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Correlates and determinants of climate change adaptation strategies of food crop farmers in Oke-Ogun area of South-western Nigeria

Olutegbe N. S.[1*] and Fadairo O. S[2].

[1]Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan, Nigeria.
[2]Department of African Climate and Development Initiative, University Of cape Town, South Africa

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Information on determinants of climate change adaptation strategies in Oke-ogun area, the food basket of South western Nigeria is scarce. Determinants of adaptation strategies to climate change among food crop farmers in Oke-Ogun area of Oyo State were therefore assessed. Multistage sampling procedure was used to select 160 food crop farmers, and data were collected through a well-structured interview schedule. Chi-square, Pearson Product Moment Correlation (PPMC), and Multiple Linear Regression were used in data analysis. Mono-cropping practices (χ^2 = 14.213), access to extension services (χ^2 = 6.201) and credit facilities (χ^2 = 8.077) had significant relationship with respondents' level of climate change adaptation strategies. Farm size (r = 0.232), level of awareness (r = 0.199), information exposure (r = 0.205) constraints to climate change adaptation strategies (r = -0.228) and perception (r = 0.319) also had significant relationship with level of adaptation strategies. Farm size (β = 0.259), perception of climate and effects (β = 0.257), constraints to adaptation to climate change effects (β = -0.118) were the three most important determinants of climate change adaptation strategies of food crop farmers. Agricultural extension activities should intensify awareness creation, while it also provides solutions to all climate change adaptation related constraints.

Key word: Perception, climate change, awareness, information exposure, constraints to adaptation.

INTRODUCTION

Agricultural production remains the main source of livelihood for most rural communities in developing countries and sub-Saharan Africa in particular. Here, agriculture provides a source of employment for more than 60% of the population and contributes about 30% of gross domestic product (Kandlinkar and Risbey, 2000). Rain-fed farming however dominates agricultural production in sub-Saharan Africa, covering around 97% of the total cropland and exposes agricultural production to high seasonal rainfall variability (Alvaro et al., 2009). Unfortunately, agriculture in the developing world according to Action Aid (2008) is particularly vulnerable to climate change. IPCC says that in some African countries, yield from rain-fed agriculture could be reduced upto 50% by the year 2020 (Intergovernmental Panel on Climate Change, IPCC, 2007).

Climate change adaptation aims to mitigate and develop appropriate coping measures to address the

*Corresponding author. E-mail: siji004u@yahoo.com. Tel: 1+2347032077856.

negative impacts of climate change on agriculture. In fact, one focus of adaptation strategies to climate change is targeted towards improving the wellbeing of the people. It is however worrisome that in spite of various adaptation strategies being pushed forward, food production level in the country is assuming an increasingly low trend in recent years, or at best, not matching the growing trend in the population. For example, the population of Nigeria is projected to increase by more than 50% by 2021 (Food and Agriculture organization, FAO, 2001).

During this 20 year period, the rural population is projected to increase by more than 25%, and the agricultural component is expected to grow by a slightly lower proportion, moderated by climate change and undercapitalization of the smallholder farmers. Therefore, it becomes imperative that appropriate adaptation measures be developed, with the aim of reducing the effects of climate change on food crop production.

Oke-Ogun, a region under the Saki Agricultural Zone of Oyo State Agricultural Development Programme (OYSADEP), consists of all the ten LGAs in Oke Ogun area of the state, and is known to produce the bulk of the food that is consumed both in and outside Oyo State. The region has about two-third of the total land area in Oyo State, suitable for the production of different food crops, including cassava, maize, yam, rice and cowpea. Others are vegetables, fruits, spices, among others.

Affirming this, Sangotegbe et al. (2012) asserted that Oke-ogun is the food basket of South-western Nigeria. However, recent food crisis in Oyo State and South western region of Nigeria suggests that climate change is already taking its toll on the activities of farmers as well as the production of major food crops for which the savannah region is renowned. Although, available statistics were not explicit about and affirmative of this, Sangotegbe et al. (2012) reported that majority of farmers in Oke-ogun area of south-western Nigeria perceived climate change to have unfavourable effects on food crop production activities and outputs. Developing appropriate adaptation measures will invariably reduce the negative impacts of climate change, and thereby contribute to improved productivity of the farmers and food security status of the south-west Nigerians. Identifying factors responsible for this low trend therefore becomes very imperative.

A number of factors have been linked with adaptation strategies to climate change of the people, and particularly of the farming population. Inter-governmental panel on Climate Change, IPCC, (2001) posited that poverty is directly related to vulnerability, and is therefore a rough indicator of the ability to cope and adapt. Corroborating IPCC, Lawrence et al. (2002) asserted that the poverty index is directly proportional to water availability, especially for farming communities. Even exploitation of water resources for economic gains is hindered by poverty. This therefore implies that the economic power of the people has a strong link with their adaptation strategies. Other factors such as awareness of new technologies (Maddison, 2007), perception of such technologies (Hassan and Nhemachena, 2008), inadequate technology adoption, education of farmers (Dinar et al., 2008), information and skills (Lee, 2007; Scheraga and Grambsch, 1998; United Nations Environment, Programme, UNEP, 2009), poor infrastructure (WDR, 1998; Mati, 2008), gender and religious issues (Spencer and White, 2007) and institutional constraints (Kelly and Adger, 1999) have equally been identified by different authors.

A number of authors have however disagreed on many of these factors, suggesting that it may not be an absolute rule that the factors apply for all places, as these may vary with ecological differences, among others. Ayanwuyi et al. (2010) reported that farm size was significantly and positively related to farmers' adaptation strategies in Ogbomosho Agricultural zone of Oyo State, while Nyangena (2007) posited that farmers with a small area of land are more likely to invest in soil conservation than those with a large area in Kenya.

On gender issues, FAO (2010) reports that male are often given greater priorities than female in terms of their access to credit facilities, land tenure system and training of farmers. On the other hand, Apata et al. (2009) establishes no significant relationship between sex and farmers' adaptation strategies to climate change in a similar study in western Nigeria. Clay, Reardon and Kangasniemi (1998) also reports a significant relationship between education and adoption decisions in a study in Rwanda, as against Ayanwuyi et al. (2010), which establishes no significant relationship between the two variables in another study with farmers in Ogbomoso Agricultural zone of Oyo State.

These divergent positions therefore are indications that factors affecting adaptation strategies to climate change may depend on several other externalities, an example of which is local peculiarities. Therefore, since there is a dearth of information on determinants of adaptation strategies to climate change among food crop farmers in Oke-Ogun area of Oyo State Nigeria; this study sets out to fill this gap.

The specific objectives of this study include to determine if significant relationship exists between food crop farmers adaptation strategies and their:

1. Socio-economic characteristics;
2. Preferred sources of information on climate change;
3. Awareness of food crop farmers on climate change
4. Perception of food crop farmers on effects of climate change on food crop production
5. Constraints faced by food crop farmers in adapting to climate change; and
6. Investigates the collective and individual contribution of each of these factors to farmers' adaptation strategies to climate change in the study area.

The following hypotheses were tested in pursuance of the specific objectives of the study:

Table 1. Sampling procedure for correlates and determinants of climate change adaptation strategies among food crop farmers Oke-Ogun Area of South-western Nigeria.

No. of LGAs Oke-Ogun	20% of LGAs	No. of wards	20% of wards	No. of communities/ wards	20% of community	No. of farmer in the communities	20% of farmer in the communities	Total no of farmers
10	Kajola	11	2	32	6	175	35	35
				30	6	210	42	42
	Saki west	10	2	30	6	200	40	40
				28	6	215	43	43
Total	2	21		120	36	800	160	160

Methodology adopted from Sangotegbe et al. (2012).

Ho1: There is no significant relationship between selected socio-economic characteristics of food crop farmers and their adaptation strategies.
Ho2: There is no significant relationship between food crop farmers preferred sources of information on climate change and their adaptation strategies
Ho3: There is no significant relationship between level of awareness of food crop farmers on climate change and their adaptation strategies.
Ho4: There is no significant relationship between the perception of food crop farmers on effects of climate change on food crop production and their adaptation strategies.
Ho5: There is no significant relationship between constraints faced by food crop farmers due to climate change and their adaptation strategies.
Ho6: There is no significant collective and individual contribution of each of these factors (independent variables) to farmers' adaptation strategies to climate change in the study area.

METHODOLOGY

Study area

The study was carried out in Oke-Ogun area of Oyo State which is located within the guinea savannah zone. It shares border with Kwara, Niger, Ogun and Osun States, as well as Niger Republic (a neighbouring country). The area is recognized as the 'food basket' of the Southwestern Nigeria, having an annual rainfall ranging between 700 to 1100 mm. The landmass of Oke-Ogun is about 13,537 km^2. This is about 60% of the total land mass of the present Oyo State. There are rivers and streams in most towns. Some of the rivers do not dry up even in the dry seasons. The land is good for large scale production of a wide variety of agricultural products. The people are Yorubas and the main economic activities include: farming, hunting, fishing, food processing, transportation and craft businesses. There is a limited level of infrastructural and institutional development in the study area.

Most farm families reside in the various settlements abounding in the villages and farmers still adopt traditional cultivation methods. The common food crops grown in the area include yam, cassava, maize, vegetables, melon, guinea corn, pawpaw, water melon, plantain, banana, and groundnut. Farmers still make use of traditional tools such as cutlass, hoe, axe, and so on. There are ten local government areas in the region. These include: Kajola, Iseyin, Itesiwaju, Iwajowa, Saki East, Saki West, Atisbo, Orelope, Irepo and Olorunsogo Local Government Areas, Oyo State. The notable towns in the Oke-Ogun
include Saki, Iseyin, Okeho, Kishi, Ago-Are, Tede, Ago-Amodu, Sepeteri, Ilero, Otu, Ado Awaye, Okaka, Ogboro and Igboho (Sangotegbe et al., 2012).

Multistage sampling procedure was used for this study. In the First stage, a simple random sampling technique was used to select 20% of a total of 10 Local Government Areas (LGAs), to make a total of 2 LGAs, which are Saki-West and Kajola Local Governments Areas. In the second stage, food crop farmers were purposively selected in the two LGAs. Two wards were selected in Stage 3 from each of the wards and 20% of each of the communities were selected across each ward in Stage 4. The list of the food crop farmers was then obtained from where 20% of food crop farmers was selected as the unit of analysis. This makes a total of 77 and 83 food crop farmers in Kajola and Saki West LGA, respectively. Therefore, a total of 160 food crop farmers were selected for the study (Table 1).

Methodology

Measurement of variables

The study measures socio-economic variables, sources of information, awareness of climate change and effects, perception of climate change and effects, constraints to climate change adaptation as well as the climate change adaptation strategies of food crop farmers in the study area. Respondents indicated their sex, marital status and level of education. Mono-cropping, access to credit facilities and access to extension services were assigned a score of 1 each, while 0 was assigned to otherwise (dummy). Respondents' age and farm size were measured in actual number of years, while farming experience was measured in hectares (Sangotegbe et al., 2012).

For respondents' level of exposure to information and adaptation strategies, a list of information sources (for exposure to information) and adaptation strategies (for level of adaptation strategies) were presented to the respondents from which they indicated frequency of use of each, as always (3) occasionally (2) rarely (1) and never (0). Sample items for each for these variables are presented below:

Sources of information

1. Radio.
2. Television.
3. Newspaper.

4. Magazines.
5. Extension Agents.
6. The internet.
7. Books.
8. Seminars.

Adaptation strategies

1. Cereal/legume intercropping.
2. Ridges across the slope.
3. Planting different crop varieties.
4. Use of organic fertilizers.
5. Fadama/irrigation.
6. Mixed farming.
7. Changing planting dates.
8. Soil protection through planting trees.
9. Planting different crops.
10. Zero tillage.

Awareness of climate change and effects was measured as Yes (1) and No (0), as response options to a list of items on the awareness scale. Sample items are presented below:

Awareness of climate change

1. I am aware the climate is changing
2. I know Climate change reduces quantity of food crop produced.
3. I am aware Climate change reduces quality of food crops.
4. I know the frequent drought is a result of climate change.
5. I am aware cropping calendar is varying due to climate change.
6. I know the atmosphere is getting hotter.

Perception of climate change and effects was measured as respondents indicated their level of agreements to a list of 28 negatively and positively worded perception statements. For positive statements, the order of scoring was strongly agree = 5, agree = 4, undecided = 3, disagree = 2 and strongly agree = 1. A reverse order applies for negative statements. Sample items are presented below:

Perception of climate change

1. Continuous rise in annual temperature reduces production of common food crops.
2. Yearly rains are not supporting food crop production as before.
3. Infestation of crops by pest is common due to climate change.
4. Climate change reduces working hours of food crop farmers.
5. There is a rapid loss of soil nutrients to erosion due to climate change.
6. Labour availability is being reduced due to climate change.
7. There is poor germination rate of food crops due to climate change.
8. Poor harvest of food crops cannot be due to climate change.

For constraints to climate change adaptation strategies, a list of constraints: Very severe = 3, severe = 2, not severe = 1 and not a constraint = 0, sample items are provided below.

Constraints to climate change adaptation strategies

1. Shortage of water.
2. Lack of credit facilities.
3. High cost of inputs.
4. Inadequate knowledge of adaptation strategies.
5. Inappropriate information on weather incidences.
6. Scarcity of improved seeds.
7. Inadequate access to fertilizers.

Index of each of these variables was obtained by summing up the score for each of the sources of information, adaptation strategies, awareness of climate change and effects, perception of climate change and effects and constraints to climate change adaptation. These scores were therefore obtained at interval levels and are used in the test of Hypotheses 2 to 5.

Level of adaption strategies was reduced to a lower level of measurement by categorizing respondents into two (high and low adapters), using the mean adaptation scores as the benchmark. This is necessary to appropriately determine relationship with the socio-economic variables measured at lower levels than the interval level in which the level of adaptation strategies had been originally represented.

For Objective 1, the relationship between sex, marital status, level of education, mono-cropping, inter cropping, access to extension contacts, access to credit facilities and the dependent variable (level of adaptation strategies) was analyzed using Chi-square. This is appropriate since the listed socioeconomic variables were measured at nominal levels. However, relationship between age, farming experience, farm size and level of adaptation strategies were determined using Pearson Product Moment Correlation (PPMC).

For Objectives 2 to 5, PPMC was used. Each of the objectives were operationalized as a Null Hypothesis 1, 2, 3, 4 and 5. All hypotheses were therefore tested at 5% level of significance. Multiple Linear regression was used to determine the key determinants of respondents' level of adaptation strategies in the study area. This is given as:

$$Y = a + \beta X_1 \ldots \beta_8 X_8$$

Where Y = Level of adaptation strategies (at interval level); X_1 = Exposure to information (at interval level); X_2 = Perception of climate change and effects (at interval level); X_3 = Constraints to climate change adaptation (at interval level); X_4 = constraints to climate change adaptation (at interval level); X_5 = awareness of climate change (at interval level); X_6 = Mono-cropping (Yes = 1; Otherwise = 0); X_7 = Access to credit facilities (Yes = 1; Otherwise = 0) and X_8 = extension contacts (Yes = 1; Otherwise = 0).

RESULTS AND DISCUSSION

The results of Ho1 (Table 2) shows that there is no significant relationship between the age of respondents and their adaptation strategies ($r=0.14$, $P>0.05$). This may be attributed to the fact that age may not be the key determinants of access to source of information which they need to adapt to change on their activities. This agrees with Ayanwuyi et al. (2010) and Apata et al. (2009) which reported no significant relationship between age and farmers adaptation strategies in part of Oyo State.

Farm size is however significantly related to the adaptation strategies of the farmers ($r=0.232$; $p<0.05$). The reason may be due to the fact that the respondents with larger farm size tend to take more proactive measures in order to reduce loss which could be greater

Table 2. PPMC table showing the relationship between age, farm size and adaptation strategies.

Variable	r-value	p-value	Remark	Decision
Age	0.140	0.077	NS	Accept Ho
Farm size	0.232	0.003	S	Reject Ho
Farming experience	0.070	0.377	NS	Accept Ho

Table 3. Chi-square analysis of relationship between respondents' sex, marital status, level of education, cropping system, access to credit facilities and access to extension contact.

Variable	χ^2	Df	p-value	Remark	Decision
Sex	1.381	1	0.240	NS	Accept Ho
Marital status	2.005	2	0.367	NS	Accept Ho
Level of education	2.132	3	0.545	NS	Accept Ho
Mono cropping system	14.213	1	0.000	S	Reject Ho
Intercropping system	0.830	1	0.362	NS	Accept Ho
Access to credit facilities	8.077	1	0.04	S	Reject Ho
Access to extension services	6.201	1	0.013	S	Reject Ho

than their counterparts with smaller farm size. This is also in agreement with Ayanwuyi et al. (2010), where it was found out that farm size was significantly related to farmers' adaptation strategies. It however negates that of Nyangena (2007) who posited that farmers with a small area of land are more likely to invest in soil conservation than those with a large area. There is no significant relationship between farming experience and farmers adaptation strategies ($r=0.070$; $p>0.05$). This may be attributed to the lack of relationship between age and level of adaptation strategies. It implies that farming experience is not important to adaptation strategies of respondents.

Table 3 is a presentation of chi-square analyses of relationship between respondents' sex, marital status, level of education, cropping system, access to credit facilities and access to extension contact. There is no significant relationship between respondents' sex and the adaptation strategies they employed. This negates the reports that male are often given greater priorities than female in terms of their access to credit facilities, land tenure system and training of farmers (FAO, 2001). It however agrees with Apata et al. (2009) which established no significant relationship between sex and farmers' adaptation strategies.

Marital status is also not significantly related to respondents adaptation strategies ($\chi^2=2.005$; $p>0.5$). The level of education has no significant relationship with adaptation strategies of the farmers. This agrees with Clay et al. (1998) who found that education was an insignificant determinant of adoption decisions. It however disagrees with Ayanwuyi et al. (2010), where they found the educational level of respondents to be significantly related to farmer adaptation strategies. The level of education may not be an important factor since agricultural extension services are available and provides information to farmers from different sources accessible by majority of the illiterate farmers.

Other sources of information were also being used for disseminating information across to the farmers, and this may be more important than formal education that may not really have direct bearing with formal education.

The cropping systems investigated by this study were mono-cropping and intercropping. There is a significant relationship between the practice and non-practice of mono-cropping system and the adaptation strategies ($\chi^2=14.213$; $p=<0.05$) of the respondents. The reason may be due to the desire to reduce the risk of loss that could be associated with mono-cropping system, and to compensate for the lack of cover crops which may help conserve moisture, especially, during the period of high temperature. However, intercropping system did not show any significant relationship with the adaptation strategies ($\chi^2=0.830$; $p=0.362$) of the farmers. The availability of cover crops which help to reduce water loss and nutrient loss to erosion and leaching may be one of the reasons.

Access to credit facilities and extension contacts by the respondents show a significant relationship with farmers' adaptation strategies to climate change at the respective χ^2 values of 8.077 and 6.201, with p-values of 0.04 and 0.013. These findings agree with Apata et al. (2009) which established a significant relationship between access to credit facilities and extension contacts with farmers' level of adaptation strategies.

Extension education was also found to be an important factor motivating increased intensity of use of specific soil and water conservation practices (Traoré et al., 1998; De

Table 4. PPMC analysis of the relationship between respondents awareness to climate change and adaptation strategies.

Variable	R	P	Remark	Decision
Awareness	0.199	0.012	S	Reject Ho
Information	0.205	0.009	S	Reject Ho
Constraints	-0.228	0.004	S	Reject Ho
Perception	0.319	0.000	S	Reject Ho

Harrera and Sain, 1999; Baidu-Forson, 1999; Bekele and Drake, 2003; Tizale, 2007).

Results of Ho2 *Relationship between respondents' non-socio-economic variables and climate change adaptation strategies in the study area*

Results of Ho2 (Table 4) also shows that there is a significant relationship between farmers sources of information and adaptation strategies to climate change ($r=0.205$; $p<0.05$). This result is in agreement with Kandlinkar and Risbey (2000) and Jones (2003) that the availability of better climate and agricultural information helps farmers make comparative decisions among alternative crop management practices and hence choose those that enable them cope better with changes in climate.

Awareness of the problem and potential benefits of taking action is another important determinant of adoption of agricultural technologies. Maddison (2007) found that farmers' awareness of changes in climate attributes (temperature and precipitation) is important for adaptation decision making. Several studies have found that farmers' awareness and perceptions of soil erosion problems positively and significantly affected their decisions to adopt soil conservation measures (Gould et al., 1989; Araya and Adjaye, 2001) associated with these changes.

The result of Ho3 (Table 4) shows that there is a significant relationship between respondents awareness and their adaptation strategies to climate change ($r=0.199$; $p<0.05$). The result is an indication that awareness is an important factor in the determination of climate change adaptation strategies farmers employ to improve food production. Hence, the more an individual is aware of climate change effects, the higher the likelihood of such to be proactive towards it.

The result of Ho4 (Table 4) shows a significant relationship between farmers' perception of climate change and their adaptation strategies ($r=0.228$; $p<0.05$). The implication is that farmers who unfavourably perceived effects of climate change will likely put up measures to adapt to these changes. It agrees with Hassan and Nhemachena (2008) that perception is an important factor influencing adoption.

Testing Ho5 (Table 4), the study also establishes that there is a significant relationship between food crop farmers' constraints to adaptation to climate change and their adaptation strategies ($r=-0.228$; $p<0.05$). The implication here is that farmers who are constrained one way or the other in their approaches to adapting to climate change effects are more unlikely to adapt as much as others who may be at an advantage. Kulukusuriya and Mendelsohn (2006) posited that lack of credit facilities and enabling environment for farmers will impede farmers' adaptive behaviours to climate change.

Results of Ho6: Key determinants of farmers adaptation strategies

Table 5 shows the contributions of various correlates of adaptation strategies of respondents. The result shows that on the over all, the covariates contribute about 26% of the adaptation strategies of the respondents, showing that the over-all contribution was significant at 5% level. The regression result (Table 3) goes further to show individual contribution of these correlates to the dependent variable. It reveals that of all the correlates, farm size ($\beta=0.259$) of respondents contributed highest to their adaptation strategies, followed by their perception of climate change and its effects ($\beta=0.257$). However, extension contacts ($\beta=0.028$) and access to credit facilities ($\beta=0.043$). This underlines the significance of the behavioural and economic factors in influencing adoption decisions and adaptive capacities of farmers.

Conclusion

It becomes imperative to conclude from the outcome of this study that since adaptation strategies to climate change can vary from place to place, factors affecting these strategies also vary. Based on the outcome of this study, owing to the low income status of the respondents, provision of credit facilities is an important tool for equipping food crop farmers against climate change effects. Also, the rural nature of the Oke-Ogun area of Oyo State, with many of the farmers having their farms located miles away from their homes, may have limited their access to extension services. However, the few respondents who have limited access to these services have benefited in terms of enhanced adaptive capacities

Table 5. Contribution of correlates to the level of climate change adaptation strategies of respondents.

Variable	Standardized co-efficient	T	P
Constants		2.804	.006
Information	0.135	1.746	.083
Perception	0.257	3.296	.001
Constraints	-0.188	-2.573	.011
Awareness	0.082	1.077	.283
Mono-cropping	0.189	2.579	.011
Access to credit facilities	0.043	0.555	.579
Access to extension contacts	0.028	0.365	.715
Farm size	0.259	3.620	.000

R^2 = 26.4% adjusted R^2 = 22.5%. $Y = a + 0.135X_1 + 0.257X_2 + 0.19X_3 + 0.082X_4 - 0.19X_5 – 0.04X_6 + 0.03X_7 + 0.259X_8$.

towards climate change effects on the production of food crops.

The study also concludes that food crop farmers' exposure to information, level of awareness to climate change as well as their perception of climate change and effects influenced their levels of adaptation strategies. This underlines and emphasizes the importance of information at effecting behavioural changes in people. It is however worthy of note that food crop farmers were being faced with different constraints which significantly reduced their adaptation strategies. The study finally concludes that both economic and behavioural factors interplay to determine the level of adaptation strategies, the food crop farmers in the area adopt against climate change effects. The following recommendations are therefore important:

1. Agricultural extension activities should place more emphasis on passing across information on adaptation strategies to climate change effects, and as a matter of fact, more extension agents should be recruited so as increase the number of food crop farmers covered in the process of disseminating agricultural innovation, and more importantly, climate change adaptation related information;.
2. Food crop farmers in Oke-Ogun area of Oyo State should form themselves into cooperative groups, so as to be able to access funds needed for adequate response to climate change effects.
3. Information on developing appropriate measures for climate change adaptation should be more intensified and more importantly, spread through different communication channels that can be easily accessed by the illiterate rural farmers. This is expected to induce behavioural change in the farmers, all things being equal.
4. Government should create enabling environments like provision of irrigation and credit facilities, as these will enhance the capacities of the rural poor farmers towards reducing the effects of climate change to the barest minimum.

Conflict of interest

The authors hereby declare that no conflict of interest exists among them.

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