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Understanding Farmers Information Communication Strategies for Managing Climate Risks in Rural Semi-Arid Areas, Tanzania

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ABSTRACT

Crop production risk caused by climate variability cannot be managed in the absence of climate information. Despite the use of various communication strategies by rural communities in Tanzania, access and use of agricultural information is inadequate to cope with challenges in crop production. This study aims at assessing farmers information needs, examine communication strategies used and hence recommend information and knowledge sharing strategies for improved decision making. In addition, the study examined how modern ICT used together with tradition methods can reduce risks and improve crop productivity of smallholder farmers. A cross-sectional research design and simple random sampling techniques were used for the study. Interviews using structured questionnaires and focus group discussion were conducted to collect primary data from farmers and extension workers. Data were analyzed using descriptive statistics where Statistical Package for Social Science (SPSS) was used. The findings showed that smallholder farmers require climate, market and agricultural inputs information to make strategic and tactical farm-level decisions for managing climate variability and extreme events. Climate information was found to be important factor for making decisions. Radio was found to be an important communication channel by the respondents in the study area, for communicating climate information. In addition, the respondents used extension officers and fellow farmers to access climate, market and agricultural input information. Mobile phones were noted to be preferred by surveyed farmers for communicating agricultural information. The study concluded that, efforts to improve adaptation capacity of smallholder farmers in rural areas should target the extended use of information technology for improved access to climate information and advisories. Furthermore, development initiatives for managing risks of climate variability should focus on improving climate forecasts issued by Tanzania Meteorological Agent (TMA).

Keywords: *Information Communication, Communication Strategies, Semi-arid Tanzania*

1. INTRODUCTION

There are several traditional methods used by farmers in rural area to access climate forecasts, market information and agricultural technologies in a realistic time [1, 2]. The methods used include radio, village meetings, extension services and even television to some extent. Traditionally, these have been used in rural areas because of their affordability under environment with limited electrical power and where most of farmers are poor [3]. Limited number of extension workers in relation to number of farmers, lack of funds for supporting farmer fields schools and farmers demonstration plots constrain flow of information reaching farmers. For example, the extension service is inadequate especially in remote rural areas whereby the records indicates that the ratio of farmers to extension workers was about 10,000-20,000:1. [4] Communication and sharing of knowledge from farmer to farmer has remained to be the main methods despite of the inadequate reliability of information and experience shared among them. Information communication with fellow farmers is made easy through meetings in the village such as local beers places, market places, churches, mosques and funeral gatherings. Farmer to farmer communication is also enhanced by information delivery through formal village and district meetings.

In supporting the tradition methods, the application of information and communication technologies (ICT) has inadequately given farmers ability to access information for improved crop productivity despite the increased benefit [5]. It should be noted that, the use of ICT should not be done in isolation from traditional communication methods in enhancing farmers' access to information [1]. Other studies have shown that the use of ICT including internet, mobile phones, emails, community radio, TV, telecenters, computers are not full utilized by farmers, especially in rural areas. This has been as a result of high cost of ICT services, low literacy level, low income and limited number of service providers in rural areas [2]. However, use of ICT, such as mobile phone, that are of low cost and hence affordable to rural farmers has not been assessed for accessing agricultural information for informed farm-level decisions [3].

The popularity on the use of mobile phones in rural areas has tremendously increased very fast despite of their low level of income. This increase has been contributed by falling costs and prices of mobile services, increased network coverage in rural areas and facilitations from national policies on information and communication technologies [6]. In addition, despite low level of literacy of smallholder farmers, the use of mobile phone has increased in audio and textual communications. It is important to establish communication framework that optimize utilization of ICT and existing tradition communication methods that support rural farmers' environments.

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In order to examine the information communication and knowledge sharing strategies for enhancing farm-level decisions used by smallholder farmers in semi-arid areas the study with addressed the following specific objectives. First, the study identified information on climate, market and agricultural input required for various farm-level decisions. Secondly, the study assessed the channels used by smallholder farmers in sharing and communicating identified information and knowledge. Thirdly, the study suggested framework that effectively enhances communicating and sharing of information and knowledge by farmers.

2. STUDY METHODOLOGY

Description of the Study Area

The study was carried out in Same District on the Western Pare Mountains in Tanzania. The area is characterized by three agro-ecological zones, namely, the highlands (elevation of 1371m), midlands (elevation of 860m) and lowlands (elevation of 648m). The western side of the mountains receives low amounts of rainfall and is characterized by semi-arid conditions. Annual mean rainfall is in the range of 400 to 600 mm with bimodal pattern. This area is characterized by two distinct seasons, locally called *Vuli* and *Masika*. Vuli is characterized by short rains that start from November to January while Masika is characterized by long rains that start from March to May. Masika receives 180mm in lowland, 260mm in middle land and 600mm in highland zone. The evaporation in this area varies in the range of 3.0 to 5.4 mm d^{-1} with an annual long term average of 1,575mm y^{-1} [7]

Study Design and Sampling

This survey methodology was used to identify and assess promising agricultural information including climate information and communication pathways which enhance use of climate forecasts for informed farm-level decision making. During surveying different methods including interveiwing, focus group discussion and evaluation workshops were conducted. Individuals involved in the survey process include smallholder farmers, extension workers, stockists and agro-meteorologists.

A total of six villages were covered in the study. These included Njoro, Vumari, Mwembe, Chajo, Bangalala and Mhezi in Same district. The selection of these villages considered those that were part of the research activities on climate and representing three topographic zones of the study area. However, one village was selected as representative of village where research activities on climate variability was not conducted.

Multi-stage sampling was adopted where Same district was selected purposively to represent semi-arid conditions. From Same district, six villages were selected purposively based on their accessibility with one village from highlands, one from lowlands and four villages from midland zone. The design of the research applied focus group discussion method with key informants for collecting data on information, knowledge and communication strategies used by smallholder farmers for their informed farm-level decisions. Then, data was collected using structured interviews with 40 randomly selected farmers from each village. The selection of farmers considered gender sensitivity where a balance of males and females interviewee was observed (Table 1).

Table 1: Composition of Interviewed Smallholder Farmers by Gender (N=240)

Village name	Male	Female	Total
Njoro	22	18	40
Vumari	25	15	40
Bangalala	24	16	40
Mwembe	20	20	40
Mhezi	23	17	40
Chajo	24	16	40
Total	138	102	240

Primary Data Collection Process

Data collection form smallholder farmers, FGD and interviews using structured questionnaire were used. A total of 240 smallholder farmers were interviewed. FGD were held from each village with a team of 5 to 7 participants. In each team gender sensitivity and coverage from various sub-villages was considered. In addition, one or two extension officers participated in the discussion.

Data Analysis

The purpose of data analysis was to understand various agricultural information and knowledge used by smallholder farmers for their informed farm-level strategic and tactical decisions. In addition, the analysis aimed at establishing the sources of information and knowledge and channels used for communication. Quantitatively data were analyzed using descriptive statistics in order to establish information needs of stallholder farmers and how such information is communicated from various identified sources.

3. STUDY FINDINGS AND DISCUSSIONS

Socio-economic and Demographic Characteristics of the Respondents

Out of the 240 respondents, 114 (47.5%) were young smallholder farmers and this implies that relatively few youths involve in farming activities as compared to old ones (Table 2). Based on education level, of the 240 respondents from the study area (92.5%) had primary education. Similar results were found by Nyamba and Mlozi [8] and this implies that majority of farmers in rural areas have primary education. In terms of economic status of the 240 respondents, 157 (65.4%) were poor and this has implication on the choices of agricultural options for improved crop productivity under climate risks [9].

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Table 2: Distribution of Respondents by Demographic Characteristics

Variables		Frequency	Percent (%)
Age	Young (≤40 years)	114	47.5
	Old (> 40 years)	126	52.5
Education attainment	No formal education	5	2.1
	Primary	222	92.5
	Secondary	12	5.0
	Higher education	1	0.4
Wealth status	Well off	83	34.6
	Poor	157	65.4

Source: Field data (2009/10)

Important Agricultural Information in Crop Production Decisions

In this study, the smallholder farmers use market information, climate information, agricultural input information and household food security information for making farm-level decisions. As shown in Figure 1, the results showed a significant difference between agricultural information ($p \leq 0.01$). The results show that the respondents considered climate information as important agricultural information in making farm-level decisions. These results imply that climate information is important input to farming decisions in rain-fed agricultural systems of dry land areas. These results suggest that, farmers, when equipped with climate information, targeted with their needs for farm-level decisions, farming goals such as income, household food security are improved. This means that, farmers will be able to make targets of crop production and hence household income efficiently.

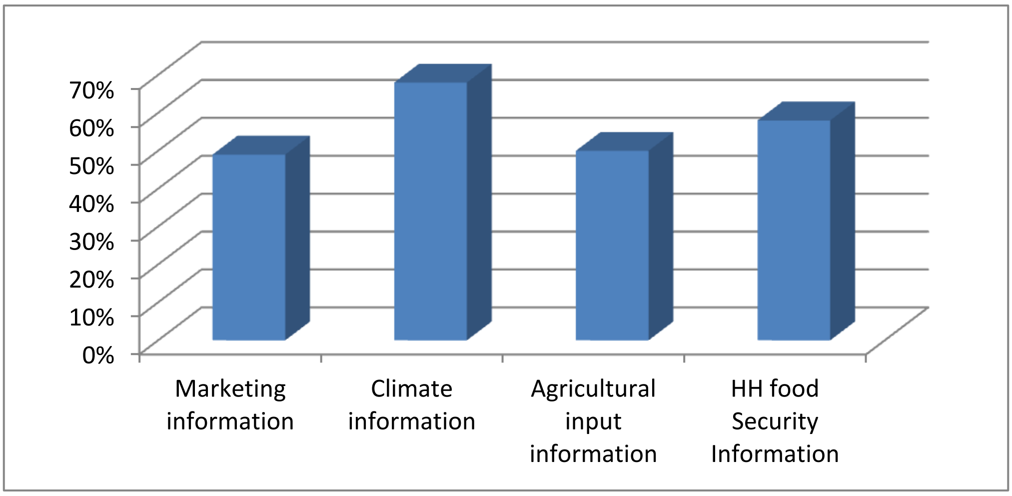

Figure 1: Farmers' Consideration of Importance of Climate Information.

Importance of agricultural information was analyzed to test a significant relationship between social economic factors (sex, wealth status, age group) and topographic zones. As shown in Table 3, there was no statistical significant relationship between age groups and choice of agricultural information ($p = 0.685$). Similarly, there was no statistical significant relationship between sex and choice of agricultural information ($p = 0.493$). Again, there was no statistical significant relationship of agricultural information to wealth status of the respondents ($p = 0.165$). However, there was a statistical significant relationship between importance of agricultural information and different topographic zones in the study area ($p \leq 0.01$). As shown in Table 3, majority of the respondents considered climate information as important element in their crop production. These results conform to those obtained through FGD where in lowland zone they mainly practice rain-fed crop production with very limited irrigation options.

These findings suggest that, the need for agricultural information by the farmers is independent of socio-economic status. Decisions whether or not to use input in various farm

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operations could be constrained by purchasing capacity of smallholder farmers or lack of education on opportunities to use recommended inputs [10]. However, the results showing no statistical significant relationship have been attributed by poor status of majority of the respondents. Other constraints for not using recommended input was unavailability when needed, limited farm size to accommodate cash crops, marketing decisions comes after harvesting as a result of family requirements (education, medical services, emergence and improving shelters), lack of markets and few options to cash crops.

Table 3: Respondents Views of Importance of Agricultural Information

	Topographic zones		
Agricultural information	**Upland (%)**	**Midland (%)**	**Lowland (%)**
Market	0.0	24.4	22.4
Climate	71.7	23.5	31.1
Input	10.9	25.7	19.1
Household food security	17.4	26.4	27.3

Source: Field data (2009/10)

Channels for Communicating Climate and Market Information

The results indicate a statistical significant difference between channels used to communicate climate information ($p > 0.01$). Duncan multiple comparison tests indicated that radio and mobile phones were considered important communication channels for accessing agricultural information. Preference of the respondents to use radio was noted to be attributed by their ability afford to buy it and have a wide coverage in the area. However, radio programmes for agricultural issues was noted to be not enough and information provided is limited. The use of mobile phones by the respondents in agricultural information communication and knowledge sharing was noted to have increased. Majority of the respondents possessed mobile phones which are cheap and easy to use; as a result they were able to make calls to input suppliers, extension workers and other agricultural stakeholders.

The relationship between communication channels and social economic status and topographic factors, showed no statistical significant with sex ($p = 0.964$), age group ($p = 0.091$) and wealth status ($p = 0.901$) of the respondents. Similar results were obtained on the relationship between communication channels for market information and age ($p = 0.075$), sex ($p = 0.828$) and wealth status ($p = 0.422$).

Preferred Channels for Market and Climate Information

Analysis performed to determine the preference of channels of agricultural information showed a statistical significant difference of the channels of climate information ($p \leq 0.01$), with radio and mobile phones ranking the highest preferred channels. However, as shown in Table 4, preference of communication channels had no statistical significant differences with social economic status of the respondents including age group ($p = 0.068$), sex ($p = 0.971$) and wealth status ($p = 0.940$). Similar results were found by Nyamba and Mlozi [8] that, socio-economic status of the respondents affects ability to possess and apply mobile phones for their agricultural and other uses. The results, however, do not conform to those found by Okwu and Iorkaa [11], where the use of socio-economic status of farmers had a statistical significant relationship with the use of mobile phone and internet for agricultural extension.

Table 4: Channels for Communicating Agricultural Information to Farmers with Socio-economic Status

	Sex		Age	
Channels	**Male (%)**	**Female (%)**	**<=40 (%)**	**>40 (%)**
Radio	58	42	49	51
TV	20	14	12	22
Internet	17	11	16	12
Mobile phone	53	37	41	49

Source: Field data (2009/10)

Analysis to determine preference of channels for communicating market information showed a statistical significant difference among channels of communicating market information ($p \leq 0.01$). However, the analysis to determine relationship with social economic parameters, preference of communication channels had statistical significant relationship with age group ($p \leq 0.05$) and sex ($p \leq 0.01$) of the respondents.

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These findings corroborated with results from other researchers where radio is a popular and widespread channels for communicating climate and market information. Popularity of radio as effective channel for communicating climate and market information because of its ability to reach illiterate farmers with contents related to agricultural production of understandable language. However, despite that radio is affordable and cheap to maintain, agricultural information programs do not in line with national information dissemination policy; messages do not address agricultural information needs of farmers; poor reception and limited area coverage. These results suggest improvement over information dissemination using radio programmes in rural communities.

Radio is not the only channel for disseminating agricultural information to rural smallholder farmers. In Tanzania, efforts have been made to establish community radio and telecenters [2]. Mobile phones found to become popular method for communicating agricultural information. Similar results were found by Mtega [12], where majority of farmers used, in addition to radio, mobile phones (66%) for communicating agricultural information. Similar findings indicated the use of mobile phones for communicating market information to farmers [13]. However, potential of mobile phones for communicating agricultural information is constrained by limited availability of power [12]. This implies that, efforts to benefit from mobile phones for communicating agricultural information should be linked with ensuring availability of power sources to rural communities.

Sources of Climate and Market Information

It was found that majority of smallholder farmers use extension workers (67.1% of 240 respondents) and meteorological services (50.8% out of 240 respondents) to obtain climate information. Despite other sources such as stockists, IK (indigenous knowledge) forecasts, district and village leaders with a statistical significant difference ($p \leq 0.01$). These results suggest that extension workers and meteorological services places vital role to provide climate forecasts to farmers. These results corroborated with other studies that farmers access climate forecasts from regional climate outlook for and national meteorological agencies [14, 15, 16, 17]. According to Okwu and Daudu [18], farmers prefer interpersonal communication with fellow farmers and extension workers because this media provides a room for translating information including climate forecast into their farm-level decision making processes.

Extension workers seek information from meteorological services. As found from the study that, generally farmers use radio for obtaining climate information. Getting information using radio does not adequately provide reliable information for decision making [19]. However, importance of climate information sources was not statistically significant related to social economic status of smallholder farmers. This means that, usefulness of climate information was independent of sex, age group and wealth status of farmers. However, as found by Okwu and Daudu [18], Okwu and Umoru [20], the frequency of media use to access climate information had a significant relationship with gender, age and farm size of the respondents. Nevertheless, it is still not known about the relationship between effective use communication media and sex, age group and farm size.

Sources of market information analyzed during this study were fellow farmers, extension workers, meteorological services, stockists and IK experts. These sources were compared and the results indicated a statistical significant difference of sources of market information ($p \leq 0.01$). Extension workers and fellow farmers were ranked highest as important sources of market information for their crop produce. The results suggest that, farmers prefer accessing information which guides them in making farm level decisions. This means that, technologies developed for supporting farmers decision making, should be able to provide not only information but also interpreted in their decision making process. These findings corroborated those of Okwu and Daudu [18] which reveal that extension workers and fellow farmers were considered as important source of market information. The results also support the findings of Adhiguru *et al*. [21] which show that other progressive farmers and input dealers followed by mass media. Adhiguru classified agricultural information communication systems into two categories namely, one way and two way communication. These findings suggest that farmers prefer two way interactive information systems.

The results also showed that importance of sources of market information had a statistical significant relationship with wealth status ($p \leq 0.05$). However, sources were not statistically significant related to age group ($p = 0.981$) and sex ($p = 0.742$) of the respondents. High preference in using fellow farmers and extension workers implies that communication between farmers and extension workers needs improvement using modern ICT technologies. These technologies should not only enable direct communication of farmers/extension workers to agricultural actors but also enabled to access agricultural knowledge repositories in automatic way. Agricultural knowledge stored in the shelves and farmers experience will be exposed to other farmers in a convenient way. This means that, with the use of simple and low cost mobile devices, farmers and extension workers will be able to interact with agricultural knowledge managed by computing systems linked with mobile phone interfaces. This implies that, productivity of farmers and extension services is improved.

Channels for Communicating Input Information

Analysis of channels used for communicating input information showed that radio and mobile phones were considered as important communication channels. In addition, the results indicated no statistical significant relationship between perception of importance of communication channels and socio-economic status of the respondents (age

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group, sex, wealth status).The results implies that, farmers need input information and the difference of usage of communication channels is attributed by their difference in socio-economic status. These results from FGD indicated that the farmers rely on mobile phones for getting information on availability of seeds, herbicides and fertilizers from local dealers. These results suggest that improving information repository about inputs communicated using mobile phones would improve decision making of farmers. This implies that stockists should actively participate in updating input information in the system repository using mobile phones or web applications.

Sources of input information (fellow farmers, extension workers, stockists, village, and district leaders) were also analyzed and found that extension workers and village leaders were most important. There was a statistical significant difference ($p \leq 0.01$) of sources of input information in terms of importance in supporting strategic and tactical farm-level decisions. The results suggest that, extension workers and village leaders are useful in communicating input information to farmers. Developing computing systems used by extension workers and village workers would improve their capacity of disseminating input information to farmers.

Accessibility of Climate Information in Rural Areas

There is no doubt that smallholder farmers' need of climate information (seasonal climate forecasts and weather forecasts) has increased due to improved forecasts and increased complexities of climate risks in agriculture such as erratic rainfalls and excessive floods. The results indicate a statistical significant difference on climate information ($p \leq 0.01$). Duncan multiple-comparison Test showed daily weather forecasts and seasonal climate forecasts as the most accessible and useful climate information.

These suggest that for improved crop productivity, farmers require to be updated at each stage of crop growth. Before the start of the season, farmers require seasonal climate forecasts to make strategic farm level decisions for improved household food security and income. Within the cropping season farmers also require short term weather forecasts including decadal and daily weather forecasts for planning operational activities [22]. This implies that farmers will be able to adjust tactical farm operations when informed on changing weather conditions, such as drought spells and floods, within the season.

Despite that, decadal forecast to be not accessed by farmers, TMA provides it to districts regional extension workers through email services. These workers in turn disseminate to farmers and extension workers at village levels. This communication system does not ensure that farmers access information timely and at the right interpretations. Following these constraints, a system to provide weather information, to farmers and extension workers at district and village levels, in time and at the same meaning using mobile phone technology was developed.

Influence of Socio-economic Status to Accessibility of Climate Information

The accessibility of climate information was analyzed to find out whether it had any relationship with socioeconomic status of the respondents farmers. The results indicate no statistical significant relationships of accessibility between climate information and age group ($p = 0.374$), sex ($p = 0.823$), and wealth status ($p = 0.518$). The accessibility of climate information was not influenced by socioeconomic status of the respondents. This suggests that, climate information needs of farmers are the same and hence policies developed for communicating climate information should not consider socio-economic differences of the farmers.

Despite that, accessibility of climate information was not influenced by socio-economic status; the pathways used to access such information could have influenced how the farmers get information. A combination of fellow farmers and radio which were commonly used by farmers to access climate information, introduction of mobile phones improved such communication that involved extension workers at district and village levels and fellow farmers. The study developed improved a system that improved communication using mobile phones and internet application for accessing climate information directly from meteorological services through a centralized database. The developed database also provides a depository of agricultural information and knowledge of climate, market and agricultural inputs required for various decisions making at farm level. This allows automatic generation and coordination of advisories for farmers in linking climate forecasts, inputs availability and strategic and tactical decisions.

4. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In this study the need of agricultural information varies form village to village in the study area. Climate information was identified as critical in farm level decisions in all the villages. In particular daily weather forecast and seasonal climate forecast was noted to be highly needed by farmers. Other information including droughts and string winds alerts was also identified as important climate information for their crop planning. However, some villages have identified household food security objectives as key driver for farm-level decisions. Other information used by smallholder farmers includes market and agricultural information. The respondents also indicated that, they did not plan for market instead they seek market after harvest and when there was a need for selling crops.

Other factors that influence accessibility agricultural information was identified to be caused by lack of belief over climate forecasts from scientific and indigenous knowledge sources. Low use of agricultural inputs influenced the need to such information during crop planning operations. When

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assessing the effectiveness of channel and sources used by farmers to communicate agricultural information, it was noted that radio was effective channels for getting climate information. In addition, farmers use extension workers and fellow farmers in getting agricultural information. Other sources such as met services, researchers, agricultural inputs suppliers, NGOs, district and village leaders was less effectiveness. When assessing preferences of sources and channels farmers preferred radio, mobile phones, extension workers and fellow farmers for communicating climate information. However, farmers noted that internet was identified as important channels for sharing agricultural knowledge when special training is given to them.

Recommendations

When designing communication strategy for sharing agricultural information and knowledge in the study area, it is important to consider the sources available, channels and socio-economic status of smallholder farmers. In this area, for farmers to improve access and use of climate information important elements of communication should include radio, mobile phones, extension workers, fellow farmers and agricultural inputs suppliers. Still TMA and researchers play important support to farmers and these elements should be connected indirectly to farmers. For example TMA communicate climate information using radio, mobile phones and extension workers both at village and district level. Researchers communicate information and knowledge to farmers using radio, extension workers, and farm field demonstration and farmers field schools. Information flow through extension workers should also be designed in such a way that the delay is minimized and hence improve timely access to information by farmers. Still the research on agricultural databases, information processing and communication systems is needed to be developed and implemented for enhancing extension services for the farmers.

It is also recommended that, agricultural information processing and communication systems need to be developed to provide a new platform for storing and sharing knowledge to farmers in convenient and semi-automatic way using simple and low cost mobile phones. This implied that some of extension services to farmers could be automated to reduce weakness of human factors in communicating information with minimum language, technical and socio-economic barriers. Regular updates and alerts in case of abnormal environments are communicated easily through specialized computerized information and communication platform. Further studies need to be conducted to understand farmers interface for accessing information and knowledge using computerized services in agriculture so that farmers enjoys the fruitful of modern ICT.

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