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RESEARCH ARTICLE

Implications of Farmer's Adaptation Strategies to Climate Change in Agricultural Sector of Gujarat: Experience from Farm Level Data

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Abstract: This study examined the farmer's perception on climate change and adaptation strategies to mitigate the adverse effect of climate change in the agricultural sector of Gujarat. It used farm level information of 400 farmers who were purposely selected from 8 districts. Thereupon, linear, non-linear and log-linear production function models were used to examine the impact of climate change, farmer's adaptation strategies and technological change on agricultural production in Gujarat. The descriptive and empirical results specify that adaptation strategies (i.e., change in showing time of crops, mixed cropping pattern, irrigation facilities, application of green and organic fertilizer, hybrid varieties of seeds, dampening of seed before planting, climate tolerate crops, organic farming and technology) have a positive impact on agricultural production. Thus, farmer's adaptation strategies are useful to mitigate the negative impact of climate change in the agricultural sector. Maximum temperature and minimum temperature, precipitation and rainfall have a negative impact on agricultural production. However, the impact of these factors seemed positive in the agricultural sector when farmers apply aforementioned adaptation strategies in cultivation. Family size, education level of farmers, annual income of farmers, arable land, irrigated area, cost of technology, appropriate technology and financial support from government have a positive contribution to increase agricultural production in Gujarat.

Keywords: Adaptation strategies; Agricultural sector; Technology; Climate change; Gujarat; India; Mitigation approach

1. Introduction

Climate change has been increased the high uncertainty in production and vulnerability in the agricultural sector world-wide [1-3]. Recently, climate change has been observed in terms of rising minimum and maximum temperature, and change in rainfall pattern and precipitation [1,2,4,5]. High fluctuation in floods, droughts and natural disasters clearly show that climatic factors are changing due to anthropogenic and natural activities at global level [5,6]. It is likely to be expected that the impact of climate change will be more on socio-economic development and production activities of the agricultural sector in most developing

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counties including India. Climate change would be caused to increase the vulnerability of 60% of the population who depend upon the agricultural sector in India [2,5]. There are many reasons which would increase high vulnerability for agricultural sector due to large dependency of population on agricultural sector; large dependency of sugarcane, oilseed and textile industries on agricultural sector in India [5]. India is located at low latitude and it has small size of land holdings with low economic capacity of farmers who are unable to maintain their income due to climate change. There exists high illiteracy of farmers, ineffective mechanism of government policies towards climate change, low technological upgradation of farmers and ineffective supports from agricultural extension services in India [5,7,8]. Subsequently, climate change will create several obstacles to increase sustainability in production and yield, food and health security, farmers' income and trust in farming, price stability, rural development, and socio-economic development of farming and non-farming communities in India [2,9,10]. Also, poverty, income inequality, food insecurity, nutritional insecurity and hunger may increase due to climate change in India [2,9,10]. Therefore, it would be a major challenge for agronomists, agricultural scientists and policy makers to implement an effective plan to increase agricultural sustainability in the presence of climate change and changing socio-economic activities of the people in India [10,11].

Agriculture sector is useful to ensure food security, nutritional security and poverty alleviation in India [5,8]. It is useful to generate employment for a large segment of society [5]. Agriculture sector also provides the raw material for several agriculture industries. Thus, it is useful to increase industrial growth and economic development. It also provides fodder for livestock which meet the requirement of milk and raw material for dairy based industries in India. Moreover, the agricultural sector is useful to produce surplus labour for the industries, provide the raw material for the agriculture industries, generate revenue for the government as a tax and foreign currency, create capital assets and develop rural infrastructure. Most specifically, in India, agricultural sector is useful to: meet the food requirement of present and growing population; provide jobs to large segment of society and increase the exports of many products such as tea, sugar, jute, coffee, etc. [5,12]. India is also a main producer of several crops in the world. For example, it is the largest producer of milk, jute; second largest in wheat, rice, groundnut, vegetables, fruits, sugar cane, and potatoes, onion; third in tea, rapeseed and tobacco production in the world. Agriculture and allied sectors are the mainstay of the Indian economy. This sector also creates the demand for many industrial products such as fertilizers, pesticides, agricultural instruments and machines. India has a first position in total pulses, jute, buffaloes and milk production in the world. India also has a 2nd position in arable land, total cultivated land and participation of economic active population in agriculture. India is a major producer of wheat, rice, groundnut, vegetables & melons, fruits (excluding melons), potatoes, onion (dry), sugarcane, cotton, cattle, and goats in the world. India has a 3rd position in many agricultural products such as total cereals, rapeseed, tea, tobacco leaves, sheep, and eggs production. India has a 5th position in chicken which meets the nutritional security of most of the population. India also has a 7th position in coffee (green) production in the world. It is also the 2nd largest producer of flowers after China. It is also a leading producer, consumer and exporter for spices and plantation crops like tea and coffee at global level.

In India, the agricultural sector has a significant contribution to increasing sustainable livelihood security of farming and non-farming communities. However, climate change is causing a high vulnerability for the Indian agricultural sector. In this regard, existing studies estimated the impact of climate change in the Indian agricultural sector in several ways. Most studies have focused to examine the climate change impact on production and yield of food-grain and commercial crops in India [1,5,8,11-30]. Other studies also assessed the influence of climatic and non-climatic factors on productivity and performance of agricultural sector in India [31-38]. Few studies examined the association of climate vulnerability with farmer's suicides; climate change and human health; and agricultural practices and ecosystem services in India [2,9,39]. Some studies have also assessed the role of organic farming in the agricultural sector [40,41]. Existing researchers also observed the farmer's perception and natural disaster, and mitigation approach in the Indian agricultural sector [42-45]. Some studies have examined the importance of organic farming and credit facilities in Indian agricultural sector [46-51]. Descriptive and empirical findings of aforesaid studies concluded that production and yield of food-grain and cash crops, agricultural productivity are expected to decline due to climate change in India. Therefore, it is necessary to apply technological advancement which can be effective to mitigate the negative impact of climate change in the agricultural sector [6]. Also, more practises of agricultural technology will work as an effective adaptation strategy toward climate change in Indian farming. Technological applications such as biotechnological tools and heat tolerance crops will be also useful to mitigate the negative consequences of climate change in farming.

Previous studies have used different proxy variables to capture the influence of technological change in agricultural sector using time series, panel data and cross-sectional data [1,5,7,8,12,19,27,30,52]. However, limited studies could examine the impact of technological change on Indian agriculture using farm level data. Furthermore, there are many socio-economic variables which may have a positive impact on agricultural production. These variables may be used as adaptation strategies to mitigate the climate change impact in the agricultural sector of India and other economies [1,3,6,53-55]. Few studies assessed the role of social-economic factors and climatic factors in agricultural sustainability in Indian states [10]. As previous studies have been argued that technology and specific characteristics of farmers can be considered as adaptation strategies to climate change in the agricultural sector. Though, limited studies could assess the significance of technology and farmer's socio-economic variables in the Indian agricultural sector [42-44,52]. Hence, this study has a significant contribution to the existing literature which examines the impact of climate change and farmer's socio-economic profile on agricultural production in Gujarat using a farm level data of 400 farmers. Accordingly, this study assessed the answers on the following research questions:

- What is the farmer's perception towards climate change and adaptation strategies in the agricultural sector?
- What is the influence of climatic factors and farmer's adaptation strategies on agricultural production of Gujarat?
- How farmer's adaptation strategies may be used to mitigate the negative impact of climate change in the agricultural sector of Gujarat?
- What may be the role of technology to mitigate the adverse impact of climate change in the agricultural sector of Gujarat?
- What may be the policy initiatives to mitigate the negative consequences of climate change in the agricultural sector of Gujarat?

With regards to aforesaid research questions, this study achieved following objectives:

- To examine the farmers' perception on climate change and adaptation strategies in context of agricultural sector of Gujarat.
- To assess the impact of climate change, farmer's adaptation strategies and technological change on agricultural production in Gujarat.
- To provide the practical approaches to mitigate the negative consequences of climate change in agricultural sector of Gujarat.

2. Research Methods and Materials

2.1 Study Area and Sources of Data

This study comprises the farm level information which was composed through personal interviews of 400 farmers from 8 districts (i.e., Anand, Banas Kantha, Bhavnagar, Junagadh, Kheda, Surat and Vadodara) of Gujarat. These districts were selected based on their percentage share in agricultural labourers, agricultural district domestic product, gross cropped area and net sown area in Gujarat. These districts also occupied more than 30% cropped area and production of wheat, rice, jowar, bajra, arhar, rapeseed & mustard, sugarcane and potato crops in Gujarat. Two blocks from each district were selected randomly and one village from each block was chosen purposively. Thus, 16 villages were considered in this study. Thereafter, 25 farmers from each village were identified randomly for a personal interview. Total 400 farmers were interviewed, however, only 240 respondents could provide the completed information. A structural questionnaire was used to collect the relevant information from the farmers. The interview of farmers was conducted from 01 October 2019 to 31 December 2019. Information of climatic factors was derived from the India Meteorological Department (IMD), Ministry of Earth Sciences (Government of India (GoI)) and website of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Farm harvest price of each crop was taken from the Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Famers Welfare (GoI).

2.2 Formulation of Empirical Model

Existing studied have been used different variables like production and yield of individual crop, aggregate production of food-grain and cash crops, agricultural production and productivity (monetary value) as dependent variables to examine their association with climatic and non-climatic variables in India [13,15-18,21-23,26,28,30,35,36]. Thus, agricultural production (in monetary terms) of all crops was used as a dependent variable in this study. Monetary value of production of each crop (that was cultivated by farmers during survey year) was estimated based on farm harvest prices.

Agricultural production is significantly associated with several climatic factors such as rainfall, wind speed, CO_2 concentration, precipitation, maximum and minimum temperature, actual evapotranspiration, solar radiation, solar intensity, water availability, soil moisture and relative humidity [4,14-17,20,21,24,26,28,31,33-35,56]. Hence, coefficient variation in actual annual evapotranspiration, annual average maximum temperature, annual average minimum temperature and annual average precipitation during 1991-2015 were used as climatic factors in this study. Kumar et al. [12] also used coefficient variation in maximum temperature, minimum temperature and rainfall in empirical models.

Age, family members, education level, annual income of farmer, agricultural land, irrigated area, agricultural labour, application of fertilizer, gender of farmers and main occupation of farmers have significant contribution in the agricultural sector [6,12,19,27,32,34,36,57,58]. Accordingly, these variables also can be used as adaptation strategies to mitigate the climate change impact in the agricultural sector [53-55,59]. Financial support for farmers from the government to buy new technology or inputs was also used to examine the impact of government policies on agricultural production. Therefore, aforesaid variables were used as agricultural inputs in this study.

A technology has several usages in the agricultural sector. Therefore, it is difficult to examine the impact of technology on the agricultural sector. Previous studies have used different variables such as irrigated area, fertilizers and others to capture the impact of technological change in the agricultural sector. Furthermore, few studies also used time trend factors to examine the influence of technological change in the agricultural sector [5,7,8,12,27]. Hence, in this study the cost of technology was used to capture the impact of technological change in agricultural production. While, it measures as an aggregate cost of technology which was used by farmers to grow various crops. Also, farmer's perception on appropriate technology was included to capture the influence of technological change in agricultural sector. Thus, cost of technology and appropriate technology was considered as independent variables in this study. Moreover, farmers were used several adaptation strategies (e.g., late sowing of crops, more irrigation, high yielding of seed, mixed cropping pattern, wetting of seed before planting, use of green fertilizer, used of climate tolerate crops, increasing intensity of inputs, and use of technology, etc.) to mitigate the negative impact of climate change in cultivation. Thus, this variable was also used an independent variable in the empirical models.

Linear, log-linear and non-linear production function models were used to examine the regression coefficients of aforementioned explanatory variables with agricultural production in this study. Several studies have also used similar regression models to examine the influence of climatic and non-climatic factors on agricultural production in India [5,8,12,19,25,30,36]. Thus, in this study, linear production function model was used in following form:

$$\begin{aligned}(ap)_i = \boldsymbol{\alpha}_0 + \boldsymbol{\alpha}_1 (cvaaea)_i + \boldsymbol{\alpha}_2 (cvaamaxt)_i + \boldsymbol{\alpha}_3 (cvaamint)_i \\ + \boldsymbol{\alpha}_4 (cvaapre)_i + \boldsymbol{\alpha}_5 (cvaarf)_i + \boldsymbol{\alpha}_6 (agre)_i + \boldsymbol{\alpha}_7 (fame)_i \\ + \boldsymbol{\alpha}_8 (edlere)_i + \boldsymbol{\alpha}_9 (aninfa)_i + \boldsymbol{\alpha}_{10} (toagla)_i, + \boldsymbol{\alpha}_{11} (irar)_i \\ + \boldsymbol{\alpha}_{12} (usagla)_i + \boldsymbol{\alpha}_{13} (usfe)_i + \boldsymbol{\alpha}_{14} (cote)_i + \alpha_{15} (gere)_i \\ + \boldsymbol{\alpha}_{16} (maocre)_i + \boldsymbol{\alpha}_{17} (apte)_i + \boldsymbol{\alpha}_{18} (fisugo)_i + \boldsymbol{\alpha}_{19} (adstfa)_i + \boldsymbol{\mu}_i\end{aligned} \quad (1)$$

Here, $\boldsymbol{\alpha}_0$ is constant term; $\boldsymbol{\alpha}_1$, $\boldsymbol{\alpha}_2$, …, $\boldsymbol{\alpha}_{19}$ are the regression coefficient of corresponding explanatory variables; $\boldsymbol{\mu}_i$ is the error-term; and *i* is the cross-sectional farmers (1 to 240) in Equation (1). The explanation of remaining variables is given in Table 1.

Non-linear production function model was useful to identify the long-term association of independent variables with agricultural production [30]. Also, it measures that up to what extent a specific variable has a positive or negative impact on output. Hence, a non-linear production function model was also applied to examine the long-

Table 1. Summary of the variables

Variables	Symbol	Unit
Agricultural production	*ap*	Rs.
Coefficient variation in annual average evapotranspiration	*cvaaea*	mm
Coefficient variation in annual average maximum temperature	*cvaamaxt*	^{0}C
Coefficient variation in annual average minimum temperature	*cvaamint*	^{0}C
Coefficient variation in annual average precipitation	*cvaapre*	mm
Coefficient variation in annual actual rainfall	*cvaarf*	mm
Age of respondents	*agre*	Years
Family members	*fame*	Number
Education level of respondent	*edlere*	Number
Annual income of the family	*aninfa*	Rs.
Total agricultural land	*toagla*	Ha.
Irrigated area	*irar*	Ha.
Use of agricultural labour per Ha.	*usagla*	Number
Use of fertilizer	*usfe*	Kg.
Cost of technology per hectare	*cote*	Rs./Ha.
Gender of respondents [1= male; 0 = female]	*gere*	Number
Main occupation of respondents [1= agriculture; 0= non-agriculture]	*maocre*	Number
Appropriateness of the technologies [1= Appropriate; 0= Inappropriate]	*apte*	Number
Financial support from government to buy new technology or inputs [1 = yes; 0 = No]	*fisugo*	Number
Adaptation strategy of farmers (1=yes; 0 =No)	*adstfa*	Number

Source: Authors' compilation.

term association of explanatory variables with agricultural production in this study. For this, the original and square terms of independent variables were included in non-linear production function model in the following form:

$$\begin{aligned}(ap)_i =&\gamma_0 +\gamma_1 (cvaaea)_i +\gamma_2 (Sq.\ cvaaea)_i +\gamma_3 (cvaamaxt)_i \\ &+\gamma_4 (Sq.\ cvaamaxt)_i +\gamma_5 (cvaamint)_i +\gamma_6 (\text{Sq.}\ cvaamint)_i \\ &+\gamma_7 (cvaapre)_i +\gamma_8 (Sq.\ cvaapre)_i +\gamma_9 (cvaarf)_i +\gamma_{10} (Sq.\ cvaarf)_i \\ &+\gamma_{11} (agre)_i +\gamma_{12} (Sq.\ agre)_i +\gamma_{13} (fame)_i +\gamma_{14} (Sq.\ fame)_i \\ &+\gamma_{15} (edlere)_i +\gamma_{16} (Sq.\ edlere)_i +\gamma_{17} (aninfa)_i +\gamma_{18} (Sq.\ aninfa)_i \\ &+\gamma_{19} (toagla)_i +\gamma_{20} (Sq.\ toagla)_i +\alpha_{21} (irar)_i +\gamma_{22} (Sq.\ irar)_i \\ &+\gamma_{23} (usagla)_i +\gamma_{24} (Sq.\ usagla)_i +\gamma_{25} (usfe)_i +\gamma_{26} (Sq.\ usfe)_i \\ &+\gamma_{27} (cote)_i +\gamma_{28} (Sq.\ cote)_i +\gamma_{29} (gere)_i +\gamma_{30} (maocre)_i \\ &+\gamma_{31} (apte)_i +\gamma_{32} (fisugo)_i +\gamma_{33} (adstfa)_i +¥_i\end{aligned} \quad (2)$$

Here, γ_0 is constant term; *Sq.* is the square term of corresponding variables; γ_1, γ_2, …, γ_{23} are the regression coefficients of corresponding explanatory variables; $¥_i$ is the error-term in Equation (2). Natural *log* of all quantitative variables was also considered for the log-linear production function model in this study. The log-linear production function model was used in following form:

$$\begin{aligned}\log (ap)_i =&\beta_0 +\beta_1 \log (cvaaea)_i +\beta_2 \log (cvaamaxt)_i \\ &+\beta_3 \log (cvaamint)_i +\beta_4 \log (cvaapre)_i \\ &+\beta_5 \log (cvaarf)_i +\beta_6 \log (agre)_i +\beta_7 \log (fame)_i \\ &+\beta_8 \log (edlere)_i +\beta_9 \log (aninfa)_i +\beta_{10} \log (toagla)_i \\ &+\beta_{11} \log (irar)_i +\beta_{12} \log (usagla)_i +\beta_{13} \log (usfe)_i \\ &+\beta_{14} \log (cote)_i +\beta_{15} (gere)_i +\beta_{16} (maocre)_i +\beta_{17} (apte)_i \\ &+\beta_{18} (fisugo)_i +\beta_{19} (adstfa)_i +\lambda_i\end{aligned} \quad (3)$$

Here, β_0 is the constant term; *Sq.* is the square term of corresponding variables; β_1, β_2, …, β_{19} are the regression coefficients of corresponding explanatory variables; λ_i is the error-term in Equation (3).

2.3 Selection of Appropriate Model

This study collects the primary data from the selected farmers. Hence, it was essential to check the validity of data. Previous studies have used Cronbach's Alpha Test to estimate reliability of primary data [60-62]. If the statistical value of Cronbach's Alpha Test is greater than 0.70 for an individual variable, then it has validity. Therefore, statistical values of Cronbach's Alpha Test were estimated for all variables. Thereafter, statistical values of skewness and kurtosis were also estimated for each variable to check the normality. Previous studies have argued that if the statistical values of kurtosis and skewness for a particular variable lie between –1 to +1, then it can be observed that it is in a normal form. Multi-correlation measures the exact linear relationship among the explanatory variables [61]. It may be caused to increase misleading in the regression coefficients. Thus, variance inflation factor (*VIF*) was estimated to identify the existence of multi-correlation among the independent variables. Breusch-Pagan/Cook-Weisberg test was used to identify the presence of heteroskedasticity in the cross-sectional data [63]. As this study used linear, log-linear and non-linear production function models to estimate the regression coefficients of independent variables, thus, Ramsey *RESET* test was used to identify the appropriate function form of the proposed empirical model (8). Akaike information criterion (*AIC*) and Bayesian information criterion (*BIC*) tests were applied to check the consistency of regression coefficients in proposed empirical models [8].

3. Descriptive Results

3.1 Social-economic Profile of the Respondents

Sample size of 240 farmers had the significant diversity in term of gender, age, family size, education level, main occupation, annual income, total agricultural land, irrigated area, use of agricultural labour per hectare, fertilizer application per hectare and cost of technology per hectare (Table 2). The sample included 97.50% males, age of 34.17% respondents were between 30-39 years, 51.67% respondents had the family's size between 4-5 members, 29.58% respondents were graduate, 26.67% respondents were engaged in farming and livestock rearing sector, 32.50% farmers had annual income between INR550001-700000, 50.83% respondents had 0-5 hectare irrigated area and 60.42% respondents used 51-60 agricultural labour per hectare. Around 64.2%, 89.2%, 63.3% and 46.67% respondents have understanding on economic viability, social viability, environmental viability and appropriate technology, respectively. Also, 43.75% respondents received financial support from government and banking sector for cultivation. Only 46.25% respondents were applying practices of adaptation strategies to mitigate the climate change impact in the agricultural sector.

3.2 Explanation of Farmers' Perception on Climate Change and Technology

Based on descriptive results, it was reported that most farmers accepted that agricultural production has declined due to climate change. It was also observed that farmers were applying several adaptation strategies such as change in showing time of crops, more irrigation, application of additional fertilizer, hybrid varieties of seed, wetting of seed before planting, mixed cropping pattern, use of high yielding varieties of seeds, use of green and organic fertilizer, use of technology, use of climate tolerate crop, planting date adjustment, and increasing intensity of inputs in cultivation to mitigate the negative impact of climate change in this sector. Furthermore, as per the farmer's view, application of technology has a crucial contribution to mitigate the negative impact of climate change in the

Table 2. Sample distribution based on characteristics of farmers

Variables	Characteristics	Frequency	%
Gender	Male	234	97.50
	Female	6	2.50
Age (Years)	20 - 29	44	18.33
	30 - 39	82	34.17
	40 - 49	65	27.08
	50 - 59	35	14.58
	60 and above	14	5.83
Family size (Number)	0 - 3	18	7.50
	4- 5	124	51.67
	6 - 8	79	32.92
	9 - 10	12	5.00
	11 and above	7	2.92
Education level	8th Passed	43	17.92
	10th Passed	41	17.08
	12th Passed	46	19.17
	Graduate	71	29.58
	Post graduate	39	16.25
Main occupation	Only farming	157	65.42
	Farming and livestock rearing	64	26.67
	Farming and milk production	12	5.00
	Farming and dairy farming	7	2.92
Annual income of the family (in Rs.)	140000 - 250000	12	5.00
	250001 -350000	22	9.17
	350001 -450000	40	16.67
	450001 -550000	55	22.92
	550001 -700000	78	32.50
	710001 -912000	33	13.75
Total agricultural land (in Ha.)	0 - 6	98	40.83
	7 - 12	68	28.33
	13 - 18	30	12.50
	19 - 25	25	10.42
	26 - 30	19	7.92
Irrigated area (in Ha.)	0 - 5	122	50.83
	6 - 10	69	28.75
	11 - 15	25	10.42
	16 - 20	15	6.25
	21 - 25	9	3.75
Use of agricultural labour per hectare (Number)	40 - 50	60	25.00
	51 - 60	145	60.42
	61 - 78	35	14.58
Fertilizer application per hectare (Kg./Ha)	100 - 150	136	56.67
	151 - 200	168	70.00
	200 - 250	26	10.83
Cost of technology per hectare (Rs./Ha.)	1500 - 2000	18	7.5
	2001 - 2500	84	35
	2501 - 3000	138	57.5
Economic viability	Yes	154	64.2
	No	86	35.8
Social viability	Yes	214	89.2
	No	26	10.8
Environmental viability	Yes	152	63.3
	No	88	36.7
Appropriate of technologies	Yes	112	46.67
	No	128	53.33
Financial support from government and banking sector	Yes	105	43.75
	No	135	56.25
Farmer's adaptation strategy to climate change	Yes	111	46.25
	No	129	53.75

Source: Author's estimation based on farm level information.

agricultural sector. Change in showing date and use of more technology in the agricultural sector work as a better adaptation strategy to mitigate the climate change impact in cultivation [1]. Mixed cropping patterns, soil conservation practices and crop rotation may be better adaptation strategies to cope with climate change in the agricultural sector of Lebanon [3]. Furthermore, technology was effective to increase water conservation, environmental sustainability, farmer's income, social equity and agricultural productivity. It was also found that poor and small-land holders were unable to use technology in cultivation due to small size of land holdings, low economic capacity of farmers to bear the high cost of technology, low skills of farmers, inappropriate financial support from government and banking sector, low association of farmers with various stakeholders (i.e., agricultural entrepreneurs, agricultural universities, agricultural extension offices, agriculture cooperative societies), and insignificant skill and technical support from sellers or agricultural technology creator industries.

3.3 Validity of the Variables

The validity and consistency of individual variables are checked through Cronbach's Alpha test. This test is highly effective to examine the internal consistency of a specific variable or set of variables. The statistical values of Cronbach's Alpha test all variables are given in Table 3. As per the estimated values of Cronbach's Alpha test, the variables can be segregated in six categories i.e., excellent if the value is greater than 0.90; good if the value lie between 0.80 to 0.89; acceptable if the value lie between 0.70 to 0.79; questionable if the value lie between 0.60 to 0.69; poor if the value lie between 0.50 to 0.59; and acceptable if the value is less than 0.49. As per the estimated value of Test Scale is 0.85 and Alpha values for all variables were found more than 0.80 [60-62]. Thus, the estimates show that the selected set of variables have consistency and rationality for considering undertaken indicators in statistical and empirical investigations.

The statistical summary (i.e., minimum, maximum, mean, standard deviation, skewness and kurtosis) of the variables is given in Table 4. As per the estimated values of standard deviation, it was perceived that most variables (except agricultural production, age of respondents, annual income of farmers, use of fertilizer, cost of technology) do not have high leverages. Furthermore, most variables (except, agricultural production, use of fertilizer, cost of technology, and gender of respondents) have the skewness values between –1 to +1. Thus, these variables were in normal form. However, values of kurtosis were not between –1 to +1 for all variables. Thus, the natural logarithm of all variables were used to convert them in a normal form.

3.4 Correlation Coefficients among the Variables

The correlation coefficients of agricultural production with explanatory variables are given in Table 5. The correlation coefficients of coefficient variation in annual

Table 3. Scale reliability coefficient of variables

Variables	Sign	*Item-test correlation*	*Item-rest correlation*	*Average interitem correlation*	*Alpha*
ap	+	0.49	0.41	0.23	0.85
cvaaea	+	0.76	0.71	0.21	0.84
cvaamaxt	+	0.86	0.83	0.21	0.83
cvaamint	+	0.86	0.83	0.21	0.83
cvaapre	+	0.85	0.82	0.21	0.83
cvaarf	+	0.86	0.83	0.21	0.83
agre	–	0.34	0.25	0.24	0.86
fame	–	0.27	0.18	0.24	0.86
edlere	+	0.54	0.46	0.23	0.85
aninfa	+	0.46	0.38	0.23	0.85
toagla	+	0.86	0.83	0.21	0.83
irar	+	0.83	0.79	0.21	0.83
usagla	–	0.10	0.00	0.25	0.87
usfe	+	0.61	0.54	0.22	0.84
cote	–	0.16	0.06	0.25	0.86
gere	+	0.06	-0.04	0.26	0.87
maocre	–	0.25	0.15	0.24	0.86
apte	+	0.51	0.43	0.23	0.85
fisugo	+	0.15	0.05	0.25	0.86
adstfa	+	0.52	0.44	0.23	0.85
Test Scale				0.2276	0.85

Source: Estimated by authors.

average evapotranspiration, coefficient variation in annual average maximum temperature, coefficient variation in annual average minimum temperature, coefficient variation in annual average precipitation, coefficient variation in annual actual rainfall, education level of farmers, annual income of the farmers, total agricultural land, irrigated area and use of fertilizer with agricultural production were seemed positive and statistically significant. Hence, the estimates indicate that aforesaid variables have a positive contribution in the agricultural sector. The correlation coefficients of other variables with agricultural production seemed statistically insignificant.

Table 4. Statistical Summary of the Variables

Variables	*Min*	*Max*	*Mean*	*SD*	*Skewness*	*Kurtosis*
ap	12324	1789244	129299.9	170837	6.91	59.60
cvaaea	0.14	5.02	1.31	0.93	1.06	3.68
cvaamaxt	0.01	0.27	0.10	0.06	0.69	2.64
cvaamint	0.02	0.46	0.17	0.10	0.71	2.78
cvaapre	0.29	8.20	2.71	1.67	0.81	3.09
cvaarf	0.36	9.20	3.51	2.17	0.67	2.51
agre	22.00	65.00	39.98	10.64	0.33	2.19
fame	2.00	12.00	5.83	1.83	0.80	3.75
edlere	7.00	17.00	12.59	3.09	–0.11	1.69
aninfa	140000	912000	531692	159320	–0.02	2.55
toagla	1.00	25.00	9.27	5.57	0.67	2.67
irar	0.50	20.00	6.16	4.12	0.88	3.15
usagla	51.00	86.00	65.47	5.48	0.38	4.07
usfe	143	22452	1897	2398	4.56	32.50
cote	165	2986	2528	325	–2.02	13.57
gere	0.00	1.00	0.98	0.14	–6.71	46.02
maocre	0.00	1.00	0.65	0.48	–0.65	1.42
apte	0.00	1.00	0.72	0.30	–0.51	1.91
fisugo	0.00	1.00	0.44	0.50	0.25	1.06
adstfa	0.00	1.00	0.46	0.50	0.15	1.02

Source: Estimated by authors.

Table 5. Correlation coefficients of the variables

Variables	*ap*	*cvaaea*	*cvaamaxt*	*cvaamint*	*cvaapre*	*cvaarf*	*agre*	*fame*	*edlere*	*aninfa*
ap	1	0.435**	0.454**	0.446**	0.433**	0.453**	–0.069	–0.019	0.124*	0.201**
cvaaea	0.435**	1	0.858**	0.818**	0.893**	0.864**	–0.105	–0.001	0.093	0.200**
cvaamaxt	0.454**	0.858**	1	0.995**	0.957**	0.991**	–0.112*	–0.028	0.180**	0.345**
cvaamint	0.446**	0.818**	0.995**	1	0.945**	0.984**	–0.116*	–0.019	0.185**	0.360**
cvaapre	0.433**	0.893**	0.957**	0.945**	1	0.954**	–0.115*	–0.01	0.173**	0.334**
cvaarf	0.453**	0.864**	0.991**	0.984**	0.954**	1	–0.119*	–0.024	0.170**	0.348**
agre	–0.069	–0.105	–0.112*	–0.116*	–0.115*	–0.119*	1	0.252**	–0.469**	–0.165**
fame	–0.019	–0.001	–0.028	–0.019	–0.01	–0.024	0.252**	1	–0.448**	–0.070
edlere	0.124*	0.093	0.180**	0.185**	0.173**	0.170**	–0.469**	–0.448**	1	0.322**
aninfa	0.201**	0.200**	0.345**	0.360**	0.334**	0.348**	–0.165**	–0.07	0.322**	1
toagla	0.441**	0.822**	0.977**	0.984**	0.963**	0.978**	–0.128*	–0.003	0.183**	0.377**
irar	0.430**	0.782**	0.927**	0.936**	0.924**	0.924**	–0.118*	0.012	0.162**	0.395**
usagla	–0.030	–0.041	–0.004	0.004	–0.032	–0.012	0.079	0.068	0.091	0.021
usfe	0.228**	0.549**	0.620**	0.619**	0.614**	0.625**	–0.118*	0.008	0.115*	0.198**
cote	–0.049	–0.076	–0.030	–0.018	–0.010	–0.034	0.076	0.081	–0.091	0.147*
gere	0.030	0.065	0.023	0.015	0.041	0.030	0.159**	0.162**	–0.152**	0.045
maocre	–0.030	0.021	–0.067	–0.087	–0.058	–0.053	0.000	0.095	–0.239**	–0.035
apte	0.085	0.135*	0.190**	0.190**	0.174**	0.178**	–0.369**	–0.297**	0.801**	0.262**
fisugo	0.051	–0.032	–0.024	–0.011	–0.011	–0.023	0.069	–0.193**	0.144*	0.000
adstfa	0.103	0.127*	0.166**	0.167**	0.152**	0.152**	–0.342**	–0.352**	0.886**	0.270**

Table 5 continued

Variables	*toagla*	*irar*	*usagla*	*usfe*	*cote*	*gere*	*maocre*	*apte*	*fisugo*	*adstfa*
ap	0.441**	0.430**	–0.030	0.228**	–0.049	0.03	–0.03	0.085	0.051	0.103
cvaaea	0.822**	0.782**	–0.041	0.549**	–0.076	0.065	0.021	0.135*	–0.032	0.127*
cvaamaxt	0.977**	0.927**	–0.004	0.620**	–0.03	0.023	–0.067	0.190**	–0.024	0.166**
cvaamint	0.984**	0.936**	0.004	0.619**	–0.018	0.015	–0.087	0.190**	–0.011	0.167**
cvaapre	0.963**	0.924**	–0.032	0.614**	–0.010	0.041	–0.058	0.174**	–0.011	0.152**
cvaarf	0.978**	0.924**	–0.012	0.625**	–0.034	0.030	–0.053	0.178**	–0.023	0.152**
agre	–0.128*	–0.118*	0.079	–0.118*	0.076	0.159**	0.000	–0.369**	0.069	–0.342**
fame	–0.003	0.012	0.068	0.008	0.081	0.162**	0.095	–0.297**	–0.193**	–0.352**
edlere	0.183**	0.162**	0.091	0.115*	–0.091	–0.152**	–0.239**	0.801**	0.144*	0.886**
aninfa	0.377**	0.395**	0.021	0.198**	0.147*	0.045	–0.035	0.262**	0.000	0.270**
toagla	1	0.953**	–0.012	0.627**	–0.010	0.028	–0.085	0.174**	0.005	0.159**
irar	0.953**	1	–0.006	0.585**	0.008	0.052	–0.076	0.155**	0.005	0.135*
usagla	–0.012	–0.006	1	–0.025	0.059	–0.004	–0.013	0.084	0.058	0.068
usfe	0.627**	0.585**	–0.025	1	–0.058	0.049	–0.072	0.154**	–0.110*	0.109*
cote	–0.010	0.008	0.059	–0.058	1	–0.014	–0.04	–0.118*	0.033	–0.123*
gere	0.028	0.052	–0.004	0.049	–0.014	1	0.017	–0.138*	0.011	–0.157**
maocre	–0.085	–0.076	–0.013	–0.072	–0.040	0.017	1	–0.250**	–0.206**	–0.274**
apte	0.174**	0.155**	0.084	0.154**	–0.118*	–0.138*	–0.250**	1	0.081	0.875**
fisugo	0.005	0.005	0.058	–0.110*	0.033	0.011	–0.206**	0.081	1	0.176**
adstfa	0.159**	0.135*	0.068	0.109*	–0.123*	–0.157**	–0.274**	0.875**	0.176**	1

Source: Author's estimation.

Note: **- Correlation is significant at the 0.01 level; * - Correlation is significant at the 0.05 level.

4. Discussion on Empirical Results

Two regression models were run simultaneously to get a better understanding of the impact of climatic factors and other inputs on agricultural production in this study. In the 1st empirical model, climatic and non-climatic factors (Table 6), and 2nd empirical model only climatic factors were included (Table 7). The regression coefficients of explanatory variables with agricultural production were estimated through linear, non-linear and log-linear production function models. The statistical values of *Ramsey RESET test* for all models appeared statistically insignificant. Thus, the estimates show that functional forms of aforementioned production function models were seemed correctly-well-defined. The *Chi*^{2} values under Breusch-Pagan/Cook-Weisberg test were also found statistically insignificant, thus it infers that cross-sectional data do not have heteroskedasticity. Log-linear production function model has lower values of *AIC* and *BIC* as compared to linear and non-linear production function models. Hence, the log-linear production function model produces consistent results which were used to provide statistical inferences.

The regression coefficient of annual average maximum temperature with agricultural production was found positive. Thus, it indicates that agricultural production may be improved as increased in maximum temperature. The estimate is not consistent with previous studies which have reported negative impact of maximum temperature on agricultural production and yield at state-level estimation in India [25,34]. The regression coefficient of annual average minimum temperature with agricultural production seemed negative. Hence, it is suggested that agricultural production is expected to be declined due to increase in minimum temperature. Annual average precipitation and annual actual rainfall also showed a negative impact on agricultural production. Hence, the aforesaid estimates show that agricultural production declines due to climate change in Gujarat.

The *R-squared* value was found 0.8298, thus, the estimate shows that 83% variation in agricultural production can be explained by undertaken explanatory variables. Furthermore, the regression coefficient of family members with agricultural production appeared positive and statistically significant. Thus, estimates show that agricultural production increases as an increase in family size of farmers. Literate farmers have more understanding of

Table 6. Regression coefficient of explanatory variables with agricultural production

Regression Models	Linear Regression		Log-linear		Non-linear	
Number of obs.	240		240		240	
F - Value	3.71		62.34		2.4	
Prob > F	0.000		0.000		0.0001	
R-squared	0.2429		0.8434		0.2778	
Adj. R-squared	0.1775		0.8298		0.1621	
Mean VIF	186.80		294.90		1310.21	
Breusch-Pagan/Cook-Weisberg test for heteroskedasticity [Chi^2]	290.47		21.76		493.00	
Ramsey RESET test for (*DV*) [*F* - Value]	1.2		2.13		7.39	
Ramsey RESET test for (*IV*) [*F* - Value]	0.63		0.86		0.85	
AIC	6436.572		148.3235		6453.247	
BIC	6506.185		217.9363		6571.589	
Agricultural production (*DV*)	*Reg. Coef.*	*Std. Err.*	*Reg. Coef.*	*Std. Err.*	*Reg. Coef.*	*Std. Err.*
cvaaea	45841.330	36568.700	0.131	0.104	43998.180	101364.50
(*cvaaea*)^2	-	-	-	-	–188.481	23056.750
cvaamaxt	8349013.00	6354368.00	1.896	1.473	8609792.0	17800000.0
(*cvaamaxt*)^2	-	-	-	-	–5930011.0	51100000.0
cvaamint	–4133836.0	3593001.00	–1.652	1.332	–3689721.0	9909242.00
(*cvaamint*)^2	-	-	-	-	1175084.00	17800000.0
cvaapre	–88990.100	50729.710	–0.702	0.385	–96476.60	149641.000
(*cvaapre*)^2	-	-	-	-	2331.052	13373.450
cvaarf	–57433.330	59383.210	–0.543	0.484	–262033.80	177406.400
(*cvaarf*)2	-	-	-	-	19506.410	14756.020
agre	121.410	1160.805	–0.034	0.093	–1991.738	8151.804
(*agre*)^2	-	-	-	-	24.954	96.138
fame	5123.179	6571.116	0.035	0.077	23979.730	31353.820
(*fame*)^2	-	-	-	-	–1362.207	2335.016
edlere	11316.060	8522.278	0.137	0.188	42173.560	39270.030
(*edlere*)^2	-	-	-	-	–1490.799	1596.023
aninfa	0.066	0.075	0.030	0.071	–0.139	0.385
(*aninfa*)^2	-	-	-	-	0.0001	0.0001
toagla	35396.390	31083.000	1.982	0.656	111783.000	86435.090
(*toagla*)^2	-	-	-	-	-2809.722	2860.114
irar	4671.183	8331.863	0.001	0.094	–1657.953	20596.440
(*irar*)^2	-	-	-	-	262.135	976.602
usagla	–1141.709	1902.503	–0.054	0.256	13779.570	28239.620
(*usagla*)^2	-	-	-	-	–111.729	211.720
usfe	–5.202	5.503	–0.093	0.057	–17.356	17.709
(*usfe*)^2	-	-	-	-	0.001	0.001
cote	–16.201	32.478	0.018	0.101	193.371	157.366
(*cote*)^2	-	-	-	-	–0.047	0.035
gere	–5438.471	73695.370	0.085	0.153	1662.428	77573.580
maocre	–8411.764	23138.330	0.006	0.047	–15066.40	24561.350
apte	–33323.750	74370.400	0.059	0.152	–21031.70	78118.480
fisugo	24488.180	22326.880	0.053	0.045	20175.710	23500.990
adstfa	–38325.670	59798.980	0.046	0.112	–4510.820	65286.770
Con. Coef.	–45654.170	189386.200	10.213	1.931	–905897.0	1011192.00

Source: Author's estimation.

technology and various inputs and their usages in cultivation [5,6]. Subsequently, the education level of farmers showed a positive impact on agricultural production. Furthermore, educated farmers have more skills as compared to uneducated farmers. Annual income of the farmers has a positive impact on agricultural production. Cultivation is not possible without arable land [12]. Therefore, it is a most significant input for cultivation. The estimate also exhibited the positive impact of total agricultural land on agricultural production. Irrigated area is a crucial input for farming. Subsequently, agricultural production will increase as an increase in irrigated area. The regression coefficient of irrigated area with agricultural production was also observed positive in this study. A group of researchers have claimed that irrigated area produce has high yield in cultivation [7,5,8,12,18,21]. The regression coefficient of use of fertilizer per hectare land with agricultural production was found positive. Hence, recommended application of fertilizer in cultivation may be effective to increase yield of crops and agricultural production [5]. Otherwise, it may be caused to reduce crop yield due to decline in soil fertility and quality in log-run. The cost of technology per hectare of land has a positive impact on agricultural production. The estimate can be justified that technological advancement would be useful to increase agricultural production. Previous literature have also observed positive influence of technology on agricultural production [64,65]. Subsequently, agricultural production increases as use of appropriate technology in cultivation increase.

The regression coefficient of gender of respondents with agricultural production was found positive. Thus, the estimate provides evidence that male farmers have a more contribution in agricultural production activities as compared to females. Occupation of farmers has a significant impact on agricultural production. Age of farmers has a negative impact on agricultural production. It may happen due to decrease in the contribution of farmers when their age increases. The regression coefficient of financial support for farmers from the government with agricultural production appeared positive. It can be useful to increase the economic capacity of the farmers to buy new technology, seeds, fertilizer and other inputs for farming. Therefore, it is obvious that financial support for farmers from the government and banking sector will be useful to increase agricultural production [46]. The descriptive results also specify that the farmers were applying different adaptation strategies to mitigate the negative climate change impact in farming. Therefore, this study also assessed the influence of farmer's adaptation strategies on agricultural production. The regression coefficient of adaptation strategies with agricultural production was observed positive. Thus, the estimate implies that adaptation strategies are found useful to mitigate the negative consequences to climate change in the agricultural sector [10,42-44]. Human resources play a crucial role in farming. Therefore, the use of agricultural labor per hectare land has a positive impact on agricultural production.

The regression results based on non-linear production function, showed that climatic and non-climatic variables have a non-linear relationship with agricultural production. This study found U-shaped and hilly association of explanatory variables with agricultural production as per the sign of the regression coefficients of original and square terms of respective variables. Evapotranspiration, maximum temperature, family members, education level of farmers, arable land, use of agricultural labour and cost of technology have an U-shaped relationship with agricultural production. While, minimum temperature, precipitation, rainfall, age of farmers, annual income of farmers, irrigated area and use of fertilizer have a hilly-shaped association with agricultural production.

The regression coefficients of climatic factors with agricultural production are given in Table 7. The *R-squared* value was observed 0.8312. Thus, 83% variation in agricultural production depends upon undertaken climatic factors. The regression coefficient of coefficient variation in maximum temperature with agricultural production was appeared negative and statistically significant. The estimate indicates that agricultural production is expected to decline by 1.85% due to 1% increase in maximum temperature. Precipitation, minimum temperature and actual rainfall have a positive impact on agricultural production. The estimates demonstrate that agricultural production is expected to be increased by 1.78%, 0.30% and 0.67% as an increase 1% increase in annual average minimum temperature, annual average precipitation and annual actual rainfall, respectively. As ground water increases due to increase in annual actual rainfall. Subsequently, annual rainfall may be useful to meet the water requirement for farming activities and it would be useful to increase the productivity and production of food-grain and cash crops. The regression results based on non-linear production function model, showed that agricultural production has a non-linear association with climatic factors. Evapotranspiration, minimum temperature and precipitation have an U-shaped relationship with agricultural production. Agricultural production has a hilly-shaped association with maximum temperature and rainfall. Prior studies have also reported non-linear association of climatic factors with crop production and productivity in India [8,19,30].

Table 7. Regression coefficients of climatic factor with agricultural production

Regression Models	Linear Regression		Log-linear		Non-linear	
Number of obs.	240		240		240	
F - Value	12.66		230.39		6.79	
Prob > F	0.000		0.000		0.000	
R-squared	0.2129		0.8312		0.2287	
Adj. R-squared	0.1961		0.8276		0.195	
Mean VIF	119.84		219.7		889.51	
Ramsey RESET test for (*DV*) [*F* - Value]	0.07		1.22		1.66	
Ramsey RESET test for (*IV*) [*F* - Value]	0.76		1.09		0.79	
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity [Chi2]	167.54		9.16		251.74	
Cameron & Trivedi's decomposition of IM-test	16.17		8.01		26.28	
AIC	6417.886		138.3228		6423.039	
BIC	6438.77		159.2066		6461.326	
ap	*Reg. Coef.*	*Std. Err.*	*Reg. Coef.*	*Std. Err.*	*Reg. Coef.*	*Std. Err.*
cvaaea	47557.66	32340.14	0.1052	0.098	35902.21	87774.03
(*cvaaea*)^2					–56.79336	18539.55
cvaamaxt	538533.9	2790006	–1.8505	0.712	–8889458	8703948
(*cvaamaxt*)^2					2.79E+07	2.43E+07
cvaamint	309695.4	1373392	1.7888	0.577	6303996	4414759
(*cvaamint*)^2					–1.10E+07	7475095
cvaapre	–22618.4	23565.76	0.3006	0.178	74503.26	82422.12
(*cvaapre*)^2					–8941.018	7729.299
cvaarf	4389.973	34330.14	0.6657	0.265	–67738.63	94526.53
(*cvaarf*)2					6003.597	8127.961
Con. Coef.	5370.183	19154.23	9.4601	1.087	–18326.24	32917.95

Source: Author's estimation.

5. Conclusions and Policy Implications

The main objective of this study was to detect the farmer's perspective on adaptation strategies to climate change in cultivation. Thereupon, it examined the impact of climate change, technology, adaptation strategies and socio-economic profile of farmers on agricultural production using linear, non-linear and log-linear production function models. Farm level data were used, while it was collected through personal interviews of 400 farmers from purposely selected eight districts of Gujarat. However, only 240 farmers could provide the complete information. This study, therefore, provides the statistical inference of descriptive and empirical results based on this sample size of 240 respondents.

Descriptive results imply that most farmers were conscious about climate change and its negative implications in agricultural sector. Therefore, farmers were adopting several methods such as change in showing time of crops, irrigation facilities, application of fertilizer, and use of hybrid varieties of seeds, wetting of seed before planting in soil, climate tolerant crops, improving intensity of inputs and use of various technologies to cope with climate change in agricultural sector. Few farmers have adopted organic and green fertilizer to increase soil fertility for mitigation the adverse impact of climate change in the agricultural sector. The empirical result also clearly enforces that adaptation strategies have a positive impact on agricultural production. Hence, aforesaid practices can be considered as adaptation strategies to mitigate the negative consequences of climate change in the agricultural sector.

Furthermore, the empirical results indicate that maximum and minimum temperature, precipitation, and rainfall have a negative impact on agricultural production in the study area. The impact of maximum temperature, minimum temperature and rainfall were seemed positive on agricultural production when farmers were applied different adaptation strategies such as change in showing time of crops, improve irrigation facilities, application of fertilizer, hybrid varieties of seeds, wetting of seed before planting in soil, climate tolerate crops, and maintain intensity of inputs in farming. The empirical results also showed that family size, education level of farmers, annual income of farmers, arable land, irrigated area, cost of technology, appropriate technology, financial support for farmers from government and farmer's adaptation strategies have a positive and significant contribution to increase agricultural production in Gujarat. The estimate also indicates that agricultural production is expected to be declined by 1.85% due to 1% increase in maximum temperature. Precipitation, minimum temperature and actual rainfall have a positive impact on agricultural production. The estimates demonstrate that agricultural production is expected to be improved by 1.78%, 0.30% and 0.67% as an increase of 1% increase in annual average minimum temperature, annual average precipitation and annual actual rainfall, respectively. It was also observed that climatic factors have a non-linear association with agricultural production.

This study provides several policy suggestions which might be helpful for farmers and policy makers to mitigate the negative impact of climate change on agricultural production in Gujarat. Application of technology is useful to increase farmer's income, water sustainability, soil quality and fertility, land productivity, and efficiency of agricultural inputs in farming. Policy makers should implement water conservation and management plans to meet the irrigation requirement in cultivation and to maintain the agricultural sustainability. Furthermore, small and medium land holding farmers were unable to use technology in cultivation due to their low economic capacity, low literacy and skills, weak understanding on technology, and high cost of technology. Thus, the government should provide credit to the small and marginal farmers to increase their economic capacity to bear the high cost of technology and other inputs. Agriculture entrepreneurs, agricultural universities, agricultural extension offices and agricultural cooperative societies should provide the training and technical supports to the farmers to increase their understanding on new technology and climate change related issues. Collaboration of agriculture industries with farmers would be effective for farmers to cultivate a specific crop which provides them better return. Farmers should grow commercial crops as per the needs of agriculture industries to maintain their profitability in the long-term. There is also a requirement to develop appropriate marketing of agricultural products to increase the farmer's trust in agricultural production activities.

This study develops the conceptual framework to assess the influence of climate change, technological change and other variables on agricultural production using farm level information in Gujarat. Also, it provides several policy proposals to mitigate the negative consequences of climate change in farming based on empirical findings. Hence, the present study is a significant contribution in existing literature. Though, the empirical finding of this study is based on eight districts of Gujarat. Despite that, the estimates of this study are crucial to develop climate action plans and agricultural development policies in Gujarat. Further research can be replicated in other districts of Gujarat to check the consistency of this study.

Conflict of Interest

There is no conflict of interest.

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