



## **ELECTRICITY CONSUMPTION AND AGRICULTURAL GROWTH IN INDIA: THE ROLE OF FERTILIZER USE AND IRRIGATION**

Ranjan Kumar Mahato <sup>1</sup> & Souvik Dasgupta <sup>2</sup>

### **RESEARCH ARTICLE**



#### **Author Details:**

<sup>1</sup> Research Scholar,  
Department of Economics,  
Sidho-Kanho-Birsha University,  
Purulia, West Bengal, India;

<sup>2</sup> Assistant Professor,  
Department of Economics,  
Sidho-Kanho-Birsha University,  
Purulia, West Bengal, India

#### **Abstract**

In India, agriculture sector accounts for more than 20 per cent of total electricity consumption in the country as a whole. The present study examines the relationship between electricity consumption for agriculture and its growth in India for the period 1983-84 to 2018-19 in the vector error correction model (VECM) framework. It found that in the long run electricity use in agriculture sector has a significantly positive effect on this sector's value added during the study period. The results also suggested that any short-run deviation from long-run equilibrium will automatically be corrected in the next year and thus in the present model the process will converge towards its long-run equilibrium value.

#### **Corresponding Author:**

Ranjan Kumar Mahato

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#### **Introduction**

Agriculture sector is the most significant sector of Indian economy. Approximately 20–22% of the electricity is used in the agricultural sector (According to pib.gov.in). Direct and indirect energy demands can be distinguished in agricultural energy consumption. The direct electricity requirements involve the electricity needed for land preparation, planting, watering, cultivating, harvesting, processing the produce once it has been picked, producing food, storing it, and transporting it for use in agriculture. In India context agriculture sector uses electricity primarily for land preparation and irrigation. Electricity and carbon-based fuels had significantly replaced human and animal power in the agriculture sector's energy consumption structure. Agriculture sector electricity consumption of India in 2019-2020 was 211295 GWh which is about 20.08 per cent of total electricity consumption of whole country. The trajectory of India's agriculture sector's consumption of energy has been significantly influenced by the policies that the Indian government developed and put into effect. Groundwater became the major source for agriculture due to subsidized electricity; however, the government can also be held burden for that yet it can impact on agriculture production. The specific objective of the study is to analyse the long run relationship between electricity consumption (agriculture purpose) and agriculture growth in India for the period 1983-84 to 2018-19.

Narayanamoorthy (1997) reported that the growth rate of power consumption in the agricultural sector is larger than the growth rate of the domestic and industrial sectors. The pace of expansion in the area covered by groundwater and electric pump sets is substantially slower than the rate of increase in the amount of power consumed. Karkacier et al. (2006) analyzed the impact of energy use on agricultural output in Turkey. The authors employ regression analysis to examine the relationship between energy use and agricultural output based on yearbook data from 1971 to 2003 and they highlighted significant role of energy inputs in influencing agricultural output. Murthy and Raju (2009) found that irrigation using ground water began to take precedence over irrigation using canals. With irrigation using ground water, farmers have more control over the availability of water. Bardi et al. (2013) emphasized that incorporate renewable energy in agriculture can reduce carbon emissions and improve sustainability. Although, the transition faces obstacles because maximum agricultural inputs still rely on fossil-fuel-based production. Karanfil (2015) considered the four potential links between energy use and economic growth: growth, conservation, neutrality, and feedback. Liu and Hao (2018) suggested energy consumption and growth in economy are linked in the two ways. Kumar et al. (2022) investigated to determine the long-term co-movement and causal association among real gross state domestic product (GSDP) from agriculture and its related sectors and power consumption.

**Data and Methodology**

The present study used annual time series data of India on agriculture and allied sector growth, electricity consumption in agriculture, irrigation and fertilizer consumption for the period 1985-86 to 2018-19. The data sources used are Agriculture statistics 2021, World Bank and RBI hand book data and for the empirical analysis some simple statistical tools like, percentage, mean, median and Skewness and kurtosis, unit root test, JCT and Vector error correction model (VECM).

**Table 1: Variables’ description and Data sources**

Variable	Description	Data Source	Natural Logarithm
<b>A</b>	GVA of agriculture and allied sectors (% of GDP)	WDI (World Bank)	LNA
<b>E</b>	electricity consumption in agriculture (% of total consumption)	Agricultural Statistics at a Glance, Govt. of India	LNE
<b>F</b>	Total fertilizer consumption per hectare	RBI	LNF
<b>I</b>	Gross irrigated area	RBI	LNI

The empirical strategy is composed of three parts:

1. Unit root test – stationary or not?
2. if needed, Cointegration Test.
3. If cointegrated, ECM.

**Data Analysis and Results**

Table 2 presents the descriptive statistics of the variables used in study, namely agriculture growth (LNA), electricity uses in agriculture (LNE), fertilizer (LNF) and irrigation (LNNI). From the table, it is observed that the mean value of agricultural growth (LNA) is near about 3.07 with a SD of 0.23. Similarly mean of electricity use agriculture (LNE) is about 3.16 with a SD of 0.16. The average value of fertilizer near about 5 percent with SD of 0.40 and mean of irrigation 6.32 with a SD of 0.16.

**Table 2: Descriptive Statistics**

	LNA	LNE	LNF	LNNI
Mean	3.071662	3.161012	5.116436	6.326864
Median	3.073386	3.109923	5.123964	6.345636
Maximum	3.484513	3.446171	5.639066	6.572982
Minimum	2.774564	2.880321	4.345103	6.037155
Std. Dev.	0.238828	0.167741	0.402293	0.162626
Skewness	0.143177	0.316998	-0.351257	-0.376406
Kurtosis	1.425127	1.810017	1.978454	2.049054
Jarque-Bera	3.843336	2.727015	2.305623	2.206537
Probability	0.146363	0.255762	0.315748	0.331785
Sum	110.5798	113.7964	184.1917	227.7671
Sum Sq. Dev.	1.996367	0.984791	5.664401	0.925654
Observations	36	36	36	36

Source: Authors’ calculation.

Values of the skewness of agricultural growth (LNA) and electricity use in agriculture (LNE) follow a positive skewness distribution, and the variables fertilizer and irrigation are negatively skewed. If we also consider the kurtosis values, all the variables follow a platykurtic distribution.

The ADF test (Dickey & Fuller, 1981) and Phillips–Perron (PP) test (Phillips & Perron, 1988) is performed to examine the stationary properties of the variables and their order of integration. The table 3 summarizes the results of ADF and PP tests, which shows that LNA, LNE, LNF, and LNNI are non-stationary at level as the null hypothesis of unit roots for both the test cannot be rejected for all the variables. However, first differencing makes them stationary. Thus, all the variables are non-stationary with integration of order one, that is,  $I(1)$ .

**Table 3: Unit Root Tests Results**

Variables	Augmented Dickey-Fuller Test				Comment
	Constant		Constant, Linear Trend		
	At level	First Difference	At level	First Difference	
LNA	-0.711870	-3.221075**	-1.972237	-7.332358 ***	I(1)
LNE	-1.506842	-3.188689 **	-2.907398	-3.613050 *	I(1)
LNF	-1.772956	-5.014469 ***	-1.729851	-5.167199 ***	I(1)
LNNI	-0.948825	-7.001438 ***	-2.287106	-7.007780 ***	I(1)

Variables	Phillips-Perron Test				
	Constant		Constant, Linear Trend		
	At level	First Difference	At level	First Difference	
LNA	-1.355165	-7.002506 ***	-1.416960	-7.138350 ***	I(1)
LNE	-1.749615	-3.119703 **	-2.749301	-3.573319 *	I(1)
LNF	-1.926880	-5.008689 ***	-1.906826	-5.220675 ***	I(1)
LNNI		-6.993717***		-7.018576 ***	I(1)

Source: Authors' calculation.

Notes: \*\*\* and \*\* denote the level of significance at 1% and 5% respectively

I(1) => non-stationary nature of the variable with the integration of order one.

Table 4 presents different criteria for lag length selection such as the Log Likelihood (LogL), Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan–Quinn Criterion (HQ) based on our endogenous variable LNA, LNE, LNF and LNNI.

**Table 4: VAR Lag Order Selection Criteria** (Endogenous variables)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	131.3863	NA	5.21e-09	-7.720382	-7.538987	-7.659348
1	282.6396	256.6723	1.45e-12	-15.91755	-15.01058*	-15.61238
2	304.4755	31.76132*	1.07e-12*	-16.27125*	-14.63869	-15.72194*
3	320.0431	18.86981	1.24e-12	-16.24504	-13.88691	-15.45160

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

From the table 4, it can be observed that LR, FPE, AIC, SC and HQ criteria suggest that the optimum value of lag length is 2 because their minimum values at lag 2. On the other hand, the Schwarz Criterion (SC) suggests an optimum value of lag length is 1 because it has minimum value at lag 1. Since most of the criteria (LR, FPE, AIC, and HQ) suggest taking lag length 2 for the VAR model.

The multivariate analysis of this study examines the cointegrating relationship among LNA, LNE, LNF and LNNI. In this context, Johansen cointegration test (1988) is applied to find out whether any long-run relationship exists among them. Table 5 reports the results of Johansen cointegration test.

**Table 5: Johansen Cointegration Results**

	Trace Statistic	Critical value	Max. Eigenvalue Statistic	Critical Value
None *	83.58303	47.85613	43.80132	27.58434
At most 1 *	39.78171	29.79707	30.34381	21.13162
At most 2	9.437897	15.49471	6.569586	14.26460
At most 3	2.868311	3.841466	2.868311	3.841466

Source: Authors' calculation.

**Note:** Both the Trace test and Max-eigenvalue test indicate 2 cointegrating eqn.(s) at the 0.05 level.

\* denotes rejection of the hypothesis at the 0.05 level

Both Trace statistics and Max Eigenvalue statistics indicate that there are two cointegrating equations among the variables, implies that all the variables are cointegrated.

### VECM Result

Cointegration provides long-run equilibrium relationship between two or more non-stationary variables. However, it does not say anything about short-run dynamics that keep the long-run equilibrium relationship intact. In this context, the study applies VECM to assess the long run relationship among agriculture growth, electricity use in agriculture, fertilizer and irrigation in India along with short-run dynamics. The result of estimated long-run relationship is presented in Table 6. The estimated long-run relationship indicate that Fertilizer (LNF) impact is insignificant in long-run.

**Table 6: Estimated Long-run Relationship**

	Coefficient	Std Errors	t-statistic
LNA	1.000000		
LNE	-0.738823	0.08231	-8.97584

LNF	-0.344527	0.21399	-1.60998
LNNI	-1.347387	0.48350	-2.78671
Constant	-7.471368		

Source: Authors' calculation.

The coefficient of the error correction term, ECT(-1) is reported in Table 7. The coefficient of ECT(-1) is negative and statistically significant at 5% level. It indicates that any short-run deviation from the long-run equilibrium relationship will automatically be corrected in the next year, and estimated speed of error correction is around 13%. It implies that the process will converge towards its long-run equilibrium value.

Table 7: Short-run Dynamics

	Coefficient	Std Errors	t-statistic
ECT(-1)	-0.125801	0.06147	-2.04650

Source: Authors' calculation.

### Conclusion

From the results we can conclude that in log-run electricity use in agriculture has significantly positive effect on agriculture growth during the study period (1983-84 to 2018-19). The results also suggest that any short-run deviation from long run equilibrium will automatically corrected in the next year. Thus, in the VECM model the adjustment process will converge towards its long-run equilibrium. Its indicate that presence of a stable long-run relationship among the variables.

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