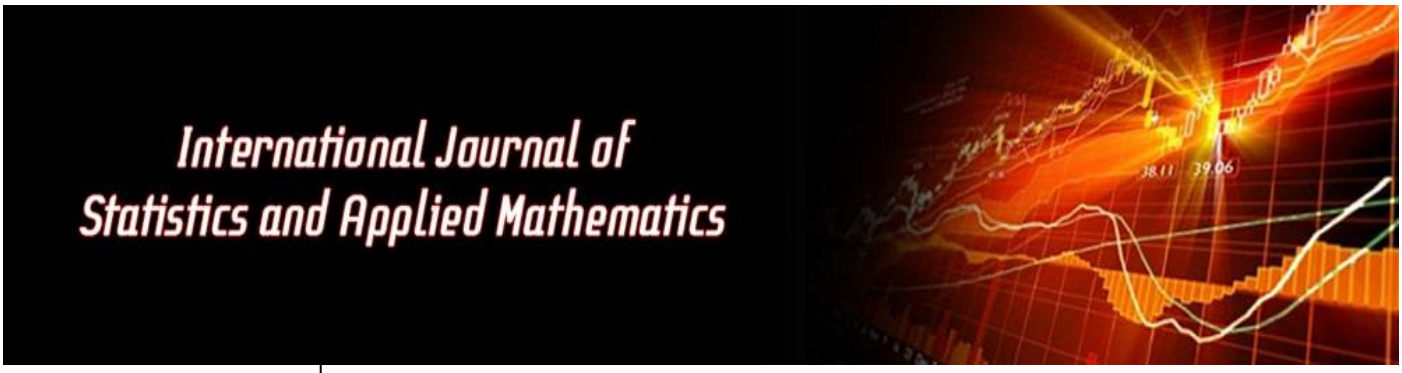
International Journal of Statistics and Applied Mathematics 2023; SP-8(5): 1075-1079



ISSN: 2456-1452
Maths 2023; SP-8(5): 1075-1079

https://www.mathsjournal.com
Received: 16-07-2023
Accepted: 20-08-2023

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Climate Change Adaption and Socioeconomic Dynamics in Vidarbha, India: A Regression Approach

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Abstract
Climate change poses global challenges, with countries like India particularly vulnerable due to their large populations and heavy dependence on agriculture. This study focuses on the socioeconomic conditions of sampled farmers and their capacity to adapt to climate change. The multiple regression model was applied to set relationship between individual's choice of adopting particular adaptation measures and factors influencing to adopt that measure. Factors such as climate change awareness, landholding size, cropping patterns, and institutional support significantly influence adaptation levels, while education and landholding size also contribute to variations in adaptation. Remarkably, age does not impact adaptation significantly. These findings emphasize the significance of education, resource access, and climate awareness in enhancing farmers' adaptive abilities. These insights can guide policies and interventions aimed at bolstering the resilience of agricultural communities in the face of evolving environmental conditions.

Keywords: Climate change, socioeconomic, level of adaptation, and Regression Analysis etc.

Introduction
Climate is the long-term average of daily weather conditions over a thirty-day period. The climate of a specific area is assessed by studying the consistent variations in temperature, humidity, precipitation, atmospheric pressure, and other meteorological factors in that region over extended time frames. This differs from weather, which only refers to short-term conditions in a given area.

Agriculture contributes to climate change both through human-generated emissions of greenhouse gases and by converting forests into farmland. Climate change impacts are observable worldwide, but countries like India, with their large populations and heavy reliance on agriculture, are especially susceptible. Climate change has significant economic ramifications for agriculture, affecting farm productivity, cropping patterns, profitability, prices, supply, and trade. The ever-changing climate poses significant challenges for many marginalized and small-scale farmers.

The International Panel on Climate Change's 2014 report predicts global temperature increases of 0.3 to 4.8 degrees Celsius and sea-level rises of up to 82 cm by the late 21st century due to ice melt and warming-induced water expansion. As climate influences various aspects of plant and animal biology, changes in climatic elements and extremes significantly impact agricultural productivity. These disruptions to the ecological balance can have adverse socio-economic effects, especially in developing nations like India, where agriculture contributes nearly a quarter of the GDP and supports half of the population.

Global warming is expected to lead to additional regional and global climate-related changes, such as alterations in rainfall, soil moisture, and sea levels. Climate change also threatens agricultural biodiversity, thereby endangering national food security.

Adaptation to climate change is influenced by socio-economic status and connections to various institutions. Identifying the socio-economic factors that determine adaptation choices can help formulate more effective climate change policies. Furthermore, while certain choices may be effective in the short term, they might prove unsustainable in the long run. Thus, it is essential to identify short-term strategies and develop them into sustainable alternatives. The.

study analyzed farmers' adoption characteristics and examined their relationship with the level of adaptation.

Methodology

The study took place in nine villages across three distinct blocks in the Chandrapur district. A sample of 120 farmers with varying landholdings was carefully chosen. The selection of primary sampling units involved a multi-stage random sampling approach, as depicted in Table 1. This approach encompassed the selection of blocks, villages within each block, and then the identification of respondent farmers, resulting in a total sample size of 120.

Table 1: Sampling Design

State	District	Block	Village	No. of Farmers
Maharashtra	Chardrapur	Warora	Wadadha	13
			Ralegaon	13
			Shegaon	14
		Chimur	Khadsnagi	13
			Bhisi	13
			Hirapur	14
		Pombhurna	Dewada kh	13
			Jamkhurd	13
			Wadoli	14
			Total	120

Data was gathered through direct interviews with each farmer, and their responses were meticulously recorded in a structured survey questionnaire. An interview schedule was employed to collect the necessary information for the study.

In line with the study's stated objectives, various statistical models including functional and tabular analyses were employed to analyse the collected data. Initial objectives were met through the use of simple statistical techniques, such as calculating averages and percentages. The second objective was analysed by using Multiple Linear Regression.

Multiple Regression Model

The multiple regression model attempts to set relationship between individual's choice of adopting particular adaptation measures and factors influencing to adopt that measure. To describe the multiple regression model, let Y_i be a random variable representing the adoption index of adaptation measures chosen by particular farmer. Each farmer has a set of adaptation measures which are influenced by factors such as awareness about climate change, land holding, institutional support, cropping pattern and assets of farmers. These factors are explanatory variable which are represented by X_j.

$$Y_{i=}\beta_0+\beta_1X_1+ \beta_2X_2+\ldots\ldots. +\beta_jX_j$$

Where

j=0,1,2,…..n

Where, β_j is the vector of coefficients on each of the independent variables.

The independent variables are

X_1=Farmer's Age

X_2=Total Land holdings

X_3= Farmer's education

Results

Socioeconomic characteristics of sampled farmers

Socioeconomic characteristic plays an important role while adopting strategies to combat adverse impact of climate change. Indicators like age, education, land holdings influence the decisions of adopter. The adoption of adaptation measures to climate change vary with age, education level and amount of land holdings.

Age

The age of farmer is key factor in the adoption of adaptation measures. Respondent farmers are grouped according to their age in four categories (Table 2). Farmers in the age group of below 30 years' age are younger, innovative and risk bearer. The age group of farmers between the ages of 31-40 is moderate risk bearer. They adopt the practices after seeing its actual results from other farmers and emulate them. The age group of farmers of 41-50 years is late adopter and they are more sceptical. Farmers above 50 years old are laggards and averse to take risk. Out of the sample of 120 farmers, maximum number (40%) of farmers are found in the age group of above 50 years followed by in the age group of 41-50. There are only 9% and 13% farmers in the age group of below 31 and between 31-40 respectively. So there is less number of farmers in the young age group (21-40) as compared to old age group. The average age of farmer is computed as 48.66, the youngest one being 25 years of age and oldest is 70 years of age. Though age of respondent plays an important role in determining the adoption level but it is not the single factor. Others factors like Education level and land holdings which are discussed later in this chapter.

Table 2: Age profile of sampled farmers

S.N.	Block	Age				
		<31	31-40	41-50	>50	Total
1	Warora	07	00	13	20	40
2	Chimur	04	12	10	14	40
3	Pombhurna	00	04	22	14	40
	Total	11 (9%)	16 (13.33%)	45 (37.77%)	48 (40%)	120 (100%)

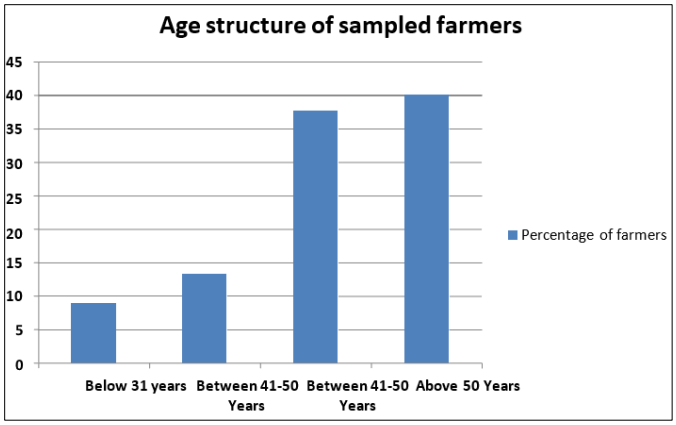

Fig 1: Age profile of sampled farmer

Education

Education level of respondent is reflection of his awareness about climate change. Education level of the farmer plays an important role in determining the adoption level. Farmers with higher education adopt more adaptation strategies than less educated ones. So there is positive correlation between the level of education and level of adaptation to climate change. Education helps in making decisions regarding the measures to adapt to climate change. Out of 120 sampled farmers, maximum numbers of farmers were found in primary or elementary level of education and with education up to intermediate level (Fig. 2). Nearly 50% of total farmers were found in these categories. About 18% of total farmers were

that they did not any formal education. Very less number of farmers are graduated or post graduated (13%). Farmers having education up to high school level are 20% of total farmers. So majority of farmers wre moderately educated i.e. up to high school. Nearly same scenario was found in all three blocks.

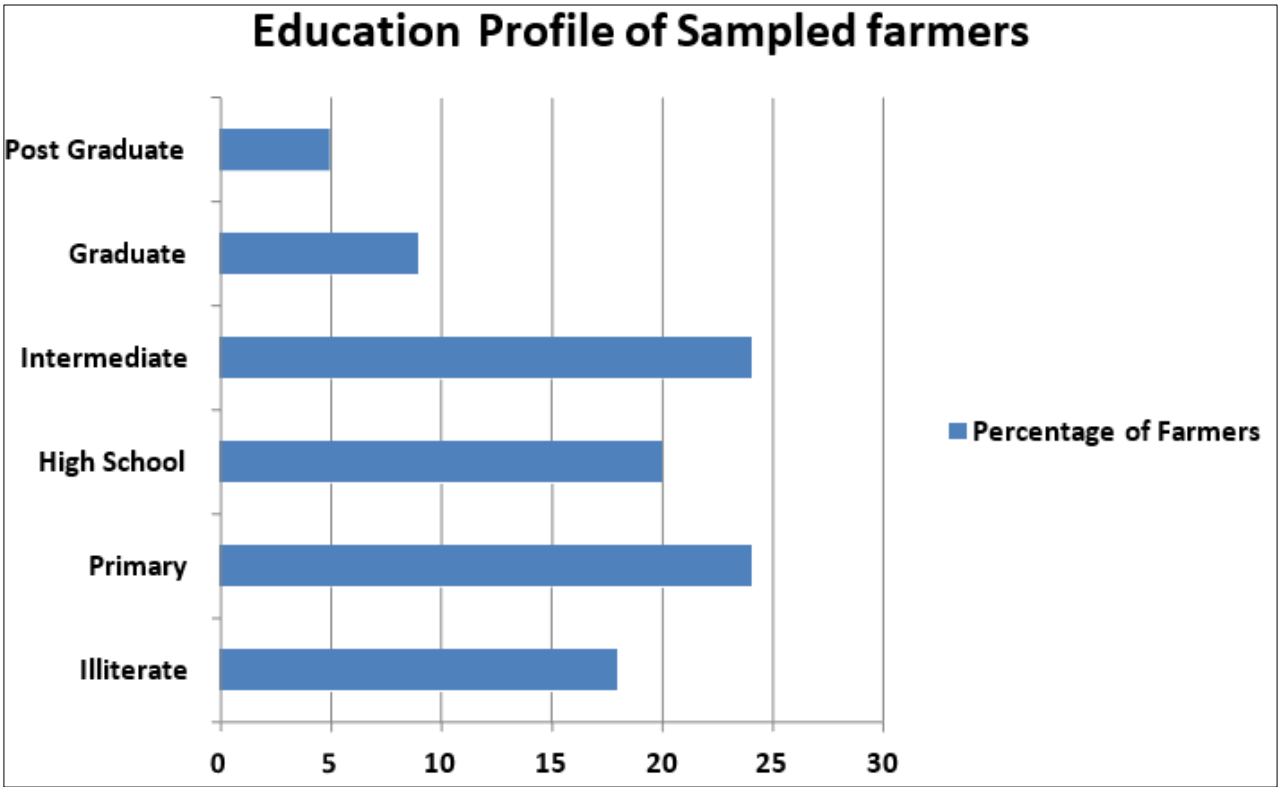

Fig 2: Education profile of sampled farmers

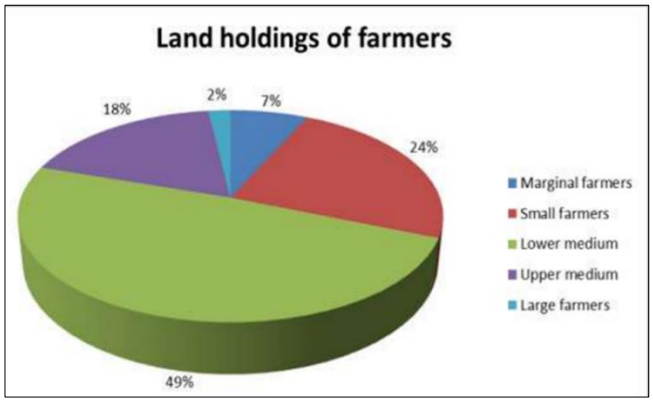

Fig 3: Size of Landholding

Fig 4: Farming experience of respondent

Land holdings

The farmers are classified into four different categories according to land holdings. These categories are standardized by agriculture census data of 2015-16. Out of 120 sampled farmers, there were 48.88% farmers fall into lower medium category followed by 25% small farmers. Only 7% of total farmers were marginal farmers and 2.22% were large farmers. Average size of land holding is 8.68 acre.

Farming Experience:

Farmers having more farming experience are known about possible effects of particular farm practices. They tend to adopt or reject the particular adaptation measures by applying their previous experience. Out of 120 sampled farmers, 31% farmers had farming experience between 21 to 30 years. There were 29% of total farmers having more than 30 years of farming experience. Only 11% of total farmer having less than 5 years of farming experience. (Fig.4)

Source of Technical Information:

All the farmers do not have technical knowledge of agriculture. They take advise from the government personnel of agriculture department, krishi kendra operators, cooperative groups, Krishi Vigyan Kendra(KVK), radio and newspaper, etc. From the table 6. it is clear that majority i.e. 42% of total sampled farmers wre technically advised by krishi Kendra operators followed by radio programmes and newspaper. Only 25% of farmers visited KVK and government's agricultural personnel.

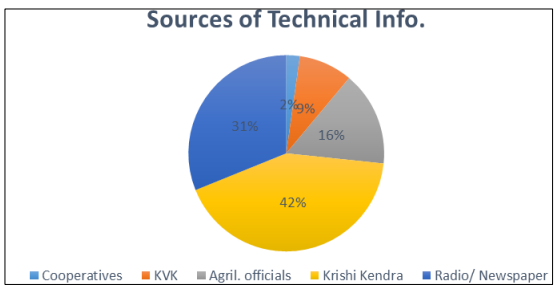

Fig 5: Sources of Technical Information

Sources of Credit

Timely availability of credit encourages farmer to buy inputs, such as fertilizer, improved crop varieties, installing irrigation facilities, purchasing of farm implements, paying wages to labours, land improvement measures, etc. Thus, there is a strong relationship between the level of adaptation to climate change and the availability of credit. The credit requirement of farmers is fulfilled by different sources such as formal and informal credit sources. Formal sources include all the institutional sources such as commercial banks, cooperative banks, primary agricultural credit societies and RRBs. Informal sources include moneylenders, friends and relatives. Out of 120 sampled farmers, 80% of farmers access to institutional credit sources such as commercial banks, RRBs and cooperative societies. (Table 7)

Table 3: Sources of Credit

S. N.	Type of Farmer	Institutional (%)	Non-institutional (%)
1	Marginal	00	100
2	Small	90	10
3	Medium	84	16
4	Large	100	00
5	Total	80	20

Relationship between adaptation level and socio economic characteristics of farmer

To examine the relationship between adaptation level of farmers and their personal characteristics such as age, education level and land holdings, Multiple regression analysis was used. The level of adaptation of farmer to climate change is the degree of adoption of adaptation measures by farmer which is measured by collective adoption index for each is farmer. It is calculated by taking average of the responses of farmers regarding adaptation measures in the form of dummy variable (0 or 1).The results of this analysis is discussed below.

Table 4: Regression statistics of adaptation level and socioeconomic characteristics

Regression Statistics	Value
Multiple R	0.894063
R Square	0.686445
Adjusted R Square	0.6232457
Standard Error	0.429619
Observations	120

From the above table it is clear that Coefficient of determination (R^2) is 0.69 (Table 5). It means that the personal factors such as age, education level and land holdings contributes 69%change in adoption index or adaptation level. All others factor cause remaining 31% change in adaptation level or adoption index. So these personal characteristics cause significant change in adaptation level of farmer. The actual change in adoption index caused by individual factor is discussed in table 5.

Table 5: Relationship between adaptation level and Socioeconomic characteristics

Variable	Coefficients	Standard Error	P-value
Intercept	0.517803	0.368094	0.167047
Age	0.65489	0.006271	0.383023
Education	0.58676	0.043271	0.048065
Total Landholding	0.26054	0.013746	0.046525

Discussion

From the above table, it is concluded that factors such as level of education and landholdings of farmer cause significant change in the adoption level. Age of farmer does not have any significant impact on the adaptation level of farmer.

Age: The more experienced farmers are more inclined to adopt climate change adaptation measures, because experienced farmers have better risk bearing ability and can make well decisions regarding adaptation. The positive coefficient indicates that there is direct relationship between age of respondent farmer and his adaptation level to climate change. Similar results had been found by the study done by Maddison (2007) [3] and Nhemachena and Hassan (2007) which showed positive relationship between age and adaptation to climate change. So, it can be concluded that older farmers with more farming experience tend to be more aware of past climate events and can decide how to adapt their farming to extreme changing climate events.

Education level of farmer: Educated farmers have more knowledge, can easily understand and respond to anticipated changes, are better able to forecast future scenarios and have greater access to information and opportunities than others, which may incentivize them for adapting to climate change. The highly significant coefficient of education of the respondent farmer revealed that the probability of adapting to climate changes increases with an increase in the years of schooling

Table 5). There is positive relation between level of education and level of adaptation. Similar results have been found (Maddison 2007) [3] between education of farmer and adaptation to climate change in other studies as well.

Size of landholdings: Farmers having more land under cultivation seems to have more capacity to try out and invest in adaptation strategies. The size of landholding is positively related with change in adaptation level because they will use more part of their land for trying out various adaptation measures. Larger farm size leads to use of other innovative technologies which are more expensive. The significant positive relationship between size of land holding and adaptation level indicates increase in adoption of innovative adaptation measures either increase in land holdings. The various studies (Langyintuo and Mungoma 2008; Vijayasarthi and Ashok 2015) showed that household with larger size of land holding may be more willing to adapt technologies that require high cost of installation.

Summary

Climate change is one of the major challenges before world. Many studies had been conducted to measure socio economics characteristics and their relation with level of adaptation to climate change. The data was collected by using multistage sampling technique and analyzed by using Multiple Linear Regression. these were the findings leveled as objective wise:

Major findings of the study area

Socioeconomic condition of sampled farmers

- The study revealed that average age of farmer is 48.66 years, the youngest being of 25 years and oldest being of 70 years.

- Education level of farmers shows that more than 65% of farmers are educated from primary to intermediate level and 18%farmers are uneducated.
- The study revealed that about 67% of farmers are medium farmers followed by 24% small farmers. An average size of land holding is 8.68 acre with the maximum is 30 acre and minimum is 2 acre.
- There are about 60% farmers having farming experience more than 20 years. Only 11% farmers have farming experience less than 10 years.
- The study concluded that about 42% farmers are advised on technical information of farming by Krishi Kendra Operators. There are 31% farmers still using radio and newspaper for technical information about farming.
- The study reveals that about 80% farmers had accessed to institutional credit and remaining 20% farmers had borrowed from non-institutional sources such as moneylenders and relatives.
- Farmer's participation in training activity is low. Only 33% farmers had participated in training activities, 55%farmers had insured their crops, 51% farmers had subscribed to weather information services and 64% farmers had joined any formal group or organization. Small farmers had maximum participation in these activities.

To examine relationship between Adaptation level and Socioeconomic Characteristics

Factors such as awareness about climate change, size of land holding, cropping pattern and institutional support have significant influence on the level of adaptation of farmer.

Socioeconomic factors such as level of education and landholdings of farmer cause significant change in the adoption level. Age of farmer does not have any significant impact on the adaptation level of farmer.

Conclusion

In conclusion, the study provides insights into the socioeconomic conditions of the sampled farmers and their level of adaptation to climate change. It is evident that factors such as awareness about climate change, landholding size, cropping patterns, and institutional support play a significant role in influencing farmers' adaptation levels. Socioeconomic factors, particularly education and landholding size, also contribute to variations in adaptation levels. Interestingly, the age of the farmer does not appear to have a significant impact on their adaptation level.

Overall, the findings underscore the importance of education, access to resources, and awareness in enhancing farmers' ability to adapt to climate change. These insights can inform policy and intervention strategies aimed at improving the resilience of agricultural communities in the face of changing environmental conditions.

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