



## Energy Consumption and Agricultural Economic Growth Nexus: Evidence from India

Krishna Murthy Inumula<sup>1</sup>, Seema Singh<sup>2</sup>, Sandip Solanki<sup>1\*</sup>

<sup>1</sup>Symbiosis Institute of International Business, Symbiosis International (Deemed University), Pune, Maharashtra, India, <sup>2</sup>Director, Symbiosis Centre for Corporate Education, Pune, Symbiosis International (Deemed University), Pune, Maharashtra, India.

\*Email: [sandip.solanki@siib.ac.in](mailto:sandip.solanki@siib.ac.in)

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### ABSTRACT

This study aims to empirically test the relationship between agriculture economic growth and energy consumption in India covering the annual time series data for the period 1985-2017 on four economic indicators namely agricultural value added (constant 2010 US\$) as an alternate favoring fiscal development of agriculture, energy spending represented by agricultural electricity consumption (GWh), agricultural gas consumption (mmcft) and agricultural oil consumption (tons) in India. The study variables are assessed for stationarity using the ADF tests and after confirming the same order of integration, the Johansen's Co-integration Test is exercised to find the extended association amid agriculture growth and energy consumption. Both the Trace and Lmax tests found that there exists one co-integrating equation in the system. The co-integration test confirms the long run equilibrium relation between energy consumption and agricultural economic growth in India. The short run relationships are tested by using the VECM methodology and finally the impulse responses are studied for the forecast horizon of ten years period to assess the performance of agricultural growth Vis a Vis energy consumption by imposing one standard deviation shock to the independent variables.

**Keywords:** Co-integration, Agricultural Growth, Energy Use and Time Series Analysis

**JEL Classifications:** C32, O13, Q40

### 1. INTRODUCTION

Agricultural economic growth and energy consumption is vital for the decision making of both the agricultural policy and energy policy. Energy is one of the critical impelling strengths for monetary goings-on, chiefly agriculture growth. Energy has relentlessly performed an imperative function in the lives of human-beings and of course economic development has been getting the fillip through it. Agriculture has always been making a vital impact on the Indian economy. There can be no economic activity devoid of agriculture. However, the agricultural sector has to pass-through intricate ordeals with unprecedented force of energy consumption. It was accounted that energy consumption in 26 developed nations had grown at an average yearly rate of 0.62 percent and in the developing nations at an average rate of

4.36% since 1996. Energy has been consumed by the entire world to prop up worldwide fiscal and societal enlargement to uplift living standards of human-beings.

The coal based electricity generation in India is a major policy threat as well as opportunity to explore alternative sources of energy to achieve energy efficiency across all the sectors of India economy. Agriculture as a primary sector in Indian economy plays an important role and attracts government incentives in terms of subsidized power tariffs which drastically increases the public expenditure and free electricity to farmers due to this, achieving the energy efficiency in agriculture is a major policy concern as it drives the country's social, political and geographical issues which needs to be well addressed and give a certain direction to the policy makers. India spends around 2% of its GDP value

as power subsidy expenditure in agriculture sector and there is much needed opportunity for India to achieve energy efficiency by increasing the alternative renewable energy use in agriculture and thus provide a balance between the environment protection and economic growth of the country.

In the Indian context, the energy consumption to agricultural sector via the conventional and renewable sources of energy is not well addressed in the literature but few studies have highlighted the impact of using different sources of energy to agricultural growth and its implications on environment via carbon emissions. The greenhouse effect of the agriculture economic growth (Qiao et al., 2019) in relation with the energy consumption are studied respectively for Group of Twenty (G20) countries and South Asian Association for Regional Cooperation (SAARC) countries, results found a long run relationship between the variables. For G20 countries it is found that agriculture growth increases the carbon emissions whereas the renewable energy consumption reduces the carbon emissions. But for SAARC countries the agriculture growth and renewable energy consumption has led to reduction in carbon emissions but the overall economic growth has caused increase in the carbon emissions.

## 2. LITERATURE REVIEW

There are numerous contents that have tried to experiment causality amid energy and monetary expansion, although exceptionally a small number of literature has been considered to validate for causality amid power use and agricultural expansion. This paper, therefore; focuses on what type of relationship exists amid energy use along with agricultural monetary expansion, extended and squat run relation with particular reference to India.

Chontanawat et al., (2008) studied causality amid power and GDP by exercising a reliable statistics and tactic for 100+ nations. Causality from power to GDP is initiated to be further widespread in the advanced OECD nations; entailing that a strategy to trim down power use targeted at lessening releases is probable to have a superior influence onto GDP of the advanced globe. Chandio et al., (2019) examined the bond amid power use and fiscal growth in Pakistan from 1984 to 2016. Extract of this monograph has presented that fiscal advancement in agriculture is optimistically impacted by gas use and electrical energy use in extended and squat sprint. Abbas and Choudhury (2013) analyzed that the majority imperative power supplies are oil and renewable for Turkey. Both power supplies have identical significance to fiscal expansion. Choudhury (2013) observed the causality linking electrical energy use along with fiscal advance in 2 compactly peopled nations in SA - India and Pak. Causality investigation had been anticipated at amassed and disaggregated point where spotlight of investigation was on agri-sector. Disaggregated causality study signified bi-directional causality amid agri power use and agri GDP in India, whilst in Pak. causality was unfolded to operate from agri- GDP to agri power use. Nuryartono and Rifai (2017) studied the causality connection amid fiscal expansion, power utilization, and CO<sub>2</sub> discharges in four ASEAN nations throughout 1975-2013. The result showed that monetary enlargement and power utilization in

Indonesia and Singapore are not interrelated. Whilst in Malaysia and Thailand, there is an undeviating causal link. A one course link amid monetary enlargement along with CO<sub>2</sub> release took place in Indonesia and Thailand, whilst in Malaysia and Singapore didn't subsist. Causal affiliation amid power use and CO<sub>2</sub> release in Indonesia, whereas in other nations didn't subsist. The reply of each variable on the shock in other variables is dissimilar in every nation. Esen and Bayrak (2017) reviewed the impacts of power use on financial enlargement by panel data study of 75 net power importing nations from 1990 to 2012. Outcome received for panel statistics as well as for every nation designate that there is optimistic as well as factually noteworthy affiliation amid power use and fiscal expansion over long term such that power use adds additional to fiscal expansion as the import reliance of nation reduces. Furthermore, the result of power use on fiscal expansion reduces as earning level of nation augments.

Kwakwa (2011) observed the causality amid disaggregated power use (electric and fossil use) and general augmentation, agriculture and manufacturing expansion in Ghana's financial system from 1971 to 2007. Work pointed a unidirectional causality from general expansion to electric and relic use; a unidirectional causality from agri to electric use together in squat and extended run. Power seems not to be an indispensable aspect of manufacturing in agri-segment however vital in the industrialized segment; thus, it is suggested that attempts be geared to ensure elevated flow of power to manufacturing segment to maintain its part to the financial system. Mozumder and Marathe (2007) examined that there is unidirectional causality from per capita GDP to per capita electric use. Conversely, per capita power use doesn't cause per capita GDP in Bangladesh. Karhan (2019) studied causality amid renewable energy use and fiscal expansion was examined for 19 EU nations by exercising Rolling Windows Granger Causality Test for 1994-2015. Output of the research confirms that renewable energy use Granger caused fiscal expansion at 2001, 2002, 2003 and 2014. Fiscal expansion Granger cause renewable energy use at 2004, 2005 and 200. It can be comprehended that course of the causality affiliation amid variables alters in dissimilar durations. Pragmatic outputs have vital strategy insinuations for EU-19 nations. Kebede et al., (2010) assessed sum of power requirement, that's formed of conventional power and power used in business activity, in the Central, East, South, and West parts of Sub-Saharan Africa. Cross-sectional time series statistics for 20 countries in 25 years are studied and outcome of the work depicts firewood energy counts for 70% of power usage. Outcomes suggested that power need is opposite to cost of fuel as well as manufacturing expansion, but is optimistically associated with GDP, populace increase pace, and agri-expansion, and cost suppleness. The replica inferences too depict that there are local dissimilarities in power need.

Zamani (2007) investigated causal connection amid general GDP, industry and agri-worth added and usage of diverse sorts of power exercising vector fault alteration replica for Iran in 1967-2003. A long-run unidirectional association from GDP to sum power and bidirectional association amid GDP and gas as well as GDP and fuel merchandises usage for entire financial system was unearthed. Causality is functioning from value added to sum power, electric power, gas and gasoline merchandises

usage and from gas usage to value added in the industry sector. The long-run bidirectional associations seize amid value added and sum power, electricity and petroleum products usage in agri-segment. Short-run causality functions from GDP to complete power and petroleum merchandise; moreover, business worth is added to sum power and petroleum merchandises usage in this sector. Rafiq and Salim (2011) examined that there subsists unidirectional squat and prolonged causality operating from power usage to GDP in China, uni-directional squat causality from extract to power usage for India, while bi-directional squat causality in Thailand. Impartiality amid power usage as well as revenue is seen for Indonesia, Malaysia, and Philippines. Both indiscriminate discrepancy putrefactions and yen reply functionality authenticates course of causality. Ferguson et al., (2000) investigated those rich nations possess a powerful link amid electric usage and affluence formation for world financial system, there is a strong correspondence amid electric usage and prosperity foundation. The work depicts that, in rich nations, the boost in prosperity over time associates with an augment in e/E ratio. Tang et al., (2017) inspected that there is an approximately downbeat affiliation amid EEI and gross household product (GDP) per capita, though there are a few omissions, like Russia and Taiwan. Kalu et al., (2019) inspected that there is tough proof of the survival of a long-run affiliation amid power usage and pointers of fiscal expansion. There are tough evidences that economic expansion and agri value added to alter to the upsets and dynamics of the worked out power usage associated variables whilst industrialized value added confirmed or else. Shengfeng et al., (2012) observed the squat and extended expressions of causal liaison amid electric usage as well as actual GDP in China in the course of vector mistake alteration form that can shun fake causal affiliation. Consequences of VECM disclosed co-integration association amid actual GDP and electric usage and existence of unidirectional causality from electric usage to fiscal expansion in squat and extended time that is consequently authenticated in 2 dissimilar sub-phases.

Chen et al., (2007) signified that causality courses in 10 Asian nations are blended whilst there is a uni-directional squat-course causality functioning from fiscal expansion to electric usage and bi-directional long-run causality amid electricity use and fiscal expansion if sheet statistics modus operandi is executed. Mehrara (2007) inspected causal association amid per capita energy usage and per capita GDP in a plate of 11 chosen oil exporting nations by exercising pane unit-root trials and pane co-integration examination. Outcomes demonstrate a unidirectional powerful causality from fiscal expansion to power usage for oil exporting nations. Desfiandi et al., (2019) opened quite a few macroeconomic aspects viz power cost, GDP, and substitute charges impacting point of usage of power, whilst rise in global oil prices and decrease in petroleum funding by the administration will impact on reduced energy usage in Indonesia. Yıldırım et al., (2014) examined causal associations amid fiscal expansion and energy usage in 11 nations. It is seen that the impartiality proposition is suitable for all of the nations excluding Turkey. These inferences entail that power saving strategies must be iexecuted in Bangladesh, Egypt, Indonesia, Iran, Korea, Mexico, Pakistan and Philippines. In the instance of Turkey, a unidirectional causal relation was seen from power usage to fiscal expansion. Since the expansion proposition

is suitable, the power protection strategy causes an impediment for fiscal expansion in Turkey. Fatai et al., (2004) examined that power protection strategies donot have momentous effects on actual GDP expansion in industrial nations such as New Zealand and Australia put side by side to a few Asian financial systems.

Tsani (2010) studied the causal correlation amid summative and non-summative points of power usage and fiscal expansion for Greece for 1960-2006. Outcome pointed the occurrence of a uni-directional causal correlation functioning from sum power usage to actual GDP. At disaggregated points, experiential verification advises that there is bi-directional causal correlation amid industrialized and housing power usage to bona fide GDP however this is not instance in transportation power usage with causal correlation has been acknowledged in neither course. Kouakou (2011) investigated the causal association amid the electric control commerce and the fiscal expansion of Cote d'Ivoire from 71 to 08. Inferences stated bi-directional causality amid per capita power usage and per capita GDP. A uni-directional causality functioning from electric usage to manufacturing significance emerges in squat run. Fiscal expansion has enormous impacts on electric usage and repeal causality from electricity to fiscal expansion might emerge. In extended run, there is a uni-directional causality amid electricity and both GDP and industry. Rezitis and Ahammad (2015). Xundi et al., (2010) found that Beijing's building expansion is feeling a move from financial expansion hysteresis to power usage hysteresis. The elevated synchronized expansion quantity forecast the powerful structure of economy and that leans to immovability of Beijing's building engineering that doesn't inevitably define an ideal expansion inclination nevertheless a higher boundary of the escalating pace in power usage. Rezitis and Ahammad (2015) examined the energetic affiliation amid power usage and fiscal expansion in 9 South and Southeast Asian nations during 1990-2012. Inferences stated that bidirectional causality impacts power usage and fiscal expansion that assist criticism proposition, meaning that these variables have strong interdependency amid one another.

### 3. DATA AND METHODS

#### 3.1. Data and Scope

Undertaken econometric research work exercises yearly time series statistics from 1985 to 2017. Data on four economic indicators namely agricultural value added (constant 2010 US\$) as an alternative for agri fiscal expansion, power usage represented by agri-electricity use (GWh), agricultural gas use (mmcft) and agricultural oil use (tons), collected. The study data is collected from different sources like world bank, data.gov.in an Open Government Data (OGD) platform in India, Statistical yearbook, Ministry of Statistics and Programme Implementation (Mospin), Indiastat.com and from diverse fiscal reviews to fill the statistics gaps.

The relationship amid agricultural fiscal expansion and energy use is essential for both agricultural policy and energy policy decision making. This research study focuses on what type of relationship exists amid energy use and agricultural fiscal expansion, elongated and squat run association, how originality and fright to one

variable alteration the other variables. The endogeneity framework facilitates each variable as a study variable or dependent variable so that the interrelationships among the variables are captured through the causality flow amid the variables. In this monograph, agricultural fiscal expansion is judged as study variable to perceive elongated course association amid energy use and agricultural fiscal expansion.

### 3.2. Econometric Methodologies

Preceding time-series variables are trialed for stationary by exercising ADF assessment that in component source proposition presumes that series beneath the deliberation is non-stationary and another proposition is series' stationary. Choice of lag extent is indispensable for representation formation as it impacts extent of statistics, lag span and failure of acquaintance. For opting lag span, typical familiarities principles viz AIC, BIC and HQC were exercised. Johansen-s co-integration assessment is exercised to decide extended course affiliation amid given variables. Stationary of statistics variables is pre-condition for co-combination, once statistics variables are seen to be co-integrated that entails that there subsists a extended symmetry liaison amid the variables, later assessing in support of squat course associations via exercising replica of VECM.

The rationale of the co-assimilation assessment is to verify if non-stationary series is co-integrated. Further EG causality system, Johansen (1988; 1991) modus operandi of co-integration is too in use. Johansen's view commences with unhampered VAR entailing non-stationary variables that permit functioning with replicas quite a few endogenous variables. Main dynamics of Johansen-s co-integration view is separating as well as recognizing "r" co-integrating amalgamations amid cluster of "k" incorporated variables as well as include them into an experiential replica. The co-integration grade separates the statistics into r associations, as progression is regulating and k - r (k, number of non-stationary I [1] variables) associations that are forcing procedure.

VAR is usually exercised to predict the methods of organized time-series and to investigate lively force of arbitrary troubles on scheme of variables. VAR evades the want of conservative structural presentation by considering each variable as endogenous in structure for purpose of wrapped worth of all other endogenous variables. Subsequent VAR structure is used in this study to explore the relationship amid energy use and agricultural fiscal expansion.

$$AgrGro_t = C_1 + \sum_{i=1}^k a_{1i} AgrGro_{t-i} + \sum_{i=1}^k b_{1i} AgEle_{t-i} + \sum_{i=1}^k c_{1i} AgGas_{t-i} + \sum_{i=1}^k d_{1i} AgOil_{t-i} + e_{1t}$$

$$AgEle_t = C_2 + \sum_{i=1}^k a_{2i} AgrGro_{t-i} + \sum_{i=1}^k b_{2i} AgEle_{t-i} + \sum_{i=1}^k c_{2i} AgGas_{t-i} + \sum_{i=1}^k d_{2i} AgrGro_{t-i} + e_{2t}$$

$$AgGas_t = C_3 + \sum_{i=1}^k a_{3i} AgrGro_{t-i} + \sum_{i=1}^k b_{3i} AgEle_{t-i} + \sum_{i=1}^k c_{3i} AgGas_{t-i} + \sum_{i=1}^k d_{3i} AgOil_{t-i} + e_{3t}$$

$$AgOil_t = C_4 + \sum_{i=1}^k a_{4i} AgrGro_{t-i} + \sum_{i=1}^k b_{4i} AgEle_{t-i} + \sum_{i=1}^k c_{4i} AgGas_{t-i} + \sum_{i=1}^k d_{4i} AgOil_{t-i} + e_{4t}$$

Where AgrGro is the agricultural fiscal expansion, AgEle is the agricultural electricity use, AgGas is agricultural gas use, and AgOil is the agricultural oil use. The direction of causality flow is tested up to lag 3 amid all the four variables. The occurrence of co-integrating association shapes the foundation of VECM pattern. We approximate the subsequent classification of equation devised in a VECM.

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k-1} + \Pi X_{t-1} + \mu + \epsilon_t; t=1, \dots, N$$

Where,

$\Delta$  is primary dissimilarity operative, X indicates vector of variables in logarithmic shape,  $\epsilon_t$  error term is a standard, sovereign as well as similarly disseminated casual variable with mean zero as well as standard deviation  $\Sigma$ ,  $\mu$  is a float consideration, moreover  $\Pi$  is (p x p) extended milieu of shape  $\Pi = \alpha \times \beta$ .

## 4. RESULTS AND DISCUSSION

### 4.1. Trend of Time Series Variables

The time series trend of the data variables are showed in Figure 1, agricultural value added (constant 2010 US\$) as a proxy for agricultural fiscal expansion showing almost a steady 45-degree linear growth over the study period. Both the electricity and gas use pattern is the same in line with the agriculture growth with minor fluctuation in the study period. Whereas the agricultural oil use is declined from the year 2000 to 2001 coinciding with the periodic reforms undertaken by India. The usage of oil use for agriculture declined during 2000-2017, and at the same time, the electricity and gas use are at peaks. It is observed that agricultural fiscal expansion has increased from 2113375 trillion dollars in the year 2000-3586185 trillion dollars in 2017. Electricity use for agriculture has increased from 84729 GWh in the year 2000-210611 GWh in the year 2017; agricultural gas use has increased from 7254 mmcf in the year 2000-15611 mmcf in the year 2017, oil use for agriculture has decreased from 2732 tons in the year 2000-489 tons in the year 2017.

### 4.2. Stationary Time Series

Data variables are altered in a natural logarithmic scale (log level) to mitigate the heterogeneity and scale effect. Both log point 1<sup>st</sup> dissimilarity of log-transformed variables are assessed pro stationarity by exercising ADF assessment in which element

origin proposition guesses that series beneath deliberation is non-stationary and another proposition is series' stationary. Outcome of Table 1 depicts that statistics variables in log level figure are non-stationary, but after the first difference, they became stationary. As statistics variables are non-stationary in point as well as stationary in principal dissimilarity there subsists at least one linear amalgamation of non-stationary variables is stationary. Consequently step is to perceive if four variables viz. agricultural fiscal expansion, agri- electric usage, agri-gas usage, along with agri- oil usage are co-integrated or not, that is, if agri- fiscal expansion and energy use have extended term balance correlation amid them or not.

### 4.3. Lag Selection and Direction of Causality

All the three information criterion AIC, BIC, and HQC gave optimal time of lag 1. Table 2 presents the details of lag choice along with course of causality. Course causality is assessed up to 3 lag periods by exercising VAC of Engel and Granger (Engle and Granger, 1987). VAR inferences are depicting causality at diverse

lags where null proposition is that agricultural fiscal expansion does not (Granger) reason agri-electricity usage, agricultural gas use and agricultural oil use and vice versa.

Results from Table 2 show that up to lag 3 there subsists a uni-directional causality amid agricultural fiscal expansion and agricultural gas use, where agricultural fiscal expansion (Granger) causes agri-gas use which alters in agricultural fiscal expansion are valuable to assume the alterations in agricultural gas use over three years. For one period lag there subsists a uni-directional causality amid agricultural fiscal expansion and agri-electric use, where agricultural fiscal expansion (Granger) causes agri-electric use meaning that changes in agricultural fiscal expansion are valuable to assume alteration in agri- electric usage within one-year time period. For a period of lag2 there subsists a uni-directional causality amid agri-gas use and agri-electric use, where agri-gas use (Granger) reasons electric use meaning that alterations in agri- gas use are helpful to assume alterations in agri-electric use for forceful use of gas will impact the use of electricity use

Figure 1: Time series graph

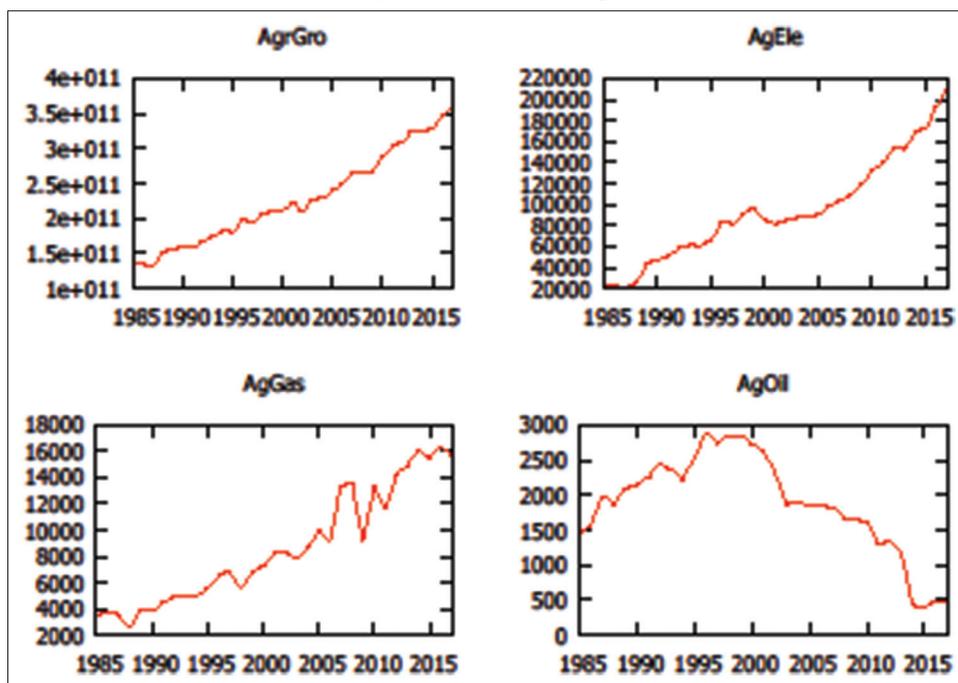


Table 1: ADF tests for stationary

Variables extended point	Assessment	ADF assessment –P-values	Variables in 1 <sup>st</sup> difference	Assessment	ADF Test–P values
l_AgrGro	wc	00.584	d_l_AgrGro	wc	00.00
	wc	00.914		wc	00.00
	wc and t	00.134		wc and t	00.00
l_AgEle	wc	00.521	d_l_AgEle	wc	00.02
	wc	00.978		wc	00.00
	wc and t	00.185		wc and t	00.02
l_AgGas	wc	00.657	d_l_AgGas	wc	00.03
	wc	00.420		wc	00.00
	wc and t	00.143		wc and t	00.02
l_AgOil	wc	00.248	d_l_AgOil	wc	00.02
	wc	00.967		wc	00.00
	wc and t	00.822		wc and t	00.00

1- wc (without constant), 2 – wc (with constant), 3 – wc and t (without constant and trend)

**Table 2: Direction of Causality amid agricultural fiscal expansion and energy use**

The asterisks point the top (i.e. curtailed) values of individual information criterion, AIC, BIC, and HQC					
Lags	loglik	p(LR)	AIC	BIC	HQC
1	132.99		-7.79*	-6.84*	-7.49*
2	145.07	0.08	-7.52	-5.82	-6.99
3	155.52	0.18	-7.13	-4.68	-6.37
4	170.85	0.01	-7.09	-3.88	-6.08

Direction of causality	Number of lags	F-value (P-value)	Decision
l_AgEle → l_AgrGro	1	0.3070 (0.5840)	-Accept
l_AgGas → l_AgrGro		0.5090 (0.4817)	-Accept
l_AgOil → l_AgrGro		0.2231 (0.6404)	-Accept
l_AgrGro → l_AgEle		11.033 (0.0026)	-Reject
l_AgGas → l_AgEle		9.2613 (0.0052)	-Reject
l_AgOil → l_AgEle		0.0450 (0.8334)	-Accept
l_AgrGro → l_AgGas		21.314 (0.0001)	-Reject
l_AgEle → l_AgGas		0.0346 (0.8536)	-Accept
l_AgOil → l_AgGas		1.1304 (0.2971)	-Accept
l_AgrGro → l_AgOil		1.4242 (0.2431)	-Accept
l_AgEle → l_AgOil		1.6633 (0.2081)	-Accept
l_AgGas → l_AgOil		0.2951 (0.5914)	-Accept
l_AgEle → l_AgrGro	2	0.3510 (0.7078)	-Accept
l_AgGas → l_AgrGro		1.0021 (0.3833)	-Accept
l_AgOil → l_AgrGro		2.1864 (0.1361)	-Accept
l_AgrGro → l_AgEle		2.1173 (0.1442)	-Accept
l_AgGas → l_AgEle		3.6645 (0.0420)	-Reject
l_AgOil → l_AgEle		0.0243 (0.9760)	-Accept
l_AgrGro → l_AgGas		6.1957 (0.0073)	-Reject
l_AgEle → l_AgGas		0.0614 (0.9405)	-Accept
l_AgOil → l_AgGas		0.8818 (0.4281)	-Accept
l_AgrGro → l_AgOil		1.0384 (0.3707)	-Accept
l_AgEle → l_AgOil		0.8576 (0.4379)	-Accept
l_AgGas → l_AgOil		0.4358 (0.6522)	-Accept
l_AgEle → l_AgrGro	3	0.2308 (0.8736)	-Accept
l_AgGas → l_AgrGro		1.9589 (0.1585)	-Accept
l_AgOil → l_AgrGro		1.4900 (0.2529)	-Accept
l_AgrGro → l_AgEle		0.8570 (0.4822)	-Accept
l_AgGas → l_AgEle		1.3099 (0.3037)	-Accept
l_AgOil → l_AgEle		0.3442 (0.7937)	-Accept
l_AgrGro → l_AgGas		3.9434 (0.0264)	-Reject
l_AgEle → l_AgGas		0.0598 (0.9802)	-Accept
l_AgOil → l_AgGas		1.1637 (0.3526)	-Accept
l_AgrGro → l_AgOil		1.2774 (0.3139)	-Accept
l_AgEle → l_AgOil		0.7617 (0.5309)	-Accept
l_AgGas → l_AgOil		0.8888 (0.4668)	-Accept

for agricultural growth. The proposition that agricultural fiscal expansion does not (Granger) cause energy use is refused, meaning that alterations in agricultural fiscal expansion are helpful to predict the alterations in energy (gas and electricity) use.

**4.4. Test for Co-integration**

Table 3 offers the outcomes of Johansen’s co-integration assessment to verify co-integration grade grounded on trace test and Lmax value. Both hold refusal of null proposition that there is no co-integrating association inside structure. Trace and Lmax test indicate there subsists one co-integrating formula in structure meaning that agri- fiscal expansion is having a long run equilibrium relation with the agri-electric use, agricultural gas use, and agricultural oil use. In extended, run agri-fiscal expansion and agricultural power use move together so that if there are any deviations because of shock the system will tend to restore to equilibrium. If the variables are co-integrated, then we can gauge squat associations by using Vector Error Correction Model (VECM) to capture the speed of the adjustment to the equilibrium.

From the above normalized co-integrating equation a significant association can be seen amid agricultural fiscal expansion and agricultural power use, from the inferences it is concluded that 1 percent change in agricultural electricity use reasons the agricultural fiscal expansion to boost by 0.09% though the contribution is minimum but significant in the long run. A noteworthy association subsists amid agricultural fiscal expansion, and agricultural gas use, 1% change in agricultural gas use reasons the agricultural expansion to boost to 0.43% in extended course. Similarly, a 1% change in agricultural oil use causes agricultural expansion to shrink by about 0.03%. In extended course, gas and electricity is contributing more to agri-fiscal expansion.

VECM demonstrates that error correction term (-0.104) is downbeat as well as noteworthy that means that there subsists an extended course causality functioning from energy use to agricultural fiscal expansion. The rate of alteration to extended course balance is reinstated to 104%. However, in squat course, there is no noteworthy causal relationship existing in the system. Except for the agricultural oil use, all other variables have extended course causality functioning from one another, though the speed of adjustment takes longer with respect to oil and electricity use to

**Table 3: Johansen’s co-integration assessment**

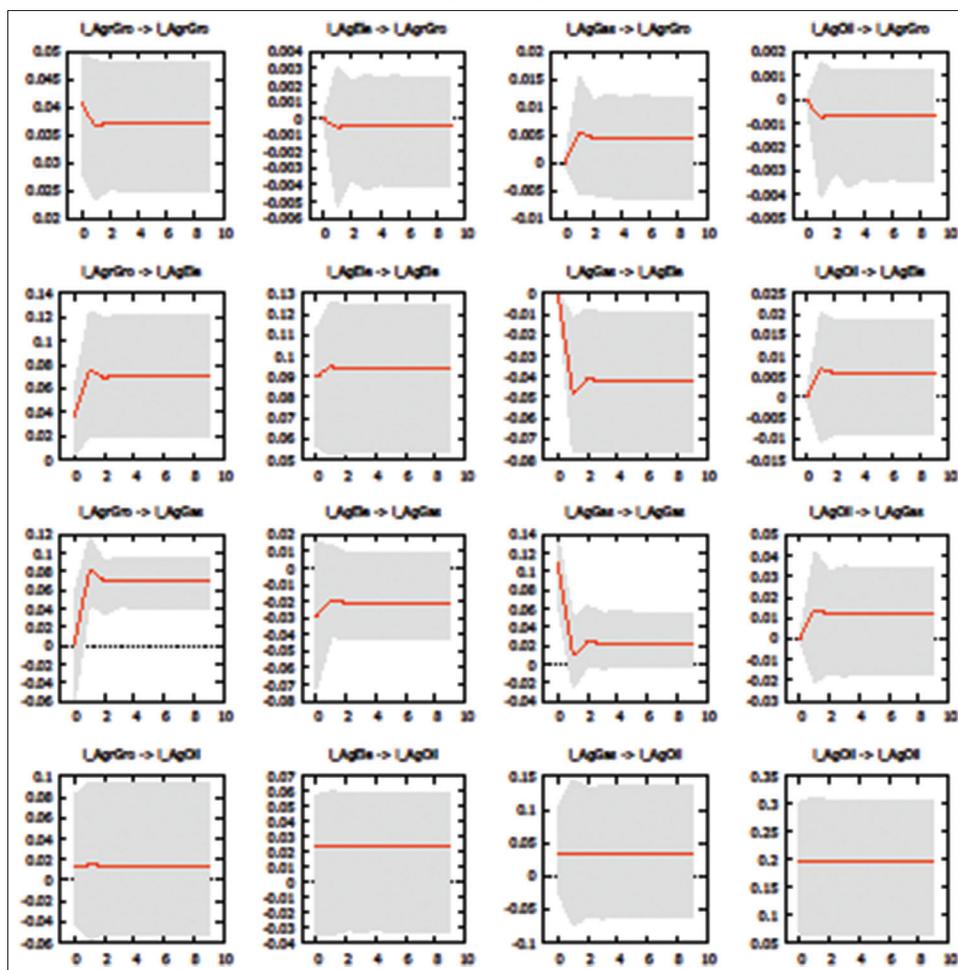
A.Co-integration rank Assessments			
Unhampered co-integration rank Assessments, trace and maximum eigen (Lmax) value			
No. of co-integrating equations or rank	Eigenvalues ( $\lambda_i$ )	Trace test P-value	Lmax test P-value
00	00.7239	57.307 (00.0043)	41.187 (00.0002)
01	00.2740	16.120 (00.7100)	10.248 (00.7253)
02	00.1676	5.871 (00.7131)	5.870 (00.6352)
03	00.0000	0.0008 (00.9766)	0.0008 (00.9766)

\*Trace and Lmax assessment points one co-integrating equation

B.Normalized co-integrating $\beta$ and alteration of coefficients (standard errors in parenthesis)					
$\beta$ Coefficients	l_AgrGro	l_AgEle	l_AgGas	l_AgOil	Constannt
	1.00(0.00)	-0.09* (0.034)	-0.432* (0.04)	0.03** (0.01)	2.48 (2.67)
$\alpha$ Coefficients	l_AgrGro	l_AgEle	l_AgGas	l_AgOil	(P-values in parenthesis)
	-0.104* (0.04)	1.04**(0.00)	2.14*(0.00)	0.03 (0.95)	

\*at 5% and \*\*at 10% level of significance

Figure 2: Impulse response graph



restore the long-run equilibrium. The left over as well as analytical tests of VECM are acceptable.

#### 4.5. Impulse Response

From the Figure 2, impulse reactions obtained to predict prospect of 10 years by cholesky sorting, maintaining the order from expansion to energy use. It seen that single customary divergence upset the agriculture expansion results in instantaneous reduction in expansion followed by stable performance in agriculture growth, decrease in both the electricity and gas use in immediate period followed by stable performance, oil use is stable over the forecast horizon. One standard deviation fright to agriculture gas use outcomes in an instantaneous increase in expansion followed by a steady performance in agriculture growth, the decrease in both the electricity and gas use in the immediate period followed by stable performance. It is observed that in extended course agriculture power use and agriculture fiscal expansion are in steady state condition.

### 5. CONCLUSION AND POLICY IMPLICATIONS

The co-integration test confirms the long run equilibrium relation among agricultural economic growth, agricultural electricity

consumption, agricultural gas consumption and agricultural oil consumption meaning that all variables all move together in the long run. Agricultural economic growth is having a long-run equilibrium relationship with agricultural electricity consumption, agricultural gas consumption, and agricultural oil consumption. There exists a uni-directional causality amid economical expansion of agriculture and fuel consumption from agriculture. Furthermore, agricultural economic growth (Granger) causes agricultural gas consumption which in turn changes in agricultural economic growth which is advantageous for foretelling the modifications in agricultural gas consumption. In the extensive run; agricultural economic growth and agricultural energy consumption move together so that any deviations because of shock the system will tend to restore to equilibrium. A significant association exists between agricultural economic growth, and agricultural gas consumption, 1% change in agricultural gas consumption causes agricultural escalation to boost by about 0.43%.

This study results in to two important policy decisions on which policy makers should draw attention; one is the use of different energy inputs to agriculture growth Viz ...Electricity, Oil and Gas consumption and its impact on economic growth and environment both in the long run and short run. The second policy decision is based on the selection of the product mix of the energy inputs to agriculture growth in achieving the optimization of different energy

sources and ultimately the overall energy efficiency. The study concludes the significant impact of using Electricity, Oil and Gas on agriculture growth and thus providing new experimentation of energy mix in further studies to explore additional renewable sources of energy to achieve agriculture and overall economic growth.

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