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A Historical Cum Empirical Overview of Agriculture Spending and Output Nexus in India

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Abstract

This research aims to have a holistic view of the relationship between agriculture outcome/output and agricultural spending in India. The unique part of the study is that it highlighted the nexus between agriculture outputs from a historical point of view. The empirical part of this study is analyzed using the development of the co-integration method followed by the VECM model. The empirical analysis shows -a long-run association between agriculture spending and production, and this feedback is bidirectional. Agricultural production positively responds to agricultural spending in India both in the short and long run, especially in sowing seasons. However, the exciting finding of the study is that the speed of adjustment of agricultural spending on output is plodding. This implies that any shock of the agricultural production can be corrected by agricultural spending by just 20 percent, and it will take more than four years to stabilize the agricultural output with agricultural expenditure. Thus the tendency of agrarian spending to stabilize agrarian output in India is not so encouraging.

Keywords

History, agriculture, output; spending, institutions.

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Introduction

India is the second-largest producer and exporter of food grains, fruits, vegetables, and wheat (Mukherjee, et.al, 2019). Agriculture is considered the backbone of the Indian economy. A vast majority of our total population is dependent on their livelihood from agriculture. The agricultural sector plays a vital role in developing the Indian economy (Arjun, at the time of independence. As a legacy from British Colonialism, age-old and traditional techniques were applied in agriculture (Burton, 1998). The productivity was inferior and high taxation (Bayly, 1985). Due to its low productivity, agriculture could manage only subsistence livings to Indian peasants under feudal structure (Pradhan, 2007).

The Indian economy has continued being predominantly agrarian both in terms of its Gross Domestic Product (GDP) and providing employment to the country's labor force (more than 60 percent of the workforce is still engaged in agriculture) (Ghose, 1982). As being primarily dependent on monsoons, the initial challenge was to build irrigation infrastructure that began even before Britishers' independence (Habib, 2006). By 1947 the network of irrigation canals was only 17% of the net sown area. Almost 80% of the cultivable area was still dependent on monsoons, resulting in low crop production and was prone to famines (Subramaniam, 2008).

However, after independence, the rapid growth accelerated but was quite low than the non-farming sector. A long way from the chronic food-deficit country to a self-sufficient food country had been a commendable achievement (Roy, 2002). During the early phase of independence, agricultural policy witnessed tremendous growth. Agrarian reforms, institutional changes, development of major irrigation projects, and strengthening cooperative credit institutions were key features of early plans (Kumar 2005; Pradhan 2007; Subramaniam, 2008). Land reforms' most important contribution was abolishing intermediaries and giving land titles to the actual cultivators (Travers, 2004). This released productive forces, and the owner cultivators put in their best to augment production on their holdings. Land reforms were significant in increasing agricultural production during this phase (Balakrishnan and Parameswaran, 2007).

A new phase started in Indian agriculture during the mid-1960s by adopting a new agricultural strategy (Green revolution). The new agricultural strategy relied on high-yielding varieties of crops, multiple cropping, the package approach, Credit facilities, modern farm practices, and the spread of irrigation facilities (Kumat et al., 2010; Tirthakar, 2002). During the early 1980s, India started witnessing the process of diversification, which resulted in fast growth in non-food grains output like milk, fishery, poultry, vegetables, fruits, etc. which accelerated growth in agricultural GDP during the 1980s (Bannerjee, 2005).

Recent studies show that India has witnessed a significant increase in food grain production (green revolution), oilseeds (yellow revolution), milk (white revolution), fish (blue revolution), and fruits and vegetables (golden revolution) (Mahadevan, 2003). Now, India is marching towards what is called as ICT (information and communication technology) Revolution in agriculture (Bharti, 2018). The food safety net for every of the over a billion citizens - a growing number - requires enhanced agricultural production and productivity in the form of a Second Green Revolution (Saradhi et al., 2020; Ramakumar, 2020; Mozumdar, 2012). Further, special attention is required for achieving higher production and productivity levels in pulses, oilseeds, fruits, and vegetables, which had remained untouched in the First Green Revolution but are essential for nutritional security. In this regard, achieving high poultry production, poultry, and fisheries (Manida and Nedumaran, 2020).

In contrast to India, the EU agricultural area has reduced slightly, mainly driven by decreasing cereals and oilseed acreage (Schebesta and Candel, 2020). However, land use for pasture, fodder, and protein crops has grown. The areas for barley and wheat have decreased, while maize areas have compensated for this by meeting the demand for cereal feed (European Commission, 2020; Baldos et al., 2019). Overall there has been a decline of 12 percent in agricultural production in the EU in the last decade. The decline in agricultural output would tighten the EU food supply, resulting in price increases impacting consumer budgets (Beckman et al., 2018; Schebesta and Candel, 2020). In trade, EU exports of agriculture have strengthened thanks to converging EU and world prices and proximity to importing markets, primarily in the Mediterranean region and sub-Saharan Africa (Beckman et al., 2018). There has been a decline in the farm workforce due to structural changes at the EU level and that has slowed down to 1% per year, primarily from technological progress in machinery and equipment (Schebesta and Candel, 2020). However, the real income per worker has increased by 0.5% per year, slowing down from 1.9% in the past decade (Rossi et al., 2012). The above trends in agriculture production in the EU are due to public and private investment in agricultural research and development (R&D), spurring innovation in the field (Fuglie, 2018; Garnett et al., 2013). The investment in agricultural research and development (R&D), the technology treadmill, Insurance support to farmers, marketing facilities, and the strategies goal put forward by EU in 2020 has resulted from growth in agricultural production (Maggi et al., 2019; Skevas and Oude Lansink, 2020; Bastiaans et al., 2008; Chikowo et al., 2009).

On the other hand, Public expenditures on agriculture have been the most important driving force for agricultural output. The expenditure includes short-term costs and long-term investments (Pardey, Roseboom and Craig, 1992; Rosegrant and Evenson, 1992). Investment in agriculture and forestry includes government expenditures directed to agricultural infrastructure, research and development, and education and training (Evenson et al., 1991). Comparisons between developed and developing countries reveal, a more significant variation among developing countries than industrial countries (Chavas and Aliber, 1993). Investment in infrastructure has been cited as an essential source of growth in agriculture (Jayne et al., 1994). Public investment in forms of human capital: education, extension, training, and technology research have also been shown to increase productivity (Antholt, 1994; Beal, 1978; Evenson and McKinsey, 1991; Pray and Evenson, 1991; Zdráhal, 2021). Egwu (2016) also examined the impact of agricultural financing on agricultural output, economic growth, and poverty alleviation in India from 1980 to 2010. The study found that commercial bank credit to the agricultural sector and agricultural credit guarantee scheme fund loan to the agricultural sector is significant to agricultural sector output percentage to gross domestic product.

As far as the state of Indian Agriculture is concerned, Agriculture is the livelihood for a majority of the population and can never be underestimated.

Although its contribution to the gross domestic product (GDP) has reduced to less than 20 percent and the contribution of other sectors increased faster, agricultural production has grown. This has made us self-sufficient and taken us from being a begging bowl for food after independence to a net exporter of agriculture and allied products. GDP from Agriculture in India increased to 6364.44 INR Billion in the fourth quarter of 2020 from 3802.39 INR Billion in the third quarter of 2020 (Government of India, 2019).

Total food grain production in the country is estimated to be a record 291.95 million tonnes, according to the second advance estimates for 2019-20. This is news to be happy about, but as per the Indian Council for Agricultural Research (ICAR) estimates, demand for food grain would increase to 345 million tonnes by 2030. The share of agriculture in the gross domestic product (GDP) has reached below 20 percent for the first time in the last 17 years, making it the only bright spot in GDP performance during 2020-21, according to the (Economic Survey 2020-2021).

The resilience of the farming community in the face of adversities made agriculture the only sector to have clocked a positive growth of 3.4 percent at constant prices in 2020-21 when other sectors slid. The share of agriculture in GDP increased to 19.9 percent in 2020-21 from 17.8 percent in 2019-20 (Government of India, 2019). The last time the agriculture sector's contribution in GDP was at 20 percent was in 2003-04. This was also when the industry clocked 9.5 percent GDP growth, after the severe drought of 2002 when the growth rate was negative.

The growth in GVA (gross value added) of agriculture and allied sectors has fluctuated over time. However, during 2020-21, while the GVA for the entire economy contracted by 7.2 percent, growth in GVA for agriculture maintained a positive growth of 3.4 percent. The continuous supply of agricultural commodities, especially staples like rice, wheat, pulses, and vegetables, also enabled food security (Handbook of India Economy, 2020). In 2019-20 (according to fourth advance estimates), total food grain production (296.65 million tonnes) in the country was higher by 11.44 million tonnes than in 2018-19. It was also higher by 26.87 million tonnes than the previous five years (2014-15 to 2018-19) average production of 269.78 million tonnes (Reserve Bank of India, 2020). The production also boosted allocation of food grains under the National Food Security Act (NFSA) increased by 56 percent in 2020-21, compared to 2019-20

As far as agricultural spending in India is concerned, the revenue expenditure budget estimate on agriculture and allied services in India by the state and central governments amounted to an estimated 4.1 trillion Indian rupees in 2018 (Bharti, 2018). This was a significant increase compared to the fiscal year 2009 (De and Dakhar, 2018). However, the expenditure on agriculture has not yielded the dividend to India as expected (Amarnath and Prasad, 2009; Mozumdar, 2012; Subramaniam, 2008). The Indian government has also made several other efforts to finance the agricultural sector to improve its contribution to annual income in the economy (Recent schemes include the Pradhan Mantri Krishi Sinchai Yojana, National Scheme of Welfare of Fishermen, KCC for animal husbandry and fisheries, Pradhan Mantri Kisan Samman Nidhi, Pradhan Mantri Kisan Maan Dhan Yojana, Interest subvention for the dairy sector, Credit facility for farmers, Crop insurance schemes. Despite these vast sums of money allocated to the industry through these schemes over the years, the contribution of agriculture in India remains doubtful (Saradhi et al., 2020; Ramakumar, 2020).

Therefore, the above-mentioned trends and discussion have called for the need for empirical investigation of the relationship between government agricultural spending and agricultural output in India spanning 1980 to 2019. Therefore, the study aimed to examine the nature of causation between government agricultural spending and agricultural output in India and the extent to which government agricultural spending affects agricultural output in India. Further, it is pertinent to re-examine the relationship between government agricultural spending and agricultural output in India using recent data and employing the best fit methodology to address the endogeneity issues among the explanatory variables. The study also aimed to explore the effective variables that can be targeted through government spending to boost the long-run agricultural output.

Material and methods

This study is primarily based on time series secondary data for the period 1980-2019. The data has been collected from many sources, including the state finance reports, RBI, MOSPI, NABARD, and India's Ministry of Agriculture government.

Model specification

To capture the effect of government agricultural spending on agricultural output in India, the study adopts the essence of Cobb-Douglas production function with modifications. Thus, decomposing capital into government agricultural spending, the value of loans guaranteed by NABARD to the agricultural sector and commercial bank loans to the agricultural sector, the interest charged on loans to the sector and agricultural labor force, the functional form of the model can be stated as:

$$OPt = f(Op\ t\text{-}i + GAt + CBt + NABARDt + It + + Alt) \quad (1)$$

Expressing equation (1) in stochastic form and taking the natural logarithm (ln), the model can be stated as:

$$Op_t = \alpha_0 + \beta_0 \ln GA_t + \beta_1 \ln CB_t + \beta_2 \ln NABARD_t + + \beta_3 \ln I_t + \beta_4 \ln AL_t + \mu_t \quad (2)$$

Where:

OP is Agricultural output at the time, *T, GA* is Government expenditure on Agriculture, *CB* is loaned to Agriculture from commercial banks, *NABARD* is loans and assistances from NABARD, *I* is the interest rate on loans for Agriculture, and *AL* is the agriculture labor force. α_0 is Constant Intercept; β_0, β_1, β_2, β_3, β_4 are Slope of Coefficients of the explanatory variables and μ_t is Stochastic disturbance term.

Estimated model

The econometric framework adopted in this paper is based on developments in the co-integration and error correction model suggested by Johansen (1988) and Johansen and Jusellious (1995). By applying VECM techniques to the time series data, based on the results of the unit root and multi-variate co-integration test, we can approximate a dynamic structure in which initially all the variables in both the models are treated as endogenous. Most time series analysis de- demonstrates nonstationary characteristics in their mean or trending pattern. If the data is trending, then some form of de-trending is needed. The most common de-trending practices are differencing and time-trend regressions (Junková, 2011; Tyrychtr, 2015). Thus, the first step in co-integration modeling is often taken by testing for unit roots to determine whether trending data should be differenced or regressed on deterministic functions of time.

After employing unit root and co-integration modeling for the time series data set of each determinant function, we can constitute a model free of spurious properties and having a dynamic robustness structure. Based on the unit root and co-integration results, we identify the VECM suitable for generating powerful results in agricultural output. As stated above, this study employs Johansen's multivariate co-integration approach developed by Johansen (1988) and Johansen and Jusellious (1995), specified as a reduced-form VAR model of order *p*. Therefore, in this study, the VECM model is used to assess the short- and long-run determinants of Agriculture output through various institutional inputs.

$$y_t = A_1 y_{t-1} + \ldots + A_i y_{t-i} + \ldots + A_p y_{t-p} + Bx_t + e_{t-1} \quad (3)$$

The above equation (3) states that the procedure by which the dependent variables in yt vary about their time-invariant means is entirely determined by the parameters in A_i and B, and the (infinite) past of y_t itself, the exogenous variables x_t, and the history of independently and identically distributed shocks, e_{t-1}, e_{t-2}, .. Therefore, the joint distribution of y_t is determined by the distributions of x_t and e_t and the parameters B and A_i.

However, according to the Granger representation theorem (Granger, 1988), if co-integration is established among a vector of variables in the model, then a valid error correction model may be estimated; if not, then VAR is used. Therefore, in this study, the choice of whether to use VAR or VECM for estimations follows the Granger representation theorem; that is, it is based on co-integration results.

Estimation procedure

Nonstationary data leads to spurious regression due to non-constant mean and variance (Dimitrova, 2005). If a series is stationary without any differencing, it is said to be I(0) or integrated of order 0. However, if a series is stationary after first difference is said to be I(1) or integrated of order 1. To this end, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests have been adopted to examine the stationary, or otherwise, of the time series data. The lowest value of the Akaike information criterion (AIC) has been used in this to decide the optimal lag length in the ADF and PP regression. These lags were used in ADF and PP regression to make sure that the error term is white noise. If all the variables in an equation are in integral order of I(1) and the resulting residuals are I(0). According to Engle and Granger (1988), it can be declared that there resides a corresponding error correction mechanism (ECM or e_{t-1}), and the basic models will be transformed accordingly. The regression from the ADF test is of the following form:

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + \varepsilon_t \quad (4)$$

where D is the first-difference operator, y_t is the respective variable of expenditure over time, p is lag, a_0 is constant, a_1 and g_j is parameters, and e_t denotes stochastic error term.

If $a_1 = 0$, then the series is said to have a unit root and is nonstationary. Hence, if the hypothesis, $a_1 = 0$, is not accepted according to the equation, it can be concluded that the time series does not have a unit root and is integrated of order I(0). In other words, it has stationarity properties.

Similarly, the regression from Phillips-Perron (PP) test is in the following form:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2(t-T/2) + \mu_t \quad (5)$$

Where α_0 is the intercept, a_1 and a_2 are the expected least squares regression coefficients, the hypotheses of stationarity to be tested is H0: $a_1 = 0$ and $\alpha_0 = 0$.

Co-integration test

After analyzing whether the series is stationary in levels or first difference or integrated in the same order, then Johansen's co-integration method is used to verify whether there exists a co-integrating vector among the variables or not (Johansen, 1988). Johansen's co-integration test employs two test statistics to identify the number of cointegrating vectors: the Trace test and the Maximum Eigenvalue test. The Trace statistics tests the null hypothesis of r co-integrating vectors/equation in the given series against the alternative hypothesis of no co-integrating equations. The Trace statistics test is calculated by using the following expression:

$$LR_{tr}(r/n) = -T * \sum_{i=r+1}^{n} \log(1 - \check{Y}_1) \quad (6)$$

where

$\check{Y}$ is the Trace statistics value, n is the number of variables in the system, and r = 0, 1, 2, .. ., n - 1 co-integrating equation.

The test statistic for Max Eigenvalue is computed as:

$$LR_{max}(r/n+1) = -T * \log(1 - \check{Y}) \quad (7)$$

where

$\check{Y}$ is the Max Eigenvalue and T is the sample size.

In case the Max Eigenvalue statistic and the Trace statistic yield different results, then trace test statistic will be preferred as suggested by Alexander (2001).

VECM Models for Nexus

After the Johansen co-integration test, the next is to fit the suitable time series model. If co-integration has been established between the variables, this implies a long-run relationship between the variables under the integration equation. Hence, the VECM is applied to determine the short-run relationships of co-integrated variables. On the other hand, if there exists no co-integration, then the VECM is transformed to Vector autoregressive (VAR) model, followed by impulse analysis, variance decomposition, and the Granger causality tests to determine casual links and response. The study used VECM to account for the endogeneity that could exist. This is because it avoids simultaneous equation bias in the case of endogeneity among explanatory variables. Applying a VECM specification to equation (2) since the variables or series were stationary at the first difference and co-integrated, the models can be specified as:

$$\begin{aligned} DlnOP_t = \alpha_0 &+ \sum_{i-1}^{p} \beta_1 DlnOP_{t-i} + \sum_{i-1}^{p} \beta_2 DlnGA_{t-i} + \\ &+ \sum_{i-1}^{p} \beta_3 DlnCB_{t-i} + \sum_{i-1}^{p} \beta_4 DlnNABARD_{t-i} + \\ &+ \sum_{i-1}^{p} \beta_5 DlnI_{t-i} + \sum_{i-1}^{p} \beta_6 DlnAL_{t-i} + \\ &+ \prod ECT_{t-i} \end{aligned} \quad (8)$$

where

D is the difference level of the variable; ln is the natural log form of the respective variable and α_0 is the intercept coefficients. Parameters β_1, *β_2, β_3, β_4, β_5 and β_6 are coefficients of the equation. The coeffici*ent of error correction term (ECT) in the equations represents $\prod ECT_{t-1}$ shows the speed of adjustment towards the long-run equilibrium. The coefficient of adjustment should be negative and statistically significant for convergence. The study further uses the Granger causality testing at the end to understand the feedback and direction of effect between the variables.

Diagnostic tests

The diagnostic tests applied in the restricted equations of the government expenditure and demographic variables are: the Breusch-Godfrey Serial Correlation or LM Test done for serial correlation of the model, ARCH Test (autoregressive conditional heteroskedasticity) has been carried for Heteroskedasticity. Similarly, the model's parameter stability test has been performed by the CUSUM statistics. The Normality test has been done through the Jarque-Bera test. All the diagnostic tests are estimated through the null hypothesis, which is tested through the test statistic value of each test at the probability value at a 5% level of significance.

Result and discussion

Unit Root test

The results of the ADF test are shown in the Table 1. The results show that trend nd constant are significant for OP, GA, and CB while only constant is significant for I and AL at a 5% level of significance.

The table shows that the variables are non-stationary at level, but after the first difference, the variables are stationary. This explains that the order of integration for the given variables is I(1).

Table 2, reveals that there is cointegration among the variables. This is because the trace statistic of 119.5858 and 79.5859 is greater than the critical values of 95.75366 and 69.818 at a 5% level of significance, respectively. The study, therefore, rejects the null hypothesis of at most one hypothesized number of co-integrating vectors. This means that there is two cointegrating equation(s) at the 5 percent level. This implies that there is a long-run relationship among the variables incorporated in the model.Co-Integration Test

The Johansen and Juselius (1995) co-integration approach was applied to determine the number of cointegrating vectors. It offers two tests, the Trace test, and the Max-Eigen value test, to identify the number of co-integrating

Variables at Natural Lag	At level	First Difference	1%	Order of Integration
Agriculture Output (OP)	-0.872	-4.288	-4.227	I(1)
Prob.	0.949	0.0086*		
Expenditure on Agriculture (GA)	-1.762	-7.395	-4.227	I(1)
Prob.	0.703	0.0000*		
Commercial bank Loans (CB)	-2.487	-6.994	-4.227	I(1)
Prob.	0.332	0.0000*		
Loans from NABARD	-1.033	-5.556	-4.227	I(1)
Prob.	0.927	0.0003*		
Interest Rate (I)	-2.493	-6.840	-3.621	I(1)
Prob.	0.125	0.0000*		
Agriculture labor force (Al)	-1.119	-6.365	-3.621	I(1)
Prob.	0.698	0.0000*		

Note: * is the significant at 1 % level of significance; Prob. ss the probability
Source: Authors calculation

Table 1: Estimated results of ADF stationary test.

Null hypothesis	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.*
r = 0	None *	0.660	119.58	95.75	0.0004
r ≤ 1	At most 1 *	0.644	79.58	69.81	0.0068
r ≤ 2	At most 2	0.437	41.35	47.85	0.1777
r ≤ 3	At most 3	0.344	20.03	29.79	0.4204
r ≤ 4	At most 4	0.111	4.412	15.49	0.8675
r ≤ 5	At most 5	0.001	0.045	3.841	0.8308

Note: * is the significant at 1 % level of significance;
Source: Authors calculation

Table 2: Result of Unrestricted Cointegration Rank Test (Trace).

relationships. The results are shown in the Table 2 and the Table 3.

Also, the Eigenvalue test rejects the null hypothesis if the Maximum-Eigen value test statistics 3exceeds the respective critical values. The Table 3 reveals that there is cointegration among the variables. The Eigenvalue statistics of 59.99 and 38.23 are greater than the critical values of 40.07 and 33.87 at a 5% level of significance, respectively. The study rejects the null hypothesis of at most one hypothesized number of co-integrating vectors. This means that there is two cointegrating equation(s) at the 5 percent level. Hence, the Maximum-Eigen value statistic indicates two (2) co-integrating equations at a 5 percent significance level. As evidenced from the Trace and Max-Eigen test statistics, there is a long-run relationship between government agricultural spending and agricultural output in India.

Agricultural Spending and Agricultural Output Nexus

Given that the series are non-stationary and the need to account for the effect of lagged values of variables on the current values on others within a VAR framework, the study estimated the VEC Granger Causality/Block Exogeneity Wald test. The results of the granger causality test are presented in Table 4.

The Table 4 shows the results of the VECM

Null hypothesis	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.*
r = 0	None *	0.660	59.99	40.07	0.0110
r ≤ 1	At most 1 *	0.644	38.23	33.87	0.0142
r ≤ 2	At most 2	0.437	21.31	27.58	0.2576
r ≤ 3	At most 3	0.344	15.62	21.13	0.2475
r ≤ 4	At most 4	0.111	4.367	14.26	0.8187
r ≤ 5	At most 5	0.001	0.045	3.841	0.8308

Note: * is the significant at 1 % level of significance;
Source: Authors calculation

Table 3: Result of Unrestricted Cointegration Rank Test (Maximum-Eigen value).

Sample: 1980-2019; Lags: 2				
Null Hypothesis:	**Obs**	**F-Statistic**	**Probability**	**Decision**
OP does not Granger Cause GA	37	2.55	0.024**	Rejected
GA does not Granger Cause OP		3.23	0.043**	Rejected
OP does not Granger Cause CB	37	5.135	0.008 *	Rejected
CB does not Granger Cause OP		0.742	0.539	Accepted
OP does not Granger Cause NABARD	37	3.361	0.039**	Rejected
NABARD does not Granger Cause OP		0.539	0.610	Accepted
OP does not Granger Cause IN	37	0.351	0.983	Accepted
IN does not Granger Cause OP		0.187	0.361	Accepted
AL does not Granger Cause OP	37	1.054	0.13 0	Accepted
OP does not Granger Cause AL		4.863	0.035**	Rejected
GA does not Granger Cause CB	37	2.56	0.08 6	Accepted
CB does not Granger Cause GA		0.35	0.789	Accepted
GA does not Granger Cause NABARD	37	0.288	0.255	Accepted
NABARD does not Granger Cause GA		0.790	0.517	Accepted
CB does not Granger Cause NABARD	37	1.168	0.492	Accepted
NABARD does not Granger Cause CB		4.79	0.031**	Rejected
AL does not Granger Cause NABARD	37	2.32	0.694	Accepted
NABARD does not Granger Cause AL		0.032	0.533	Accepted
AL does not Granger Cause CB	37	0.517	0.180	Accepted
CB does not Granger Cause AL		0.0204	0.178	Accepted

Sources: Authors calculation
Note * denotes rejection at 1% &** denoted as rejected at 5% levels respectively

Table 4: Results of VEC Granger Causality/Block Exogeneity Wald test.

Granger Causality/Block Exogeneity Wald test. The table depicts the bidirectional relationship or Granger causality between government agricultural spending and agricultural output at a 5% level of significance. Thus, the causality runs from government agricultural spending to agricultural output and agricultural output to government agricultural spending in India. The implication is that lagged values and current agricultural output can influence the current level of government agricultural spending in India. In contrast, the lagged government agricultural spending and current government agricultural spending influences the current performance of the agricultural sector. There is also a unidirectional relationship running from NABARD loans to commercial bank loans to agricultural in India at a 5% significance level. The implication is that the NABARD loans are orchestrated through commercial banks, hence, the causal effect. The result also shows that government agricultural spending has Granger caused agricultural NABARD loans at a 5% level of significance. The implication is that the amount of past and current spending on the agricultural sector affects the current amount of NABARD Loans in India. More so, there is a unidirectional relationship running from agricultural output to agricultural labor in India at a 5% level of significance. This implies that output from the agricultural sector can affect the agricultural labor force in India.

Estimated results of VECM for long-run and short-run

The Table 5 shows the estimated short and long-run results. The long-run estimated coefficient of Government expenditure on agriculture (GA) is positive theoretically plausible and statistically significant at a 5% critical value. This implies that an increase in Government expenditure on agriculture leads to an increase in agricultural output in India by 0.82 percent. These results are in line with (Evenson et al. al., 1991; Zdarhal, 2021). This might be because government expenditure on agriculture creates infrastructure for technology, research, agricultural marketing, transport, insurance, and credit, which indirectly increase productivity and production of agricultural output. Similarly, the estimated coefficients of Commercial banks (CB) to the agricultural sector and NABARD loans to agriculture are positive and theoretically plausible. They are statistically significant at a 5% critical value. This implies that an increase in expansion of Commercial banks loans to the agricultural sector and NABARD loans lead to an increase in agriculture output by 0.42 percent and 0.81 percent, respectively.

Long Run estimates: Equation 7			
Regressor	**Coefficient**	**Standard error**	**T-statistic**
LNOP(1)	1.000000		
LNGA(1)	0.62	.133	7.75**
LNCB(1)	0.42	0.180	3.45*
LNNABARD(1)	0.81	0.144	8.23**
LNI(1)	-0.14	0.263	3.41*
LNAL(1)	**18.20**	**10.21**	**6.66****
Dep. Var: Agricultural Output (OP)		**Equation 7**	
Ind. Variables	**Coefficient**	**t-Statistic**	**Prob.**
D(LNOP(-1))	0.440	2.016	0.045**
D(LNGA(-1))	0.123	0.587	0.112
D(LNCB(-1))	0.195	3.946	0.014*
D(LNNABARD(-1))	0.093	2.881	0.029**
D(LNI(-1))	-0.017	-0.893	0.652
D(LNAL(-1))	19.60	1.525	0.825
ECM or C(1)	-0.201	-1.710	0.017**
C	0.105537	2.352692	0.041**
R-squared	**0.632**	**Adj. R-Sq.**	**0.574**
Log-likelihood	**44.91**	**D.W**	**2.210**

Note * denotes rejection at 1% &** denoted as rejected at 5% levels respectively
Sources: Authors calculation

Table 5: Estimated results of VECM for short and long run.

The plausible explanation for these results is that the availability and accessibility of credit encourage the farmers to produce those crops in particular, which are either high market market-oriented or have had high yield. These results are in line with (Pardey et al., 1992; Amarnath and Prasad, 2009; Egwa, 2016)).

On the other hand, the estimated coefficient of interest rate (I) is negative. The coefficient is also statistically significant at a 5% critical value. This implies that an increase in interest rate (I) by banks leads to a decrease in agriculture output in India in the long run by 0.14 percent. Thus, there is a significant negative relationship between the interest rate (I) and agriculture output in the long run. This might be because an increase in interest rate increases the cost of money/loans and thus restrict farmers to get more credit from banks. Thus decrease in credit decreases agriculture output. These results are in line with Bharti (2008) and De and Dakhar (2018). Furthermore, the agricultural labor force (AL)'s estimated coefficient is in line with the a priori expectation and statistically significant at 0.5 %. This indicates that an increase in the agricultural labor force leads to an increase in agriculture output by 18.2 percent in the long run. In this way, there is a significant positive relationship between India's agricultural labor force and agricultural output. These results are in line with Bannerjee (2005) and Tirthaker (2002).

The short-run estimates and the speed of adjustment are used to eliminate the discrepancy that occurs in the short-run towards long-run equilibrium are also summarized in Table 5. The estimated coefficient of the agricultural output of the previous year has a positive and significant impact on the current year's agricultural output. This implies that a 1 percent increase in agricultural output in last year leads to an increase in agricultural output of the current year by 0.44 Percent. The results are in line with Mahadevan (2003). The government agricultural spending of the previous year shows a positive but statistically insignificant impact. This implies that an increase in government agricultural spending in the last year does not significantly lead to an increase in agricultural output in the current year in the short run.

Similarly, the -run estimated coefficients of Commercial Bank loans to the agricultural sector and NABARD loans show a positive and significant impact on the current years of agricultural. This implies that an increase in commercial bank loans to the agricultural sector and loans by NABARD in the previous year leads to an increase in agriculture output in the current year by 0.19 and 0.09, respectively. The results are in line with Nedumaran and Manida (2020) and Kumar et al. (2010). However, the table further shows that Interest rate and Agriculture labor don't affect agriculture output in the short run. The agricultural labor force is though positive in the short-run, but not statistically significant at a 5% level of significance.

On the other hand, the estimated coefficient of interest rate is negative in the short-run but not statistically significant, implying that an increase in interest rate in the previous year reduces agriculture output in the short run but is insignificance. The error coefficient of the Error Correction Term (ECT), which ECT denotes, is negative (-0.201) and statistically significant at a 5% level of significance. It reveals the evidence of a slow pace of response to bring equilibrium in agriculture output when there are shocks in the short run. The negative coefficient f the error correction model determines the speed of adjustment to long-run equilibrium by the independent variables. The negative coefficient is an indication that any shock that takes place in the short run by the independent variables mentioned in the above model would be corrected in the long run. It shows that any fluctuation caused in previous years or the short run will bring equilibrium in the long run by 20%. In other words, it means that it will take at least four years to restore any disequilibrium agriculture output. The rule of thumb is that the larger the error correction coefficient (in absolute terms), the faster the variables equilibrate in the long run when shocked (Acheampong, 2007). Therefore, this implies that the adjustment mechanism of agriculture output is not robust. The estimated coefficient of multiple determinations (R2) explains that the independent variables were found to jointly explain 63% of the movement in the dependent variable with the R^2-adjusted ($\overline{R}^2$) of 57%. The overall significance of the model is explained by the F-statistic of 10.9. Coefficients of the short-run dynamics show that government agricultural spending has insignificantly affected the agricultural output of the Indian economy.

Diagnostics testing

A diagnostic check is appropriate to establish whether the model is valid. In other words, a diagnostic check is applied to know if the model developed has a problem or not. Therefore, residual tests were conducted to see whether estimates are reliable and can yield reliable statistical inferences.

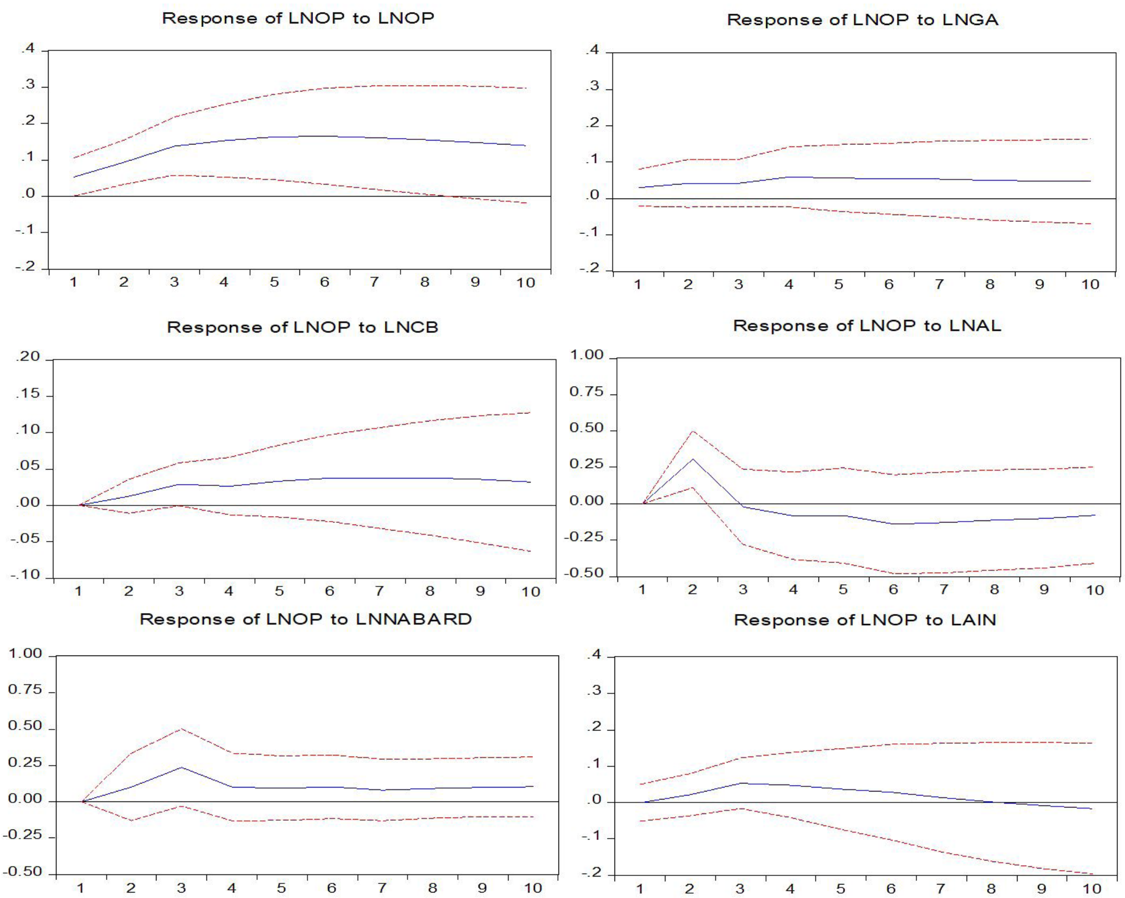
The result of Vector Error Correction VEC residual serial correlation Lagrange multiplier (LM) tests shows that there is no serial correlation at lag order 1. The multivariate normality test using Cholesky of variance was used for testing orthogonality. The study found that residuals are multivariate normal. The model used for the study was proven dynamically. This means that results or estimates produced are reliable and can stand statistical inferences. The overall significance of the model was good, indicating that the results or estimates are not spurious but valid for statistical inference.

Impulse response of agricultural output to government agricultural spending in India

The results of the impulse responses of agricultural output to shocks are presented in the Figure 1.

Results of the impulse response of the variables

The Figure 1 shows the response of government expenditure on agriculture, Commercial bank loans, NABARD loans, Interest rate, and Agriculture labor force to agriculture output. The result of the ten-year forecast shows that a positive shock of one-standard deviation to government agricultural spending in India would eventually positively impact agricultural output throughout the forecast. This implies that the response of agricultural output to shocks in government agricultural spending has exhibited a weakly upward trending pattern. Similarly, a one-standard-deviation shock to commercial bank loans to the agricultural sector and NABARD fund would positively affect agricultural output throughout the forecast. This implies that one standard deviation shock to commercial bank loans to the agricultural sector and NABARD fund would exact a positive response on agricultural output in India permanently. Also, a positive shock of one-standard deviation to interest rate would positively impact agricultural output in India in the short run and long run. On the other hand, one standard deviation shock to the agricultural labor force would exert a negative influence on agricultural output in India throughout the forecast period. From above, it can be deduced that agricultural output in India would respond positively to one standard deviation shock to government agricultural spending,



Sources: Calculated by author

Figure 1: Response to Cholesky One S. D. Innovations ± 2 S. D.

commercial bank loans to the agricultural sector, and NABARD loans to the agricultural sector. Shocks to agricultural output (own shocks) are estimated to positively impact agricultural output in India throughout the forecast period.

Conclusion

The study attempts to have a holistic view of the relationship between agriculture outcome/ output and agricultural spending in India. The unique part of the study is that it highlighted the nexus between agriculture outputs from a historical point of view as well. The empirical part of this study is analyzed using the development of the co-integration method followed by the VECM model. The empirical analysis shows a long long-run association between agriculture spending and output, and this feedback is bidirectional. The agricultural output positively responds to agricultural spending in India both in the short and long run, especially in sowing seasons. However, the interesting finding of the study is that the speed of adjustment of agricultural spending on output is very slow. Therefore, it can be concluded that Government spending on agriculture is weak but statistically significant in the long run. However, in the short-run spending on agriculture doesn't seem favorable. It might be due to the gestation period in agriculture where it takes more time to slip over the effect of government spending on agriculture. Other factors which lead to the significant change in agricultural output both in the short and long run are NABARD funds/schemes, Loans from commercial banks, and the Agricultural labor force. Given the findings, we recommend that Government expenditure on agriculture should be improved upon the funds allocated to the sector and made available to real farmers through the provision of fertilizers, improved seedlings, and grant aiding to farmers through farmers cooperatives. There is also the need to judiciously utilize the resources allocated to the Agricultural Sector as the increase in the percentage of budgetary allocation to the sector does not automatically increase the sector's performance if the resources are mismanaged. Consistently in government policies/programs is also needed to boost the sector's performance.

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