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Climate Forecast Information: The Status, Needs And Expectations Among Smallholder Agro-Pastoralists In Machakos District, Kenya

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Climate Forecast Information: The Status, Needs And Expectations Among Smallholder Agro-Pastoralists In Machakos District, Kenya

A Report by

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SUMMARY

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 looks 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 agroecological zones. The results reveal a surprisingly 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 access to resources such as seeds. It is suggested here that collaborative efforts between the forecast providers and the users of information may be directed towards addressing these constraints.

INTRODUCTION

This report 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 Nairobi and National Meteorological Services. 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. Yet 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 Kenya. The specific objectives of the survey were:

1) to assess the current level of awareness and application of climate forecast information (traditional and meteorological) among the smallholder agro-pastoralists in Central Kenya;

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.

SURVEY AREA

Location

The survey was conducted in Machakos District, Eastern Province, Kenya (Figure 1). 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. It borders Kitui and Mwingi Districts to the east, Makueni District to the south, Kajiado to the west, Nairobi City and Thika District to the northwest, Murang'a and Kirinyaga Districts to the north and Mbeere District to the northeast.

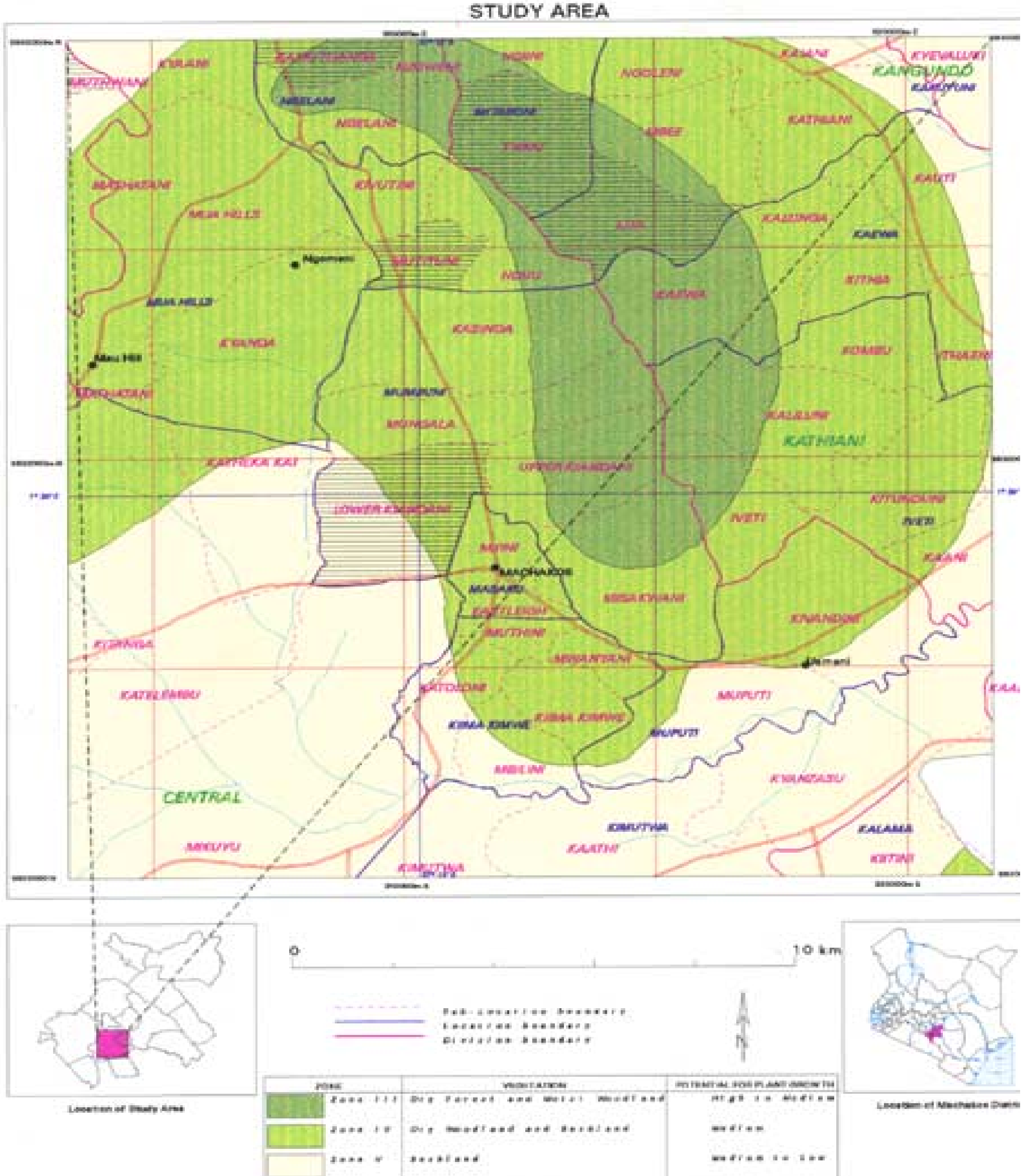
Since Machakos District is large and varied in terms of climate, physiography and agricultural potential, the southwestern part of the district which is fairly representative of the rest of the district was selected for the survey. Two sub-locations were randomly selected from each of the three agro-ecological 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 1,700 m high in the west and 700 m in the southeast. This undulating peneplain is interrupted by isolated mountains like Oldoinyo Sabuk (2,144 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 18^{o}C and 25^{o}C. 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. The plains support ranching (MDDP 1997-2001).


STUDY AREA
KANGUNDO
KATHIANI
CENTRAL
MACHAKOS
0
10 km
Location of Study Area
Location of Machakos District

The district transcends five agro-ecological zones (AEZ) as follows:

- AEZ II covers about 3% of the district area including the upper slopes of the Iveti, Mua and Kangundo hills. The zone has an average annual rainfall of 1,000 mm. Maize, citrus fruits, forestry and dairy farming are the main agricultural activities.
- AEZ III covers about 9% of the district area including the lower slopes of the Iveti, Mua, and Kangundo hills; plus parts of Matungulu and Mitaboni. The zone has an average annual rainfall of 850 mm. Maize, beans, pigeonpeas, sunflower, citrus, bananas, cow peas and dairy farming are the key agricultural activities.
- AEZ IV covers about 40% of the district area, including most of the dry lowlands. The average annual rainfall is 700 - 750 mm. The zone has a short cropping season with a fairly good yield potential for *Katumani* maize, *Mwezi moja* beans, pigeonpeas, sorghum, cotton, mangoes and cowpeas. Livestock rearing is also a major agricultural activity here.
- AEZ V covers about 31% of the district area. The average annual rainfall is 600 - 650 mm. The main economic activities include ranching, bee-keeping, growing of pigeon peas, sorghum, maize (*Katumani* variety), cotton and other drought tolerant and early maturing crops.
- AEZ VI comprises about 17% of the district area. The average annual rainfall is less than 600 mm. Ranching is almost exclusively the only economic activity, although with irrigation, quick-maturing crops can be grown

Population

According to the 1999 census, the population of Machakos district was 915,000. Among these, 446,000 were males and 469,000 were females, giving a 95 sex ratio. The population is predominantly youthful with around 75% of the population below 30 years. The annual population growth rate is high (about 3.0%) attributed to both the youthfulness of the population and the general preference for a large family size. There is a higher number of females in the rural areas than in urban areas as women migrate less. Women therefore, are the main contributors to family labor.

The population is unevenly distributed within the district. In the rural areas, distribution is influenced by the availability of rainfall and fertile soils for agriculture. There are large spatial variations in population density with the relatively wetter and fertile hill masses having the highest population densities. The highest population densities are found in Kathiani and Kangundo divisions. Most of the other divisions have fairly low population densities.

The current trend shows that areas with high populations might experience larger population increases in the next few years. Furthermore, with the on-going subdivision of ranches and migration of people from the high population density areas to areas of marginal agricultural potential, the areas with low populations are also expected to register substantial population increases.

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.

Agricultural production

Farming ranges from intensive small-holdings to large company 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 and other inappropriate husbandry practices, such as poor land preparation, late planting, improper weeding and use of inferior seeds.

Maize and beans dominate the household "food basket". The most suitable areas for maize growing are the upper midland areas of Central, Kangundo, Kathiani, Mwala, Matungulu and Ndithini divisions. Pulses are grown in all the divisions of the district. The predominant ones are beans, pigeonpeas, cowpeas, greengrams and chickpeas. In favorable seasons, the district achieves self-sufficiency in pulses.

Because of the 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, and cut flowers. Vegetables and flowers are produced for both the domestic and export markets. Cotton was at one time a major cash crop in the district.

The district frequently experiences food deficits. Currently, large volumes of maize and maize meal are bought into the district from other parts of the country. Households also sell maize and other food crops at the local markets, but most of these are distress sales, mainly due to the need for money for other uses.

Livestock production

Livestock production in the district is significant as 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.

Large-scale livestock production is practiced in 13 operational ranches concentrated in the upper midland ranching zone of the Athi-Kapiti plains. The ranches mainly rear beef cattle while small-scale farmers, particularly in the more humid agro-ecological zones II and III, keep a few dairy cattle. The traditional grazing practices are predominant, but a few farmers practice zero-grazing (feeding of livestock in confinement).

Crop-livestock reliance ratio

Table 1 shows the estimated values of farm incomes according to the major activities between 1993 and 1995. The crops and livestock values were based on the prevailing market prices.

Table 1. Estimated District level value of farm incomes by major activities, 1995 (Million KS)

Activity	Million Kenyan Shillings
Food crops	80
Cash crops	84
Horticultural crops	16
Total	**180**
Livestock sales	72
Livestock products	73
Total	**146**

Source: Machakos District Development Plan, 1997-2001

As shown in Table 1, farmers in the district rely more on agriculture than livestock. However, the reliance ratio may vary among households within the same zone, from one agro-ecological zone to the other and from season to season.

The combined forces of a high population growth rate and high population density in the agriculturally high potential areas have resulted in migration of people from the densely populated areas to areas of marginal agricultural potential. The trend is promoting sedentary small-scale farming activities in areas that were traditionally used for livestock production. The pattern seems to have been accelerated by the recent wave of ranch sub-divisions in the district. Upon sub-division of a ranch, the members (or their children) settle on their pieces of land and embark on crop cultivation and raising a few domestic animals. The size of land allocated each member is normally proportional to the number of shares he or she owns. In most ranches, one share was equivalent to 2.0 ha. The cultivated plots are abandoned during the dry season, pasture areas are overgrazed and tree cutting is rampant. Consequently, land degradation is a common feature in these areas.

DATA COLLECTION

The assessment of the climate information status in the survey area involved on-farm interviews by experienced enumerators using a written questionnaire (Appendix I). The questionnaire was administered to 240 households in six sub-locations. As already indicated, 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 filled out copies of the questionnaire were critically reviewed jointly by the researcher and the enumerators. The necessary changes or adjustments to the questionnaire were made before the actual survey was carried out.

Since the questionnaire was designed in English and the interviews were to be conducted in either *Kikamba* (the local dialect) and/or *Kiswahili* (national language), it was necessary to ensure that enumerators came up with the same translation for each question. For this purpose, the researcher and the

enumerators went through each question and by consensus agreed on the most accurate vernacular translation for each question.

At the sub-location level, each enumerator first reported to the sub-chief (the administrative head of a sub-location) to obtain permission to conduct the survey in the area. This was necessary for security reasons. Once permission was secured, the enumerators selected a route that roughly 'cut' across the sub-location and interviewed every alternative household until the total sample for the sub-location was achieved. The sampling was purposeful, targeting household heads and/or farm level decision-makers. Simple descriptive statistics on various variables were generated form the data collected.

RESULTS

Household information

The household survey data shows that majority of the participants (>70%) have lived on and cultivated their pieces of land for at least 40 years. There are, however, a few recent migrations into the area especially in the more arid zone V. Regarding land ownership, the highest proportion of respondents (97%) indicated that they own the land they are currently utilizing, having either inherited it or bought it (58% and 31%, respectively). Our household data further shows that the average land size per family ranges between 0.5 and approximately 4.0 hectares. The smallest holdings are found in the agriculturally higher potential and more densely populated zones III and IV, and the largest in the more arid and sparsely populated zone V. About 20% of the families own less than 0.5 ha. Assuming 4.0 ha as the minimum land size for an average family, then approximately 70% of the households in the district operate on sub-economic land units. For the arid and semi-arid environments, such communities are highly vulnerable to the vagaries of climate resulting in enhanced food insecurity.

The majority of the households in the survey area are male-headed, with the highest proportion of household heads (88%) residing and working on the farm. The rest are either teachers in local schools or do business in the local shopping centers.

Many household heads were reluctant to disclose their age. Of the few who did, 58% were within the 26-45 year bracket while 37% were more than 45 years old. Majority (50%) of the household heads did not have any formal agricultural training and only small number of them had attended agricultural seminars.

With reference to family structure, the largest number of households (80%) comprised 2-5 adults and 2-4 children. In addition, the highest number of the interviewees indicated they had 1-3 relatives (children or adults) living with them. To meet the farm labor requirements, our survey data shows that most households maintained at least one permanent farm employee and 1-2 casual workers.

Farm management activities

Farm management activities are to a large extent climate-driven with some being more important during the wet season and others during the dry season. For instance, just before the beginning of the rainy season, land preparation is the main preoccupation. According to the results of this survey, most farmers plow the land and plant before the on-set of the rains (95% and 58%, respectively). The main reason for completing these activities before the on-set of the rains was that it is easier to work on dry than wet soil.

The main food crops grown 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 short-maturing crops, mainly the pulses.

Our data indicates that a large number of farmers (67%) in the survey area 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. The problem is compounded by lack of cash, lack of proper advice from agricultural extension personnel and rampant presence of fake or wrong seeds in the market. With the on-going government retrenchment program, only a few field agricultural extension officers are currently remaining.

The highest number of the respondents who indicated that they do not buy seeds select some from their previous season's crop. The practice of selecting/preserving ones own seeds from the previous season's harvest is a long-standing tradition not only within the Wak*amba* community, but many African communities. Actually, some farmers have more confidence in their own seeds than the certified ones. The practice is however, rapidly disappearing with the increased awareness of 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 apply one or more of these inputs, at one time or another. Fertilizers and manure are mostly applied before or at planting. Top-dressing is a rare practice in this area. Several factors determine whether a farmer will apply the inputs or not. These include 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.

Farm Income

Off-farm employment, sale of crops and livestock (33%, 13% and 9%, respectively) were found to be the most common sources of farm income in the survey area. Regarding sale of crops, the highest proportion (46%) of participants indicated that they only sell food crops when in deep financial crisis, while 32% indicated that they only sell when they have surpluses. Our data showed that 14% of the respondents played it safe and only sold the previous season's crop when the next one was just about to be harvested in order to create storage space. A few (7%) of the participants prefer to sell food crops as needs arise.

The decision to sell livestock and particularly the large stock, to raise cash for domestic use, is not an easy one. As long as the proceeds from sale of foodstuff and wage employment can generate enough money to meet family needs, and the weather is favorable, majority of the farmers would rather not sell livestock. However, adverse climatic conditions such as impeding drought or disease outbreak, spurs sales of livestock, albeit at very low prices.

As far as seeking alternative income-generating activities is concerned, 27% of the participants pointed out that they prefer to do it when farm labor requirement is off peak.

Credit facilities

About half of the respondents indicated that they have access to credit facilities. Six different types of credit facilities were listed including co-operative societies, commercial banks, micro-finance institutions, 'merry-go-rounds' and individuals (nicknamed 'Shylock money'). Co-operative societies and commercial banks are the most common formal commercial credit institutions (16% and 15%, respectively). A small number of those interviewed (5%) indicated that they have access to micro-finance institutions, which support small businesses. 'Merry-go-rounds' are fairly popular informal (not registered by government) community-based credit associations in this community. The concept involves small groups of people who know and trust each other (mostly friends and relatives) who agree to be contributing a certain amount of money at agreed time intervals. All or an agreed percent of each period's collection is allocated to one of the members. Payment is according to the order the members join the group. Once all the members have been paid, the cycle begins all over again. No security is required in this types credit facility and no interest is charged on monies given to the members. Money obtained from any of these credit facilities is applied to such things as paying of laborers, buying farm inputs such as fertilizers and seeds, building houses, paying school fees, etc.

The survey showed that most farmers do not borrow money from banks because they do not have the required collateral, such as land title deeds. Lack of information on how to access the facilities is another hindrance. Above all, is the fear of high interest rates charged by these institutions and the possibility of mismanaging the loan and losing the collateral. A small proportion of the participants indicated that they do not need credit facilities.

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 (93%, 85% and 67%, in zones III, IV and V, respectively). The 1997-1999 data (Table 2) 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.

Table 2. Reception, accuracy and usefulness of seasonal climate forecasts by seasons and agro-ecological zones, 1997-1999

	Reception (%)			Accuracy (%)			Usefulness (%)		
Season	**III**	**IV**	**V**	**III**	**IV**	**V**	**III**	**IV**	**V**
Long rains 1997	50	51	64	56	77	89	58	80	86
Short rains 1997	54	52	84	63	67	69	55	74	67
Long rains 1998	78	89	76	62	80	81	61	76	77
Short rains 1998	78	78	74	76	85	82	79	88	80
Long rains 1999	90	88	84	77	89	69	77	93	65
Short rains 1999	90	92	80	79	89	84	78	91	84

Types of climate forecast information received and channels of dissemination

Of the five types of climate forecasts issued by the Kenya Meteorological Department (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 zone V is suspected to be random since the KMD does not disseminate these forecasts to the general public.

Table 3 presents the primary and secondary 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 zones III-V, respectively). A few participants own both radio and television (27%, 28% and 57%, zones III-V, respectively). The higher number of radio and television sets in zone V compared to zones III and IV is anomalous since zone V is the driest and most resource-poor and farmers would not be expected to have extra income to invest in electronic equipment.

Inter-personal contacts turned out to be the most common secondary source of climate forecast information. Therefore, in the absence of a radio or television, most farmers will depend on what they hear from friends, relatives, neighbors, administration personnel (chiefs, sub-chiefs, etc. 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 (amount, on-set, distribution, etc) constitute the most common topic in social encounters. People who have met exchange greetings and often update one another on the climate situation of their respective villages.

Table 3. Primary and secondary sources of various types of climate information by agro-ecological zones (% of respondents)

	Agro-ecological zone		
I. Primary source	**III (N=73)**	**IV (N=68)**	**V(N=52)**
Radio	74	93	85
Inter-personal contact	11	0	12
Television	1	3	0
Newspaper	4	0	2
Traditional methods	8	0	0
Government extension officers	1	4	0
Drought Monitoring Center	0	0	0
Private climate information services providers	0	0	0
Other organizations	0	0	0
Internet	0	0	0
II. Secondary source	**N=74**	**N=68**	**N=42**
Inter-personal contacts	50	47	33
Television	10	13	48
Newspaper	7	12	2
Radio	11	6	12
Traditional methods	12	0	5
Churches	3	6	0
Government extension officers	8	16	0

Application of climate information in tactical and operational farm decisions

Our data shows that majority of the interviewees currently receiving climate information say they 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 received, i.e., whether the rains would be normal, above normal or below normal. Table 4 represents the different farm management decisions that would be potentially influenced by the three climate forecasts in the three agro-ecological zones. The responses are hypothetical and may vary from the actual.

- **Above normal rainfall. D**ecisions related to soil conservation 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 zone III, which is not only hilly, but also normally receives more rainfall than the other two zones. Other important decisions included selection of long-maturing crop varieties (hybrid maize varieties) and planting of trees, including fruit trees.

  In zone V, 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 a shorter-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 is not very popular as the risk is quite high.

- **Below normal rainfall.** Farm management decisions related to the types (varieties) of crops to be planted seemed to take precedence. In zone V, majority of the respondents indicated that they would select more of the short-maturing crop varieties. For instance, in the case of maize, the farmers would plant more of the *Katumani* variety which is a shorter maturing variety than the hybrids. However, although the *Katumani* variety is the ideal variety for this area, most farmers disdain it mainly because of its shortness. The tall hybrid varieties are associated with prestige. Some farmers will not plant the *Katumani* variety at all, while others will only allocate a small fraction of the total area they plan to devote to maize. Therefore, in the event of a below normal rainfall scenario, some of the farmers who do not normally plant any of the *Katumani* variety might plant some while those who usually plant some might increase the area. Among the common bean varieties, some, such as *Mwezi moja* (meaning 'one month'), have a remarkably short time to maturity. As in the case of maize, more area might be allocated to such a variety in case of below normal rainfall forecast.

  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 zones III and IV. Water, food and fodder are known to be major constraints in zone V. To some participants, particularly in zone V, the decisions to plant early using mainly the short-maturing crop varieties was critical in order to take advantage of the limited moisture.

- **Normal rainfall.** Overall, no major tactical decisions were made. According to our results, a relatively high number of farmers, particularly in zones IV and V, would, as usual, prepare the land early and plant early using manure and the most popular crop varieties.

Table 4. Farm management decisions influenced by different potential climate forecasts in three agro-ecological zones (% of respondents)

Forecast & Decision	Agro-ecological zone		
I. Above normal rainfall	**III (N=74)**	**IV (N=63)**	**V (N=36)**
Repair and/or construction of terraces	68	51	31
Planting of trees	6	0	0
Repair of farm structures (houses, stores, etc)	5	0	3
Planting of long-maturing/high-yielding crops	20	33	58
Increase use of manure & fertilizers	1	14	0
Double plantings within same season	0	2	8
II. Below normal rainfall	**N=74**	**N=78**	**N=35**
Planting drought tolerant crops	30	26	17
Water storage and/or conservation	15	8	0
Food storage and/or conservation	12	1	0
Fodder conservation	8	1	0
Reducing cutting of trees	1	0	0
Reducing farm labor	1	0	0
Planting early	22	30	29
Planting short-maturing crop varieties	11	9	54
Irrigation	0	1	0
III. Normal rainfall	**N=72**	**N=58**	**N=22**
Early land preparation	4	27	23
Early planting	15	22	32
Early planting with manure	49	16	9
Early procurement of seeds	4	9	0
Plant normal crop varieties	9	10	27
Diversify crops	1	7	0
Repair houses and other farm structures	1	0	0
Hire more farm labor	0	2	0
Plant short- maturing crop varieties	15	5	0
Preserving fodder (Nappier grass)	0	0	9

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 (Table 5). As with those receiving the information, lack of a radio and/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 (Table 5).

Table 5. Reasons for not receiving climate information and potentially the most useful information needed (% of respondents)

	Agro-ecological zone		
Reasons for not receiving climate information	**III (N=5)**	**IV (N=12)**	**V (N=25)**
Unaware of existence of climate information	20	8	52
Information not accessible	40	25	8
Illiterate	20	8	0
Lack of radio	20	8	0
Not interested	0	50	0
Lack of batteries for the radio	0	0	4
Remoteness of area and poor infrastructure	0	0	0
Do not know when to turn on the radio/TV	0	0	24
Information is vague	0	0	8
Type of information they would like to receive	**N=4**	**N=10**	**N=23**
Seasonal forecast	100	70	39
Monthly	0	30	22
Decadal	0	0	4
Weekly	0	0	9
Daily	0	0	26

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 to plant and what to plant (Table 6). 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 zones III and IV indicated before the rainy season, while in zone V, 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.

Table 6. Potential uses of climate forecast by farmers currently not receiving it, when required and usefulness (% of respondents)

	Agro-ecological zone		
I. Farm decisions influenced by type of forecast	**III (N=4)**	**IV (N=10)**	**V (N=23)**
When to start preparing the land	50	30	13
When to plant	50	30	52
What to plant	0	30	9
Planning of farm activities	0	10	4
Irrigation	0	0	22
II. When information most needed	**N=4**	**N=11**	**N=27**
During the dry season	100	55	19
During the rainy season	0	9	30
Throughout the year	0	36	52
Other	0	0	0
III. Potential usefulness of information	**N=8**	**N=19**	**N=28**
Very useful	63	42	79
Somewhat useful	0	11	21
Not at all useful	38	47	0
IV. Problems which can potentially be reduced if climate information was available	**N=5**	**N=12**	**N=26**
Making untimely decisions	100	8	31
Making 'blind decisions'	0	42	42
Planting wrong crop varieties	0	50	27
V. General comments/suggestions on climate information.	**N=5**	**N=12**	**N=25**
No comment/suggestion	20	33	16
Making the information readily available	60	33	80
Climate information is very important	20	34	4

Need for additional climate forecast information

On the need for additional forecasting 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 (Table 7). 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.

Table 7. Farm decisions that might be influenced by on-set and end of rains in three agro-ecological zones (% of respondents)

Type of extra climate information and decisions it influences	Agro-ecological zone		
I. On-set of rains	**III (N=74)**	**IV N=78)**	**V (N=35)**
Early land preparation	54	64	41
Plant early	32	36	43
When to plant	7	0	5
What to plant	1	0	5
Whether to apply manure and fertilizers	5	0	5
II. End of rains	**N=65**	**N=21**	**N=42**
When to start conserving water	42	5	7
When to harvest the crop	8	5	33
When to prepare the store	8	0	24
When to weed and control pests	6	0	19
What to plant (crop diversification)	35	86	5
When to engage in off-farm employment	0	0	2

The highest proportion of respondents in all the three zones indicated that with additional information on when the rains are likely to start they would start preparing the land early and hence 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 these activities, thereby increasing the chances of a successful crop harvest.

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 a dreaded climatic phenomena in the survey area. Therefore, any 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. 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 reduction of numbers. 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 V. 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.

Table 8. Farm decisions that might be influenced by additional climate forecast information on possibility and timing of a drought in three agro-ecological zones (% of respondents)

Type of extra climate information and decisions it influences	Agro-ecological zone		
I. Possibility of a drought.	**III (N=67)**	**IV (N=41)**	**V (N=44)**
Fodder conservation	49	32	34
Food conservation	30	24	32
Planting drought tolerant crops	3	17	7
Reduction of livestock numbers	5	2	5
Water conservation	10	7	14
Plant short-maturing crops	21	10	2
Not planting any crop	14	7	7
II. Timing of a drought	**N=49**	**N=29**	**N=41**
Conservation of food from previous season	20	45	7
Fodder conservation	20	7	15
Water conservation	20	7	12
Planting drought tolerant crops	4	0	7
Reduction of livestock numbers	20	3	12
Not planting any crop	12	10	5
Not knowing how to use the information	2	14	0
When to engage off-farm income-generating activities	0	14	42

Climate forecast information status during year 2000

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.

Seasonal forecasts and accuracy

Our data shows that the highest proportion of the respondents in the three zones received the year 2000 long rains forecast (Table 9). 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 9). However, unlike the long rains' forecast, there was a considerable variation in the message the respondents received. In zones III and V, majority of the respondents heard that the rains would be below normal. In zone IV, majority heard that the rains would most probably be normal while the rest were almost equally split between the upper and lower terciles.

Table 9. Seasonal forecasts and accuracy in three agro-ecological zones

	Agro-ecological zone and season					
Whether forecast was received	**III (lr) (N=70)**	**III (sr) (N=72)**	**IV (lr) (N=65)**	**IV (sr) (N=66)**	**V (lr) (N=54)**	**V (sr) (N=52)**
Yes	87	93	85	96	82	77
No	13	7	15	5	19	23
Forecast received	**N=64**	**N=68**	**N=57**	**N=63**	**N=44**	**N=40**
Above normal	0	32	0	30	0	40
Normal	0	2	7	43	0	0
Below Normal	100	66	93	27	100	60
Accuracy of forecast	**N=63**	**N=59**	**N=55**	**N=53**	**N=44**	**N=44**
Very accurate	52	75	87	91	11	73
Accurate	45	7	11	8	86	25
Somewhat accurate	3	19	2	2	2	2

lr = long rains; sr = short rains

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 difficult 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 short-maturing and drought-tolerant crops. In zone III, 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 more short-maturing crop varieties than the long-maturing ones to be planted.

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 zones III and IV than V. In line with the advisory, most farmers prepared the land early and planted early using mainly the short-maturing crop varieties.

Table 10. Crop and livestock advisories for year 2000 long and short rains forecasts

	Agro-ecological zone and season					
I. Crop advisory	**III (lr) (N=63)**	**III (Sr) (N=70)**	**IV (lr) (N=57)**	**IV (sr) (N=60)**	**V (lr) (N=45)**	**V (sr) (N=41)**
Plant drought resistant crops	24	16	49	12	27	15
Plant short maturing crops	11	6	28	3	73	27
Plant early	-	7	-	8	-	15
Plant early & drought resistant crops	-	0	-	8	-	0
Plant late maturing crops	-	-	-	2	-	44
No advisory given	27	23	17	20	0	0
Store food	3	-	4	-	0	0
Use manure and fertilizer	-	6	-	7	-	0
Diversify crops	-	0	-	13	-	0
Plant normal crops	-	0	-	15	-	0
Prepare land early/plant early	35	37	2	2	0	0
II. Livestock advisory	**N=64**	**N=63**	**N=48**	**N=48**	**N=17**	**N=11**
Plant fodder (Nappier grass)	3	5	4	-	18	-
Reduce livestock numbers	23	18	10	0	24	73
Conserve fodder/feed	9	41	58	2	0	18
Zero-graze	-	0	-	2	-	0
No advisory given	30	35	23	81	0	0
Conserve water for livestock	-	0	-	0	-	9
Preserve pasture and fodder	34	-	2	-	0	-
Move to other areas	0	-	0	-	18	-
Keep more goats then cattle	0	-	0	-	6	-
Vaccinate livestock	0	2	2	8	0	0
Avoid grazing allover to reduce disease spread	-	0	-	4	-	0

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 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. Otherwise, it was suspected the respondents misunderstood the question and indicated the measures they actually took rather than what was recommended by KMD. Fodder conservation and reduction of livestock numbers were the most important tactical measures in the more arid zones IV and V, respectively.

As in crops, the highest number of respondents indicated that they adopted the advisory (Table 12). Thus, they put in place some forage conservation measures for their livestock. A smaller proportion (10%) reduced the livestock numbers. The few who did not adopt the livestock advisory, did not provide a reason as to why.

Table 11 Adoption of advisory and measures taken against year 2000 long rains and short rains on crops and livestock in three agro-ecological zones

	Agro-ecological zone and season					
	III (lr*)	**III (sr)**	**IV (lr)**	**IV (sr)**	**V (lr)**	**V (sr)**
Adoption of advisory	**N=38**	**N=64**	**N=42**	**N=57**	**N=36**	**N=44**
Yes	92	100	91	93	58	100
No	8	0	10	7	42	0
Measures taken on crops	**N=38**	**N=51**	**N=42**	**N=39**	**N=28**	**N=23**
Early land preparation	18	-	10	-	0	-
Early planting with manure	-	86	-	31	-	4
Planting drought tolerant crops	-	8	-	64	-	26
Planting high-yielding crop varieties	-	6	-	5	-	70
Early planting	18	-	2	-	0	-
Planting short-maturing crops	53	-	88	-	100	-
Not planting at all	11	-	0	-	0	-
Measures taken on livestock	**N=22**	**N=29**	**N=8**	**N=4**	**N=5**	**N=1**
Preserve fodder	-	76	-	75	-	0
Checking livestock body condition	-	3	-	25	-	0
Planting more fodder	68	-	86	-	75	0
Reducing livestock numbers	32	21	14	0	25	100

**lr = long rains; sr = short rains*

Those currently not receiving climate forecast information

The data on questions related to why the seasonal forecasts were not received, the decision criteria in the absence of the said forecasts and the relative performance of the farms in the absence of the information are summarized in table 12. Ignorance or lack of interest was the major hindrance to reception of forecasts in zones III and IV (100% and 85.7%, respectively). For about 50% of the respondents in zone V, the main problem was radios being often out of order.

In the absence of the forecasts, all of the participants in zone III indicated that they depended on divine intervention, while 100% and 60% in zones IV and V, 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 zones III and V, respectively, noted no difference, while 75% in zone IV reported that the performance was lower without the forecast than with it.

Table 12. Reasons for not receiving forecasts, decision criteria and farm performance by seasons and zones (% of respondents)

	Agro-ecological zone and season*					
I. Reasons for not receiving the forecast	**III (Lr) (N=1)**	**III (Sr) (N=2)**	**IV(lr) (N=7)**	**IV Sr (N=1)**	**V (lr) (N=10)**	**V (sr) (N=8)**
Not keen	100	-	86	-	20	-
Too busy	0	-	14	-	0	-
Radio out of order	0	-	0	-	50	-
Lack of a radio	0	-	0	-	10	-
Being away from home	0	-	0	-	20	-
Does not follow the weatherman	-	100	-	100	-	100
II. Decision criteria in absence of forecast	**N=1**	**N=31**	**N=9**	**N=14**	**N=10**	**N=12**
God's power	100	-	0	-	0	-
Past experience	0	100	100	100	60	67
Traditional indicators	0	0	0	0	10	33
Trial and error	0	-	0	-	30	-
III. Farm performance in absence of forecast	**N=1**	**-**	**N=8**	**-**	**N=9**	**-**
Same	100	-	13	-	56	-
Better	0	-	13	-	33	-
Lower	0	-	74	-	11	-

*lr = long rains; sr = short rains

Traditional climate prediction methods

The art of predicting climate using traditional techniques is part and parcel of the Wak*amba* culture. Rainmakers, diviners, dreamers and seers, are revered members of the community due to their supernatural powers to 'cause rains to fall' and predict future climate outlook. Traditional forecasts are based on observations of various natural environmental phenomena. The information is disseminated verbally to the community in traditional worship ceremonies characterized by rituals and rites. However, the level of trust in traditional forecasting knowledge is progressively being eroded by several factors such as education and religion.

A very high number of participants in this survey (>90%) reported that they were aware of existence of traditional climate forecasting methods in their neighborhood. A similarly large number of those who are aware of existence of this information system confirmed that they use it in making important farm management.

The largest proportion of the 'consumers' of traditional forecasts rated them as accurate and reliable. Our data indicated that more than half of the respondents in each of the three agro-climatic zones preferred

traditional forecasts to meteorological forecasts. However, upon further interrogation, it was evident that the greater proportion of these respondents (76%, 77% and 59%, in zones III, IV and V, respectively) apply traditional forecasts in conjunction with the meteorological forecasts, when both were available. According to these results, traditional indicators are more qualitative than quantitative. Also, the variables predicted may be different than those predicted by the Meteorological Service. For example, they forecast the on-set of the rains rather than the amounts and duration. Furthermore, unlike the meteorological forecasts, traditional forecasts are restricted to the area where the natural phenomena have been observed, rather than elsewhere. This makes them relatively more useful to the farmers who are more interested in whether it will rain in their area rather than in other areas.

Some of the common natural phenomena used in traditional climate forecasting include, leafing and/or flowering of certain trees such as *Balanites aegyptica* and *Acacia mellifera*, winds (speed and direction), ambient temperature, humidity, army worm infestation, appearance of certain types of clouds in a certain location in the sky.

CONCLUSIONS

Our 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 tactical and operational decision making processes. This result was surprising given the generally low usage recorded in other studies of this kind. 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. Uses of information varied by agro-ecological zone and whether the forecast was for 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. Traditional forecasts often predict variables of greater relevance to farm decisions that do scientific forecasts. It was evident from the survey that when both the traditional and scientific forecast information are 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 the coming season. 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.

Despite 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. 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 to the leader of this project (Ngugi) during post-survey meetings held in the participating communities. Farmers that 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 sort of community-level involvement should be integrated into any information dissemination system for maximum benefit of seasonal forecasts to be realized.

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ANNEXE I

QUESTIONNAIRE TO ASSESS THE FARM-LEVEL CLIMATE INFORMATION NEEDS IN MACHAKOS DISTRICT, KENYA

Date of interview……..Name of Enumerator: …… .

A. Survey Location

Division: ……..Location: …….. Sub-location: ……..…

……..Town/Village:

B. **Respondent's information**

i. Name:……Age: ……Sex: ……..Marital status: ……...…

ii. Occupation: …… Level of formal education: ……...…

iii. Language most fluent in: ……...Level of agricultural training: ……

iv. Relationship to household head: …….Permanent residence: (on-farm or off-farm): ……...

C. Information about the household head (If not the respondent)

i. Name: …….Age: …….. Sex: ……Marital status: …….

ii. Occupation: ……..Level of formal education: ……...

iii. Language most fluent in: ……Level of agricultural training ……

v. Permanent residence: (on-farm or off-farm) ……

D. Household size and composition

i. Family size: Total members: ……..<u>Adults:</u> Males:……Females……..

Children: Males …….. Females ……

ii. Other people living on the farm:

a. Relatives: Total …….. <u>Adults</u> Males:……. Females: ……..

Children: Males: ……. Females: …….

b. Employees: Total: ……. <u>Full-time</u>: Males: …….Females: ……

Part-time: Males: …….. Females: ……

E. Other household information

a. How long has the family been living/farming in this area? ……

b. Which of these does the family own? Radio [ ] Television[ ]

F. Meteorological information

1. Do you receive any climate information at present?
   i. Yes [go to 2]
   ii. No [go to 26]
2. For how long (years) have you been receiving climate information? ……...

Information provided in the box below is to help in answering question number three.

COMMON SOURCES OF CLIMATE INFORMATION	**COMMON TYPES OF INFORMATION**
National meteorological station Television Newspaper Radio Traditional methods Other organizations Drought Monitoring Center (DMC) Government extension officers Private climate services providers Internet-Personal contacts	Daily forecast Weekly forecast 10-Day forecast (Decadal) Monthly forecast Quarterly (Seasonal) forecasts

3. In the table below, list the different types of climate information that the respondent normally receives. For each type of information, indicate the primary (main) and secondary sources of climate information; and how often (hourly, daily, weekly, monthly quarterly, yearly) the information is received?

Type of information	Primary source	Secondary source	How often received

4. Do you use this information in making any farm management decisions? Yes [ ] No [ ]

5. If 'YES', in the table below, list the various kinds of farm management decisions/activities that might be influenced by the following possible seasonal climate forecasts.

Seasonal Climate forecast		
Above normal rainfall	**Normal rainfall**	**Below normal rainfall**

6. In the table below, explain how you would use the additional type of climate information listed, if available.

Additional information	How information would be used
Beginning of rainy season	
End of rainy season	
Chance of a dry spell	
Timing of dry spell	

7. In reference to the seasonal climate forecasts you have received during the last three years (1997-1999), fill in the table below.

Season/Yr	**Did you receive the information?**	**Was it accurate?**	**Was it useful?**
Long rains 1997			
Short rains 1997			
Long rains 1998			
Short rains 1998			
Long rains 1999			
Short rains 1999			

8. Did you receive the climate forecast for the last long rains season? Yes [ ] No [ ] (if NO, skip to Question 16)
9. If YES, what was the forecast for your area? ……
10. Which of the following best describes the accuracy of that forecast? [Tick the most appropriate]
    a. Very accurate [ ]
    b. Accurate [ ]
    c. Somewhat accurate [ ]
    d. Not accurate [ ]
    e. Don't know [ ]
11. What general advisory accompanying the forecast for your area with reference to crops and livestock:
    a. Crops ……...
    b. Livestock …….
12. Did you adopt the advisory? Yes [ ] No [ ]
13. If 'YES', what measures did you take with reference to crops and livestock:
    a. Crops ……...
    b. Livestock …….
14. If you did not adopt the advisory, why not?……...
15. If the answer to question 8 is 'NO':
    a. Why didn't you receive the forecast?
    b. What did you base your farm management decisions on that season?
16. Which of the following best describes your farm's performance (production) during that season compared to a similar season when you had the forecast information: (Tick the most appropriate)
    a. Better [ ]
    b. Same [ ]
    c. Lower [ ]
17. Did you receive the forecast for the last short rains season? Yes [ ] No [ ] (Skip to 23)
18. If 'YES', what was the forecast for your area?
19. What general advisory was given for your area with reference to:
    a. Crops:…….
    b. Livestock:……
20. Did you adopt the advisory? Yes [ ] No [ ]
21. If 'YES', list the measures you took with reference to crops and livestock:
    a. Crops……..
    b. Livestock…….
22. If you did not adopt the advisory, explain why not …….
23. If you did not receive the forecast for the last short rains season, explain why not……..
24. In the absence of the forecast information, what did you base your farm decisions on?
25. Do you have any comments (suggestions or recommendations) regarding the climate information you have been receiving that you would like to share with me? ……..…

If you answered "No" to Question 1, please answer the remaining questions that address how you could possibly make use of climate information.

26. Why don't you receive any climate information? (Give reasons)
27. If you were to start receiving climate information, list the different types of this information that would be most useful to you, how you would use the information (i.e., in making what kind of decisions) and how long (days, weeks, months) in advance of the period to be forecasted you would like to receive this information? [Please specify]

Type of information	Use	**How long in advance**

28. When would you require this information? [Circle all those that apply]
    a. Throughout the year
    b. During the rainy season
    c. During the dry season
    d. Other times [Please specify]……..
30. How useful do you think this information would be to your farm operations? [Circle the most applicable]
    a. Very
    b. Somewhat
    c. Not at all
31. List important problems or challenges that you face on your farm, which you think, would be reduced if you started receiving climate information?
32. Do you have any comments (suggestions/recommendations) on any aspect of the climate information that you would like to share with me? …… ……

Traditional climate information

33. Are there traditional/customary methods of predicting climate in your area?
    Yes [ ] No [ ] (Go to section H)
34. If 'YES', fill in the information indicated in the table below.

Traditional indicator used	**Characteristic /parameter of indicator used**	**Climate aspect Predicted**	**How long in advance the Climate can be predicted**	**Reliability****
1. 2. 3. 4.				

**Reliability ranking: 1=very reliable; 2=sometimes reliable; 3= not reliable; 4=used to be reliable but no longer is

35. Do you use this information in making farm management decisions? Yes [ ] No [ ] (skip to question 38)
36. If 'YES', do you use it in combination with the meteorological information or separately?……
37. On the basis of traditional indicators, what was the forecast for the last short rains season?……
38. Given a choice, which information would you use first? (a) Traditional [ ] (b) Meteorological [ ] (Tick one)
39. If NO to question 35, how do you use this information?……..
40. Do you have any comments on any aspect of the traditional climate information system that you would like to make?…….

Ancillary information

41. Do you own this land? Yes [ ] No [ ]
42. If 'YES', how did you acquire it?
    a. Bought [ ]
    b. Inherited [ ]
    c. Other (please specify
43. If no to question 41, which of the following best describes the ownership status?
    a. Communal [ ]
    b. Rented [ ]

c. Other (please specify)

44. What is the total size of your land? (ha/acres)……
45. What area is arable? (ha/acres) ……..
46. What area is pastureland? (ha/acres)……
47. What area is not useful for grazing or cultivation? (ha/acres)…….
48. Do you normally prepare your land before or after the rains?……
49. Why do you prepare the land at that time?…….
50. For the last long rains season, how long before or after the on-set of the rains did you complete preparing the land? Days/weeks/months
51. For the last short rains season, how long before or after, the on-set of the rains did you complete preparing your land? Days/weeks/months……
52. Do you normally plant before or after the onset of the rains?……..
53. Why do you plant at that time? ……..
54. How long before or after the onset of the last long rains did you plant? …… Days/weeks/months
55. How long before or after the on-set of the last short rains did you plant? …….Days/weeks/months
56. Fill in the table below to show how you utilized your land during the last long rains season.

Crop grown	**Preferred cultivars**	**Area allocated (Ha/Ac)**	**Planting dates**	**Harvesting date**
1. 2. 3. 4.				

57. Fill in the table below to show how you utilized your land during the last short rains season.

Crop grown	**Preferred cultivar**	**Area allocated (Ha/Ac)**	**Planting dates**	**Harvesting date**
1. 2. 3. 4.				

58. Do you buy any seeds for your farm? Yes [ ] No [ ]
59. If 'YES', complete the table below.

Crop	**Preferred seed variety**	**Source of seed**

60. Do you have any difficulty procuring the seeds you want? Yes [ ] No [ ]
61. If 'YES', list the major difficulties that you face?…….……
62. If you don't buy any seeds, where do you get them?
63. Do you apply any of the following inputs to your farm? (Tick all that you apply)
    a. Chemical fertilizer [ ] b. Animal manure [ ] c. Compost [ ] d. Pesticides
64. If you do, fill the table below to show how you normally apply the input(s) to different crops?

Crop	**Inputs applied**	**When applied**	**How often applied**
1. 2. 3. 4.			

65. How do you decide whether or not to apply any of the above inputs? (Explain)

Farm Income

66. Which of the following are common sources of your income? [circle one]
    a. Sale of crops

b. Sale of livestock
c. Off-farm employment (please specify)

Other (specify)…… …….

67. How do you decide when to:
    a. Sell crops?
    b. Sell livestock?
    c. Seek off-farm employment?
    d. Engage in other income-generating activities
68. In the table below, indicate your sources of income (main and others) during different seasons and years as indicated.

	Wet season	**Dry season**	**Normal year**	**Drought year**
Main source				
Other sources				

69. Complete the tables below to show how you generated your income during the year 2000.

i. Sales of Crops

Crop sold	Yield (kg)	Amount Sold (kg)	Average price per Kg	Income earned	Where sold

ii. Sale of livestock

Kind of Livestock	Total owned	No. Sold	Average price	Income earned	Sold to who
Cattle					
Sheep					
Goats					
Pigs					
Chicken					
Camels					
Donkeys					

iii. Other income generating activities

Type of activity	**Family member involved**	**When involved (month)**	**Amount earned (KSh)**

Access to credit facilities

70. Do you have access to any credit facilities? Yes [ ] No [ ]
71. If YES, which kinds of facilities are these? (e.g., bank, co-operative, micro-finance, merry-go-round, etc.)
72. Do you use these facilities? Yes [ ] No [ ]
73. If YES, how do you use these facilities?
74. If you don't have access to any credit, why not?
75. Do you have any comments on any aspect of this survey?

THANK YOU