ISSN: 0975–833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 3, Issue, 5, pp.058-064, May, 2011

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

CLIMATE FORECAST INFORMATION: THE STATUS, NEEDS AND EXPECTATIONS AMONG SMALLHOLDER AGRO-PASTORALISTS IN MACHAKOS DISTRICT, KENYA

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ARTICLE INFO

Article History:
Received 13th February, 2011
Received in revised form
9th April, 2011
Accepted 27th April, 2011
Published online 14th May 2011

Key Words:
Climate forecast,
Smallholders,
Agro-pastoralists,
El Niño, Kenya.

ABSTRACT

The potential use of seasonal climate forecasts in farm and resource management has been studied in a number of cultural contexts around the world. Many of these studies reveal difficulties that smallholders encounter in accessing, interpreting and applying forecasts for their own benefit. This study looked at the awareness of and usage of climate forecast information in central Kenya in the aftermath of the 1997/98 El Niño event. Household surveys were conducted in Machakos District, Kenya, in January 2001. Retrospective and concurrent awareness and application of seasonal forecast information was assessed for 240 households across a range of agro ecological zones. The results reveal an incredibly high degree of awareness and use of forecasts. Farmers discussed both actual and potential application of forecasts for both above-normal and below-normal rainfall. The influence of the El Niño event of 1997/98 was clear in their emphasis on strategies to mitigate the impacts of above-normal rainfall. Applications of information in both crop and livestock management are documented. Constraints still exist, such as interpretation of information, relevance of the variables forecast to the management decisions of concern, confidence in the forecasts, and timely and affordable access to resources such as seeds. We suggest that collaborative efforts between the forecast providers and the users of information may be directed towards addressing these constraints. For instance in case of abnormal phenomenon, forecasts can be closely followed by early warning campaigns with clear guidelines of community preparedness in order to abate human suffering enhance human welfare and generally secure livelihoods and livelihood systems.

INTRODUCTION

Agricultural systems are notoriously responsive to climate fluctuations, creating real potential for skillful climate forecasts to improve farm and resource management and the welfare of rural populations. Because climate shocks can have especially devastating effects among the rural poor, special attention is being given to understanding what potential, if any, exists for using climate forecasting to mitigate downside risk and to create new opportunities for reducing poverty and vulnerability, and much effort is currently being directed toward improving the skill and dissemination of climate forecasts (Hammer et al., 2001). This paper provides the results of a household survey carried out in Machakos District, Kenya, designed to improve our understanding of the potential application of seasonal climate forecasts for smallholder agro-pastoralists in East Africa. Seasonal forecasts are now routinely released in the region through the Drought Monitoring Center (DMC), Nairobi and the Kenya Meteorological Department (KMD). Although there are countless theoretical uses for climate forecasts, particularly in the agricultural sector, there is to date sparse evidence that farmers are adopting this new technology to improve farm and resource management. Documenting evidence of usage is going to be necessary if resources are to continue to support this activity. It is recognized that there are a number of potential constraints to the use of seasonal forecasts as they are currently expressed. These have been documented in other contexts (Eakin, 2000; Phillips et al., 2001; Roncoli et al., 2002), and are generally centered on lack of access to credit or resources, lack of trust or comprehension of the information, or poor relevance of the climate variables forecast to the operational needs of farmers. However, there is also evidence that some of these constraints can be overcome (Phillips et al., 2002). Farmers are creative and if a new technology is useful, they are likely to at least experiment with it.This work was intended to explore in depth the potential uses of seasonal forecasts in the context of Central-eastern Kenya. The specific objectives of the survey were:

1. To assess the current level of awareness and application of climate forecast information among the smallholder agro-pastoralists in Central-eastern Kenya;

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2. To establish the current and potential value of climate forecasting information products; and
3. To evaluate the effectiveness of existing methods of disseminating climate forecasting information products.

The results presented here will compliment existing smallholder investigations, and provide updated insights into the growing awareness of seasonal forecasts and their application to farm and resource management in rural East Africa.

MATERIAL AND METHODS

Study area: The survey was conducted in Machakos District, Eastern Province, Kenya. Machakos District is situated between latitudes 0.45'S and 1.31'S, and longitudes 36.45'E and 37.45'E, with a total area of 6,051 km^2. Since Machakos District is large and varied in terms of climate, physiography and agricultural potential, the southwestern part of the district, which is fairly representative of the rest of the district, was selected for the survey. Two sub-locations were randomly selected from each of the three agro-ecological zones.

Physiography and climate: Central Machakos consists of hills and small plateaus, ranging between 700m and 2,100m high, surrounded by a large plateau about 1700 m high in the west and 700 m in the southeast. This undulating peneplain is interrupted by isolated mountains like Oldoinyo Sabuk (2144 m), Chyulu Hills, Kanzalu Ranges, Kangundo, Mua, Mitaboni, Iveti and Kiima Kimwe. The district is generally hot and dry with a bimodal rainfall distribution. The long rains are expected between March and May and the short rains between October and December. The annual average rainfall ranges between 500 mm and 1300 mm. There are significant spatial and temporal variations within the district and rainfall reliability is quite low. The high altitude areas of Matungulu, Kangundo, Kathiani, Central and Mwala divisions receive slightly higher rainfall than the lowland areas. The mean monthly temperature varies between 18oC and 25oC. July is the coldest month while October and March are the hottest. The highland areas, which receive higher rainfall, are more suitable for rain-fed agriculture than the lowland areas.

Agricultural potential and land-use types: Majority of people in the district are rural-based deriving their incomes from agricultural and livestock production activities. According to the 1997-2001 District Development Plan, subsistence agriculture is the main source of employment in the district, accounting for 29.5% of the labor force. Ranching activity is also practiced in the lowland areas of the district (MDDP 1997-2001).

Agricultural production: Farming ranges from intensive smallholdings to large scale farms, with a variety of both food and high value cash crops. Farming methods range from use of traditional cultivation tools with little or no manure and fertilizers to mechanized land preparation. Generally, yields are low for most crops which is attributed to the vagaries of the weather, low application of farm inputs, poor land preparation, late planting, improper weeding and use of inferior seeds. Maize and beans dominate the household "food basket". Pulses are grown in all the divisions of the district. The predominant ones are beans, pigeon peas, cowpeas, green grams and chickpeas. In favorable seasons, the district achieves self-sufficiency in pulses. The district frequently experiences food deficits due to unreliable rainfall. Drought tolerant crops like sorghum, millet, potatoes, bananas and cassava can improve food security in the district. However, this has not been the case because of attitudes and dietary habits. The principal cash crops grown in the district are coffee, cotton and horticultural crops. The most important horticultural crops are bananas, citrus, mangoes, paw-paws, macadamia nuts, cabbages, cut flowers and French beans. Vegetables and flowers are produced for both the domestic and export markets. Cotton was at one time a major cash crop in the district.

Livestock production: Livestock production is a significant economic activity in the district. Almost every household owns cattle and/or goats and sheep. The other types of livestock reared include donkeys, pigs, poultry, rabbits and bees. Livestock production activities range from large-scale commercial ranches, to small-scale household level livestock keeping. The traditional grazing practices are predominant, but a few farmers practice zero grazing (feeding of livestock in confinement).

Data Collection: The assessment of the climate information status in the survey area involved on-farm interviews by enumerators using a questionnaire. The questionnaires were administered to 240 households in six sub-locations. Two sub-locations were randomly selected from each agro-ecological zone after which 40 households were selected and interviewed in each of the sub-locations. The survey was carried out during January 2001, which marks the end of the short rains and the beginning of the dry season. To validate the survey instrument, a pre-survey test was conducted in one of the sub-locations. Each enumerator was allowed to administer one copy of the questionnaire to one household while the other enumerators listened. The researcher and the enumerators critically reviewed the filled out copies of the questionnaire jointly. The necessary changes or adjustments to the questionnaire were made before the actual survey was carried out. .The enumerators selected a route that roughly 'cut' across the sub location and interviewing every alternate household until the total sample for the sub-location was achieved. The sampling was purposeful, targeting household heads and/or farm level decision-makers. Data collected was analysed using descriptive statistics.

RESULTS AND DISCUSSION

The main food crops grown in the study area are maize, beans and vegetables. For the year 2000 long rains season, the highest number of farmers (70%) devoted their land to beans and peas (70% and 28%, respectively). This is because the long rains in this area are not as reliable as the short rains. Therefore, most farmers devote more land to the early-maturing crops, mainly the pulses. The data indicates that a large number of farmers (67%) require to buy seeds for some or all of the crops they plan to grow during any given season. However, the highest number of respondents (78%) indicated that they experience difficulty in securing the right varieties of seeds at the right time. Lack of cash, lack of proper advice from agricultural extension personnel and rampant presence of

counterfeit seeds in the market compounds the problem. Following retrenchment in the civil service, there are only a few field agricultural extension officers. Most respondents who do not buy seeds obtain seeds by selecting some from their previous season's crop. The practice of selecting own seeds from the previous season's harvest is a long-standing tradition not only within the *AKamba* community, but many African communities. Some farmers actually have more confidence in their own seeds than the certified ones the stockists. The practice is however, rapidly disappearing due to the increased awareness about the advantages of using certified seeds. Application of farm inputs like fertilizers, animal manure, compost and pesticides is a common crop husbandry practice within the survey area. The assessment revealed that majority (over 90%) of the respondents applies one or more of these inputs, at one time or another. Fertilizers and manure are mostly applied before or at planting. Whether a farmer uses inputs depends on factors such as the soil fertility estimated on the basis of the previous season's crop yield, availability of cash to buy the inputs, availability of the inputs and the farmer's experience. The anticipated amount of rainfall was found to have a strong influence, not only on whether any inputs will be applied but, also the quantities to be applied. Adverse climatic conditions such as an impending drought or disease outbreak, may spur sales of livestock, albeit at very low prices.

Climate Forecast Information Status: The results of this section are divided into two parts, depending on whether the respondents were or were not receiving climate information. For the group not receiving any climate information, the questions were hypothetical based on the assumption that they would like to start receiving the information. The objective was to establish the type of climate information that would be most useful if they were to start receiving, how they would use it and the appropriate lead time.

Those currently receiving climate forecast information: A majority of the respondents indicated that they are currently receiving meteorological information (82%). The 1997-1999 data (Figure 1) shows that the number of respondents receiving the information and those with a 'feel' of its accuracy and usefulness, steadily increased during this period. The increase can possibly be partly attributed to the awareness raised by the 1997/98 *El Niño* event.

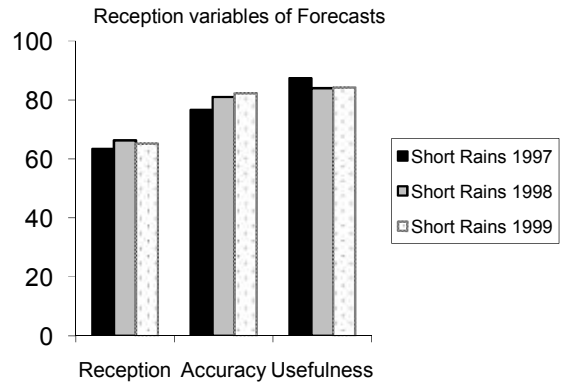

Fig. 1. Reception, accuracy and usefulness of seasonal climate forecasts 1997-1999

Types of climate forecast information received and channels of dissemination: Of the five types of climate forecasts issued by KMD, the seasonal forecast turned out to be the most commonly received product within the survey area. The other types of forecasts were virtually absent. The access to monthly and decadal forecasts in arid zone is suspected to be random since the KMD does not disseminate these forecasts to the general public. Table 1 below presents the primary sources of climate information by zones. The results indicate that radio is the primary source of climate information in all the three zones. This is supported by the fact that the highest number of respondents own radios (70%, 72% and 43% in sub-humid, semi-arid and arid zones respectively) with a few participants owning both radio and television. Inter-personal contacts turned out to be a valuable source of climate forecast information. In the absence of a radio or television, most farmers will depend on what they hear from friends, relatives, neighbors, administration personnel (chiefs and sub-chiefs). Every member of the community is concerned about the nature of rainfall during the up-coming season. Therefore, as the season approaches conjectures about the likely rainfall scenario (such as amount, on-set and distribution) constitute the most common topic in social encounters.

Table 1. Primary sources of various types of climate information (% of respondents)

	Sources of information					
	Radio	Inter-personal contacts	TV	Newspaper	Traditional methods	Government extension officer
Percentage of respondents	84	8	1	2	3	2

Majority of the interviewees currently receiving climate information apply it in their farm management decision-making processes. The assessment further revealed that decisions made by farmers in preparation for an up-coming season were strongly influenced by the type of forecast information received, e.g., whether the rains would be normal, above normal or below normal. Figure 2 presents the different farm management decisions that would be potentially influenced by the three climate forecasts in the three agro-ecological zones.

Application of climate information in operational farm decisions: During above normal rainfall, soil conservation decisions such as repair and/or construction of terraces ranked the highest in importance in all the three zones. However, the problem seemed to be more critical in the sub-humid zone, which is not only hilly, but also normally receives more rainfall than the other two zones. Other important decisions included selection of late-maturing crop varieties (hybrid maize varieties) and planting of trees, including fruit trees. In the arid zone, a few farmers indicated that they would do double planting if the rains were expected to be above normal. The practice involves planting two crops within the same season. The second crop, normally an early-maturing variety than the first, is planted just before the first one is harvested. The idea is to take maximum advantage of the excess soil moisture. Double planting was not very popular as the risk is quite high. For the below normal rainfall**,** farm management decisions related to the types (varieties) of crops to be planted seemed to take precedence. In the arid zone, majority of the respondents indicated that they would select more of the short-

maturing crop varieties to take advantage of the limited moisture. Early planting was an important decision in all the three zones. Decisions related to water, food and fodder conservation were also important although according to these results, they were only important in the arid and semi-arid zones which are drier. Generally, if normal rainfall is anticipated**,** no major operational decisions were made. According to our results, a relatively high number of farmers, particularly in the arid and semi-arid zones, would prepare the land early, apply manure and plant the most popular crop varieties early.

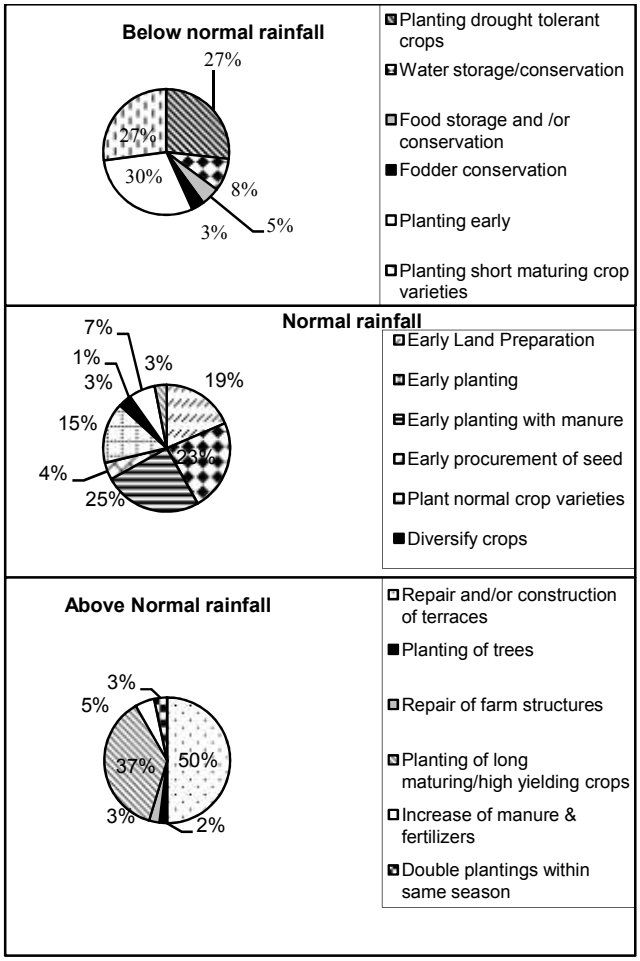

Fig. 2. Farm management decisions influenced by different climate forecasts (% of respondents).

Those currently not receiving climate forecast information: Lack of awareness of existence of the information, inaccessibility of the information and lack of interest were cited as the most common reasons for not receiving the information in all the three zones. As with those receiving the information, lack of a radio or batteries for the radio, as well as knowing when the information is broadcast came up as additional potential hindrances. Regarding the types of information that would be potentially most useful if the respondents were to start receiving any climate information, seasonal forecast again ranked the highest in all the three zones (Figure 3).

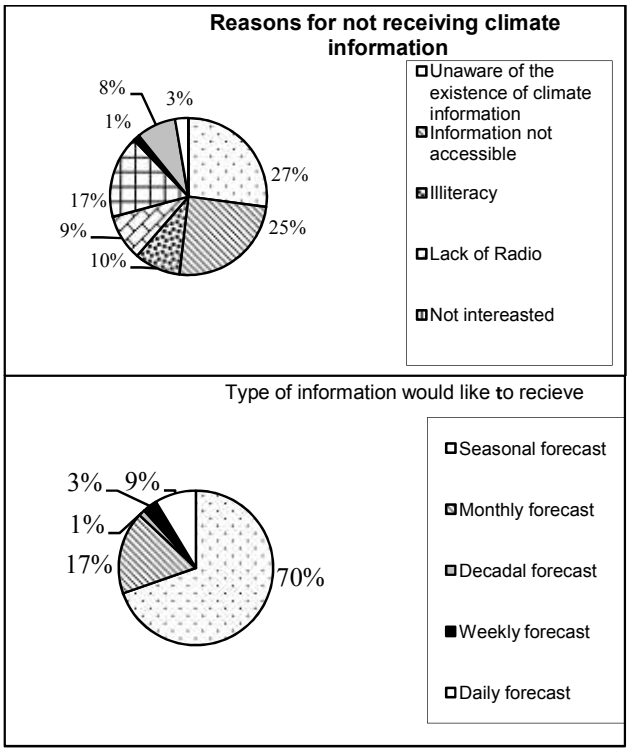

Fig. 3. Reasons for not receiving climate information and potentially the most useful information needed (% of respondents).

Like those currently receiving the information, the respondents indicated that the information would potentially be used in making important farm-level decisions such as when to start preparing the land, when and what to plant. Some participants viewed this information as potentially able to 'feed' into the overall planning of farm management activities. In terms of when the information would be mostly needed, majority of the respondents in sub-humid and semi-arid zones indicated before the rainy season, while in arid, the highest number of respondents said they would require it throughout the year. Majority of the interviewees rated the information as potentially very useful. Reduction of the number of untimely or 'blind' decisions was cited as the most important problem, which would be potentially mitigated by availability of climate information. Overall, most participants suggested that the information be made more accessible to farmers.

Need for additional climate forecast information: The assessment revealed that information such as the on-set and ending of the rains as well as the possibility and timing of a drought would be handy to the community. It was apparent from our results that each type of extra information would influence different farm management decisions to different extents (Figure 4). In total, the additional information would actually enhance the decisions farmers make on the basis of typical forecasting information – near normal, below normal or above normal. The highest proportion of respondents in all the three zones indicated that with additional information on when the rains are likely to start was essential as they would plant early. Ideally, these activities should be completed before the on-set of the rains. Therefore, availability of this information would enable farmers to make more accurate

decisions on the timing of the land husbandry practices, thereby increasing the chances of a successful crop harvest and thus household food security.

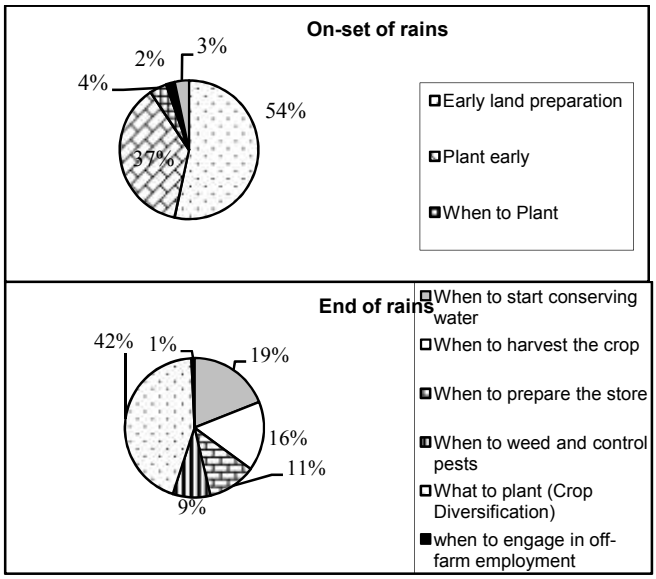

Fig. 4. Farm decisions that might be influenced by on-set and end of rains (% of respondents)

To the majority of interviewees, extra information on when the rains are likely to stop would also improve their decisions on when to start conserving water, harvesting the crops and preparing the stores. Some farmers indicated that the extra information could also influence the decision on what to plant, i.e., crop diversification. This would be particularly so if coupled with information regarding on-set of the rains. Droughts are dreaded climatic phenomena in the survey area. Therefore, information on when the next drought is likely to strike can spur more tactical measures than the below normal rainfall forecast. From the results of this assessment, the strategic decisions that would potentially be influenced by drought-specific information include water, food and fodder conservation (Figure 5).

With this information, some respondents indicated that they would plant drought tolerant crops rather than the 'normal' crops. Others indicated that they would save their seeds by simply not planting anything during the projected season. To others, the information would assist them to make more prudent livestock management decisions such as destocking. The decision to seek off-farm employment as a strategy against drought turned out to be most critical in the more arid and drought-prone zone. According to these results, conservation of fodder is a more important livestock strategy than sale of livestock. Disposing of livestock is among the last options to hedge against drought. In order to get a clearer picture of the climate information status in the district, the survey zeroed in on year 2000. The assumption was that farmers would more readily recall the events of the immediate past year. The main objective was to establish whether the farmers received the two forecasts issued that year, what they actually heard, whether the forecast was accurate, whether they used the information and if they did, how they used it. The survey further sought to establish whether respondents also received the crop and livestock advisories that accompanied each forecast, whether the advisories were adopted and if not, why not.

Climate forecast information status during year 2000: Our data showed that the highest proportion of the respondents received the year 2000 long rains forecast (Table 2). A large number of those who received the forecast heard that the rains would be below normal. According to the KMD press release, Machakos District was expected to experience enhanced probabilities of below normal rainfall. Although the probabilistic nature of the information was lost, the message heard was in the correct category. On the accuracy of the long rains forecast, majority of the respondents in zones III and IV described it as either very accurate or accurate. In zone V, majority of the respondents rated the forecast as accurate. With reference to the short rains, majority of the respondents indicated that they received the forecast (Table 2). However, unlike the long rains' forecast, there was a considerable variation in the message the respondents received. In the sub-humid and semi-arid zones, majority of the respondents heard that the rains would be below normal. In the semi-arid zone,

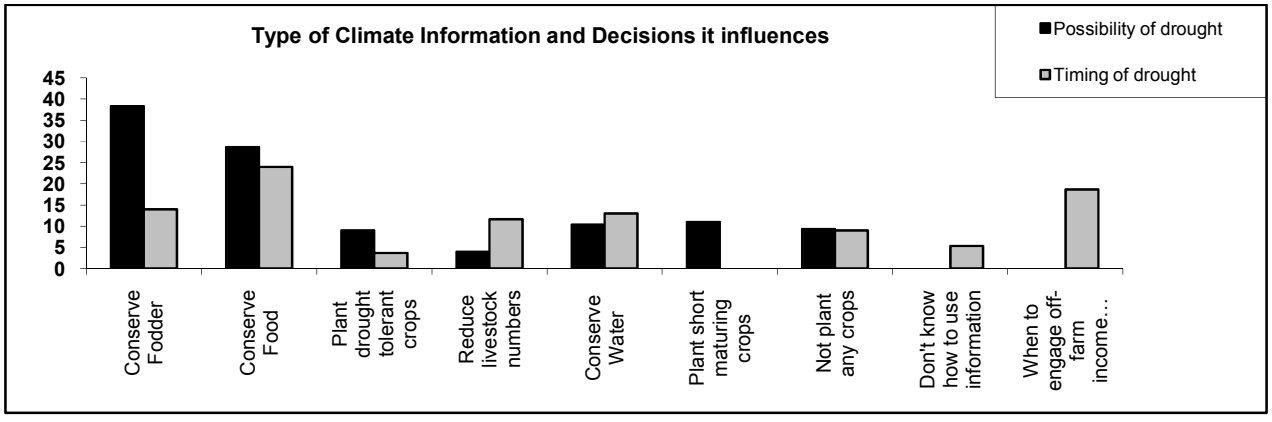

Fig. 5. Farm decisions that might be influenced by additional climate forecast information on possibility and timing of a drought (% of respondents)

majority heard that the rains would most probably be normal while the rest were almost equally split between the upper and lower percentiles. This illustrates the variability decoding of the forecast information.

Table 2. Seasonal forecasts and accuracy in three agro-ecological zones

Forecast received			
	Yes	No	
	88	12	
Percentage of respondents	Above Normal	Normal	Below Normal
	34	15	51
Accuracy of forecast	Very Accurate	Accurate	Somewhat Accurate
Percentage of respondents	79	13	8

According to the KMD, the district was expected to receive near normal rainfall, with a tendency towards slight enhancement. This type of forecast is not clear-cut and many ordinary farmers might have difficulty interpreting it. We suspect that the nature of the forecast may have contributed to the disparity in the forecast message the farmers purported to have heard.

Crop and livestock advisories: With reference to the crop advisory accompanying the year 2000 long rains forecast, the highest proportion of interviewees heard that they should plant early-maturing and drought-tolerant crops. In the sub-humid zone, 35% of respondents also heard that they should prepare the land early and plant early. The responses closely agreed with the official KMD message, which indicated that the depressed rainfall outlook was still capable of supporting some crop production provided the right choices of seeds and planting dates were made in time. It recommended planting more early-maturing crop varieties than the late-maturing ones. A large number of the interviewees who received the long rains crop advisory indicated that they adopted it. However, the adoption rates were higher in sub-humid and semi-arid zones than the arid zone. In line with the advisory, most farmers prepared the land early and planted early using mainly the early-maturing crop varieties.

The responses on the livestock advisory accompanying the long rains forecast differed from the KMD message which simply stated that the March-May 2000 rains were likely to be erratic and with a potential to affect both crop and livestock production. Thus, while the report contained no specific strategic measures that the farmers should have taken to minimize the potential impacts of the rains on livestock, the responses referred to specific measures such as planting of fodder, conservation of fodder and reduction of livestock numbers. It was hard to identify the source of the tactical measures that the farmers indicated they took. The most likely source was Agricultural Extension Officers. Fodder conservation and reduction of livestock numbers were the most important tactical measures in the more arid zones. As in crops, the highest number of respondents indicated that they adopted the advisory. Thus, they put in place some forage conservation measures for their livestock. A smaller proportion (10%) reduced the livestock numbers (Table 3).

Table 3. Adoption of advisory and measures taken against year 2000 short rains on crops and livestock

Measures taken on crops	Early planting with manure	Planting drought tolerant crops	Planting high yielding crop varieties
	40%	33%	27%
Measures taken on livestock	Preserve fodder	Checking livestock body condition	Reducing livestock numbers
	51%	9%	40%

Alternatives in absence of climate forecast information: In the absence of the said forecasts information ignorance or lack of interest was the major hindrance to reception of forecasts in the sub-humid and semi-arid zones (100% and 85.7%, respectively). For about 50% of the respondents in the arid zone, the main problem was radios being often out of order or lacking batteries. In the absence of the forecasts, all of the participants in the sub-humid zone indicated that they depended on divine intervention, while 100% and 60% in the semi-arid and rid zones, respectively, reported that they relied on past experience. Data on subjective performance of the farms with and without the forecasts was only available for the long rains. According to our results, 100% and 56% of respondents in the sub-humid and arid zones, respectively, noted no difference, while 75% in the semi-arid zone reported that the performance was lower without the forecast.

Conclusions

This field survey data shows that majority of farmers in Machakos District are aware of the existence and importance of climate forecast information (meteorological or traditional) in their farm-level operational decision making processes. The level of awareness seems to have steadily increased during the last four years, probably as a result of the impacts of the 1997/98 El Niño. The use of information varied by agro-ecological zone and the forecast itself; whether normal, above-normal or below-normal rainfall. A greater number of farmers were familiar with strategies for using a forecast for above normal rainfall, perhaps as a result of their experiences with the heavy rains during the El Nino event of 1997/98. Both traditional and scientific climate knowledge systems exist in Machakos, though not equally rooted, with some farmers being highly skeptical of the latter information base. It was evident from the survey that when both the traditional and scientific forecast information is available, both are applied. However, in the absence of meteorological forecasts, traditional forecasts together with previous experience remain the only basis for farm-level decisions pertaining to forthcoming seasons. Mechanisms for integrating the two knowledge systems could potentially improve comprehension of uncertainties and limitations to application for farm management, as well as form a basis for fitting scientific forecasts into existing decision processes. In spite of the relatively high degree of awareness of existence and role of climate information among the small-scale agro-pastoral farmers in the survey area, the most common general comment among the respondents was that the climate information should be made accessible to more users (farmers). One of the suggested methods of achieving this goal was dissemination of the forecasts in local languages, for instance using the local FM stations. Radio was the most common source of forecast information, and for the few respondents currently not

receiving forecasts, lack of awareness of existence of the information, lack of interest and/or lack of radios or televisions were cited as the main hindrances.

Current efforts in Kenya to develop a radio-based climate information dissemination system provide opportunities to tailor information products to suit the needs of the user community. Additionally, mechanisms for more interactive forums could be developed in which farmers are able to participate in the process of knowledge development and inquiry regarding seasonal climate forecasts. Evidence of the effectiveness of such opportunities was provided during post-survey meetings held in the participating communities. Farmers who attended had a chance to discuss the information in local language, ask questions, and share their own interpretation of possible strategic plans for the upcoming season, helping to build confidence and remove the mystery currently surrounding forecast information. This kind of community-level involvement should be integrated into any information dissemination system to realize maximum benefit of seasonal forecasts which would go a long way in improving the welfare and abating suffering in rural populations resulting from climatic shocks, change and variability.

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