Agro meteorology and Remote Sensing

Rainfall Variability and Farmers' Copping Strategies: the case of Kobo Woreda

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Abstract

This study examines rainfall variability and farmers coping strategies in North Wollo: the case of Kobo Woreda. Historical rainfall data of the recent past records of kobo meteorological station was statistically analyzed on annual and monthly basis. Rainfall characteristics such as the annual total rainfall, the mean monthly rainfall, the coefficient of variation (C.V) of rainfall, and the precipitation concentration index were assessed. The result show that there is greater variability in rainfall distribution and amount and it is considered to be one of the most limiting factors in Agriculture. Farming systems survey was also conducted at five Peasant associations (PA's) of the study area to investigate the effects of erratic rainfall and farmer's coping strategies to weather related risks. The result showed that rainfall variability has a significant impact on crop and livestock production. Farmers have learned to cope with the current variability and have adapted a range of management strategies to ensure at least a minimum yield. But coping strategies are only risk avoiding and there is a need to share knowledge about these traditional technologies and to critically evaluate modern solutions in terms of costs, environmental impact and long-term sustainability.

Key words*:* Erratic distribution, intermittent drought, precipitation concentration index, coping strategies

Introduction

Rain fed Agriculture is influenced and highly constrained by climatic variability. The agricultural productivity of dry land farming zones is particularly fragile and vulnerable due to a wide range of climate and thus, the efficiency of the agricultural productivity system is determined mainly by the local climatic conditions (ICRISAT.1978). Among the climatic elements, rainfall is the most important factors, as it largely determines the agricultural productivity of an area. It defines the availability of moisture and the limits of the growing season. Agricultural operations depend on the anticipated pattern of rainfall over different time and scales. Rains in dry land climates are, however, notoriously variable, not only from year to year but also within the season (ICRISAT, 1978). Usually, researchers refer to the total amount of rain when characterizing the farming systems of a given area (Surrender et al, 2004). Annual averages alone, however, are of little use. In addition to its absolute quantity, the characteristics of rainfall such as its distribution, intensity and variability play an important role. Dry periods for example often occur during the growing seasons in many locations. These can last several weeks and markedly reduce yields yet their occurrence does not show up all in averages taken over several years. Analysis of these characteristics is therefore, essential. When data on the main variables of rainfall are known and analyzed, it is possible to choose crops and verities, planting dates and input levels in such a way that water available during the crop season can be exploited to the maximum The probability of a certain amount of rain, which can be calculated statistically, can also provide valuable information in planning agricultural land uses. The level of risk of erratic and unreliable rainfall may differ from area to area and farmer to farmer. Assessing and identifying the main problem areas where the effects of erratic and unreliable rainfall on the farming system most felt (i.e. is it feed shortage? limited availability of soil moisture and risks of prolonged dry spells? need for optimal timing of ploughing and planting to use the limited rainfall period? and so on) need to be addressed for further studies on improved intervention mechanisms.

Farmers may have their own indigenous knowledge and coping strategies to reduce those effects. Statements by farmers about climate and rainfall are also a source of valuable information. They can provide detail information on local conditions, which cannot be picked up by the weather stations broad networks. Therefore, it is very important to identify the wealth of indigenous knowledge underpinning farmers' strategies to cope with a drought prone environment, as well as the potentials and constraints of the on-going external interventions that assist farmers in their copping strategies. Accordingly, farming systems survey was conducted in five kebeles at Kobo woreda to investigate the effects of erratic rainfall and farmer's coping strategies to weather related risks.

Materials and Methods

The study area

Kobo woreda is located at the northern tip of Amhara National Regional State. The main town of the woreda, Kobo, is located at about 54 kilometers north of Woldia town. The woreda borders with Tigray region in the north, Gubalafto and Habru Woredas in the South, Afar region in the east and Gidan woreda in the West. The woreda has an area of 251,405 hectares or 2514.05 km^2. Its altitude ranges from 1000 to 2800 masl. Kobo is divided in to 32 peasant associations. The agro climatic features of the woreda is inclined to be tropical as 7.9%, 37.2%, and 54.9% of it is *Dega*, *Woina Dega,* and *Kolla*, respectively. The human population in Kobo woreda is estimated to be 206,788. The livelihood of the population is dependent on mixed farming and crop production, with about 96% of its population engaged in a risky agriculture. Due to various constraints, Kobo woreda is one of the critically food insecure woredas of the Amhara National Regional State.

Methodology

coefficient of variation of 26 % and the precipitation concentration index is 17%. The value of precipitation concentration index showed that there is seasonal variation of rainfall distribution and the coefficient of variation indicates a greater risk in rain fed agriculture. Comparison of the annual rainfall with the normal rainfall also showed that there is greater deviation of rainfall amount in year to year distribution (Fig. 2).

Table1. Agroclimatic elements of Kobo (Altitude: 1470masl, coordinates: 12.09, N.L., 39.38)

Month	Rainfall (mm)	Max. Temp	Min. Temp	Humidity %	Wind speed (km/day)	Sunshine Hours	ETo-Penman (mm/day)
Jan	12.43	25.8	12.6	60.1	161	7.82	3.92
Feb	15.03	27.3	13.3	57.4	200	7.71	4.62
Mar	29.93	29.1	15.6	53.9	186	8.01	5.15
Apr	59.92	30.5	16.1	55.3	186	8.17	5.48
May	46.76	32.1	16.6	47.1	156	8.39	5.57
Jun	17.00	33.7	18	37	175	6.53	5.75
Jul	114.58	31.4	18	48.2	181	5.71	5.27
Aug	204.70	30.1	16.9	58.8	139	6.05	4.65
Sept	87.66	29.9	15.3	60.6	111	6.73	4.43
Oct	42.11	28.7	13.8	71.7	179	8.31	4.6
Nov	12.47	27.9	11.9	46.6	137	9.13	4.42
Dec	13.24	26.4	11.5	55.7	144	8.48	3.94
Year	**655.83**	**29.4**	**15**	**54**	**163**	**7.6**	**1758**

The result of questionnaire based discussion with farmers of the study area also showed that nature of rainfall is the main constraint to crop and livestock production. The most serious problem of rainfall variability is poor rainfall distribution (Table 2). The rainfall pattern of the area is mainly characterized as late start, dry spell between two rainfall events, absence in the middle and early setoff. Time series analysis of rainfall showed that there is a decreasing trend even in rainfall amount since the year 2001(Fig. 3).

The climatic water balance analysis (comparison of the monthly rainfall with the monthly potential evapotranspiration) revealed that the study area has very short growing period. Crops grow best when there is no shortage of water in the soil and this occurs when the potential evaporation rate is matched or exceeded by the rainfall, at least during the growing season of four months. For Kobo area, however, the rainfall exceeds the potential evapotranspiration for a period of less than three months (2[nd] week of July to end of September).

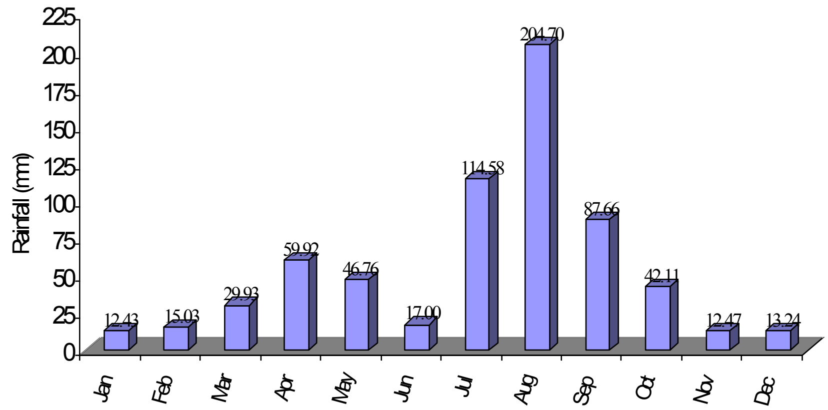

Figure 1. Mean monthly rainfall distribution at Kobo woreda

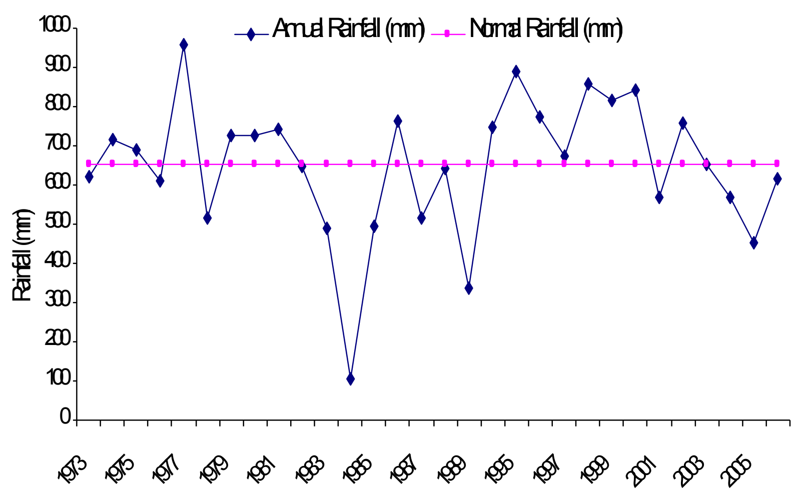

Figure 2. Comparison of annual rainfall and normal rainfall (mm) at Kobo woreda

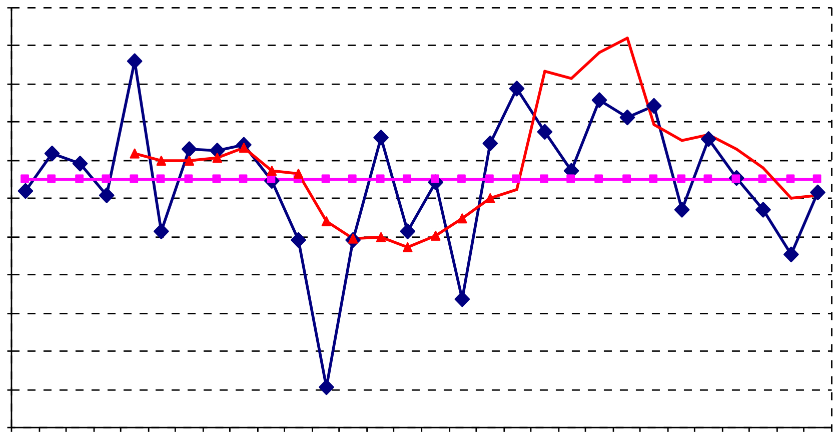

Figure 3. Time series analysis of rainfall at Kobo

Figure 4. Comparison of annual rainfall and potential evapotranspiration (PET) at Kobo

Risks of erratic rainfall: Farmers' perception

Erratic rainfall is found to be the bottleneck for agricultural production of the study area. Farmers explained that the agricultural activity heavily depends on the timing, amount and distribution of rainfall. The nature of rainfall is, however, erratic in space and time and it significantly limits agricultural production potential of the area. Risks associated with rainfall variability identified in the study areas include:

- total or partial crop failure
- shift in crop types, and genetic erosion.
- pest incidences
- shortage in feed availability
- prevalence of animal disease

Table 2. Problems associated with rainfall variability as indicated by respondents.

No	Major problems	Percentage of Respondents
1	**Rainfall variability is the main constraint to crop and livestock production**	100
2	**Most serious problem of rainfall variability**	
	Poor rainfall distribution	70
	Inadequate rainfall amount	2
	Both Poor rainfall distribution and inadequate amount	28
3	**Trend of variability in rainfall Distribution**	
	Late start, Absence in the middle and early set off	34
	Late start and absence in the middle	26
	Late start and early setoff	16
	Late start	12
	Absence in the middle and early set off	4
	Early setoff	4
	Late start, absence in the middle and too much rain in specified period	2
	Late start and too much rain in specified period	2
4	**Increase of inter seasonal drought occurrence**	96
5	**Shift in crop types related to rainfall variability**	96
6	**Loss of long cycled local crop varieties (Genetic erosion) due to successive drought**	52
7	**Pest incidence in association to rainfall variability**	90
8	**Disease prevalence related to rainfall variability**	96
9	**Incidence of frost**	54
10	**Effect of rainfall variability on livestock feed availability**	100

Local Coping strategies and Technologies for adaptation

Various coping mechanisms and adaptive strategies have been adopted by the rural households in the study area to reduce the impact of unreliable rainfall events (Table 3 and 4)). Some of them are individual measures;

while others are community based requiring group action. The coping mechanisms can be visualized as a network to maximize utility of resources from both livestock keeping and agriculture. The adopted strategies and coping mechanisms are depending on households' perception on extreme events and the problem associated with it.

A common response to erratic rains is to change the type of crop grown or to modify planting dates. Local communities have developed a knowledge base of what crops can succeed in their location, including the choice of crop species that would be suitable under drier conditions. Dry planting during late start of the rain and replacing with another crop when the rain do not persist after planting is the main strategy to cope with the effects of rainfall variability. For instance, farmers of the study area usually use dry planting of long cycled local sorghum varieties and when the rainfall is not persistent, they replant short cycle varieties of the same crop but if the rain is delayed for long time and if they felt that the season is not favorable for sorghum varieties, they used to replace it with teff and some leguminous crops like check pea.

Farmers have a practice of diverting flood to their farmland whenever there is rain which is scientifically known as runoff farming and some of them have a tradition of plowing strips of sorghum seedlings , locally known as 'shilshalo' so as to increase the soil moisture status of their farm.

During livestock feed shortage; they reduce the number of animals, exchange oxen power fro straw, and use uncommon feed sources such as leaves and pods of trees.

In addition to the aforementioned coping strategies, farmers have their own indigenous forecasting and early warning systems. They forecast the condition of the coming rainy season based on observation of migratory bird species, blooming of flowers and abnormal behavior in animals and used this information to adjust their farming systems to some extent.

Table 3. Farmers coping mechanisms to effects of rainfall variability

No	Type of Risk	Coping strategies	Percentage of respondents adopting these strategies
1	Poor rainfall distribution and lack of on time rain	Dry planting and shifting to early maturing varieties	62
		Dry planting of local varieties	28
		Using high seed rate	6
2	Absence of Rain in the middle (Limited soil moisture immediately after planting)	Replacing with another crop (for example if sorghum is planted but can not grow due to limited moisture then the land will be replanted with chickpea)	94
		Replanting the same crop	6
3	Pest incidence	• Plowing the land in June and early July to kill the eggs of the pest, • Cleaning the boundaries of the farmland, • Killing some insects using mass family labor	34
4	Livestock feed shortage	Reducing the number of animals	40
		Exchange of oxen power for straw /crop residue	22
		Using uncommon feed sources such as tree leaves and pods	10

Table 4. Possible rainfall scenarios, associated challenges and potential strategies for adoption

Possible Rainfall Scenarios	Associated Challenges/problems	Potential Strategies to be adopted
Low amount (Skewed to the left of the mean)	Insufficient to meet crop water requirements (high actual evapotranspiration)	• Selection of drought tolerant crop varieties • Moisture conservation measures • Reduced seed rate /lower plant population • Protective/life saving irrigation and extension of LGP
Low predictability of onset date (cessation date of effective rainfall not known)	Difficult to adopt fixed date of sowing, crop/varieties and management practices	• Off season tillage to capture early rains that comes any time • Development of crops varieties of wider plasticity
Short duration(short growing period), late onset, early cessation	Potentially high yielding long cycle crops cannot be grown	• Development of early crops varieties • Adjust plant population (e.g. Within 30 days after onset) • Development of crop varieties of wider adaptability
Erratic distribution (high intra and inter season coefficient of variation)	Difficult to adopt fixed date of sowing, plant population and fertilizer rate	• Develop different crop varieties of wide adaptability
Intermittent drought		
Early season stress	Reduced Stand establishment, vegetative growth hang over	• Selection of short duration crops and varieties • Use of reduced plant population
Mid season stress	• Premature switch from vegetative to reproductive stage • Reduced pollination and fertilization	• Thinning down by certain percentage • Protective irrigation • Soil and moisture conservation • Mulching
Late season stress	• Shortened grain filling period • Reduced yield	• Thinning, weed removal, mulching (and other soil and water conservation) • Repeated inter cultivation(hoes have water) • Protective irrigation(life saving irrigation
High intensity index over short time	• Rainfall exceeds infiltration rate • Accelerated Runoff • Soil erosion and increased sedimentation load at the down reaches	• Increase opportunity time for concentration and infiltration • Runoff/water harvesting inter row, inter plot, on farm pond

Conclusion

Statistical analysis of historical rainfall data showed that the rainfall is highly variable both in distribution and amount. Farmers have learned to 'cope' with current variability though a range of strategies (crop, water and livestock management practices).Coping strategies are largely local processes and actions taken by those directly at risk. However, they are very similar across communities and hence it may be possible to develop a frame work for adoption based on strategies that have generally been successful. A broader awareness of coping strategies beyond the community can also contribute to the policy process and facilitate the replication of good practices. The causes of vulnerability and livelihood decisions that people make based on their access to resources, are important in designing adaptation strategies. A systematic review of coping strategies may also reveal the limits of current coping, and where longer term impacts might require new measures. As evidenced by those cases where people are only managing to survive rather than effectively cope with extreme events, it is clear that not all traditional techniques are appropriate for dealing with disasters. There is need to share knowledge about these traditional technologies, and to critically evaluate modern solutions in terms of costs, environmental impact and long-term sustainability. To make food security more robust , the impact of climate variability require a number of strategies such as adaptation of new crop varieties , efficient land management ,mitigation of the effects of drought , improved seasonal climate prediction and so on. Exchange of experiences between regions facing similar climatic threats and risks would help broaden the knowledge base on such adaptations. Climate risk management tools are now readily available (climate analyses software: crop, soil and water management and pest simulation models: spatial weather generators: satellite imagery, seasonal climate forecasting: GIS systems etc). The uncertain impacts of climate variability must be seen in the context of, and integrated into current development priorities.

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