming in our locality is a way out from the problem of moisture stress. I remember in 1998 there was no summer rain totally. Following this incident, there was almost enough rainfall after the offset of summer season (in September and onward). In response to this, most of the farmers ploughed and sowed maize after September. I remember that much more amount of production was gained. (Interview from Bewa 13, 2009)

5. CONCLUSION AND RECOMMENDATIONS

Agriculture is the main stay of rural Ethiopia facing environmental degradation and stresses as well as mis-use of resources. This has ramifications for 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) pointed out moisture availability is the major determining factor for agricultural production in the Kobo wereda.Given the above framework, the findings of the study are recapitulated under the following headings.

Complimentarity of the local adaptive mechanisms to the modern ones-There are few indicators of tangible efforts made by interventionist (development and research institutions) that throw light of addressing the problem in the area. Indeed, farming communities in the study area have developed different locally innovated technologies and socio-cultural landscapes. Nevertheless, there exist obvious gaps in terms of providing empowering interventions for the indigenous technologies. A substantive of this is, the opportunities of communities both from sharing their knowledge to other community and the capacity to build on local technologies are given little attention. Moreover, the lack of clear external interventions towards long lasting enhancement of moisture deficit risk management capacity of the poor segment of the farming community regresses with the idea of 'one size fits all.' Embedded in this context, the worst affected and vulnerable are the poor segment of the community. However insights from the study shows that, there is complimentary of the two groups of responses to soil moisture stress under of natural resource management striving for sustainability and food security.

Determinants of Adaptation to Soil Moisture Stress- Though farmers are not passive victims of temporal juncture of soil moisture and crop failure, several factors dictate their efforts to carry out adaptive mechanisms to soil moisture stress as well as their decision on the choice of each measure. Accordingly, land fragmentation, land use type and slope of upslope area are found to be important biophysical related factors. On the other hand, livestock size, labour availability land holding size, and production asset ownership are the socioeconomic related determinants that affect farmers' effort (positively or negatively) to implement adaptive practices on their cultivated fields. Yet, not all factors equally determine adaptive capacities of households at micro and beyond spatial scale. In essence, some are bottleneck in some households (for example labor in female headed households) while others show difference beyond household level; livestock in woina dega and qolla argo-ecology.

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