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REVIEW ARTICLE

EXPLORING THE ROLE OF INDIGENOUS KNOWLEDGE IN ADAPTATION CLIMATE CHANGE (A SURVEY STUDY OF RURAL HOUSEHOLDS OF TIGRAI REGION)

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ABSTRACT

Climate change can be exacerbated by human induced actions such as: the widespread use of land, the broad scale deforestation, the major technological and socioeconomic shifts with reduced reliance on organic fuel, and the accelerated Uptake of fossil fuels. Farmers' knowledge about their soils and their management constitutes a complex wisdom system, which if integrated with modern soil science, could provide the necessary synergy for sustainable agricultural development and to adapt climate change. The very purpose of this research was to assess the perception of farmers on the prevalence of climate change/ climate variability, the strategies they adapt to mitigate it and the barriers they face to use their traditional practice (indigenous knowledge). A survey study was undertaken in two Tabias (Mayliham and Genfel) of Tigray Region to ascertain on how farmers use their indigenous knowledge to adapt climate change. It was found that farmers understand that there is a clear change of the climate indicators such as river volume, start date of rain, access of fodder, increase in pests and invasive plants etc. The finding further reveals that farmers are enriched with numerous long-aged practices of climate change adaptation. The researchers have further ensured that though farmers are endowed with such indigenous knowledge, very small attention is given by the government and development agents on this regard. So the concerned bodies should give room for these practices while they are formulating and implementing policy (especially agricultural policy). Further, awareness creation campaign, for farmers, and pre-warning system should be established.

1. BACKGROUND AND JUSTIFICATION

It is generally known that Climate change has a great impact on the livelihoods of the rural poor in developing countries. Scholze *et al*. (2006) stated that Climate change is an environmental, social and economic challenge on a global scale. According to them, Climate change can be exacerbated by human induced actions such as: the widespread use of land, the broad scale deforestation, the major technological and socioeconomic shifts with reduced reliance on organic fuel, and the accelerated Uptake of fossil fuels. In addition to this, IFPRI, 2010 clearly stated that projected reductions in yield in some African countries could be as much as 50% by 2020, and net crop revenues could fall by 90% by 2100. The projection concludes that, this amount to a serious threat to food security and to the achievement of major developmental goals.

Regarding climatic change Ban Ki-moon had made the following speech:

"I am convinced that climate change, and what we do about it, will define us, our era, and ultimately the global legacy we leave for future generations. Today, the time for doubt has passed" (UN Forum, 2008).

On top of this, during the United Nation's permanent forum (2008), it was described that Climate change causes threats and dangers to the survival of indigenous communities worldwide, even though indigenous peoples contribute little to greenhouse emissions. In fact, according to the forum, indigenous peoples are vital to, and active in, the many ecosystems that inhabit their lands and territories, and may therefore help enhance the resilience of these ecosystems. In addition, it was underlined that indigenous peoples interpret and react to the impacts of climate change in creative ways, drawing on traditional knowledge and other technologies to find solutions which may help society at large to cope with impending changes. Many studies such as Nhemachena and Hassan, (2007) concluded that farmers have a long history of responding to climate variability. The studies recommended that traditional and newly introduced adaptation practices can help farmers to cope with both current climate variability and future climate change. More specifically, as described by many scholars, indigenous knowledge adds value to climate change in the following ways:-

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- First, indigenous knowledge systems create a moral economy. It identifies a person within a cultural context, therefore providing decision-making processes or rules of thumb to be followed based on observed indicators or relationships within events.
- Second, indigenous knowledge is increasingly exhibiting a resemblance with scientific methods as many ideas in indigenous knowledge that were once regarded as primitive and misguided, are now seen as appropriate and sophisticated.
- Third, indigenous knowledge systems provide mechanisms for participatory approaches. A major requirement for the sustainability of any project is that the local population must be seen as partners in the project with joint ownership. This is best achieved when the communities effectively participate in the design and implementation of such projects.
- Fourth, indigenous knowledge systems share the same guiding principles with sustainable development framework with "3E" concerns-Economy, Equity, and Environment.
- Fifth, indigenous knowledge systems can facilitate understanding and effective communication and increase the rate of dissemination and utilization of climate change adaptation options.

But, a study made by Ajani *et al*. (2013), in some Sub-Saharan Countries, revealed that little has been done to incorporate this into formal climate change adaptation strategies. Ajani *et al* have found that Developmental projects that have been created, funded and managed by outside resources and introduced into rural communities with the hopes and promises of impacting the lives of the communities did not take into consideration the culture of the people and resulted in low participation and success rates. As a result of these failures, there was a growing interest in the incorporation of local knowledge and traditions to increase project participation rate and provide environmentally sound approaches to development. From this, we can understand two critical issues.

(1) The role of indigenous knowledge to cope up climatic change is irreversible.
(2) The trend of governments and developmental agencies to incorporate this aspect of knowledge into their strategic plan is very small.

Hence, these mismatched phenomena need to be synchronized by identifying the critical role played by the domestic knowledge and come up with constructive policy based recommendations.
Therefore, the reason why we emphasize on this issue is that:

- This area is not adequately studied (especially in Ethiopia).
- Governments and development agencies are largely relaying on the scientific (formal) knowledge.

1.2. Objectives of the project

General objective

The major objective of this paper is to assess and identify the existing climate change adaptation practices (domestic) and to pinpoint their role on winning of the nationwide anti-climate change struggle.

Specific objective

- To assess the existing knowledge (perception) that farmers have on climate change.
- To explore the adaptation strategies farmers have already adopted to cope with the consequences of climate change.
- To identify the perceived barriers to climate change adaptation strategies.
- To recommend plausible policy interventions that match farmers, perceptions, experiences, adaptation strategies and coping mechanisms.

1.3. Significance of the study

Knowledge building: This study will contribute to the analysis of the concept of indigenous knowledge with specific reference to the farmers' domestic practices to adapt climate variability in Tigrai Region. In Tigrai, there is a research gap in the assessment of the role of indigenous knowledge. This study therefore will contribute to fill the gap.

Deriving lessons for strategies of climate initiatives. It is so long that our government is giving due emphasis on climate issue in tackling the ever increasing climate variability. The government is ratifying different policy documents on how climate change is addressed. Though there is a remarkable improvement in awareness creation aspect; still, much is remain to materialize and implement the policy documents. Therefore, this study will make an effort to provide evidence that can be used and incorporate in to policies and programs of intervention to use strategically and promote indigenous knowledge as part of the policy document.

2. LITERATURE REVIEW

2.1. Introduction

Sub-Sahara Africa is among the most vulnerable continents or regions to climate change impacts, because the majority of the sub-Sahara African population lives in abject poverty, and are heavily dependent on rain fed agriculture for their economic and livelihood sustenance. Therefore, variations in rainfall patterns and temperature adversely impact their economic and social survival. Because the main long-term impacts include significant changes in rainfall patterns and temperature which affect agriculture, there is a projected significant reduction in food security; worsening water security; decrease in fish resources in large lakes due to rising temperature; increase in vector-borne diseases; rising sea level affecting low-lying coastal areas with large populations; and rising water stress (African Partnership Forum [APF], 2007). This indicates that climate change will seriously affect the socio-economic and livelihood of people.

Hence, governments and development agents must look for the traditions of farmers on how they adapt climate change. Because, Farmers' knowledge about their soils and their management constitutes a complex wisdom system, which if

integrated with modern soil science, could provide the necessary synergy for sustainable agricultural development. Such knowledge is known as "indigenous Knowledge".

What is indigenous Knowledge?

"Indigenous knowledge is the local knowledge – knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities (Warren 1991)".

*"*Indigenous Knowledge is the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems (Flavier *et al.,* 1995)".

2.2. Integrating Indigenous Knowledge into Climate Adaptation Policy

As denoted by Sharka *et al.* (2013), the evidence that climate change will adversely affect agriculture in sub-Sahara Africa has become a crucial challenge for sustainable development on the continent. This challenge is composed of the likely impacts on ecosystem services, agricultural production, and livelihoods. Generally, according to the study, losses in the agriculture sector due to climate change has economy wide consequences, like loss in gross domestic output, a decline in the income/consumption of the most vulnerable population; hence, a general deterioration in households' welfare. To dampen the adverse consequences of climate change, as recommended by the study, there is a need for farmers to adopt different adaptation strategies. Adaptation to the adverse consequences of climate change could be viewed from two distinct perspectives; i) the awareness of the risks of climate change and their capacity to adapt to climate change and ii) how adaptation can be carefully planned and implemented to avoid the possibility of mal-adaptation (Food and Agricultural Organization ([FAO 2007).

However, a study made in Ghana by Hanson (2013) states that effectiveness of traditional knowledge systems suggest that the first-hand experience of farming communities should be essential to governments and donors in the formulation of agriculture related adaptation policies in drought-sensitive regions of Africa. Many policy makers, however, remain skeptical of the credibility of indigenous knowledge, considering it an inadequate basis for sustainable harvesting.

Others development, according to Hanson, emphasize that, while indigenous knowledge is locally specific and embedded in traditional norms, scalability and shared learning is difficult as practices and beliefs are endemic to the group in which they are held. Much attention has therefore been given to high-technology, high cost and genetically modified agriculture, although smallholder farmers' adoption of these techniques remains minimal. Despite recognition of its importance by the Intergovernmental Panel on Climate Change (Parry *et al.,* 2007) and other international forums, governments throughout Africa continue to undervalue the role of indigenous knowledge in national climate change adaptation policies. Instead, policy makers are turning to international financial institutions (IFIs) and donors to transform farming by introducing large-scale industrial agriculture practices as the key to adaptation (World Bank, 2008).

This tension between knowledge systems suggests the need for climate adaptation policy to discover a better balance between the traditional and modern, both of which have their own limitations.

As described by socio-economic team (2010), Ethiopia is one of the least developed countries in the world, with a gross domestic product (GDP) of slightly more than US$10 billion and a population of more than 80 million. At present, according to the study, agriculture dominates the Ethiopian economy, accounting for nearly half of GDP and for the vast majority of employment. While the country is highly dependent on the agricultural sector for income, foreign currency, and food security, the sector is dominated by small-scale farmers who employ largely rain-fed and traditional practices - a state which renders Ethiopia highly vulnerable to climate variability (as seen during past persistent drought), and thus to climate change. According to the World Bank (2007); cited by the socio-economic team, 2010, Climate change is projected to reduce yields of the wheat staple crop by 33% in Ethiopia .This amounts to a serious threat to food security and to the achievement of major developmental goals.

To tackle the climate variability, governments and developmental agents (both national and international) have to consider the farmers' climate adaptation practices. Because, as underlined by many scholars; farmers have a long history of responding to climate variability. Traditional and newly introduced adaptation practices can help farmers to cope with both current climate variability and future climate change. However, the debate about the adaptation of small-scale farmers in Africa to climate change has occurred in the absence of knowledge about existing and potential adaptation practices. Because prevailing ideas about adaptation are vague, conducting focused research on potential adaptation practices and formulating appropriate advice for implementing new practices is difficult.

In this way as pointed out by Nhemachena and Hassan, (2007), Adaptation generally takes place at the micro- and macro-levels: Farmers introduce practices at the local level, and the main factors influencing their diffusion are seasonal climatic variations, the agricultural production system, and other socioeconomic factors; the government, NGOs, or private companies introduce practices nationally, and long-term changes in climatic, market, and other conditions influence their establishment.

Why is indigenous knowledge important?

World Bank (1998) has discussed the following benefits of indigenous knowledge.

Indigenous knowledge provides the basis for problem-solving strategies for local communities, especially the poor. It represents an important component of global knowledge on development issues. IK is an underutilized resource in the development process. Learning from IK, by investigating first what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help the communities. Understanding IK can increase responsiveness to clients. Adapting international practices to the local setting can help improve the impact and sustainability of development assistance. Sharing IK within and across communities can help enhance cross-cultural understanding and promote the cultural dimension of development. *Most importantly, investing in the exchange of IK and its integration into the assistance programs of the World Bank and its development partners can help to reduce poverty.*

How is indigenous knowledge exchanged?

The integration of IK into the development process is essentially a process of exchange of information from one community to another. According to World Bank (1998), the process of exchange of IK within and between developing countries and between developing and industrial countries involves essentially six steps:

- **Recognition and identification**: some IK may be embedded in a mix of technologies or in cultural values, rendering them unrecognizable at first glance to the external observer (technical and social analyses may, therefore, be required to identify IK).
- **Validation**: This involves an assessment of IK's significance and relevance (to solving problems), reliability (i.e., not being an accidental occurrence), functionality (how well does it work?), effectiveness and transferability.
- **Recording and documentation** is a major challenge because of the tacit nature of IK (it is typically exchanged through personal communication from master to apprentice, from parent to child, etc.). In some cases, modern tools could be used, while in other circumstances it may be appropriate to rely on more traditional methods (e.g., taped narration, drawings);
- **Storage** in retrievable repositories: Storage is not limited to text document or electronic format; it could include tapes, films, storytelling, gene banks, etc.
- **Transfer:** This step goes beyond merely conveying the knowledge to the recipient; it also includes the testing of the knowledge in the new environment. Pilots are the most appropriate approach in this step; and
- **Dissemination** to a wider community adds the developmental dimension to the exchange of knowledge and could promote a wider and deeper ripple impact of the knowledge transfer.

2.3. Farmers' Perceptions and Adaptations to Climate Change in Africa

Maddison (2006) reports that perceptions about climate change showed that a significant number of farmers believe that temperature has already increased and that precipitation has declined for eleven African countries. Farmers with the greatest farming experience were more likely to notice changes in climatic conditions which according to the study are consistent with farmers engaging in Bayesian-updating of their prior beliefs. The study also reported that farmers' experiences, access to free extension services and markets are important determinants of adaptation.

Nhemachena and Hassan (2007) examined farmers' adaptation strategies in South Africa, Zambia and Zimbabwe. The study describes farmers' perceptions about long-term changes in temperature and precipitation, as well as various farm-level adaptation measures adopted, and barriers to adaptation. The results indicated that using different crop varieties, crop diversification, changing planting dates, switching from farm to non-farm activities, increased use of irrigation, and increased water and soil conservation techniques were the different adaptation measures employed by farmers in these countries. The study also reported that most farmers perceived long-term increase in temperature and that the region was getting drier, with changes in the timing of rains and frequency of droughts. The farmers reported that lack of credit facilities and information on adaptation options and insufficient inputs are the main barriers to adopting any climate change adaptation options. The results of the multivariate discrete choice analysis show that gender, years of farming experience, access to extension services, access to credit facilities and markets are the significant determinants of adaptations to climate change in the region.

Gbetibouo (2009) argues that farmers with access to extension services in South Africa are likely to perceive changes in the climate because extension services provide information about climate and weather. Consequently, awareness and perceptions of changes in climatic conditions shape action or inaction on the problem of climate change. In a similar study, Mertz, Mbow, Reenburg, and Diouf (2009) analyzed farmers' perceptions of climate change and adaptations in the savanna zone of Senegal. The results of the study showed that farmers in this zone are aware of climate variability, and identified intensive wind and occasional excess rainfall as the most destructive climatic factors. They therefore attributed poor livestock health and reduced crop yield to these adverse climatic factors. However, the farmers also attributed crop failures and other perceived climate impacts to the political problems in the country.

In Ethiopia, Deressa *et al.* (2008) analyzed the determinants of farmers' choice of adaptation methods in the Nile Basin. Using cross-sectional data from a survey of farmers to illicit information on adaptation methods, the study found that the adaptation methods currently in place in the study area are; changing planting dates, using different crop varieties, planting tree crops, irrigation, soil conservation and not adapting. The farmers reported that the use of different crop varieties was the most common adaptation method, while irrigation was the least common. They also reported that the reasons for not adapting are lack of information on climate change impacts and adaptation technologies, lack of financial resources, labor constraints and land shortages. The level of education, age, sex

and household size of farmers were found to be significant determinants of adaptation to climate change in the study area. Also farmers in different agro-ecological settings employ different adaptation methods.

Manscheadi (2010) conducted a survey of 180 farmers in Sekyedumase District in the Ashanti Region of Ghana to investigate how they perceive long-term changes in temperature, rainfall and vegetation cover over the past twenty years. The survey also posed questions about adaptations and barriers to adaptations. The explanatory variables included households' characteristics, years of farming experience, farm size, access to markets, access to extension services, access to credit/loans, land tenure and soil fertility. Main adaptation strategies reported by farmers are crop diversification and changing planting dates. Land tenure, soil fertility levels, access to extension services, access to credit and the community in which the farmers lived were found to be the significant determinants of their choice of adaptation measures farmers took.

CHAPTER THREE: RESEARCH METHODS

3.1. Description of Study Area

The study will be conducted on Two rural Tabias of Tigrai. The proposed Tabia are: Genfel from Kilte-Awlalo Woreda and Mayliham from Tahtay Koraro Woreda.

Woreda Kilte Awlalo is found in the eastern zone of Tigrai. According to the statistics of the Woreda agricultural office, the temperature of the Woreda is 17-23 degree Celsius and the annual rain fall is 350-450 millimeter. The center of the Woreda (Wukro town) is found at 42 kilo meters away from Mekelle city to the north direction. According to the data obtained from the agricultural office of that Woreda, it has 17 rural Tabias and one town known as Agulae a total of 18 Kebeles. In Genfel, on the other hand, 6398 people are living, out of which 3379 are females. The center of Genfel is far from Wukro town by 3.5 kilometer. Mayliham though we didn't get concrete data about the temperature, altitude and population they are found far from Shire Town by 7 and 3 Kilometers respectively.

3.1. Sources and Methods of Data Collection

In this study, both secondary (documentary) and primary data sources were employed.

Documentary Sources

This research was partly depended on secondary data. The data focused on documented practices of climatic change. These data were collected from the agricultural and rural development of Tigray regional state, recorded experiences and researches done on this area.

Field Survey

The field data was collected basically from farmers. Tangible (observable) data (like; tracing, housing, fodder conserving, animal cage etc) were also collected through observation by the investigators. Hence, the information and data needed for the study were both primary and secondary data sources.

3.1.1. Data Collection Instruments

Triangulation is preferred in data collection to ensure reliability. Hence in this research, four instruments of primary data collection were employed. These were: semi-structured questionnaires, key informant interviews, focus group discussion and observation.

i. Questionnaire

A questionnaire was designed mainly to gather quantitative data. The questionnaires included closed and open ended questions.

Design of the questionnaire and procedures of data collection; the questionnaire was designed in a way that it achieves the research objective. The questions were prepared in English and then translated in to Tigrigna language believing that the respondents can easily understand English language. The survey was conducted in the form of questionnaire interview on the assumption that many of the respondents cannot read well. 18 experienced enumerators were recruited and selected to undertake the questionnaire interview. The principal investigator has provided the enumerators training for a day on issues of how to convey the messages of each question in the questionnaire to avoid misinterpretation. Besides, the trainees were informed about how to probe ideas and communicate in case some respondents become unwilling. The administrators (researchers) have partly conducted the interview together with the employed enumerators.

ii. Key Informants Interview

Farmers who have sufficient experience and know-how on the area were considered in the interview. In each Kebele, two experienced farmers were interviewed. Moreover, the head of agriculture and rural development of each Woredas were interviewed. This was intentionally done to understand the stand of the government on whether indigenous climate adaptation practices are emphasized or not.

iii. Focus Group Discussion (FGD)

In each study area, one focus group discussion was conducted. Every session of the focus group discussion has consisted of 8 participants (discussants). On the FGD session, 7 elder farmers (experienced) and 1 agricultural expert were involved.

3.3.2. Sampling Techniques and Sample Selection

Though Tigrai many Weredas, the researchers purposively confine their study to two Weredas only i.e. Kilte Awlalo and Tahtay Koraro. A simple random sampling has been employed to select one Tabia from each Woreda. For example; in Woreda Tahtay Koraro, there are 12+1 rural Tabias and the one (Tabia Mayliham) has been selected randomly. Equivalently, in Kilte Awlalo Woreda, there are 16+1 rural

Tabias and one (Genfel) has been selected randomly. This indicates that, a combination of probabilistic and non-probabilistic sampling techniques has been used.

Finally, 112 household leaders (56) from each Tabia have been selected using a convenience sampling method.

3.2. Method of Analysis

Qualitative data analysis was accomplished by developing and administering a series of analytical questions specially, during the administration of questions for interview and again by comparing data across sources. Majority of the data have been collected through a questionnaire prepared in a Likert scale form. The data, by and large, was a qualitative one. Though the researchers have tried to quantify the data using percentages and count numbers, the consequent analysis and discussion was a pure qualitative. A triangulation, one of the tools to analyze qualitative data, was used. Therefore, triangulation and interpretative data analysis techniques were used.

3. DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1. Introduction

In this chapter, the demographic distribution, the perceived indicators to climate change, farmers' adaptive strategies and some of the barriers to adapt indigenous knowledge have been presented, discussed and interpreted in detail.

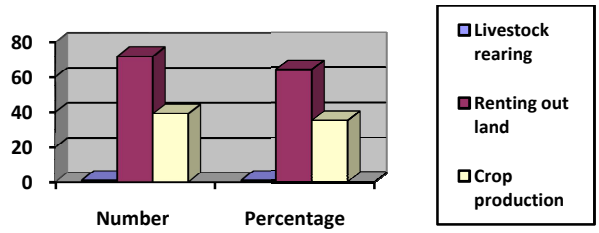
1. Socio-Demographic Characteristics

Hereunder, the sex, marital status, educational level, means of livelihood, types of animals, access to land & livestock, animals feed before 10 years and now etc are going to be covered.

their knowledge. As we can observe from the above table, about 81%, which is majority of participants educational status was found having Capable to read and write. In addition, 11% respondents were with illiterate, 8% of the respondents were primary school completed. No respondents were found secondary school and above. This implies although majority of respondents were capable to read and write. The knowledge required to reasonably understanding the indigenous knowledge and adapting climate change variability practices still remains impractical among farmers as supported by focus group discussion in study area.

Again, results of the same table above depicts that 63%, 35% and 2% of the respondents belongs to Married, Single and divorced respectively. From this, we can conclude that majority of sample respondents dominates by Married productive households.

Chart 4.1 Respondents' means of livelihood



Source: Own survey, 2014

Chart 4.1 indicates that the majority of 64% of the sample respondents were engaged in leading their life via Renting out land where as 35% of the sample respondents were used Crop production as a means of their livelihood. Key informants interview and documents analysis confirmed compare to means of livelihood , greater number farm households currently engaged in renting out land . From this, we can generalize that Renting out land was main means of livelihood in the study area.

Table 4.1 Socio-Demographic characteristics of the respondents

S.No	Items		Number of Respondents	Percent
	Background of the Respondents			
1	Sex	Male	86	77
		Female	26	23
		Total	112	100.0
2	Marital status	Single	39	35
		Married	70	63
		Divorced	3	2
		Total	112	100.0
3	Educational background	Illiterate	13	11
		Capable to read and write	90	81
		Primary school completed	9	8
		Secondary school completed		
		diploma		
		Technical and vocational completed		
		Total	112	100.0

Source: Own survey, 2014

Table 4.1 indicates that 77% of the sample respondents were males where as 23% of the sample respondents were females. From this, we can generalize that male farm households were more dominating major participation in the study area using

Table 4.2. Accessibility to land

Have land	Number	Percentage
Yes	95	85
No	17	15

Source: Own survey, 2014

The 85% of the respondents of the survey have access to land and 15% still do not have access land respectively. As results of key informants' interview, compare to the previous system now participants have access but still the distribution of land was not satisfactory because of less information and this geared to land dispute among households.

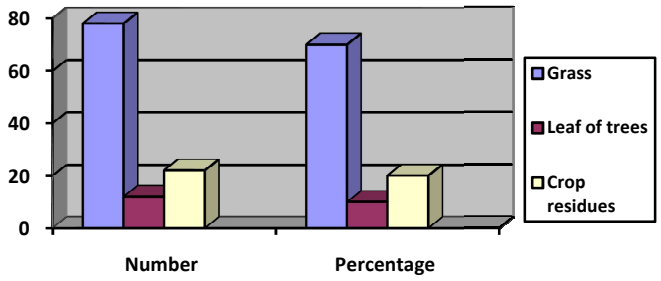
Table 4.3 Types of animals possessed by respondents

Animal type	Number	Percentage
Oxen	69	62
Cow	15	13
Equines		
Sheep	8	7
Poultry	11	10
Goat	9	8

Source: Own survey, 2014

Table 4.3 presents the number of animals those farmers possess, those with oxen was 62%, and respondents with cow, poultry was 13% and 10% respectively. Key informants interview and documents analysis confirmed to the contrast farmers shift from possessing oxen and caw to poultry , sheep and goat possession due to suppliers of feed for animals and climate change variability. In addition to this possessing oxen and caw was very expensive and discouraging this affect limited possess of oxen and caw. During focus group discussion, the general feeling of farmers was that with their access to oxen to plough, they preferred to possess poultry, sheep and goat since these are conducive means of income provided that where there is less productivity of land as a result of climate change variability.

Chart 4.2: Main source of feed for livestock before ten years



Source: Own survey, 2014

Chart 4.2 indicates that the majority of 70% of the sample respondents of the study area deliver for livestock feed from grass and 20% of them supplies for feeding of their livestock from crop residues. In contrast with this, Key informants interview and documents analysis confirmed compare main source of feed for livestock before ten years and now was that greater number farm households currently engaged in feeding their livestock from crop residues than grass this is mainly because of reasons of climate change variability and deteriorated grass in the field. From this, we can generalize before ten years grass was considering as main source of feed livestock in the case study area.

Table 4.4 Ways to minimize the impact of climate change

Ways to minimize the impact of climate change	Number	Percentage
Applying new cropping system and irrigation		
Make diversification on crop and diversification	48(43)	43
Access to information regarding to climate	64(57%)	57
Involvement in safety net program		
Others		

Source: Own survey, 2014

According to the survey result about 57% of the sample respondents were use information regarding climate change since it is the most convenient way to minimize the impact of climate change where as 43% of the sample respondents were used diversification on crop and diversification as a means to minimize climate change . Therefore, Applying new cropping system and irrigation and Involvement in safety net program are not just the right way of minimizing impact of climate change for sample farmers, it is simply too inconvenient and insufficient way of minimizing impact of climate change, in spite of their wider reach capabilities and was not satisfied with these accessibility.

Table 4.5 Government and NGOS role reduce the impact of climate change

Items	Number	Percent
Providing credit	18	16
Encouraging farmers to use their knowledge	84	75
Improving infrastructure		
Disseminating proper information		
Safety net program	10	9

Source: Own survey, 2014

Regarding role of Government and NGOS for reduction of climate change the above table shows that higher percent of respondents 75% said that Encouraging farmers to use their knowledge should considering by government and NGOS for reduction of climate change .key informants also confirmed sustainable reduction of climate change impact can be realized via making confident and encouraging farmers to use their knowledge. Nevertheless, 16% of respondents replied government and NGOS participation in providing credit. In line with this, focus group discussion replied time given to replay credit and safety net program was not enough and too short due to these respondents are dissatisfied of government and NGOS mechanism for reduction of climate change.

4.3. Perceived Indicators of Climate Change (As Perceived By Farmers)

One of the intended objectives of this study was to identify the perceived indicators of climate change and distinguish some of coping and adaptation methods practiced by farmers, in response to impacts of climate change and variability. The sample households were asked "how they perceive the climate change" and "what coping strategies" they had adopted to cope up the impacts of climate change and variability. The most widely adopted strategies were those that have little cost to the household and are relatively easily reversible, such as cutting the number of meals in a day. This is by far one of the most commonly reported coping strategies in the study area, being adopted by almost three-quarter of the households.

Generally, there was not much difference in the proportion of household's perception and adopting other coping strategies. Accordingly the respondents replied the following perceived indicators followed by coping methods.

Moreover, the researchers have tried to triangulate the above finding with a data obtained from a Focus Group Discussion. Accordingly, the summarized idea of the discussions of the two

Table 4.6 Perceived Indicators on Rain and Related Issues

No.	Perceived indicators	Likert scale				
		5	4	3	2	1
1	Change in amount of rainfall during the main rainy season	83 ,74.1%	-	-	-	29 ,25.9%
2	Unusual Rainfall increases in amount during the main rainy season	101,90.2%	9 ,8%	2,1.8%	-	-
3	The timing of the onset or ending of rain in the main season shifting	53,47.32%	17,15.18%	42,37.5%	-	-
4	Rain starts late and goes early	112,100%				
5	Planting (sowing) date changing due to change in the onset of rain	112,100%				
6	Changing date apply to most crops	84,75%	-	-	9,8%	19,17%
7	precipitation is sufficient for full cropping during short rainfall	-	-	-	219,18.75%	91,81.25%
8	Temperature of the area we live is increasing	80,71.4%	20,17.8%	20,17.8%	-	-
9	Increasing problem of heavy rain & hail	67,59.82%	35,31.25%	6,5.36%	4,3.57%	-
	Aggregate mean					

Source: Own survey, 2014

A study made by Fischer *et al.* (2005) states that Decline in rainfall during growing season causing severe agricultural damages is a main manifestation of the horn of Africa. Similarly, rain and rain related issues as have been depicted on the above table were assessed by this study. Nine indicators, as shown on table 4.8 above, have been presented and farmers were asked whether they agree or disagree on their prevalence. As clearly depicted on table 4.8 No 1, majority of the respondents (83 out 112) have perceived that there is change in amount of rainfall during the main rainy season. The value of the mean of the five point Likert scale of this item is labeled as 3.96**.** This indicated that the larger number of respondents have agreed that there is visible rainfall change during the main rainy season. On similar token, majority of the respondents have agreed that they have perceived or observed the prevalence of climate change displayed by (unusual rainfall increase, rain starts late and goes early, planting (sowing) of pants and crops variation, lesser and lesser precipitation, an increment of temperature and increasing a problem of heavy rain and hails. This indicates that the finding of the above researchers i.e. Fischer *et al.* (2005) is true for the study areas.

As shown on table 4.8 above, Farmers are aware that the variations are due to climate change/variability.

To know whether they (respondents) have really sensed the existence of climate change and what the reason to be, we have asked certain questions during the focus group discussion.
The responses are summarized like this:

"The mountains and fields you see here were covered by trees in the past! They used to keep us cool and have pleasant weather. Now the trees cut, forest cleared, hence the air condition has become hotter since the sun hits the ground directly and as a result the climate of our area has changed. And Some people especially women, lost the traditional practice of making handcrafts due to disappearance of special grasses like "sindedo, Taftafo and edini(edinti)" they used for that purpose, and the reason for the disappearance of these grasses is because of degradation of natural vegetation and climate change.''

Weredas was almost similar except for the issue mentioned under number three (Table 4.1 above). With regard to that point, the discussants of both study areas underlined that there are some crops which can't be affected by the late start and early stoppage of rain. "Shimbra or Ater" this is specifically in Tahtay Koraro, special sorghum types known as America Sorghum, which can ripe by the help of humidity and irregular rain and other types of leguminous crops can't seriously be affected by the on-off nature of rain. But, the researcher

More specifically, the group discussion participants have underlined the following conclusive idea.

"In the previous times we were counting months and dates to know when the rains will start, but nowadays we are always looking at the sky and the main rainy season starts early July and withdraws mid to late August unlike in the previous times when it was starting early June and stop early September. Reliability of rainfall increasingly become so low year after year that crop production has been affected significantly. And we (the farmers) still exercise cultivation of crops which harvested in short time and drought resistant ones"

To finalize, the perception of farmers shows that rainfall amount and pattern has changed for the worst especially in the recent years. Rainfall decreasing in amount and its pattern and distribution has become variable or irregular and more unpredictable.

On similar fashion, respondents were approached to reflect their perception on the above mentioned points (Table 4.9). The data reveals that respondents unanimously agreed on the provided items. Especially, it was fully agreed that they are facing with shortage of fodder (100% of the respondents strongly agreed), increasing problem of livestock disease and an increasing of new invasive plants. Parallel to that, Climate change and climate variability greatly affects productivity of crops (as sometimes complete failure of crop is occurred), the choice of the farmers on which type of crop to plant or sow, the health and fodder of their animals. There is also a state where by indigenous plants and wild animals have been disappeared and level of farmers' uncertainty has dramatically increased.

Table 4.7. Perceived Indicators Related with Crop and Livestock's

		Likert scale				
1	Diversity of crops is increasing	10,*8.93%*	90,80.36%	12,10.71%	-	-
2	Encountered complete crop failure	11,9.82%	88,78.57%	13,11.61%	-	-
3	Increasing problem livestock disease	100,89.29%	5,4.46%	-	2,1.79%	1,0.89%
4	Increasing of new invasive plants affecting pasture land	110,98.21%	2,1.79%	-	-	-
5	There is shortage of animal feed	112,100%				
6	There is an unusual crop pest and disease	98,87.5%	4,3.57%	5,4.46	2,1.79%	2,1.79%
7	Level of uncertainty on climate change increases	105,93.75%	2,1.79%	1,0.89%	2,1.79%	2,1.79%

Source: Own survey, 2014

Table 4.8. Perceived Indicators Related With Surface Water and Flooding

S. No	Perceived indicators	Likert scale				
		5	4	3	2	1
1	Increasing problem of frost	76,67.86%	36,32.24%	-	-	-
2	Increasing problem of seasonal flooding	99,88.39%	13,11.61%	-	-	-
3	There is a state where river volume decreases	82,73.21%				30,26.79%

Source: Own survey, 2014

Table 4.9. Farmers' Adaptive Mechanism Related With Crop and Livestock

S. No	Adaptive mechanisms	Likert scale				
		5	4	3	2	1
1	Diversifying crop and crop composition	112,100%				
2	Using early maturing crop varieties	28,25%	9,8%	21,18.75%		54,48.21
3	Decreasing number of livestock	59,52.68%	53,47.32%			
4	Using intercropping system	60, 53.57%)	23,20.54%	20(17.86%		11,9.81%
5	Planting more trees at plot	92, 82.14%)	20,17.86%			
6	Conserving and recycling local seeds	92,82.14%		20,17.86%		
7	Growing crops most sensitive to pests and disease	93,83.04%			18,16.07%	1,0.89%
8	Feeding cattle by Cut and carry	76,67.86%		1,0.89%	2017.86%	15,13.39%
9	Migrating from place to place in search of food or fodder	30,26.78%	2219.64%	3632.14%		22,19.64%
10	Selling weak and old animals before the outbreak of dry season	48,42.86%	23,20.54%	22,19.64%	20,17.86%	1,0.89%

Source: Own survey, 2014

Table 4.10. Farmers' Adaptive Mechanism Related with soil and water Management

S.No	Adaptive mechanisms	Likert scale				
		5	4	3	2	1
1	Using water soil conservation	112,100%				
2	Increasing manure application	101,90.18%	1,0.89%	10,8.93%		
3	Burning tree stem cuttings	91,81.25%	10.89%	20,17.86%		
4	Planting grass cover and terrace farming	53,47.32%	20,17.86%	20,17.86%	10,8.93%	9,8%
5	Preparation of water bank	54,48.21%	22,19.64%	36,32.14%		
6	Grass land burning	82,73.21%		20,17.86%		10,8.93%

Source: Own survey, 2014

Table 4.11. Other Mechanisms to Adapt Climate Change

S. No	Adaptive mechanisms	Likert scale				
		5	4	3	2	1
1	Selling labor of our Family Members	93,83.04%	8,7.14%		11,9.81%	
2	Reducing the amount of meal eaten per day	33,29.46%	21,18.75%		58,51.79%	
3	Eating less preferable(cheap) food items	84,75%	13,11.61%	8,7.14%		7,6.25%
4	Engaging on petty trade	6,5.36%	7,6.25%	3,2.68%	16,14.23%	80,71.43%
5	Supporting each other	78,69.64%	13,11.61%	21,18.75%		
6	Removing unpalatable species	82,73.21%			1,0.89%	29,25.89%

Source: Own survey, 2014

Table 4.12. Barriers to practices indigenous knowledge

Types of barriers	Strongly agree	Agree	Neutral	disagree	Strongly disagree
Less access to climate related information	49,44%	30,26%	33,30%		
Less access to credit	79,71%	33,29%			
Land dispute	111,99%		1%		
Land tenure insecurity	74,66%	18,16	20,18%		
High cost to adaption measures	58,52%	54,48%			
Land fragmentation	85,76%		8,7%	19,17%	
Less concern of the government	58,52%	17,15%	37,33%		
Poor infrastructure	69,62%	43,38%			

Source: Own survey, 2014

4.4. Farmers' Adaptive Practices to Climate Variability

One of the intended objectives of this part was to identify some of coping and adaptation methods practiced by farmers, in response to impacts of climate change and variability.

The sample households were asked to show their agreement or disagreement on the listed climate change adaptation mechanisms. The listed mechanisms were, the most widely adopted strategies and those have little cost to the household and are relatively easily reversible. As noted by the key informant groups, communities are the first to respond to disasters induced by climate change shocks. Generally, there was not much difference in the proportion of households adapting mechanism across the sampled Tabias. The most commonly cited adaptation strategies used first by households when dealing with climate change shocks are noted in the next sections.

A study made by Sharka *et al.* (2013) states that some of the Adaptation measures by the Ethiopian farmers are changing crop variety, soil and water conservation, water harvesting, planting of trees and changing planting and harvesting periods. Changing planting dates, using different crop varieties, planting tree crops, irrigation, and soil conservation were also identified as an adaptive measures.

Similar to the finding of Sharka *et al.* except on one or two of the above climate change adaptation strategies (Table 4.11 above), almost all farmers have agreed that they have the culture and practice of using the mentioned ones as means to mitigate climatic change/variability. More specifically, 100 %, 92%, 92%, 93% and 76% of the total respondents strongly agreed that they diversified crops and crop composition, planting more trees at plot, conserving and recycling local seeds, growing crops most sensitive to pests and disease and feeding cattle by cut and carry respectively. Paradoxically, about 48% of the respondents did not support the 'using of early maturing crops" and still another 19% of the respondents were neutral on this regard. To know why this happened, we have brought the same question on the focus group discussion. One thing that was mentioned on the focus group discussion is that there are some inherent practices that; some farmers are closely attached to their fathers' and ancestors' crop types. The other mentioned reason was the disease resistance and productivity issue of the crops. What they argued was that; the crops we use are already familiar with the soil type and weather condition of the area. Hence, it can resist to some diseases. On the productivity side, it was underlined that the longer the duration the crop stays on plot land the more crops and fodder productivity is. But, the main reason they put is the existing tradition of preserving the familiar crop types. With regard to migration, about 20% of the respondents did not support migration as a tool to cope up with climate change and about 32% were neutral on this regard.

As a conclusive point, there is no much variation between the sampled Tabias or between farmers with regard to the above listed strategies. Majority of the farmers' (respondents') reflections were found to be in favour of the given adaptive mechanisms except on the two (using early maturing crops and migrating) that a little bit variation was observed. The practice of Soil and Water Conservation (SWC) is well punctuated with the farmers of Tigray. That is why 100% of the respondents (as shown on Table 4.12 above) strongly agreed on the practice of soil and water conservation as means to adapt climate variability/ climate change. The researchers have also observed that soil and water conservation was done on every mountain, plateau, even plains. Especially, this was highly pronounced on the common grazing areas. The remaining adaptive mechanisms to climate variability (associated with soil and water) are also practiced by the farmers.

Selling labor of family member, reducing the amount of meal eaten per day (eating the cheapest food item), supporting each other in times of shock and replacing inedible plants with edible ones are also the other dimensions of climate variability adaptation mechanisms. (See table 4.13 below). But, as it is shown on the table, engagement of on petty trade as an alternative is minimal. This might be due to several reasons some of which are; the remoteness of the farmers' residence from high ways and towns (this specifically represents for Tabia Mayliham), lack of experience and shortage of facilities like electricity (for the Tabia centers).

Generally, farmers are enriched with several traditional climate adaptation practices. The inclination of the respondents indicates that these practices are fruitful and need to be preserved and suatanabily used. But, as has been described during the focus group discussions of the two study areas, it is only the farmer who struggles to maintain these values [especially the indigenous ones like supporting each other, manure application, burning tree stem cutting (the leftover) tracing and planting, Conserving and recycling local seeds]. The government's and development agents' effort one the one hand, to identify and synchronize the best traditional practices with the scientific one and on the other hand to avoid the less recommended ones like eating small amount and quality is inadequate. As a result of these, according to the discussants, many traditional practices are disappearing.

Example

- washing sorghum with urine (April's Urine) of cattle before sowing protects the crop from pests and disease during its growing time
- Using compost (keeping crop residuals, leaves and dung beneath the surface area) makes the soil more fertile and productive.
- Frequently shifting (rotating) the cage animals across the arable land (locally known as Tsbra) makes the plot to be more fertile
- Fallowing (leaving free plot lands for a season) can also make land more fertile.

All the above are on the state of disappearance, according to the participants. Hence, the government and other concerned bodies are expected to go to the downstream to search and use these traditional but practical climate adaptation mechanisms.

According to the survey result about 99% of the sample respondents were put land dispute the main barrier farmers use their indigenous knowledge since it is the most inconvenient

way to that hinders the utilization their knowledge. Whereas 76%, 71%, 66%, 62%, 52% of the sample respondents were replied Land fragmentation, less access to credit, Land tenure insecurity, Poor infrastructure, less concern of the government were potential barriers that hinder the utilization their knowledge respectively. In focus group discussion farmers was asked about general perception of challenges in utilization their indigenous knowledge, many felt that they had uncertainty about the feasibility of land tenure and high land disputes among farmers were main barriers . In general, many farmers are not utilizing their knowledge as an input for controlling climate change variability, due to land dispute and uncertainty in tenure and many other problems including the factors listed in the table.

4. SUMMARY, CONCLUSION AND RECOMMENDATION

4.1. Summary

A large segment of population in Ethiopia is still vulnerable to seasonal food insecure because of recurrent drought. Ethiopia's vulnerability to climate change goes hand in hand with poverty. Tigray region is more affected by drought due to unreliable rainfall conditions or climate variability. The complex nature of climate in the region took many lives; which also entails loss of assets in the form of crops, livestock, and productive capacity damaged as a direct consequence of water shortages and pasture degradation the lives of thousands of people has threatened.

The following is the main summary of this paper

- 64% of the sample respondents were engaged in leading their life via Renting out land where as 35% of the sample respondents were used Crop production as a means of their livelihood. Key informants interview and documents analysis confirmed compare to means of livelihood, greater number farm households currently engaged in renting out land.
- 70% of the sample respondents of the study area deliver for livestock feed from grass and 20% of them supplies for feeding of their livestock from crop residues. . in contrast with this, Key informants interview and documents analysis confirmed compare main source of feed for livestock before ten years and now was that greater number farm households currently engaged in feeding their livestock from crop residues than grass this is mainly because of reasons of climate change variability and deteriorated grass in the field.
- 57% of the sample respondents used information regarding climate change since it is the most convenient way to minimize the impact of climate change where as 43% of the sample respondents were used diversification on crop and diversification as a means to minimize climate change.
- Regarding role of Government and NGOS for reduction of climate change the above table shows that higher percent of respondents 75% said that Encouraging farmers to use their knowledge should considering by government and NGOS for reduction of climate change .key informants also confirmed sustainable reduction of climate change impact can be realized via making confident , and encouraging farmers to use their knowledge .nevertheless, 16% of respondents replied government and NGOS participation in providing credit
- Climate change and variability; as to the statistical results and farmers perception on climate condition, the study area has had shown changes in rainfall and temperature patterns. The rainfall amount of the Tabias has decreased through time (late start and early go). On the contrary, majority of the respondents have agreed that temperature pattern has shown an increasing trend. The findings of the study further revealed that uncertainty in climate and decrease the availability of indigenous plants and vegetation are the current manifestation of the study areas.
- The most commonly cited coping strategies was used first by households when dealing with shocks were: soil and water conservation, manure application, tracing on plot, planting trees alongside the farm areas. Eat less preferred or less expensive foods, reducing the number of meals, food aid or safety net, support each other & selling labor are also another dimensions of adapting strategies.
- According to the survey result about 99% of the sample respondents have mentioned land dispute as the main barrier use indigenous knowledge since it is the most inconvenient way that hinders the utilization of their knowledge. Whereas 76%, 71%, 66%, 62%, 52% of the sample respondents replied Land fragmentation, less access to credit, Land tenure insecurity, Poor infrastructure, less concern of the government were potential barriers that hinder the utilization their knowledge respectively.

4.2. Conclusion

Climate variability is a major driver of vulnerability in the study areas. Since the livelihood of the rural of the study Weredas is dependent of crop and livestock production irregular annual rainfall highly affected the livelihood of the population, Because of climate variability induced shocks and population growth the vegetation cover and grazing areas of the study areas has deteriorated and finally it caused livestock feed shortage and decrease in cattle production. There is irregularity in rainfall timing in turn which affects the cropping pattern and crop production of farmers. Farmers were found with a great deal of traditional but practical knowledge of adapting to climate change. However, the old-aged practices are at the fate of disappearance. This is due to the scientific knowledge is poor to go hand in hand with the existing one. Rather, it replaces it. Little attention is given by the government to discover and scale-up such traditional practices.

4.3. Recommendations

Given the nature of the data and based on the findings and results of the study the following policy oriented recommendations are suggested to materialize the indigenous climate adapting practices.

- The government (development agents and extension supervisors) should encourage farmers to use drought

resistant crop seeds together with commercial fertilizer, chemicals and soil moisture management practices.

- The governmental officials should train farmers on rainwater harvesting technologies that strengthen the existing water and soil conservation and expand the area cultivated with irrigation schemes.
- In relation to shortage of livestock feeding, there should be possible interventions by plating fodder trees around enclosure areas and irrigation dike. Train farmers on cut and carry so as to decrease overgrazing.
- There should be collaborative farmers' effort on preventing and controlling the expansion of invasive plant species which adversely damages livestock and crop production and over all of natural environment. This is because; it is the farmer who best knows which one the invasive plants species are.
- Adaptive capacity is especially limited in less-developed countries. This is mainly due to a lack of financial resources, resulting in a local workforce that does not have the skills or technology to adapt to climate change efficiently and effectively. Hence, the government and developmental agencies are recommended to perform two things:

i. They should provide farmers an easily operated and afforded adapting tools or technologies.
ii. Farmers are endowed with traditional, but effective, climate adapting practices. So, the government and developmental agents are expected to utilize these practices by triangulating with the modern (down-ward) system.

REFERENCES

Ajani E.N., R.N. Mgbenka and M.N. Okeke 2013. Use of indigenous knowledge as a strategy for climate change adaptation among farmers in sub-Saharan Africa: Implication for policy.

Deressa, T., Hassan, R., Ringler, C., Alemu, T. and Yesuf, M. 2008. Analysis of the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate

Discussion Papers No. 798, International Food Policy Research Institute, Washington DC.

FAO. 2007. Food and Agricultural Organization of the United Nations. Retrieved from www.fao.org/nr/water/aquastat/ countries/botswana/index.stm.

Fischer G, Shah M, Tubiello F.N, van Velhuizen H. Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990–2080. Phil. Trans. R. Soc. B. 2005; 360:2067–2083

Flavier, J.M. *et al.* 1995. 'The regional program for the promotion of indigenous knowledge in Asia', pp. 479-487 in Warren, D.M., L.J. Slikkerveer and D. Brokensha (eds) The cultural dimension of development: Indigenous knowledge systems. London: Intermediate Technology Publications.

Gbetibouo, G. 2009. Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability, the Case of the Limpopo Basin, South Africa: IFPRI Discussion paper 00849.

Hanson Nyantakyi-Frimpong, 2013. Indigenous Knowledge and Climate Adaptation Policyin Northern Ghana. Ghana-Accra

International Food Policy research Institute (2010). Micro level practices to adapt to climate change for African small-scale farmers.

Maddison, D. 2006. The perception and adaptation to climate change in Africa. CEEPA. Discussion paper No.10.Centre for Environmental Economics and Policy in Africa. Pretoria, South Africa, University of Pretoria.

Mertz, O., Mbow, C., Reenberg, A. and Diouf, A. 2009. Farmers' Perceptions of Climate Change and Agricultural

Nhemachena, C. and R. Hassan. 2007. Micro-level analysis of farmers' adaptation to climate change in southern Africa. IFPRI Discussion Paper 00714. Washington, D.C.: International Food Policy Research Institute.

Nhemachena, C., and R. Hassan. 2007. Micro-level analysis of farmers' adaptation to climate change in southern Africa. IFPRI Discussion Paper 00714. Washington, D.C.: International Food Policy Research Institute.

Parry, Martin *et al*. (eds.) 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability.

Scholze, M., Knorr, W., Amel, N.W. and Prentice, I.C. 2006. A climate change risk analysis for world ecosystems.

Sharka Juana *et al* 2013.Farmers' Perceptions and Adaptations to Climate Change in Sub-Sahara Africa: A Synthesis of Empirical Studies and Implications for Public Policy in African Agriculture

Socio-economic team (May, 2010); Farm – Level Climate change Perception and Adaptation in Drought Prone Areas of Tigray, Northern Ethiopia Vol. 3. Mekelle, Ethiopia

United Nations 2008. Permanent Forum on indigenous: New York.

Warren, D. M. 1991. Using Indigenous Knowledge in Agricultural Development; World Bank Discussion Paper No.127. Washington, D.C.: The World Bank.

World Bank 2008. World Development Report 2008: Agriculture for development. Washington DC: World Bank.

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