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Determinants of Climate Change Affecting Agricultural Productivity in the Western Uttar Pradesh: A Cross-sectional Descriptive Regression-Enter Analysis

[1]**Amit Kumar Tripathi** [2]**Prof. Md. Mahmood Alam**
[1]Research Scholar, Department of Economics, Dharam Samaj College, Aligarh (U. P.) India-202001
[2]Professor & Head, Department of Economics, Dharam Samaj College, Aligarh (U. P.) India-202001
[1]Email ID:- pinnacleamit8819@gmail.com, [2]mahmoodalam2000@gmail.com

Abstract: *The study aims to know the effect of the climate change determinants on the agricultural productivity in western Uttar Pradesh. The descriptive as well as exploratory research design was used. Preliminary pilot study was performed on the 44 samples. The Cronbach alpha, Bartlet test of significance, KMO test used under scale development and tools standardization for scale reliability and validity of the questionnaire. The sample size of this study was 484. The correlation and regression analysis were used to check the cause-and-effect relationship between ten independent variables (Temperature, Rainfall, Snowfall, Water Balance, Water Quality, Drought, Flood, Land Quality, CO_2 Emission, and Fuel Consumption) and one dependent variable (Agricultural Productivity). The nonprobability snowball sampling technique was used in this study. The empirical results reveal that by increasing one unit in the Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emission, Fuel Consumption, Snowfall there is a decrease in the Agricultural Productivity by -.137, -.091, -.245, -.013, -.473, -.035, -.459, and -.039 units respectively and by increasing one unit in the Water Quality, and Land Quality there is an increase of .375 and .131 units in the Agricultural Productivity in Western Uttar Pradesh.*

Key Words: *Climate Change Determinants; Agricultural Productivity; Correlation and Regression.*

1. INTRODUCTION :

One of the most important issues of the twenty-first century is climate change, which has significant effects on many industries, including agriculture. The effects of climate change on agricultural productivity are a major issue in areas like Western Uttar Pradesh (UP), where agriculture provides millions of people with their livelihood and the foundation of the economy. In order to clarify the complex dynamics, evaluate the vulnerabilities, and investigate viable adaptation solutions, this study explores the complex relationship between climate change and agricultural productivity in Western Uttar Pradesh. The rich agricultural legacy of Western Uttar Pradesh, which includes districts like Meerut, Muzaffarnagar, and Saharanpur, is typified by a variety of products, from wheat and sugarcane to fruits and vegetables. However, the negative effects of climate change—which include unpredictable rainfall patterns, rising temperatures, and extreme weather events—are making this agricultural environment more and more susceptible. These changes in the climate create serious problems for agricultural sustainability and food security by upsetting conventional cropping cycles, making water scarcer, and increasing pest and disease burdens. Both direct and indirect effects are among the many different and intricate ways that climate change is affecting agricultural productivity in Western Uttar Pradesh. Crop growth, development, and yields are directly impacted by changes in temperature and precipitation patterns; increasing temperatures can change phenological stages and exacerbate heat stress during crucial growth times. Crop productivity is further jeopardized by changed precipitation patterns, such as irregular rainfall and protracted dry spells, which worsen water stress, lower soil moisture content, and interfere with irrigation schedules. By expanding weed infestations, changing pest life cycles, and intensifying pest and disease stresses, climate change indirectly exacerbates already-existing agricultural problems. Crop production is seriously threatened by extreme weather events including floods, droughts, and storms, which can result in physical harm, soil erosion, and losses after harvest. These escalating difficulties highlight the pressing need for thorough investigation and focused measures to improve Western Uttar Pradesh's agricultural resilience in the face of climate change. A multidisciplinary strategy that incorporates scientific research, stakeholder involvement, and policy interventions is required to address the intricate interactions between climate change and agricultural productivity. Evidence-based adaptation plans depend on scientific efforts to comprehend the precise effects of climate change on important crops, soil health, and water supplies. In order to co-design context-specific adaptation measures that are suited to the distinct socio-economic and environmental dynamics of Western Uttar Pradesh, it is imperative that researchers, policymakers, farmers, and extension agents collaborate. This study emphasizes how urgently coordinated effort is required to address the threats that climate change poses to Western Uttar Pradesh's agricultural productivity. We can create comprehensive and context-specific policies that reduce risks, improve resilience, and guarantee the long-term sustainability of agriculture in the area by deepening our understanding of the intricate relationships that exist between climate, agricultural, and socioeconomic issues.

In Uttar Pradesh, agricultural productivity is the production and efficiency of the state's agricultural operations. In particular, it entails calculating the amount and caliber of agricultural products and services generated per unit of resources used in Uttar Pradesh's agricultural sector, including land, labor, money, and technology. By calculating the amount of agricultural products generated per unit of input, such as land, labor, capital, or technology, agricultural productivity refers to the effectiveness and output of agricultural activities. It illustrates the agricultural sector's capacity to produce yields and satisfy consumer demands for food, fiber, and other agricultural goods. High agricultural production is a sign of sustainable farming methods, efficient use of resources, and flexibility in response to shifting environmental conditions. Technological developments, crop selection, water management, and general farm management techniques that maximize output while minimizing inputs and environmental effect are some of the factors impacting agricultural productivity.

2. Literature review :

To comprehend the essence of the issues, literature is crucial. It provides a thorough grasp of all the facets of study fields, associated novel discoveries, and technique. The researcher is able to understand the many kinds of study designs and methods. Google Scholar, the J-Gate portal, the online library, and other trustworthy national and international journal sources were used to examine the earlier literature. Reviewing prior research in the APA (American Psychological Association, 7th edition) style is done using the Mendeley reference management. The following are the findings of the earlier authors:

(S. N. Kumar et al., 2012) found that the recognition of climate change as the foremost threat to the food security and sustainability of agriculture in India is increasing. To acknowledge the importance of this matter, the Indian Council of Agricultural Research initiated a National Network project that specifically targets the 'Impact, Adaptation, and Vulnerability of Indian Agriculture to Climate Change'.

(Prasad Saxena & Kumar, 2019) found that climate change is a crucial concern that affects several aspects of living in the current century. The issue of climate change poses a greater threat to agriculture, especially in emerging and low-income nations, due to their larger and more vulnerable populations.

(Naresh Kumar et al., 2011) found that the Indian agriculture is encountering difficulties as a result of various reasons, including heightened competition for land, water, and labor from non-agricultural sectors, as well as escalating climatic variability. The latter, which is linked to global warming, will lead to significant variations in food output on a seasonal and annual basis. Even in the present day, all agricultural commodities remain susceptible to such fluctuations.

(Jayaraman, 2011) found that an expeditious and fair global accord on climate change is advantageous for less-developed nations. However, the extent to which developed nations can postpone action on this matter is of crucial strategic importance to them. The apprehension over climate change largely arises from deductions drawn from well-established and continuous scientific research rather than from direct substantiation of its present consequences.

(Sanjeev Kumar & Upadhyay, 2019) found that the climate change is a crucial concern within the framework of the Indian economy. Over 60 percent of agricultural land relies on the monsoon. The global effects of climate change on agriculture are evident, with nations such as India being particularly vulnerable due to their large agricultural-dependent population and the excessive strain on natural resources.

(Yadav, 2022) found the existence of scientific evidence regarding climate science dates back to 1856, when Eunice Newton Foote released her study on the CO2-induced greenhouse effects. **(Grigorieva et al., 2023)** found that the agricultural output is intricately linked to weather and climate conditions and relies heavily on climate stability, climate change presents a multitude of varied obstacles to agricultural activities.

(Sharma et al., 2022) found that Climate change is a very intricate and demanding worldwide environmental menace that now impacts our ecology. The IPCC 2021 has documented significant alterations in worldwide temperature, precipitation patterns, and extreme weather occurrences across all regions during the near- to mid-term periods.

(Danhassan et al., 2018) found that Asia, the largest continent on Earth, encompasses four distinct climatic zones: boreal, desert and semi-arid, tropical, and temperate (Chopra, 1987). The region encounters significant environmental and socio-economic obstacles as it strives to safeguard important natural resources. The degradation of land and ecosystems poses a significant danger to food security.

(Ramana, 2020) found that the agriculture sector assumes a pivotal position in the economic development of a nation. It has had a substantial impact on the economic progress of both rich and underdeveloped nations.

(Tripathi, 2015) found that the global mean surface temperature has experienced an increase at a rate that is almost twice as fast over the past 50 years compared to the previous 100 years.

(Shiv Kumar et al., 2023) found that **w**heat, a grain that has been produced since ancient times, is the most widely grown staple crop in the world. It provides essential sustenance for over a billion people worldwide.

(Khan, 2022) found that agriculture has been an integral part of the livelihoods and cultural heritage of millions of farmers in India for generations. Over 60% of individuals rely on agriculture, either directly or indirectly. India encountered the predicament of food scarcity throughout the period of its independence.

(Bhatt et al., 2019) found that the combined crisis of food and water scarcity in India is a significant challenge for the country, which is expected to reach 1.7-1.8 billion by 2050. Rice, a key cereal crop in India, accounts for over 60% of the total cultivated land and 77% of the country's overall food output.

(Goyal, 2013) found that Uttar Pradesh is the most populous state in India and the second largest in terms of land. The total land area of the state is 24.2 million hectares, with a cultivated area of 16.68 million hectares. The total cultivated land area is 25.5 million hectares. The cropping intensity in the state is 153%. The farming community is primarily composed of small-scale and subsistence farmers. The mean size of land holdings per farmer is about 0.83 hectares.

(R. Kumar & Raj Gautam, 2014) found that agricultural production is intricately linked to climate change and meteorological conditions. The anticipated fluctuations in temperature, precipitation, and CO2 levels are likely to have a substantial influence on crop development. The global influence of climate change on global food production is deemed to be minimal to moderate, provided that effective adaptation measures and sufficient irrigation are implemented.

(N. P. Singh et al., 2020) found that climate change has become the most significant worldwide threat to food security and livelihoods based on agriculture, hindering progress towards sustainable development, particularly in developing countries.

(S. Singh & Nayak, 2017) found that the climatic factors, specifically rainfall and temperature, are the primary causal factors affecting agricultural productivity. These factors have a significant impact on the variability of major cereal crops, even in high-yield regions.

(Zhai & Zhuang, 2012) found that the rising levels of greenhouse gases in the atmosphere will have substantial effects on the Earth's climate in the next few decades.

(Shah & Srivastava, 2017) found that the humanity requires a fair and just standard of living that includes sufficient provisions for food, water, energy, secure housing, and a sustainable environment for both current and future generations.

(Bai et al., 2022) found that the phenomenon of global climate change consistently gives rise to a range of environmental, social, ecological, and economic challenges that pose a significant threat to human progress and existence. Human society has encountered numerous detrimental effects resulting from climatic changes, including glacier melting, sea level elevation, and the escalation of natural disasters such as intense tropical storms, heatwaves, and erratic precipitation patterns.

(Jean Galbert, 2023) found that the development agencies are currently greatly concerned about climate change. International institutions and research organizations have issued warnings about climate change's negative effects on the environment and beyond. As per the National Aeronautics and Space Administration (NASA), the mean global temperature rose by a range of -1° to 1° Celsius during the transition from the 19th to the 20th centuries.

(Mahesh, 2012) found that climate change will significantly affect both humans and ecosystems in the next few decades due to changes in global average temperature and rainfall patterns. The agriculture and related sectors exhibit a high degree of vulnerability to the impacts of climate change. **(Munandar & Sumiati, 2017)** found that agricultural activities in Asia have a significant impact, particularly in countries that rely heavily on farming.

(Giannarakis et al., 2023) found that agriculture worldwide must address the distinct problem of balancing the increasing demand for its products with the significant pressures caused by climate change and environmental degradation.

(Cortés, 2023) found that AI has had an impact on the agricultural industry and is providing remedies for contemporary issues such as a shortage of labor, decreased productivity, and other resulting effects. Artificial intelligence (AI) applications in developing solutions for agricultural issues enable farmers to engage in sustainable farming practices, safeguard natural resources, enhance crop quality, and facilitate rapid market expansion for different commodities.

(Tran et al., 2015) found that agriculture is an essential industry that plays a pivotal role in the economic advancement of nations. A substantial segment of the population, particularly in developing nations, relies on it as a means of sustenance. It frequently serves as the foundation of the economy in these regions.

(A. Nastis, 2012) found that agriculture is the main industry that is heavily reliant on climate change. The local weather in each region directly affects the choice of the best crops to grow and the choice of the best planting and harvesting times.

(Dhawan, 2017) found that the water is an essential factor in agriculture, influencing the final crop production in several ways. Optimal watering is crucial for plants to fully realize the potential of good seeds and nutrients.

(Kim, 2010) found that the climate change includes deviations from typical air conditions resulting from both natural reasons like the Earth's orbit, volcanic activities, and crustal movements, as well as anthropogenic factors such as the rise in greenhouse gas and aerosol concentrations. Global warming is a major and enduring trend that will lead to significant changes in the world in the future. After reviewing the previous findings, it was observed that a very little study has neen carried out on the ten climate chanage variables as (Temperature, Rainfall, Snowfall, Water Balance, Water Quality, Drought, Flood, Land Quality, CO2 Emission, and Fuel Consumption), hence this was the most significant research gaps was identified that effect of all the ten climate change variables must be checked on the agricultural producitivity in western Uttar Pradesh.

3. Objective:

The specific objective of this research is as follows:

- To find the effect of climate change determinants on the agricultural productivity in Western Uttar Pradesh.

4. Hypothesis

The null and alternative hypotheses are as follows:

- H0: There is no significant effect of the climate change determinants on the agricultural productivity in Western Uttar Pradesh.
- H1: There is a significant effect of the climate change determinants on the agricultural productivity in Western Uttar Pradesh.

5. Methodologies :

The descriptive as well as exploratory research design was used in this study. The nonprobability snowball sampling technique was used. The reliability analysis, validity analysis, exploratory factor analysis, correlation and regression analysis were used in this research study. The EFA was performed individually on the selected factors/latent variables under the head of scale development and tool standardization. The reliability was checked using Cronbach's alpha. The construct validity can be checked using three approaches such as the multi-trait multi-method matrix, item to total score correlation in a scale, and factor analysis. The factor analysis was used to prove validity and data reduction. Here the researcher applied the items to total score correlation in a scale, and factor analysis approach. The validity of individual item in the scale was tested by measuring the correlation between the item and the total score under corrected item total correlation (CITC). The high correlation items were valid whereas low correlation (below 0.300) items were dropped from the scale. The exploratory factor analysis was done using the principal component analysis. Under principal component analysis, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and percentage of variance were calculated. The IBM SPSS 23.0 version software was used for data entry, data coding, value label, and inferential analysis. The significance level was set in advance at 5% for accepting and rejecting the null hypothesis.

6. Data

The researcher used a web-based survey questionnaire to collect primary data through snowball sampling, with a sample size of 484. Out of 500 responses, only 484 responses were found complete and correct resulting 96.8% response rate. The socio-economic, demographic, and geographic questions were in nominal scale whereas construct and items question were in the 5 points Likert scale. The Likert 5-point scale was used in such a way that 1 is considered as strongly disagree and 5 strongly agree. All other responses were between 1 to 5. The 3 point was considered as neutral/ neither agree nor disagree response.

7. Measurements of variables

The reliability and validity analysis were applied on each construct. The factor analysis using PCA was performed individually on the selected construct under the head of scale development and tool standardization. Finally, as a standard for final assessment, a minimum alpha of 0.70, minimum corrected item-total correlation (CITC) values above 0.300, and a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy value above 0.500 were checked for the final selection of items in the different constructs. Under confirmatory factor analysis (CFA), all the model fit indices were checked for a better fit of each model of the different constructs. The standardized regression weight above 0.300 of each item under different constructs was also checked.

7.1 Determinants of Climate Change (CC) construct

Climate Change (CC) construct was measured using the following ten subs constructs as. 1. Temperature, 2. Rainfall, 3. Snowfall, 4. Water Balance, 5. Water Quality, 6. Drought, 7. Flood, 8. Land quality, 9. CO_2 Emissions, 10. Fuel Consumption each having 3 to 4 statements on five points Likert's scale. The brief explanation of each climate change variables is as under:

7.1.1 Temperature

Extreme temperatures, either too high or too low, can adversely affect agricultural production. High temperatures can lead to heat stress in crops, resulting in reduced yields or even crop failure. Conversely, low temperatures can cause frost damage, especially to sensitive crops. Western Uttar Pradesh experiences hot summers and cold winters. Extreme heat during the growing season can affect crops like wheat, sugarcane, and rice negatively. Conversely, sudden cold spells during the winter can harm crops like mustard and vegetables.

7.1.2 Rainfall

Adequate rainfall is crucial for crop growth as it provides the necessary moisture for germination, growth, and development. Insufficient rainfall can lead to drought conditions, affecting crop yields. Conversely, excessive rainfall can cause waterlogging, leading to root rot and other diseases. Western Uttar Pradesh receives most of its rainfall during the monsoon season from June to September. Inadequate rainfall during this period can lead to drought conditions, impacting crops like sugarcane, rice, and pulses.

7.1.3 Snowfall

Snowfall can affect agricultural production differently depending on the region and crops grown. Excessive snowfall can lead to delayed planting and harvesting, while moderate snowfall can provide moisture for spring crops. Snowfall is not a significant factor in Western Uttar Pradesh as it is not located in the higher altitude regions where snowfall is common.

7.1.4 Water Balance

Maintaining a proper water balance is crucial for agricultural productivity. Adequate irrigation and drainage systems are necessary to ensure that crops receive sufficient moisture without waterlogging. The water balance in Western Uttar Pradesh is managed through canals, tube wells, and other irrigation systems. Ensuring efficient water distribution is essential for crops like sugarcane, wheat, and rice.

7.1.5 Water Quality

Poor water quality can adversely affect crop growth and yield. Water contaminated with pollutants or high levels of salinity can damage crops and reduce their productivity. Monitoring water quality in Western Uttar Pradesh is important, especially in areas where groundwater is the primary source of irrigation. Contaminated water can impact crops such as vegetables and fruits.

7.1.6 Drought

Drought can severely impact agricultural production by reducing soil moisture, limiting crop growth, and causing crop failure. It can lead to decreased yields, food shortages, and economic losses for farmers. Western Uttar Pradesh is prone to drought conditions, particularly during the monsoon season. Drought can affect crops like sugarcane, wheat, and pulses, leading to decreased yields and income for farmers.

7.1.7 Flood

Floods can devastate agricultural land by inundating crops, causing soil erosion, and washing away nutrients. They can lead to crop damage, loss of livestock, and destruction of infrastructure. Flooding can occur in Western Uttar Pradesh during the monsoon season, especially in low-lying areas near rivers like the Ganges and Yamuna. Floods can damage crops like rice, sugarcane, and vegetables, leading to significant economic losses for farmers.

7.1.8 Land Quality

The quality of land, including its fertility, texture, and drainage, significantly impacts agricultural production. Poor land quality can limit crop growth and yield potential. The land quality in Western Uttar Pradesh varies, with fertile alluvial soil in some areas and sandy or clayey soil in others. Proper soil management practices are essential for maintaining soil fertility and maximizing crop yields.

7.1.9 CO_2 Emissions

Rising CO_2 emissions contribute to climate change, which can impact agricultural production through changes in temperature, precipitation patterns, and extreme weather events. While CO_2 emissions primarily contribute to global climate change, their effects are felt locally through altered weather patterns and increased temperatures. This can affect crop growth and yield in Western Uttar Pradesh.

7.1.10 Fuel consumption

High fuel consumption, especially in agricultural machinery and transportation, can contribute to air pollution and greenhouse gas emissions, affecting both the environment and human health. Fuel consumption in agriculture is significant for activities like tilling, irrigation, and transportation. Efficient use of fuel and adoption of sustainable practices can reduce environmental impacts while maintaining agricultural productivity.

7.2 Agricultural Productivity (AP) constructs

Agricultural Productivity (AP) construct was also measured on five points Likert's scale using the following five statement as AP1.1 Agricultural productivity has increased over the past decade., AP1.2 The quality of crops produced meets market demands., AP1.4 Agricultural productivity is competitive compared to neighboring regions., AP1.5 Government policies and support programs have positively influenced agricultural productivity., and AP1.6 Crop yields per hectare are satisfactory.

The SPSS summary results of reliability and factor analysis are as follows:

Table 1: Reliability statistics & Principal components analysis results

Main Construct/scale Name	No of Items	Cronbach's Alpha	KMO Value	% of Variance	Results
Temperature	4	.809	.708	65.003	Good
Rainfall	4	.804	.648	63.694	Good
Snowfall	4	.874	.728	72.660	Excellent
Water Balance	4	.776	.665	59.857	Good
Water Quality	3	.715	.665	64.031	Good
Drought	4	.706	.564	55.631	Good
Flood	4	.788	.623	61.817	Good
Land Quality	4	.724	.576	54.834	Good
CO_2 Emission	3	.647	.606	58.777	Acceptable
Fuel Consumption	4	.709	.605	53.900	Good
Agricultural Productivity (AP)	5	.789	.711	55.007	Good

Source: SPSS 23.0 output

Under the reliability and factor analysis table 1, it is clear that all the ten determinants of Climate Change (CC) constructs and the five items under the Agricultural Productivity (AP) construct have passed the reliability and validity conditions, therefore the sub constructs of climate change and agricultural productivity can be further used in the next level of statistical analysis.

8. Findings

Table 2: Correlations: Climate Change and Agricultural Productivity

		Agricultural Productivity	Temperature	Rainfall	Water Balance	Water Quality	Drought	Flood	Land Quality	CO2 Emission	Fuel Consumption	Snowfall
Pearson Correlation	Agricultural Productivity	1.000	-.899	-.885	-.944	**.921**	-.865	-.922	**.949**	-.887	-.843	-.845
	Temperature	-.899	1.000	.860	.859	-.860	.855	.940	-.901	.871	.916	.721
	Rainfall	-.885	.860	1.000	.904	-.786	.933	.865	-.858	.813	.821	.800
	Water Balance	-.944	.859	.904	1.000	-.861	.891	.899	-.897	.856	.837	.914
	Water Quality	.921	-.860	-.786	-.861	1.000	-.845	-.877	.929	-.930	-.866	-.733
	Drought	-.865	.855	.933	.891	-.845	1.000	.861	-.844	.851	.880	.774
	Flood	-.922	.940	.865	.899	-.877	.861	1.00	-.923	.902	.956	.776
	Land Quality	.949	-.901	-.858	-.897	.929	-.844	-.923	1.000	-.915	-.865	-.779

	CO2 Emission	-.887	.871	.813	.856	-.930	.851	.902	-.915	1.000	.905	.725
	Fuel Consumption	-.843	.916	.821	.837	-.866	.880	.956	-.865	.905	1.000	.692
	Snowfall	-.845	.721	.800	.914	-.733	.774	.776	-.779	.725	.692	1.000
Sig. (1-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
N		484	484	484	484	484	484	484	484	484	484	484

Source: SPSS 23.0 output

According to the Correlations: Climate Change and Agricultural Productivity table 2, it is clear that the Pearson correlation coefficients are (-.899, -.885, -.944, -.865, -.922, -.887, -.843, -.845), hence all the eight variables (Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emission, Fuel Consumption, Snowfall) having high significant negative correlation with the Agricultural Productivity except the Water Quality, and Land Quality having Pearson correlation coefficients are (.921, 949). Therefore, by increasing the parameter of eight variables (Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emission, Fuel Consumption, Snowfall) then there is a decrease in the Agricultural Productivity and by increasing two variables (Water Quality, and Land Quality) then there is an increase in the Agricultural Productivity in the Western Uttar Pradesh.

Regression Analysis Enter Method

Regression Analysis- Enter Method involves inputting all predictor variables simultaneously into the model to assess their collective impact on the dependent variable. This approach helps in understanding the relationships and significance of each variable within the context of the analysis, providing insights into the overall model performance and prediction accuracy.

Regression Model

Y = a + b1 X1+b2X2+b3X3+b4X4+b5X5+b6X6+b7X7+b8X8+b9X9+b10X10

Where Y is dependent variables (Agricultural Productivity) and X1, X2, X3, X4, X5, X6, X7, X8, X9, and X10 are the independent variables as Snowfall, Fuel Consumption, Rainfall, Water Quality, Temperature, CO_2 Emission, Land Quality, Drought, Water Balance, Flood respectively. a, b1, b2, b3, b4, b5, b6, b7, b8, b9 and b10 are the constants.

Table 3: Variables Entered/Removed: Climate Change and Agricultural Productivity-Enter Method

Model	Variables Entered	Variables Removed	Method
1	Snowfall, Fuel Consumption, Rainfall , Water Quality , Temperature , CO_2 Emission , Land Quality , Drought , Water Balance , Flood	.	Enter
a. Dependent Variable: Agricultural Productivity			
b. All requested variables entered.			

Source: SPSS 23.0 output

According to the Variables Entered/Removed: Climate Change and Agricultural Productivity table 3, it is clear that all the ten independent variables (Snowfall, Fuel Consumption, Rainfall, Water Quality, Temperature, CO_2 Emission, Land Quality, Drought, Water Balance, and Flood) are interned using enter method. The dependent variable is the Agricultural Productivity.

Table 4: Model Summary: Climate Change and Agricultural Productivity-Enter Method

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.983	.967	.966	.11277	.967	1377.240	10	473	.000

Source: SPSS 23.0 output

According to the model summary table 4, the R^2 is 0.967; hence, it explained 96.7% of the variance, which means it, is good enough to select the model for further statistical interpretation.

Table 5: ANOVA: Climate Change and Agricultural Productivity-Enter Method

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	175.145	10	17.514	1377.240	.000
	Residual	6.015	473	.013		
	Total	181.160	483			
Dependent Variable: Agricultural Productivity						

Source: SPSS 23.0 output

According to the ANOVA table 5, F = 1377.240 & Sig Value p value = 0.000 less than 0.05, hence the model is highly significant.

Table 6: Coefficients: Climate Change and Agricultural Productivity-Enter Method

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	**3.028**	.194		15.574	.000	2.646	3.410
	Temperature	-.090	.018	-.137	-5.026	.000	-.125	-.055
	Rainfall	-.066	.024	-.091	-2.777	.006	-.113	-.019
	Water Balance	-.179	.027	-.245	-6.517	.000	-.233	-.125
	Water Quality	.276	.022	**.375**	12.336	.000	.232	.320
	Drought	-.012	.033	-.013	-.368	.000	-.076	.052
	Flood	-.363	.038	-.473	-9.693	.000	-.437	-.290
	Land Quality	.113	.029	**.131**	3.881	.000	.056	.170
	CO2 Emission	.036	.030	-.035	1.225	.000	-.022	.095
	Fuel Consumption	.478	.045	-.459	10.633	.000	.389	.566
	Snowfall	-.025	.014	-.039	-1.783	.000	-.053	.003
Dependent Variable: Agricultural Productivity								

Source*:* SPSS 23.0 output

According to the coefficient table 6, all the (Sig value 0.000 < 0.05) is significant at a 5% significance level, it is safe to reject the null hypothesis (H0: There is no significant effect of the climate change determinants on the agricultural productivity in Western Uttar Pradesh and it can be concluded that there was a significant effect of the climate change determinants on the agricultural productivity in Western Uttar Pradesh. Therefore, the regression equation in this case is as follows:

Y (Agricultural Productivity) =

3.028+(-.137) (Temperature)+ (-.091)(Rainfall)+(-.245) (Water Balance)+ (.375)(Water Quality)+(-.013) (Drought) + (-.473) (Flood) + (.131) (Land Quality) + (-.035) (CO2 Emission) + (-.459) (Fuel Consumption) + (-.039) (Snowfall) , Therefore, it is clear that by increasing one unit in the Temperature, Rainfall, Water Balance, Drought, Flood, CO2 Emission, Fuel Consumption, Snowfall there is a decrease in the Agricultural Productivity by -.137, -.091, -.245, , -.013, -.473, -.035, -.459, and -.039 units respectively and by increasing one unit in the Water Quality, and Land Quality there is an increase of .375 and .131 units in the Agricultural Productivity. All the eight variables (Temperature, Rainfall, Water Balance, Drought, Flood, CO2 Emission, Fuel Consumption, Snowfall) having negative effect on the Agricultural Productivity except the Water Quality, and Land Quality. **(Dhawan, 2017)**[1] also confirmed that that the water is an

[1] Dhawan, D. V. (2017). Water and Agriculture in India. *South Asia Expert Panel during the Global Forum for Food and Agriculture (GFFA) 2017*, 1–25. https://www.oav.de/fileadmin/user_upload/5_Publikationen/5_Studien/170118_Study_Water_Agriculture_India.pdf

essential factor in agriculture, influencing the final crop production in several ways. Optimal watering is crucial for plants to fully realize the potential of good seeds and nutrients.

9. Discussion :

The five items under the Agricultural Productivity (AP) construct and all ten determinants of Climate Change (CC) constructs passed the validity and reliability tests under the reliability and factor analysis. As a result, the subconstructs of agricultural productivity and climate change can be utilized in the subsequent statistical analysis stage. All eight variables (Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emission, Fuel Consumption, and Snowfall) have a high significant negative correlation with agricultural productivity, with the exception of Water Quality and Land Quality, whose Pearson correlation coefficients are (.921, 949). It is evident that the Pearson correlation coefficients are (-.899, -.885, -.944, -.865, -.922, -.887, -.843, -.845). Thus, in Western Uttar Pradesh, agricultural productivity decreases when eight variables (Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emissions, Fuel Consumption, and Snowfall) are increased, while agricultural productivity increases when two variables (Water Quality and Land Quality) are increased. With an R^2 of 0.967, the model was able to explain 96.7% of the variation, making it suitable for further statistical analysis. The model is extremely significant with a p-value of 0.000, which is less than 0.05, and an F-value of 1377.240. The null hypothesis (H0: The determinants of climate change do not have a significant impact on agricultural productivity in Western Uttar Pradesh) can be safely rejected because all the data (Sig value 0.000 < 0.05) is significant at a 5% significance level. Therefore, it can be concluded that the determinants of climate change did have a significant impact on agricultural productivity in Western Uttar Pradesh. Hence, the following is the regression equation for this case: Agricultural productivity, denoted as Y, is calculated as follows: 3.028 plus (-.137) Temperature, (-.091) Rainfall, (-.245) Water Balance, (.375) Water Quality, (-.013) Drought, (-.473) Flood, (.131) Land Quality, (-.035) CO_2 Emissions, (-.459) Fuel Consumption, and (-.039) Snowfall. Agricultural Productivity decreases by -.137, -.091, -.245, -.013, -.473, -.035, -.459, and -.039 units for every one unit increase in Temperature, Rainfall, Water Balance, Drought, Flood, CO2 Emission, Fuel Consumption, and Snowfall, respectively. On the other hand, agricultural productivity increases by.375 and.131 units, respectively, for every one unit increase in Water Quality and Land Quality. Water and Land Quality are the only two of the eight variables that have a positive impact on agricultural productivity; the others are Temperature, Rainfall, Water Balance, Drought, Flood, Carbon Dioxide Emissions, Fuel Use, and Snowfall.

10. Conclusion

Agricultural productivity and climate change were the two main constructs examined in this study of Western Uttar Pradesh. There is a strong negative relationship between agricultural productivity and each of the eight variables measured: Temperature, Rainfall, Water Balance, Drought, Flood, CO_2 Emissions, Fuel Usage and Snowfall. A positive association was observed between Land Quality and Water Quality, nevertheless. For these variables, the Pearson correlation coefficients were as follows: (-.899, -.885, -.944, -.865, -.922, -.887, -.843, -.845).

Temperature, Precipitation, Water Balance, Drought, Flood, Carbon Dioxide Emissions, Fuel Consumption, and Snowfall were the eight variables that the study indicated reduced agricultural productivity, whereas Water Quality and Land Quality were the two variables that were found to increase it. For every unit rise in Temperature, Precipitation, Water Balance, Drought, Flood, CO_2 Emissions, Fuel Consumption, and Snowfall, agricultural productivity declines by -.137, -.091, -.245, -.013, -.473, -.035, -.459, and -.039 units, respectively, according to the case's regression equation. But for every one-unit improvement in water quality and soil quality, agricultural productivity goes up by .375 and.131 units, respectively.

The study finally concluded that agricultural productivity in Western Uttar Pradesh was significantly affected by the factors of climate change.

Declaration

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Availability of data and materials

The primary data were collected using a web-based survey questionnaire through snowball sampling, with a sample size of 484. The previous researches were properly cited in the manuscript. The American Psychological Association (APA) 7th edition referencing style was used for the previous studies on the climate change on the agricultural productivity in Western Uttar Pradesh.

Ethical consideration

The ethical consent was taken by stating the statement at the beginning of the questionnaire to each respondent, as "Any information filled in the questionnaire will not be used for any commercial purpose both during the research and after its publication". All the information technology professionals have given their consent for this study.

Disclaimer

The findings & conclusions in this study are those of the authors and do not necessarily represent the official position.

Competing interests

No competing interests were disclosed.

Authors' contributions

All authors read and approved the final manuscript.

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