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Perceptions and Adaptation Strategies to Changing Climate: Evidence from Farmers of Northern Dry Zone of Karnataka

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ABSTRACT

This study elicits and understands farmers' perceptions and indigenous adaptation strategies to mitigate climatic variability in northern dry zone of Karnataka. Pre-tested and structured interview schedule was used to collect data from the farmers using multi-stage random sampling technique. Statistical tool like Garret ranking technique was employed to identify and rank various adaptation strategies practiced by farmers towards changing climate. Results revealed that farmers experienced varying climatic condition in terms of decreasing and unpredictable rainfall, increase in temperature in recent years and frequent failure of monsoon. Climatic variability affected farming in terms of declining crop yields, frequent crop failure, sinking water level in bore wells and open wells and increased emergence of new pest and diseases. Farmers manifested resilience against changing climate by adopting combination of indigenous and modern scientific adaptation strategies such as crop diversification, mixed farming, water conservation structures, changing planting dates, seeking off-farm employment and adopting drought and heat tolerant varieties. Main barriers to adaptation were lack of knowledge about climate change, lack of timely availability of weather information and farm inputs. To enhance access and timely dissemination of weather forecasts information, timely availability of farm inputs and crop insurance mechanisms will have the scope to enhance farmers' resilience to changing climate and adaptation.

INTRODUCTION

Climate change is recognized as one of the leading challenges affecting the performance of agriculture and livelihood of farmers. The impacts of changing climate on agriculture witnessed all over the world, but countries like India are more vulnerable in view of the large population depending on agriculture and excessive pressure on natural resources (Ravi Shankar et al., 2013). The impact of such an unprecedented climate change would be particularly severe in the tropical areas, which mainly consists of developing countries, including India (Rao et al., 2010). In addition, non climatic pressure, such as population, poverty and unequal and inadequate distribution of resources etc. are aggravate the vulnerability of the system by reducing the adaptive capacity. India, one of the developing countries in the world, is more vulnerable of the adverse impact as it is mostly located in tropics and is backed by poor socio-economic, demographic and institutional adversaries (Dupdal & Patil, 2019). The agriculture sector particularly, armers in rainfed area depend on monsoon rainfall are likely to bear the brunt of adverse impacts of climate change. Furthermore, major impacts of climate change will be on rainfed crops, which is cultivated nearly 60 per cent of area in India. Under such circumstances, adaptation and coping mechanism to climate change could be one of the better options available for developing countries like India to counter the

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heavy burden of climate change. There are various studies in the literature which reflects that with adaptation, the risk to climate change can be reduced or minimized to a greater extent and without adaptation it can be harmful for the agricultural sector (Smit et al., 2006; Reidsma et al., 2010; Deressa et al., 2010). The policy response to climate change includes mitigation of green house gases that contribute to the adverse changes in the Earth's climate, and adaptation to potential impacts caused by the changing climate (Kavi Kumar, 2010). As the developed and developing countries are still at loggerheads regarding whom to bear the responsibility for reducing GHGs, there is an urgent need to explore suitable adaptation practices which make ecosystem more resilient to absorb larger shocks due to climate change (Boomiraj et al., 2010). In doing so, one must take into account local community's understanding of climate change, because even though climate change is a global phenomenon, adaptation is largely site specific (Lema and Majula, 2009). Moreover, indigenous knowledge is borne out of continuous experimentation, innovation and adaptations, blending many knowledge systems to solve local problems. Hence, better understanding of farmer's perceptions about climate change, its impact on agriculture production, existing adaptation measures and factors influencing in adopting them is needed to craft policies and programs aimed at promoting successful adaption of the agricultural sector (Bryan, et al., 2009; Hassan and Nhemachena, 2008; Chaudary, et al., 2011). Apart from that, there is also need to document all the indigenous practices farmers have been following over time for coping with climate change. The farmer is a critical decision maker if agricultural lands are to be effectively managed to adapt to changing climate conditions (Gordon et al., 2013).

Karnataka is the most drought-prone state and 68 per cent of cultivated area is under rainfed farming next only to state of Rajasthan in India. It is frequently affected by drought and flood simultaneously in different part of the regions. A close analysis of rainfall pattern of the state indicates that 3 to 4 years in every decade face severe drought at, sometimes consecutively. Keeping in view, the present study attempts to examine the farmers perceptions, impact, adaptation practices and coping mechanism to changing climatic conditions in northern dry zone of Karnataka comprising Vijayapura and Bagalkot district since they are fragile and complex ecosystem with poor socio-economic base with varying weather and climatic condition along with high vulnerability index to climate change (Rama Rao et al., 2013).

METHODOLOGY

The study was conducted in Vijayapura and Bagalkot district in northern dry zone of Karnataka. The primary data was collected from 240 farm households using multi-stage random sampling technique. In the first stage, two districts namely Vijayapura and Bagalkot were selected based on high vulnerability index to climate change in northern part of Karnataka (Rao et al., 2013). In the second stage, two talukas in each district were purposively selected in consultation with respective Joint Directors of Agriculture (JDA) situated at district level for collection of primary data. The selected talukas were Vijayapura and Sindagi (Vijayapura district); and Bagalkot and Hungund (Bagalkot district). In the third stage, two villages were selected randomly in each taluka with consultation of respective Agriculture Officers (AO) situated at taluka level. The selected villages were Hittinahalli and Jumnal (Vijayapura taluka) Devarahippargi and Bommanjogi (Sindagi taluka); Bevoor and Hallur (Bagalkot taluka), Hirebadawadgi and Bannihatti (Hungund taluka). In each village, 30 farmers were selected and total sample size was 240 households. The primary data was collected through personal interview with sample farmers using pre-tested and well structured interview schedule.

Data were analysed using descriptive *statistics such as frequency, percentage and tabular analysis to arrive the results.* Garret Ranking Technique was employed to identify and rank various adaptation strategies towards climate change practiced by farmers. The main benefit of this tool over simple frequency distribution is that strategies are arranged based on their importance. Hence, the same number of response on two or more strategies may get different ranks. Garrett's formula for converting normal rank into per cent was used.

RESULTS AND DISCUSSION

The demographic composition was dominated by old aged farmers with the average age being 57 with 36 years of farming experience. The old aged farmers are expected to have high farming experience and knowledge about farming and associated risks. More than one-third of farmers each fell under the category of illiterates, average size of family member in each household was five persons and about 15 per cent farmers have associated themselves with one or the other social organizations. More than half of sample farmers possess irrigation facility in the form of either bore wells or open wells. Keeping agriculture as main occupation, over one-third of farmers engaged in other off-farm activities like small businesses, agricultural labour and about 44 per cent farmers' availed institutional credit**.** Varadan and Kumar (2014) in their study reported that availability of credit eases the cash constraints and allows farmers to buy high value inputs. The sample farmers were equally distributed among marginal, small and large group. Further, livestock was an integral part of every farming system and important source of income and livelihood security especially for dryland farmers. About 45 per cent farmers possessed livestock such as cow, buffaloes, sheep and goat.

The study on farmers' perceptions about changing climate revealed that seventy five percent farmers perceived climatic variability in terms of various meteorological indicators. About 70% farmers perceived decreasing quantity of rainfall and its unpredictable behaviour with prolonged dry spells during cropping season (Figure 1). It is striking to note that farmers across the world show a remarkable unanimity in observations of seasonal change, particularly regarding rain falling in most intense burst, and generally higher temperatures and longer hot, dry spells within rainy seasons, with effects on soil moisture (Jennings and Magrath, 2009). Farmers perceived significantly increasing temperature since past one to two decades and experienced frequent failure of monsoon while portion of farmers experienced water stress and water shortage persisted specially during summer season. Farmers in the region also opined that rainfall pattern was more uneven and unpredictable in the region than before. Further, delayed onset of monsoon and increasing occurrence of heat waves was also perceived by farmers. Delayed

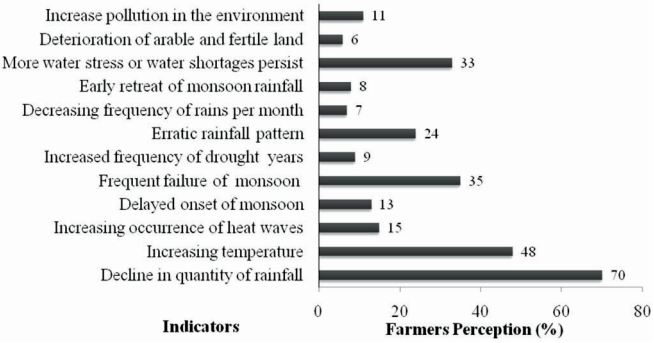

Figure 1. Farmers' perceptions about changing climatic condition in study region
*****Multiple responses

monsoon and prolonged dry spells reduced the soil moisture, which is a critical factor influencing their crop cultivation. The similar results were found in the studies conducted by Dhanya and Ramachandran, (2016). The results are also in line with Bryan et al., (2009) who reported that farmers in Ethiopia and South Africa experienced increased temperature and decreased rainfall. The similar findings were also reported by Dhaka et al., (2010) & Ravi Shankar et al., (2013).

The data on perceived impact of climate change on agriculture in the region revealed that eighty one percent of farmers reported that climate variability has adversely affected their farming in one or the other way (Figure 2). Perceived impact on changing climate were decline in crop yield, failure of crop due to delayed and unpredictable monsoon, declining water level in bore wells and open wells. Few farmers also experienced increased and emergence of new pest and disease and decline in fodder availability and consequently milk productivity. The results are in line with study of Rama Rao et al., (2018) who reported that consequences of climate change will affect agriculture are declining ground water table, increase in soil salinity, uneven distribution of rainfall, increase in disease infestations that result in crop failure and migration of men and cattle in search of livelihood.

Crop diversification and inter/mixed cropping system was identified as predominant adaptation strategies practiced by farmers in response to changing climate in Vijayapura district (Table 1). Further, in Vijayapura district, crop diversification with short duration crops like groundnut, pearl millet and cowpea were practiced and replace the traditional crops like cotton and sorghum with horticulture crops (grapes, pomegranate and citrus fruits like lime) to sustain the long term income while in Bagalkot district, mixed cropping system such as sorghum + pigeonpea, groundnut + sorghum, chickpea + sorghum were practiced as major adaptation strategy. Results further revealed that water conservation through water harvesting structure-farm ponds and bunding, change in planting date, off-farm employment, drought and heat resistant varieties, short duration and early maturing varieties. etc. in that order of magnitude are the major adaptation strategies practiced towards changing climate by farmers. In dryland area of Vijayapura and Bagalkot district, farmers also practice alternate cropping with short duration crops particularly vegetables (tomato, brinjal and chilly) since these crops withstand the heat and water stress under varying climatic situations. The adaptation measures through soil and water conservation structures helps to conserve the rainwater *in-situ* there by reducing soil loss and increasing the profile soil moisture for better plant growth. Another important adaptation practice was change in planting date in accordance with the arrival of monsoon rains to averse the negative impact of changing climate. The results are in conformity with findings of Ravi Shankar et al., (2013) who revealed that buying insurance, changing planting dates of groundnut, intercrop with redgram, construct water harvesting structures, and require quick maturing, drought resistant varieties in that order of magnitude are the major adaptation measures

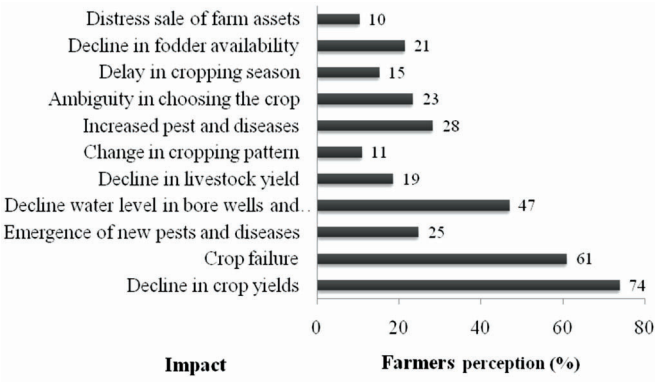

Figure 2. Farmers perceived impact of climate change on agriculture
*****Multiple responses

Table 1. Farmers adaptation strategies to changing climatic condition

Adaptation strategies	Vijayapura district		Bagalkot district	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Crop diversification	95.45	I	66.69	IV
Inter/ mixed cropping	77.42	II	86.56	I
Use of drought and heat resistant varieties	60.91	V	65.69	VII
Change in planting date	57.70	VI	73.15	III
Short duration and early maturing varieties	56.02	VII	66.34	V
Off-farm employment	70.35	III	66.20	VI
Crop insurance policies	49.33	IX	63.12	VIII
Sale of farm assets and livestock	38.67	XII	50.00	XII
water conservation through farm pond and bunding	64.09	IV	79.50	II
Migration to urban areas	55.24	VIII	57.20	X
Borrowing from relatives and money lenders	47.58	X	59.36	IX
Government relief measures	45.36	XI	52.50	XI

Table 2. Constraints experienced by the farmers in adaptation to changing climate (n=240)

S.No.	Constraints experienced	Mean Garrett Score	Rank
1.	Non-availability of timely weather forecasted information	72.80	II
2.	Lack of credit facility for farmers	38.52	XI
3.	Lack of knowledge about need based improved agriculture technologies	47.55	IX
4.	Lack of market access (poor transportation networks and market information system)	43.15	X
5.	Lack of information about crop insurance service	54.80	VII
6.	Timely availability of farm inputs	65.44	III
7.	Limited access to agricultural extension services	59.21	V
8.	Low/no subsidies on desired agricultural inputs	36.05	XII
9.	Lack of belief on current weather forecast system	51.27	VIII
10.	Irregularity in power supply	55.65	VI
11.	Lack of knowledge and information about climate change adaptation strategies	78.09	I
12.	Insufficient water for irrigation of crops	62.25	IV

followed farmers towards changing climate in Anantapur district in Andhra Pradesh. Crop diversification can serve as insurance against rainfall variability as different crops are affected differently by climate events (Orindi and Eriksen, 2005). Dupdal et al., (2020) and Raghuvanshi & Ansari (2020) in their study also revealed that farm level adaptation strategy like agro-met advisory services enhance the crop yield and income of farmers who adopted the services as compared to non adopter of service.

Apart from farm management strategies, farmers were also followed some important income management strategies such as off-farm employment opportunities, borrowing loans from money lenders, friends and relatives, buying crop insurance policies, outmigration to large cities in search of jobs, dependent on government relief measures and sale of farm assets and livestock in order to sustain their livelihood during adverse climatic situations. Similar studies were conducted in Sunderbans Ecosystem (Sarkar et al., 2010) reported that adequate capacity building programmes in area of adaptation technology need to be organized besides launch of social protection measures to empower them for better preparedness and adaptation to the consequences of climate change.

Study further observed that farmers in the region were migrated to big cities like Mumbai, Hyderabad and Pune in search of life sustaining employment and daily wage earning in unorganized sectors such as construction industry, mines and quarries, domestic workers, street vending, rickshaw pulling especially during drought years. Migrate as construction labour if monsoon fails, particularly in rainfed areas of the district is another common phenomenon (Ravi Shankar et al., 2013). Farmers in Bagalkot district were highly dependent on government relief funds followed by loans from friends and relatives and off-farm employment opportunities. The results are in line with findings of Dupdal and Patil (2017) where relief measures at the time of natural calamity were advocated in reducing risks in agriculture.

Farmers also perceived some important constraints encountered in adoption of adaptation practices to mitigate the climatic adversities in the study region (Table 2). Some of them were lack of knowledge and information about climate change adaptation strategies, non-availability of timely weather forecasted information particularly rainfall, temperature and relative humidity, lack of timely availability of farm inputs, inadequate water for irrigation, limited access of agricultural extension services, irregular supply of power required for irrigation etc. in that order of magnitude are the major constraints experienced by the farmers in adaptation to changing climate. The results are also in conformity with finding of Fosu-Mensah et al., (2012) reported that lack of information on adaptation strategies, poverty, and lack of information on weather are the main barriers for adaptation to changing climate. It was observed from the study that due to lack of knowledge and non-availability of weather information, there was ambiguity in farmers in choosing appropriate crops for the season. From the results, it was also revealed that lack of water for irrigation as it is critical input for agriculture production and non-availability of critical farm inputs in time which leads to delay in sowing, crop failure and ultimately low production in the region.

CONCLUSION

The study shows that understanding the importance of farmers' perception towards changing climate is extremely important in developing adaptation strategies to overcome the increasing effect of climate change and variability. From the results, it was found that more than 2/3rd of farmers experienced changing climatic condition in the form of declining rainfall, increasing temperature, frequent failure of monsoon and water stress condition in the region. Farmers perceived the affects of climate change on crop production in the form of decline in crop yields, frequent crop failure, decline in water levels in bore wells and open wells and increased emergence of pest and diseases. However, farmers exhibited resilience to changing climate through various local adaptation practices such as crop diversification, inter/mixed cropping, manipulating sowing date, drought tolerant varieties and adoption of various soil and water conservation measures. Therefore, indigenous knowledge and innovations of the farming community have to be appropriately blended with modern scientific practices for addressing climate change. Implications for policy making will be to enhancing access and timely delivery of weather forecasts information, timely availability of farm inputs and crop insurance mechanisms which will enhance the farmers' resilience to climate change and adaptation. Further, robust extension services which make accessible to all farmers in the region appear to be a key component of successful dissemination of adaptation strategies.

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