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Assessing the Perceptions of Local Communities on Rainfall Characteristics, Variability and Future Change: A Case Study of Sinana District, South Eastern Ethiopia

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Abstract: *Assessment of the local community's perception on rainfall variability and future change has enormous advantages in the study district, where natural rainfall is the main source of water for crop production. This study was conducted to assess the perception of local communities on rainfall characteristics, variability and future change. A proportional size method of the total population was used to determine 161 sample respondents. Systematic random sampling techniques was employed to select respondents from the selected kebelle for interview. Hence, the analysis of perception of farmers on climate related hazard indicated that excess rainfall, drought and erratic rainfall were the major identified risks for full and partial crop failure in addition to increased crop disease and weed infestation in the study area. The result generated from current trend analysis somewhat agreed with farmers perception. Moreover, the study revealed that spider web, cold air, cloud movement and group of stars seen on the sky were the signs and signals identified by local communities which indicates whether the coming season will experience excessive or deficit rainfall. Climate related hazard is a key factor which frequently quoted as the main cause for crop failure over the study area. Hence, use of climate information, improved variety, land and crop management practices are recommended to offset climate related risks on crop production under the changing climate at Hora-Boqa Peasant Association (kebelle).*

Keywords: Hora-Boqa Peasant Association,Perception, Signs and Signals

1. INTRODUCTION

According to the National Meteorological Agency, average countrywide annual rainfall trends remained more or less constant between 1951 and 2006. However, both seasonal and annual rainfall has exhibited high variability (NMA, 2007). However, some studies have indicated that rainfalls have been declining over some parts of the country. Considerable declining in March-September rainfall was observed in northeast, southeast, and southwestern portions of Ethiopia after 1997 (Oxfam, 2010). In particular, rainfall amounts have significantly decreased during the *belg* (February-May) season. *Belg* rainfall in the east and southeast exhibited the largest percent reductions. Declines in *belg* rains may impact long cycle crop production with crippling consequences for agricultural production.

According to Hadgu*et al.* (2013), trends of rainfall events such as onset date, cessation date, length of growing period, and dry spell length were changed significantly in most stations, which agreed with the farmers' perception. The perception of farmers on *kiremt* rainfall characteristic events such as onset date, cessation date and length of growing period has been supported with observed meteorological data of the stations. In this regard, perception of farmers' on increase in frequency of late onset of *kiremt* rainfall and subsequent reduction in length of growing period was agreed with observed data at Adigrat, Alamata and Mekelle. However, the perception of farmers' on early withdrawal of *kiremt* rainfall was agreed with observed data only at Mekelle. Belay (2012), Assessed farmers' perceptions of climate change and the extent to which these perceptions have influenced their current practices with respect to adapting with changes in temperature and precipitation. Most of the interviewed farmers for the studied kebelles perceived that they have observed the changing precipitation, such as reduced amount of rainfall (59.7%), shift in the timing of rainfall and shortened period of raining days. They also stated that these changes have been affecting their farming activities. Given this perception and depending on the farming system, farmers have practiced several adaptation mechanisms. At local level, some farmers experienced positive effects from increased precipitation while others experienced negative effects as results from interviewing farmers suggested. This is a reflection of the unclear impact of change in precipitation on crop activities in the area. It is also a reflection of the high degree of variability of the rainfall experienced in the recent past.

According to Besse (2010) and SDAO (2006),in Sinana district,climate related risks such asmeteorological drought, water logging, and erratic rainfall were observed at different time.

However, well-established scientific proofs regarding the perceptions of local communities on rainfall is lacking in the study area. Therefore, the main objective of this study is to assess the perception of local community on the rainfall characteristics, variability and future change

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The study area covers Sinana District, which is small portions of Southern highlands of Bale zone in Ethiopia located at 6^0 50’ N-$7^0$17’ N and 40^0 06’ E-$40^0$24’ E (Figure 1). It extends from 1700 to 3100 mean above sea level (m.a.s.l). This District is under Indian Ocean influences as southerly fluxes generating rainfall when strong southerly moisture flow and easterly perturbation engulf. This can be also affected by heavy rainfall events coming from northward advancement and southward retreat of ITCZ(Korecha and Barnston, 2007).

As a result it experiences an annual average temperature of 9^0C to 25^0C and annual rainfall totals of between 452.7 mm and 1129.5 mm, respectively.

This District is bordered by GoroDistrict in the east Dinsho Districtin west, Agarfa and Gassera in the north and northeast and Goba District in the south (SDAO, 2006).

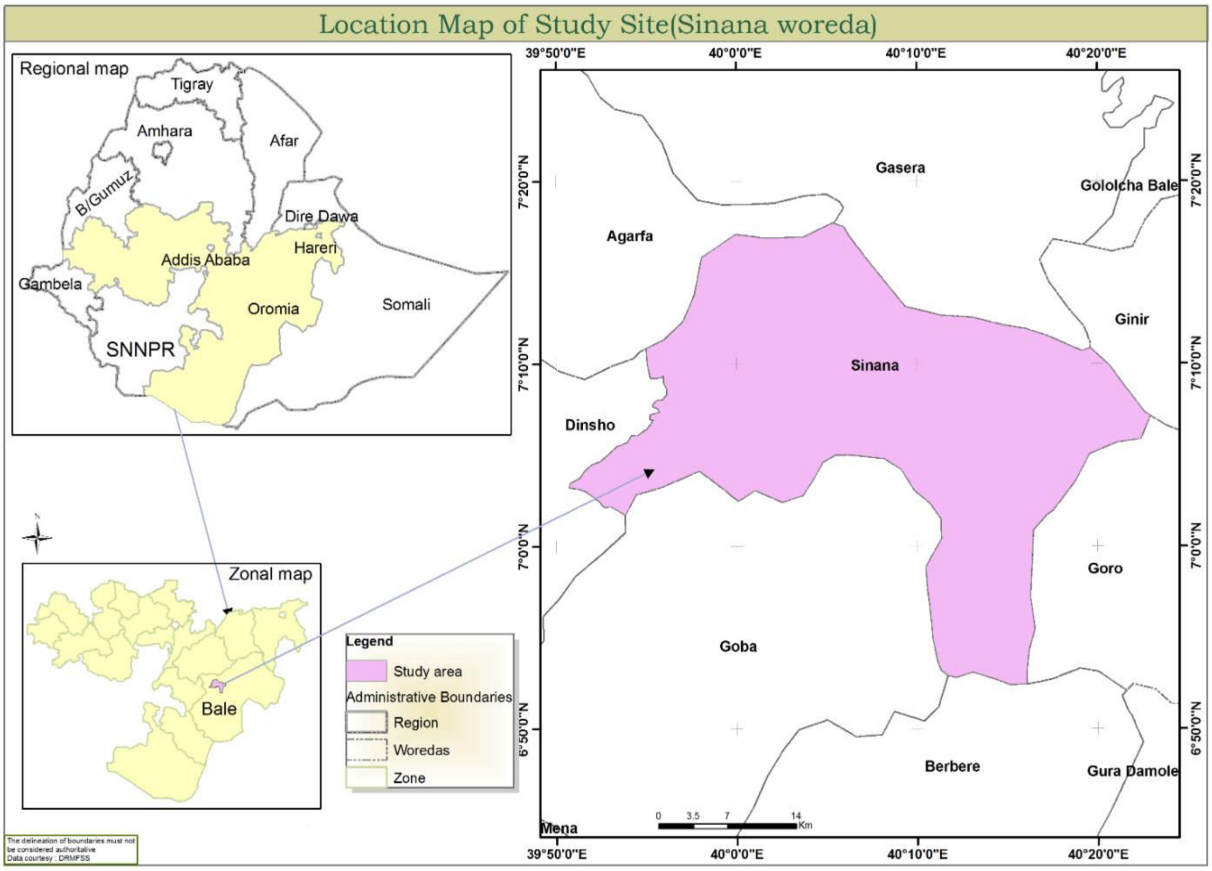

Figure 1. Map of the study area

Most part of Sinana District is found in SH2 (humid sub humid to cool mild highland) agro ecology (MoA, 2000). Rainfall climatologically patterns of the area also follow a bimodal distribution (NMSA, 1996; Bekele, 1997). Agriculture is the main economic practices in the district, from which the majority of dwellers earn their livelihood income mainly from crop cultivation. Major crops grow in the district include wheat, barley, oat, maize, bean and peas (Bogale*et al.*, *2009).* Topographical delineation of Sinana district includes moderate, steep slope and plateaus. Out of total land area of the District serving for crop cultivation, which is 163,554 hectares, 99,992 hectares are currently used for farm. However, there are a number of climate related hazards that are recurrent in this part of Ethiopia. As a result, of this, crop productivity is always at risk (Besse, 2010; SDAO, 2006).

2.2. Data methodology

2.2.1. Sampling procedure and methods of data collection

Hora-Boqa Kebelle among other Kebelles of Sinana district was selected because this area has been highly vulnerable to extreme climatic events such as droughts, waterlog which resulted in significant yield reduction on major crops (Besse, 2010).

Indigenous knowledge of local communities, particularly, farmers were interviewed based on pre-designed questionnaire in order to characterize social and economic implication of climate change or climate related hazard on their livelihood. Among the dwellers of Kebelle, some informants are selected using systematic random sampling technique.

Formula used for calculating a sample size is described as follows:-

$$\text{Sample size (n)} = \frac{N}{1 + N(e)^2}$$

Where N is population size, n is the sample size and e is the level of precision (Belay, 2012; Getachew et *al.*, 2014; Yemane, 1967 and 2001).For the selected kebelle, N=771 at ±7% precision levels the sample size was computed as (Equation 2), with confidence level of 95% and p=.5 (maximum variability).

$$\text{Sample size (n)} = \frac{771}{1 + 771\,(0.07)^2}$$

Hence, an optimum sample size for this study is161 farmers.

Generally, 161 farmers were selected for interview (Household field survey) out of 771 using systematic random sampling method from the selected Hora-Boqa Peasant Association (kebelle). After offering one day training for data collectors, face to face interview were held with the farmers using semi structured questionnaire.

Focus group discussion involving six participants were achieved and key informant interview were conducted with District Agricultural Head, Kebele leader and Development Agents.In order to maintain the credibility and quality of data, the author of this thesis fully administered the data collection process.Robe meteorological station rainfall data for the period 1995-2013 was obtained from National Meteorological Agency (NMA) which was analyzed using Microsoft Excel 2010 to present trends of rainfall in the form of graphs. The farmers'perceptions for selected questions were compared with the meteorological record data analyses.

2.2.2. Data Analysis

The primary data which is collected from farmers and key informants through interview and group discussion were analyzed using statistical software like Microsoft Office Excel 2010.
To investigate the nature of the trends in the rainfall series of Robe station, which is representative for the selected peasant association (Kebelle) , linear trend lines were plotted for both annual and seasonal (June-September and February-May) periods using Microsoft Excel Statistical Tool (2010). Finally, percentages, tables, pie and bar charts were employed to present the results of different variables.

3. RESULTS AND DISCUSSION

3.6. Perception of the local community on the variation of rainfall characteristics and climate related hazards

3.6.1. Overview of marital status and educational level of the respondents in the study area

Out of the 161 respondents, 94%, 5%, 1% were found as married, single and other (divorce), respectively (Figure 2). Likewise, educational level of the respondents were identified as; illiterates (59%), primary school (35%), high-school (secondary school) (5%), and graduates (1%) (Figure 3).

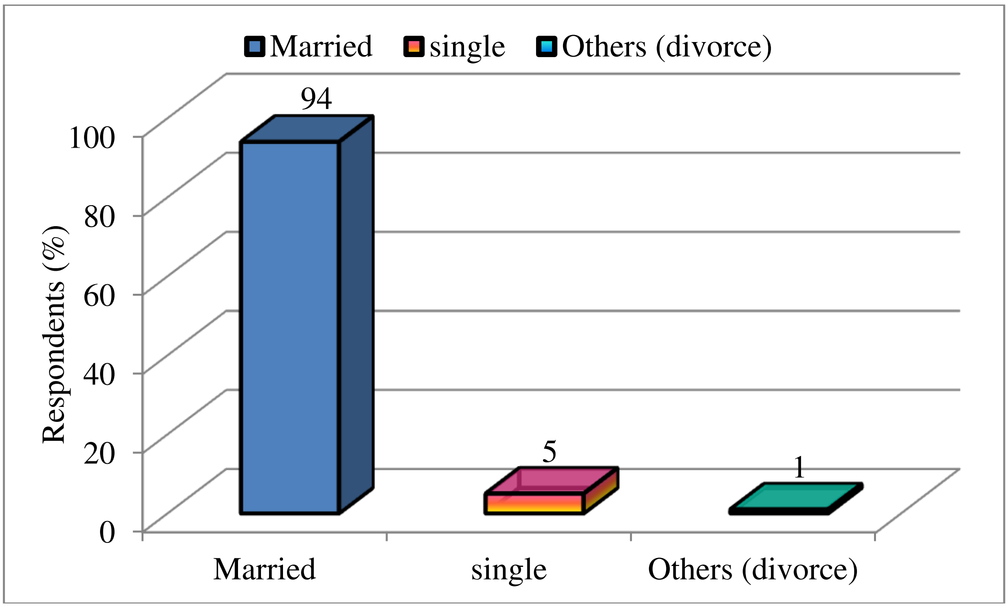

Figure 2. Marital status (in %) of farmers in Sinana district participated in the study

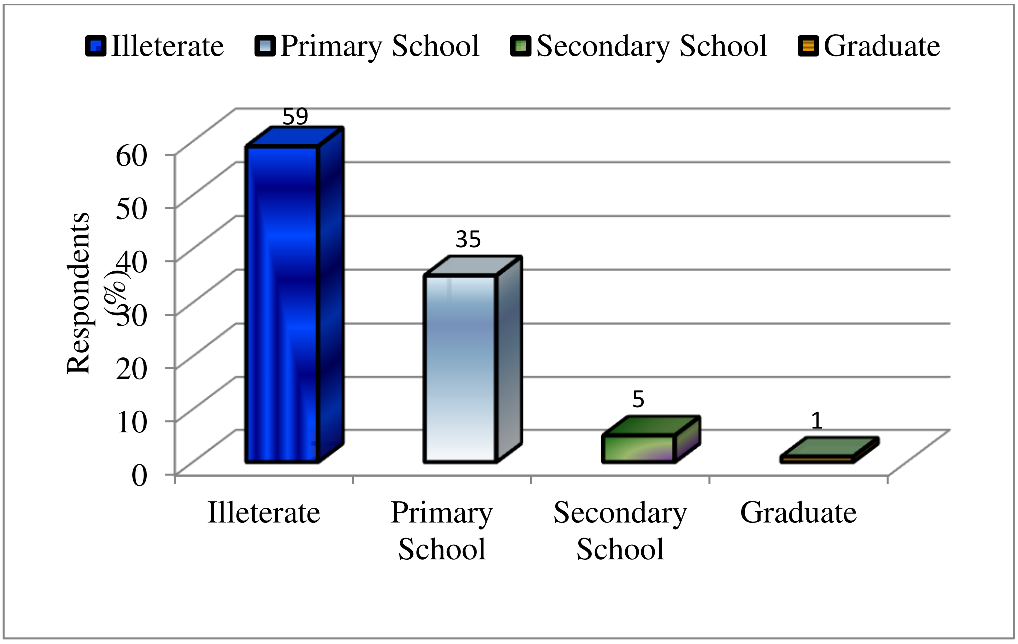

Figure 3. Educational level (in %) of farmers in Sinana district participated in the study

3.6.2. Perception of farmers on climate related hazard

From Hora-Boqa Kebelle, the farmers were asked about the major types of climate related hazard which altered their production and time of occurrence and the result is shown below.

As it was presented in Table 1**,** about 14%, 2%, 22% and 62% respondents stated that excess rainfall, drought, and erratic rainfall, respectively could be accounted for recurrent of the major types of climate related hazard, which affected crop production over different time period. Regarding the time of occurrence of climate related hazard, 8%, 39% and 53% of respondents have perceived that extreme climatic events mostly occurred during *belg*, *kiremt* and *bega* seasons, respectively.

Dejene (2011) for instance, documented that the majority of farmers in central Tigray ranked drought and untimely rainfall as first and second key climate related hazard as compared to others for the area. Furthermore Abate (2009) noted that heavy and unseasonal rain, delay in the onset of rain and prolonged drought were commonly observed in West Arsi Zone of Oromia Regional State.

Table 1. Farmers' perception for major climate related hazards

Types of hazard	Respondents (%)	Season	Respondents (%)
Excess rainfall	14	*Belg*	8
Drought	2	*Kiremt*	39
Erratic rainfall	22	*Bega*	53
All	62	All	-
Total	100	Total	100

3.6.3. Farmers perception on impacts of climate related hazard

As it can be seen from Figure 4**,** about 2%, 31%, 2% and 65% of respondents suggested that full crop damage, partial crop damage, increased crop disease and weeds were the consequence of climate related hazard occurred during different time period, respectively. This result has resembled with previous studies.

For instance, Belay (2012) and Tamiru et al. (2014) reported that farmers in Arsi-Negele district and Miesso-Assebot plain respectively perceived full crop damage, partial crop damage and increased crop disease and weed were among the identified consequence of climate change. Similarly, according to Deressa et al. (2007), crop yield was declined by 32.8% as result of shocks such as drought and flood etc.

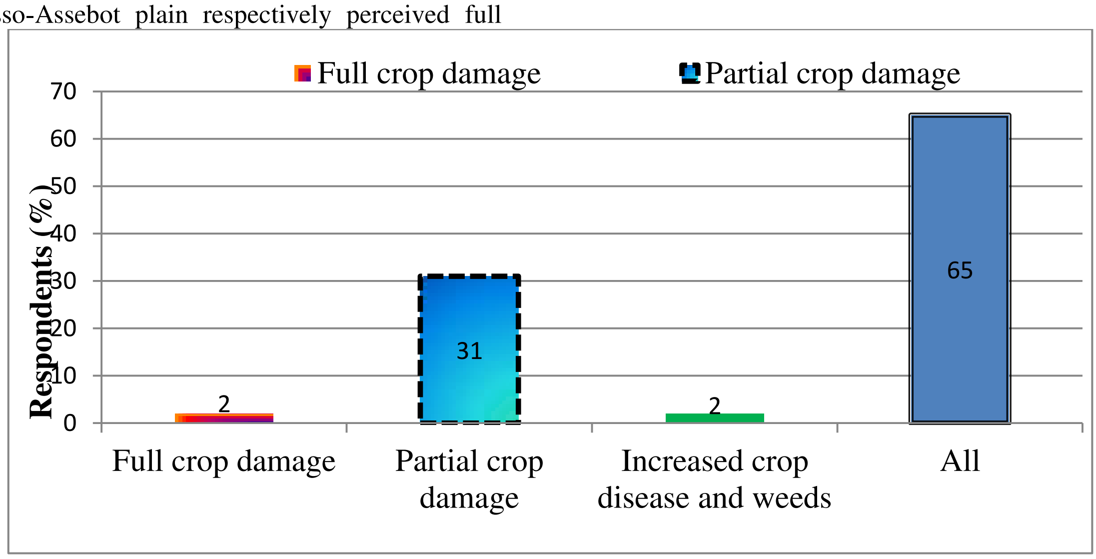

Figure 4. Farmer's perception on impacts of climate related hazard on crop production

3.6.4. Farmers observation on changing of rainfall characteristics

Farmers perception on changing of rainfall characteristics over the past19 years (1995-2013) were assessed (Figure 5) in comparison with measured climate records (Figure 6, 7 and 8).As configured in Figure 5, from 161 households interviewed about 3%, 2%, 22%, 5% and 68% of respondents have perceived that change of sowing date, change of harvesting time, increased rainfall trend, decreased rainfall trend and all, respectively were identified as good indicators for the change of rainfall characteristics. However, the record data on rainfall from1995 to2013 showed that there is a slight increasing trend in annual and seasonal (June-September and February-May) rainfall (Figure 6, 7 and 8). The result generated from current trend analysis somewhat agreed with farmers' perception (22%) in the study area.

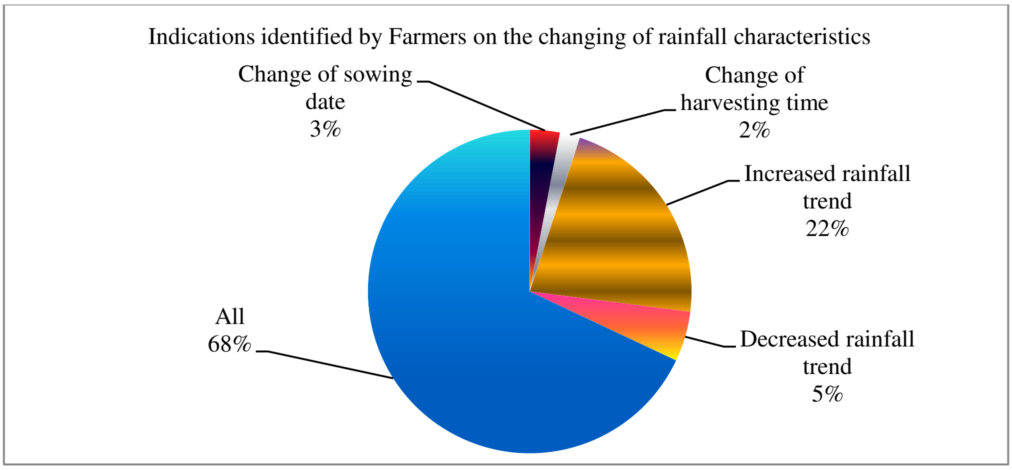

Figure 5. Indications identified by Farmers on the changing of rainfall characteristics for the past 19 years in the study area

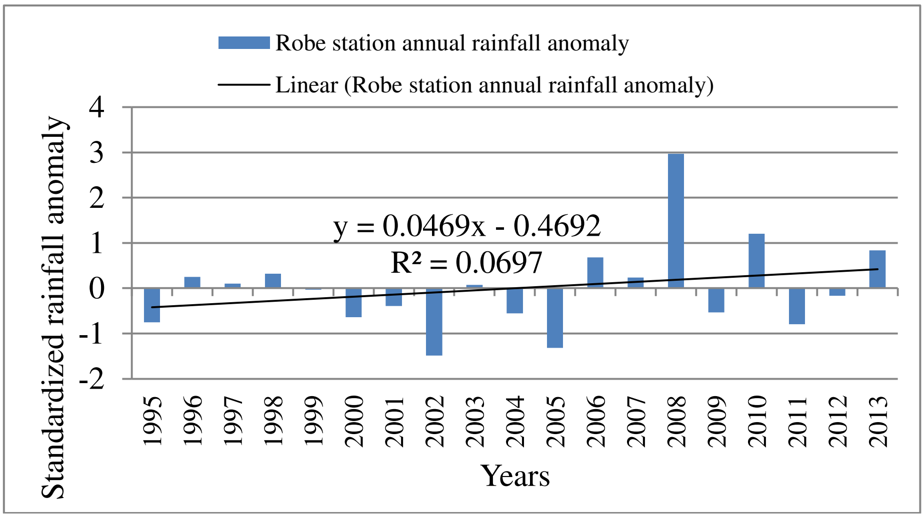

Figure 6. Time series showing annual rainfall over Robe meteorological station

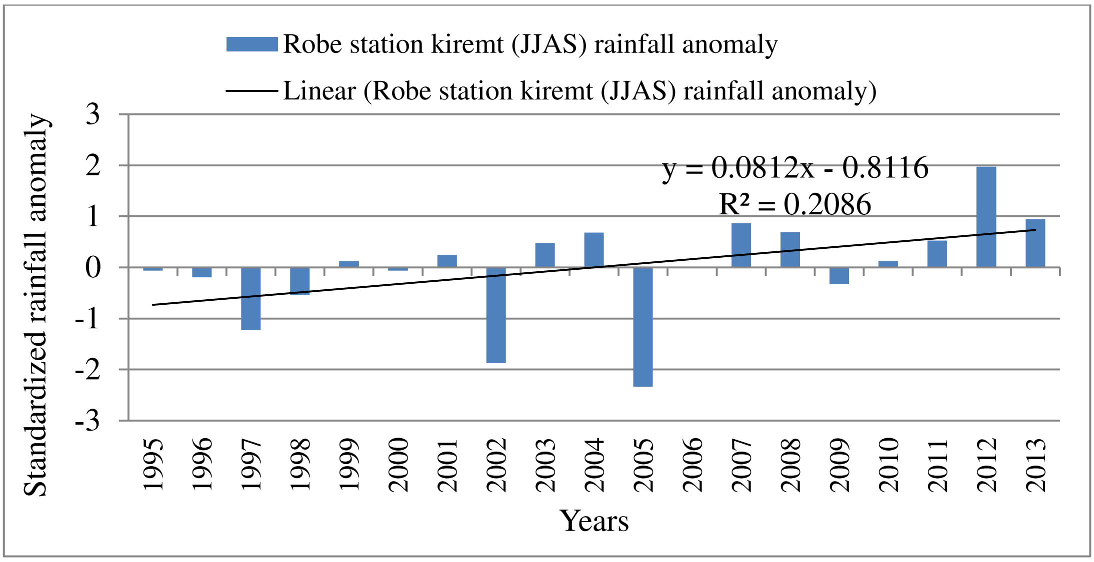

Figure 7. Time series showing *kiremt* rainfall over Robe meteorological station

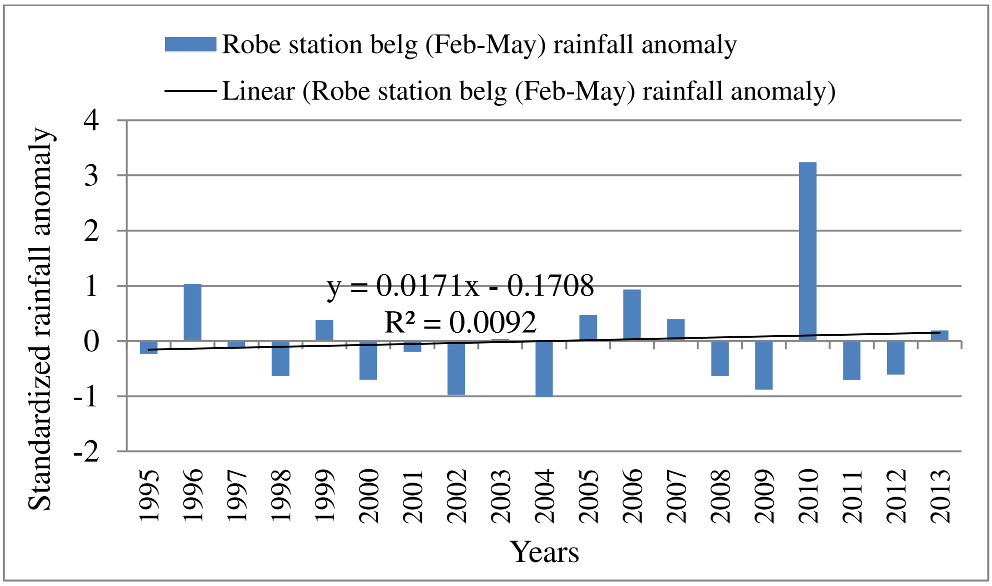

Figure 8. Time series showing *Belg* rainfall over Robe meteorological station

3.6.5. Indicators attribute for the change of agricultural activity

About 42%, 9%, 6% and 43% of respondents answered that change of sowing date in *Belg* and *Kiremt* seasons, change of growing period, change of harvesting time respectively were identified as a sign for the change of agricultural activity in the study area (Figure 9).

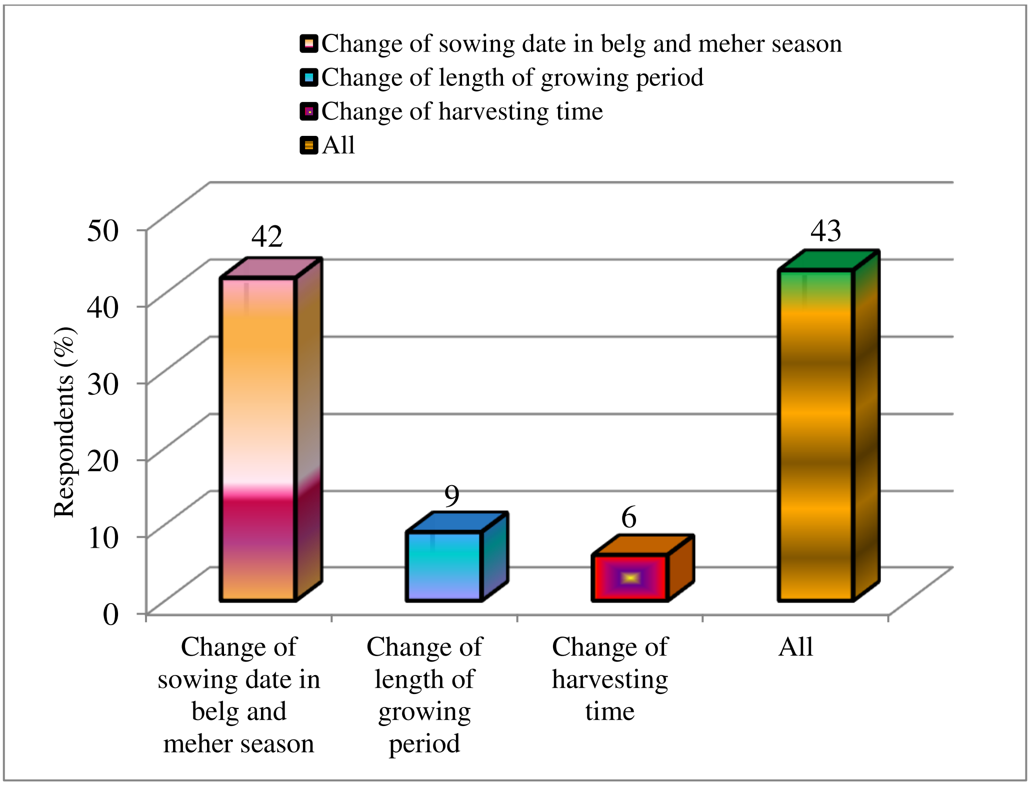

Figure 9. Indications identified by farmers on the changing of agricultural activity

3.6.6. Farmers perception on occurrence of climate related hazards

As indicated in Figure 10, about 3%, 34%, 60%, and 3% of the sample respondent were stated that most of the time climate related hazard in the area occurred during crop initial stage, vegetative stage, flowering stage and harvesting stages, respectively.

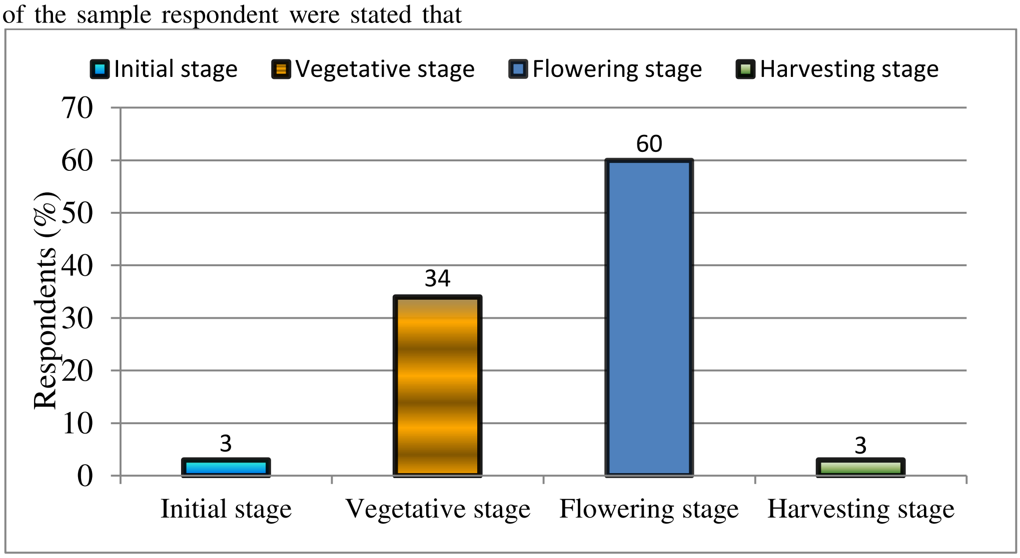

Figure 10. Farmer’s perception on occurrence of climate related hazard during various crop growing stages

3.6.7. Farmers copying strategies and indigenous knowledge for climate predictions

As it can be deduced from unstructured questionnaire survey of Table 2, farmers in Hora-BoqaKebelle adopted various copying strategies in response to climate related hazard. The most commonly adaptation strategies used includes early and late planting based on strength of hazard, soil conservation, crop rotation, fallowing and migration in search of fodder and water in the research site).Similar copying strategies were also reported by previous researchers for various parts of the country (Dejene, 2011; Belay, 2012; Tamiru et al., 2014).Other copying strategies currently practiced by farmers in the study area includes reduce animal size, planting short cycle and drought resistance crops and develop terrace (Table 2). This finding is in line with a study conducted by Abate (2009) in West Arsi zone, which indicated that farmers are accustomed to practicing planting short and drought resistance crops and saving money by selling animals in response to climate related hazard. On the other hand, farmer's indigenous knowledge to forecast the forthcoming climatic conditions using different signs and signals, indicators as documented in Table 2 below.

The most common indicators in the study area believed to be clouds and their movement east to west and blowing wind. These natural phenomena are thought to indicate whether the coming season will have excess or deficit rainfall (Table 2). Study made by Dejene (2011) in central Tigray reported that among the common indicators gathered, cloud in the sky and wind direction are becoming very useful to indicate whether the coming season will be wet or dry. The other environmental indicators include spiders' web seen on the ground which indicates as dry season persists a long. Formation of fog also indicate whether a crop disease happened or not in the following season (Table 2).

Table 2. Copying strategies and traditional prediction system of farmers on rainfall and occurrence of upcoming climate related hazard

Copying strategies	Signs and Signals	Detailed description of the indicator	Measurement (action) taken
Reduce animal size	Spider web	Appearance of spiders web on grass indicates thatlong duration of dry season is coming	Fodder will be collected
Planting drought resistance crop	Clouds	Appearance of clouds on the sky and hill indicates probability of rain	Precautions on agricultural activity should be taken
Early and late planting based on strength of hazard	Cold air	Cold air that appears during morning indicates an extended/prolonged*Bega (dry)* season	Transfer of planting crops for other season specially for *Belg*
Crop rotation	Fog	Appearance of fog on adjacent hill in the month of September indicates occurrence of crop disease and it is highly likely to occur	
Migration in search of fodder and water	Drizzle	Appearance of drizzle at night indicates occurrence of rust	
Develop terrace	Cloud movement	Cloud movement east to west indicates for excess rainfall is coming	
Soil conservation	Red termite and earth worm	Appearance of red termite and earth worm on the ground indicates as excess *Kiremt* (*Meher*) is coming	transfer of planting crops for *Belg* season
	Wind direction and thunder	Wind direction and sound of thunderstorm are indicators of upcoming weather	
	Group of star	Group of stars on sky at night indicates extended Bega(dry) season	

3.6.8. Farmers perception on major constraints to copying mechanism

The final semi-structured questionnaire result indicate that lack of climate information (51%), lack of access to climate information (21%), lack of technology (20%), lack of money (7%) and lack of laboratory (1%) were the major constraints to climate related hazard in the study area (Figure 11). Similar constraints to climate related hazard were reported from various studies, particularly conducted in Arsi-Negele district and Miesso-Assebot plain of Ethiopia (Belay, 2012; Tamiru et al., 2014).

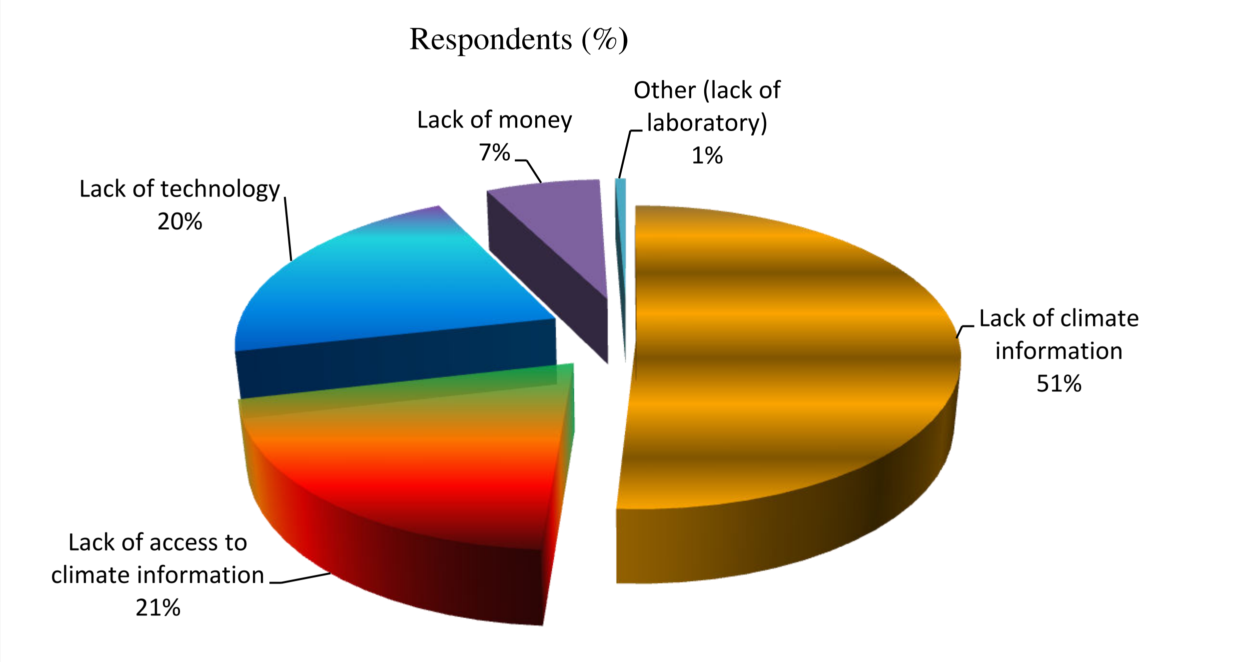

Figure 11. Farmers' perception on major constraints to copying mechanism for climate related hazard in Hora-Boqa kebelle

3.6.9. Local perception of government officials on rainfall features and climate patterns

Table 3 below illustrates perception of government officials on rainfall trend, consequence of climate related hazard and future plan. In general, the entire respondent believed that the rainfall trend over the past 19 years was changed, which can be described as erratic. Likewise crop failure, crop disease and decreased production were the major consequence of climate related risk while lack of awareness and technology were the main challenges in response to risk. Lastly, under the changing climate, use of improved variety, use of cured drugs, working in partnership, awareness creation and training were among the proposed plan for the coming seasons to flourish agricultural productivity of the area (Table 3).

Table 3. Perception of government officials on rainfall trend, consequence of hazard and future plan

	Response given by government officials		
Issues raised by respondents	Sinana District Agricultural Head	Kebelle Leader	Development Agents
Direction of rainfall trend.	erratic	erratic	erratic
Consequences of climate related on crop production.	Crop disease and failure	Production declined Crop disease	Crop disease and failure
Challenges in response to risk.	No problem	Lack of awareness	Lack of technology
Future plan to increase production.	Use of improved variety Use of drugs working in collaboration with stakeholder	Use of new technology Providing different training for the community	Awareness creation in order to use new technology

3.7. Focus group discussion on rainfall and climate related hazard

As presented in Table 4 below, the focus groups have perceived that the rainfall over the past 19 years was declined on the area. Most of the time, climate related hazards were occurred during sowing and crop harvesting time in addition to changing agricultural activity. In response to climate related hazard, lack of climate information and use of improved variety were the constraints and measurement taken respectively in the past years (Table 4).It would be very suffice to note here that the present result did not agree with the trend analysis based on recorded meteorological data (Figure 6).

Table 19. Perception gained from focus group discussion on issues of rainfall and climate related hazard

Issues raised by respondents	Response given
Direction of rainfall trend	decreased
Time of occurrence of climate related hazard	At sowing and harvesting time
Consequence of climate related hazard	Agricultural activity were changed
Time of climate information conveyed	ahead of hazard occurred
Constraints in response to climate related hazard and measurement taken	Lack of climate information and use of different crop variety

4. SUMMARY, CONCLUSION AND RECOMMENDATION

4.1. Summary and Conclusion

To assess perception of farmers on local climatic systems and their impacts farmers' livelihood systematic random sampling techniques was employed to select the respondents for interview from climate related hazard vulnerable peasant association. Hence the analysis of perception of farmers on climate related hazard indicated that excess rainfall, drought and erratic rainfall were the major identified risks for full and partial crop failure in addition to increased crop disease and weed infestation in the study area. From this study climate relate risks mostly occurred during crop flowering stages and in response to this risks lack of climate information was the key constraints in the study area.

Traditionally, some physical elements were identified as pre-indicators for local communities in performing indigenous climate forecasting systems. These indicators include spider web, cold air, cloud movement and group of stars seen on the sky. They were listed by respondents among the signs and signals, which indicates whether the coming season will experience excessive or deficit rainfall. Moreover, use of improved variety, new technology and awareness creation were the proposed future plan by the government officials in order to flourish agricultural productivity in the study site.

4.2. Recommendation

We found that indigenous knowledge on local climate have enormous advantage where farmers are in accessible for modern climatic information. In order to sustain information flow as well as better usage, however, district agricultural office would be advised to supplement indigenous knowledge with modern scientific climate information in collaboration with NMA so that the farmers can get up to date climate information.

Climate related hazard is a key factor which frequently quoted as the main cause for crop failure over the study area. Hence the use of reliable, local-specific and timely climate information occasionally produced on daily, weekly, decadal, monthly, seasonally and beyond can be utilized by the farmers community. NMA and agricultural sectors should avails all valuable climate related and agronomic information for the farmers so that it can enable the farmers to plan earlier for cropping season undertake improved land management, soil conservation, flood control method and improve farmers knowledge about proper use of weather information etc that apparently to minimize risks of climate related hazard or seasonal rainfall variability.

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