Asian Journal of Economics and Finance. **2023**, 5, 2 : 209-217
ISSN: 2582-340X
https://DOI:10.47509/AJEF.2023.v05i02.06

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

Causality between Carbon Dioxide Emission and Agriculture Production: Evidences from India

Swami Prasad Saxena[a] and Anuj Kumar[b*]

[a]Ph.D, Professor (Macroeconomics and Finance), Department of Applied Business Economics Dayalbagh Educational Institute Dayalbagh, Agra, Uttar Pradesh 282005, India. E-mail: spsaxena@dei.ac.in
[b,]Corresponding Author : Research Scholar, Department of Applied Business Economics, Dayalbagh Educational Institute, Dayalbagh, Agra, Uttar Pradesh 282005, India.*
E-mail: achaudhary278@gmail.com

ARTICLEINFO

Received: 07 May 2023

Revised: 27 May 2023

Accepted: 01 June 2023

Online: 07 June 2023

To cite this paper:

Swami Prasad Saxena & Anuj Kumar (2023). Causality between Carbon Dioxide Emission and Agriculture Production: Evidences from India. *Asian Journal of Economics and Finance.* 5(2), 209-217. https://DOI: 10.47509/AJEF.2023.v05i02.06

Abstract: Agriculture is a major economic activity in India. Green revolutions lead the Indian agriculture towards the modern mechanization and rapid growth. The modern mechanization of Indian agriculture is being held responsible for energy consumption and carbon dioxide emission in agriculture sector. The present paper explore the association among carbon emission, fertilizers consumption, food grain production and total cropped area in India from the period 1971 to 2022.The Augmented Dickey-Fuller test has employed to check stationarity of data. The OLS method and granger causality test has been applied to check the relation among the variables. The results indicate that the fertilizers consumption and food grain production positively effects the carbon dioxide emission while the total cropped area negatively impact the carbon dioxide emission further the all the variables are statistically significant except fertilizer consumption.

Keywords: Carbon dioxide Emission, Agriculture Productivity, Energy Consumption, Granger Causality test

JEL Classification: Q15, Q50

1. Introduction

Climate Change is vital ultimatum for the human civilization in current era. The phenomena of climate change simply refer to changing of weather patterns over a long period of time. The reasons of climate change are enormous and the emission of gases from different sources is main reason behind the changing weather pattern. The different gases which contribute to changing the climatic conditions are generally known as greenhouse gases (GHG). Carbon dioxide, Methane, nitrous oxide and ozone are the main greenhouse gases. The continuously changing weather patterns are directly affecting the different sphere of human life agriculture is one the most prominent, which is most affected by climate change as this is directly related to weather conditions.

Agriculture is one of the most prominent economic activities in developing countries and it contributes a major part of the GDP of India further after the Independence green revolution enhance the Indian agriculture but from last two decade, Indian agriculture starts to face the problem of climate change. The Agriculture is also a source emission of GHG gases due to lack of sustainable practices in agriculture field and this sector is also most affected by climate change as it related to temperature, rainfall and other climatic conditions.

Carbon dioxide (CO2) is a major GHG gas and the emission of Carbon dioxide has increased rapidly in last three decades and the rapid industrialization is one the major reason behind further The demand of energy consumption has increased rapidly in both developed and underdeveloped countries in last few decades and which is increasing the emission of GHG gases and the problem of climate change it directly challenging the food security.

The agriculture sector is one of the major contributor towards GDP is India. India is the second most populous country of the world and the agriculture land is shrinking year by year, so to fulfil the food grains demand of increasing population is a huge task for the government and government is trying to increase the productivity of agriculture by utilizing the existing resources. Some of the reviewed studies focused on GDP and CO_2 emission, Agriculture GDP and CO_2 emission and some the studies also try to explore the relationship between CO_2 emission and agriculture productivity in different parts of the globe.

The paper is ordered as follows: The Literature Review segment discuss prominent studies of existing literature. The methodology section talks about the methodology employed in the paper and results and discussion segment presents the results of the study. The Conclusion and Recommendations section relate conclusions from the study and the resulting policy recommendations.

2. Literature Review

This section describes the most prominent studies that define relationship between agriculture productivity and CO_2. This area of research has not much explored till now. Only few studies talk about the agriculture productivity and CO_2directly. The most of the researchers try to find a relationship among CO_2 emission, energy consumption, GDP, and other variables that directly or indirectly related to agriculture productivity and climate change or GHG gases further most of the studies used time series data for a longer period of time and applied different econometrics tools like ARDL model, co-integration test, Granger causality test, OLS etc.

Some of the studies that directly try to establish a relation between agriculture productivity and co_2 emission mainly considered the different variables of the agriculture productivity i.e. cropped area, fertilizers off take, water availability, Agriculture raw material exports, agriculture land productivity, irrigation, agriculture land and Energy consumption. Rehman et.al. (2019), (Javed et.al. 2018), Leitao (2018), (Edoja et.al. 2016), (Pant 2009). All these studies try to find long term and short term relation among the different variables that considered during the study further some of them states that The long-run effects are stronger than short-run (Rehman et.al.2019), Leitao (2018), and few of them states that the agriculture productivity and co_2 emission do not have short run or long run relation and both are not have unidirectional causality (Javed et.al. 2018).One of them states that the agriculture productivity, food security and co_2 emission have short run connection. (Edoja et.al.2016).One of them also concludes that the rich countries are responsible for CO_2 emission then the poor countries (Pant 2009).

A sizeable bit of the literature stress on the relation between the CO_2 emission and energy consumption and some of the studies also considering the renewable sources of the energy along with non-renewable sources of energy. The prominent studies of Boontome et.al. (2017), Aye & Edoja (2017), Jebli & Youssef (2017), Stamatiou & Dritsakis (2017), Tiwari (2011), Ozturk & Uddin (2015), Hussain et.al. (2012), observe long run positive relation among the variables, the all the researches directly indicate that the co_2 emission, economic growth goes side by side and due to economic growth the demand of energy consumption is increased in recent time and this also contributing to more co_2 emission. The prominent study of Boontome et.al. (2017) Conclude that the renewable and non-renewable energy sources also equally responsible for CO_2 emission.

The central part of the literature focus on the causality between CO_2 emission and agriculture production. The prominent studies of this field mainly use granger causality, co integration and ARDL model.

The causation between CO_2emission and agriculture productivity in Pakistan was analysed by Rehman et.al. (2019) by applying unit root test and ARDL model and the authors concluded that the agriculture productivity and CO_2 emission has a long run relationship further the authors says that the cropped area, energy usage, fertilizer offtake, gross domestic product per capita and water availability are the main variables from agriculture sector that's contribute to CO_2 emission and some agriculture variables mainly total food grains and improved seed distribution are not contributing to CO_2 emission Further the study concluded that the short run effects are not stronger as long run effects in CO_2 emission from agriculture productivity. Leitao (2018) also used the same econometrics tool to study the relation between carbon dioxide emission and Portuguese Agriculture productivity and the results indicate that the agriculture land and labour productivity and agriculture raw material export are the agriculture variables that's contribute to emission of carbon dioxide.

Although, some of the studies concluded that the agriculture productivity and carbon dioxide emission are not related to each other. Javed et.al. (2018), examined the long relation between CO_2 emission and agriculture productivity in Pakistan by employing vector autoregressive regressive (VAR) and Jhonson Cointegration technique (JCT) and Granger Causality test further the results of this study is different from other studies and the authors concluded by stating that the CO_2 emission and agriculture productivity are not related to each other in both long and short period of time further the CO_2 emission and agriculture productivity do not have unidirectional causality. In the similar context, Edoja et.al. (2016) used Augmented Dickey and Fuller and Phillip and Perron tests and Johnson Co integration technique to know the relation among agriculture productivity and carbon emission food security on the data from 1961 to 2010 further the results of the study concluded that the all these variables does not have any kind of relation in longer span. The results of VAR estimates and the impulse response function reveals that the carbon emission, agriculture productivity and food security are negatively associated in short run.

3. Materials and Methods

The study is based on secondary data from 1971 to 2022; further the variables used in the study are identified by reviewing the existing literature. Following variables are identified for the study purposes:

Table 1: Variable description and data sources

Variables	*Explanation*	*Data Sources*
CO_2	carbon dioxide emission (Metric tons per capital)	WDI
FER	fertilizers consumption (000 tons)	GOI
FGP	food grain production (Million Tons)	GOI
TCA	Total Cropped Area GOI (Million Hectares)	

Note: WDI: World Development Indicators, World Bank data base
GOI: Government of India, Agriculture Statistics at a Glace 2022.

4. Econometrics Model specification

4.1. Correlation Matrix

Correlation refers to relation between two variables. The correlation between two variables may high or strong and low or weak. The high correlation explains that the variables are strongly related to each other while the low or weak relation means there is no or barely a relation between the variables. The range of correlation coefficient extent from -1 to +1.The zero value of correlation coefficient reveals that there is no correlation between the variables. The value of -1 of correlation coefficient explains that there is perfect negative correlation while the +1 value of correlation coefficient means the variables have perfect positive correlation.

4.2. Stationary test

Firstly, the stationary of data has been checked to know the normality and stationary of data as it is the basic assumption of econometrics models and stationary also guides us to towards the tools or technique that should be applied to know the relationship between the variables. There are some tests to know the stationary like augmented Dickey-Fuller test (1979) has been used to check the stationary of data.

4.3. Ordinary least Square (OLS) Method

The OLS is a method of regression estimation. The OLS estimation simply estimates the unknown parameters from the known ones.

4.4. Granger Causality Test

The granger causality test is oldest method of identifying causation between the variables. The test was present by G.J. Granger in 1969. In the present study the test simply try to find out the causation between the variables of agriculture productivity and CO_2emission. The null hypothesis is tested at a level of significance and it is tries that null hypothesis should be rejected. The test is based on f-values.

5. Results and Discussion

This section of the paper explains the results of different econometrics models and also explains the needful discussion.

5.1. Correlation Analysis

The correlation analysis shows that all the variables are positively related with each other. The Coefficient values are high in all the cases that mean the variables have a high degree of correlation.

5.2. Unit root test

The ADF test shows that the some variables are stationary at level and some variables are stationary at the first difference. The variables like Total cropped area and food grain production did not found stationary at level

Table 2: Correlation between Variables

	CO_2	*LNFER*	*LNFG*	*LNTCA*
LNCO2	1.000	0.959	0.960	0.261
LNFER	0.959	1.000	0.979	0.408
LNFGP	0.960	0.979	1.000	0.377
LNTCA	0.261	0.408	0.377	1.000

Source: Own Composition

Table 3: Augmented Dickey and Fuller (ADF) unit root test results

Variables	*At Level*		*At 1 Difference*		*Decision*
	t-Statistic	*P-Value*	*T-Statistic*	*P-Value*	
LNCO2	-1.802	0.6860	-6.303***	0.0000	I (1)
LNFER	-1.475	0.8226	-5.391***	0.0000	I (1)
LNFG	-5.480***	0.0003	-25.840	0.0000	I(0)
LNTCA	-5.706***	0.0001	-12.310	0.0000	I(0)

*** Indicates significance at 1% level.
Source: Own Composition

so both the variables are tested at first difference for stationary purpose and both the variables are found stationary at the first difference. All other variables namely carbon dioxide emission (Metric tons per capital), energy consumption (per kg of oil equivalent energy use), fertilizers consumption (000 tons) found stationary at level.

5.3. *Ordinary least square method*

Before applying the OLS model optimum lag was selected for the model.

Table 4: Lag selections

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-687.66	NA	1.35e+0	30.072	30.23	30.131
1	-498.78	336.7	73695.2	22.555	23.350*	22.853
2	-478.46	32.690	62118.68	22.367	23.79	22.903
3	-449.86	41.035	37487.9	21.820	23.88	22.594
4	-424.01	32.5924*	26559.27*	21.391*	24.09	22.404*

Source: Own Composition

The maximum lag length criterion is 4 lag according to AIC criteria. The AIC criterion is selected for optimum lag.

$$Lnco_2 = \beta_0 + \beta_1 Lnfer + \beta_2 Lnfgp + \beta_3 Lntca + \upsilon i$$

Where,
$Lnco_2$ = Log value of carbon dioxide emission
Lnfer = Log value of fertilizers consumption
Lnfg = Log value of food grain production
Lntca = Log value of Total Cropped Area
υi = Error term

The results of OLS estimation is described in table 5.

Table 5: Results of OLS Estimation

Dependent Variable: carbon dioxide emission				*Period: 1971 – 2022*		
	Coefficient	*Prob.*	R^2	*Adj.* r^2	*F*	*F (Prob.)*
Constant (β_0)	-7.6253	0.0001	0.9477	0.9441	260.0	0.000
fertilizers consumption (β_1)	1.2096	0.0000				
Food grain production (β_2)	-0.3959	0.0511				
Total Cropped Area (β_3)	0.1554	0.1364				

Source: Authors' own calculations

The results of ordinary least square applied to examine the impact of agriculture productivity variables (fertilizers consumption, Food grain production and Total Cropped Area) on carbon dioxide emission in table 5. The results indicate the fertilizers consumption and food grain production positively effects the carbon dioxide emission while the total cropped area negatively impact the carbon dioxide emission further the all the variables are statistically significant. The high value of R^2 shows that the agriculture production contributes to carbon dioxide emission.

5.4. Granger Causality Test

The results of granger causality test show that there is unidirectional causality between the most of the variables of agriculture productivity and carbon dioxide emission The results shows that there is no relation between carbon dioxide emission and energy consumption same results also find in the case of fertilizers consumption and carbon dioxide emission, fertilizer consumption and energy consumption. . The results reveals that the carbon dioxide emission has a causal relation with fertilizer consumption as soon as the carbon dioxide emission increasing fertilizer consumption also increasing in the country as carbon dioxide emission have positive relation with fertilizer consumption. The carbon dioxide emission has positive causal relation with total cropped area. The results further indicate that there is positive causal relation between food grain production and fertilizer consumption and same results find in the case of total cropped area and fertilizer consumption.

Table 6: Results of Granger Causality Test

Null Hypothesis	*P-Value*	*Result*	*Relationship*
LNCO2INT does not Granger Cause LNCO2	0.6431	ACCEPTED	NO
LNCO2 does not Granger Cause LNCO2INT	0.899	ACCEPTED	RELATION
LNFER does not Granger Cause LNCO2	0.705	ACCEPTED	NO
LNCO2 does not Granger Cause LNFER	0.4341	ACCEPTED	RELATION
LNFG does not Granger Cause LNCO2	0.7043	ACCEPTED	UNIDIREC-
LNCO2 does not Granger Cause LNFG	0.0299	REJECTED	TIONAL RELATION
LNTCA does not Granger Cause LNCO2	0.3374	ACCEPTED	UNIDIREC-
LNCO2 does not Granger Cause LNTCA	0.0064	REJECTED	TIONAL RELATION
LNFER does not Granger Cause LNCO2INT	0.140	ACCEPTED	NO
LNCO2INT does not Granger Cause LNFER	0.323	ACCEPTED	RELATION
LNFG does not Granger Cause LNCO2INT	0.1626	ACCEPTED	UNIDIREC-
LNCO2INT does not Granger Cause LNFG	0.050	REJECTED	TIONAL RELATION
LNTCA does not Granger Cause LNCO2INT	0.133	ACCEPTED	UNIDIREC-
LNCO2INT does not Granger Cause LNTCA	0.012	REJECTED	TIONAL RELATION
LNFGP does not Granger Cause LNFER	0.0037	REJECTED	BIDIREC-
LNFER does not Granger Cause LNFGP	0.0397	REJECTED	TIONAL
LNTCA does not Granger Cause LNFER	0.019	REJECTED	BIDIREC-
LNFER does not Granger Cause LNTCA	0.026	REJECTED	TIONAL
LNTCA does not Granger Cause LNFGP	0.251	ACCEPTED	UNIDIREC-
LNFGP does not Granger Cause LNTCA	0.076	REJECTED	TIONAL RELATION

Source: Own Composition

Conclusion

This paper analysed the relationship among carbon dioxide emission, energy consumption, fertilizers consumption, total cropped area and food grain production. The various test applied on the time series data shows that the only energy consumption have a significant positive relationship with carbon dioxide emission. The other variables like fertilizers consumption, total cropped area and food grain production also share an association with carbon dioxide emission but they are not significant. Firstly unit root test was applied and variables were found stationary at level and first difference. The results of OLS reveal that the energy consumption is positively contributing to carbon dioxide emission. Fertilizers consumption and total cropped area have negative relation with carbon dioxide emission but the relation is insignificant statistically.

References

Boontome, P., Therdyothin A., Chontanawat J. (2017). "Investigating the causal relation between non-renewable and renewable energy consumption, co2 emission and economic growth in Thailand" *Energy Procedia* 138: 925-930.

Pant, K. K. (2009). "Effects of agriculture on climate change: a cross country study of factors affecting carbon emissions" *The Journal of Agriculture and Environment 10.*

Ozturk, I., Uddin, G., S. (2008). "Causality among carbon emissions, energy consumption and growth in India" *Economic Research,* Vol. 25(3) 752-774.

Javed, Z.H., Muhammad, S., Muhammad, R., (2018). "Agricultural productivity and co2 emission in Pakistan: an econometric analysis" *International Journal of Renewable Energy Research, (8) 3*

Aye, G, C., Edoja, P., E. (2017). "Effect of economic growth on co2 emission in developing countries: Evidence from a dynamic panel threshold model" *Cogent Economics & Finance* 5: 1379239.

Tiwari, A., K. (2011). "Energy consumption, co2 emissions and economic growth: a revisit of the evidence from India" *Applied Econometrics and International Development 11-2.*

Hussain, M., Javaid.M., I., Drake, P., R. (2012). "An econometric study of carbon dioxide (co2) emissions, energy consumption, and economic growth of Pakistan" *International Journal of Energy Sector Management,* (6)4: 518 – 533.

Rehman, A., Ozturk, I., Zhan, D. (2019). "The causal connection between co2 emissions and agricultural productivity in Pakistan: empirical evidence from an autoregressive distributed lag bounds testing approach" *Journal of Applied Science,* 9, 1692.

Stamatiou, P., Dritsakis, N. (2017). "Dynamic modeling of causal relationship between energy consumption, co2 emissions, and economic growth in italy" *Advances in Applied Economic Research.*

Edoja, P., E., Aye, G., and Abu, O. (2016). "Dynamic relationship among co2 emission, agricultural productivity and food security in Nigeria" *Cogent Economics & Finance* (issn: 2332-2039) 4: 1204809.

Jebli, M., B., and Youssef S.,B. (2017). "Renewable energy, arable land, agriculture, co2 emissions, and economic growth in morocco" *Mpra paper no. 76798 online at* https://mpra.ub.uni-muenchen.de/76798/.

Leitão, N. C. (2018). "The relationship between carbon dioxide emissions and Portuguese agricultural productivity" *Studies in Agricultural Economics* (120)143-149).