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The impact of public expenditure on agricultural growth: empirical evidence from Punjab, India

Oinam Krishnadas Singh, Laishram Priscilla and Kamal Vatta*

Department of Economics and Sociology, Punjab Agricultural University, Ludhiana 141 004, Punjab

*Corresponding author: kmlvatta@yahoo.com

Abstract This paper has assessed the impact of public expenditure on the agricultural growth in Punjab during 1990-91 to 2019-20. The expenditure on crop husbandry, dairy development, and agricultural research & education had a positive and significant impact on the state's agricultural growth, but the expenditure on soil & water conservation and forestry & wildlife did not impact it. The study confirms that the growth in the agricultural gross domestic product has led to the growth in public expenditure in agriculture. However, the lack of reverse causal flow from the total public expenditure to agricultural growth discloses that public sector expenditure in agriculture is not optimally allocated and needs reprioritization.

Keywords Public expenditure, Agricultural growth, Punjab agriculture, Wagner's law

JEL Codes H72, O49, O13

Several studies have examined the effects of public expenditure on economic growth and have yielded mixed results. While some have established a positive impact (Ram 1986, Shuaib et al. 2015, Chandio et al. 2016, Guandong and Muturi 2016, Akarue and Eyovwunu 2017), others find it negative (Kormendi and Meguire 1985, Diamond 1989). On the other hand, Landau (1986) and Scully (1989) do not find any relationship between public expenditure and economic growth. Satter (1993) observed that public spending has no impact on the economic growth of the developed countries but a positive impact in the developing countries. Such studies aim to determine the applicability of Wagner's or Keynesian hypothesis. Wagner's law emphasizes economic growth as the fundamental determinant of public expenditure (Wagner 1883), while the Keynesian approach treats public spending as a fundamental determinant of economic growth (Keynes 1936). Studies by Salih (2012) for Sudan, Srinivasan (2013) for India and Wang et al. (2016) for Romania support Wagner's law, whereas the studies by Okezie et al. (2013) and Guandong and Muturi (2016) for South Sudan support the Keynesian hypothesis.

Awokuse (2009) argues that agriculture's potential contribution to the economic growth of developing countries is a matter of debate. Such arguments have coincided with the early works (Lewis 1954, Fei and Ranis 1961, Jorgenson 1961, Johnston and Mellor 1961, Schultz 1964). The studies by Schultz (1964) and Timmer (1995) support that investment in agriculture and the development of infrastructure and institutions are prerequisites for economic growth. These studies highlight that agricultural growth acts as a catalyst for overall economic growth, as it affects rural incomes and provides resources for structural transformation (Dowrick and Gemmell 1991, Datt and Ravallion 1998, Thirtle et al. 2003). Therefore, public expenditure is of vital importance to agricultural growth, and any reduction in it may adversely affect the performance of agriculture. Instability in public expenditure in agriculture is also inversely related to growth (Selvaraj 1993).

The Punjab economy is mainly dominated by agricultural production and small and medium-sized enterprises. During the mid-1960s, the success of the Green Revolution sparked agricultural growth and a faster increase in the gross domestic product (GDP) from agriculture. However, in the last two decades, agricultural growth has started showing stagnation. According to a study by the Indian Council for Research on International Economic Relations (ICRIER), the growth rate dropped to 3% during 1986-87 to 2004-05 and further to 1.61% during 2005-06 to 2014-15, which is almost half the all-India average of 3.5%. Apart from stagnating productivity, shrinking landholdings, declining profitability, and climate change, the crisis in the agriculture sector of Punjab is also attributed to populist policies such as free electricity for irrigation and a corresponding decline in the public expenditure in agriculture. This study attempts to examine the impact of public spending on the growth of the agricultural sector of Punjab and draw lessons for higher agricultural growth in future.

Data

The study uses time-series data on public expenditure on agriculture and gross state domestic product from agriculture (GSDP) for 1990-91 to 2019-20 from the Reserve Bank of India Publications - State Finances: A Study of Budgets, and the Directorate of Economics and Statistics, Government of Punjab. The annual agricultural GSDP time series data are a proxy for growth in agriculture. The study considers spending on crop husbandry, soil & water conservation, animal husbandry, dairy development, fisheries, forestry & wildlife, and agricultural research & education. The time-series data of all the variables were deflated at 2011-12 constant prices using GDP deflator and are expressed in Rupees Crores. To avoid double-counting, the loans, advances, and central government expenditure were not considered.

Methodology

Stationarity tests

To check the stationarity of the variables, the Augmented Dickey-Fuller (ADF) test was employed.

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \Sigma_{i-1}^{m} a_i \Delta Y_{t-1} + u \quad \ldots. (1)$$

Where Y_t is the expenditure or agricultural GSDP in year 't', ΔY_t is the difference of the series Y and u is the pure white noise error term. β_1 is the constant, and β_2 and δ are the parameters to be estimated. Further, m is the optimal lag value selected based on the Akaike information criterion (AIC). The test has the null hypothesis that the variable has a unit root, indicating that the series is non-stationary.

Model specification

The econometric model was chosen after examining the correlation between explanatory variables to avoid multicollinearity. Therefore, the variables fisheries and animal husbandry, which are highly correlated with other explanatory variables, are excluded.

Thus, the model is specified as:

$$\ln AgGSDP = C + \beta_1 \ln Crop + \beta_2 \ln Soil + \beta_3 \ln Dairy + \beta_4 \ln Forest + \beta_5 \ln AgRes + u \quad \ldots(2)$$

Where,

AgGSDP = Agricultural gross state domestic product

Crop = Expenditure on crop husbandry

Soil = Expenditure on soil & water conservation

Dairy = Expenditure on dairy development

Forest = Expenditure on forestry & wildlife

AgRes = Expenditure on agricultural research & education

C = constant term

u = error term

β_n = coefficients of the respective variables

Causality tests

The Granger causality test provides the causal relationship between agricultural GSDP and public expenditure. It tests the hypothesis of predicting a particular variable's future values while incorporating the past lags of other variables in the model. If the coefficients of the lagged variables in the equation turned out to be statistically significant, then the explanatory variable does not granger cause the dependent variable. An autoregressive distributed lag (ADL) model for the Granger-causality test is given below:

Table 1 Descriptive statistics

Item of expenditure	Amount (in Rupees Crores at 2011-12 prices)			Standard deviation
	Min.	Max.	Mean	
Crop husbandry	118.22	8223.48	1188.24	2206.22
Soil & water conservation	40.77	106.11	64.25	16.96
Animal husbandry	113.00	350.40	212.95	75.52
Dairy development	4.72	43.26	12.19	9.18
Fisheries	6.63	21.43	11.30	3.28
Forestry and wildlife	36.26	286.20	108.89	59.40
Agricultural research & education	115.97	332.16	189.04	68.39
Agricultural GSDP	35928.11	101048.59	62469.78	18898.67

Source Authors' compilation from RBI publications and Economic and Statistical Office, Govt. of Punjab.

$$\Delta X_t = \Sigma_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \Sigma_{j=1}^{m} \beta_j \Delta X_{t-1} + u_{1t} \quad \ldots(3)$$

$$\Delta Y_t = \Sigma_{i=1}^{m} \sigma_i \Delta Y_{t-1} - \Sigma_{j=1}^{m} \delta_j \Delta X_{t-1} + u_{2t} \quad \ldots(4)$$

Where α, β, σ, and δ are the coefficients of the respective variables, t represents time while i and j are their lags, U_{1t}, and U_{2t} are the error terms. Y and X are the agricultural GSDP and public expenditure, respectively.

Results and discussion

The descriptive statistics of agricultural GSDP and public expenditure on agricultural and allied sectors are given in Table 1. The average agricultural GSDP of Punjab has been estimated at Rupees 62469.78 crores. The average expenditure is the highest on crop husbandry and the lowest on fisheries.

Trend and composition of expenditure

Figure 1 shows the trend (three-year moving average) of Punjab state's public expenditure on agriculture and allied sectors at 2011-12 prices. The revenue expenditure (RE) is much higher than the capital expenditure (CE). The capital expenditure declined from 2000-02 to 2002-04, and after that, it increased continuously. On the other hand, the revenue expenditure increased during 2000-02 to 2001-03, then declined immediately, and remained almost constant during 2002-04 to 2011-13. The revenue expenditure increased sharply since 2011-13 and thus, resulted in a sharp increase in the total expenditure (TE).

Figure 2 depicts the share of agriculture and the allied sector in the GSDP and the amount of public expenditure as % of total developmental expenditure,

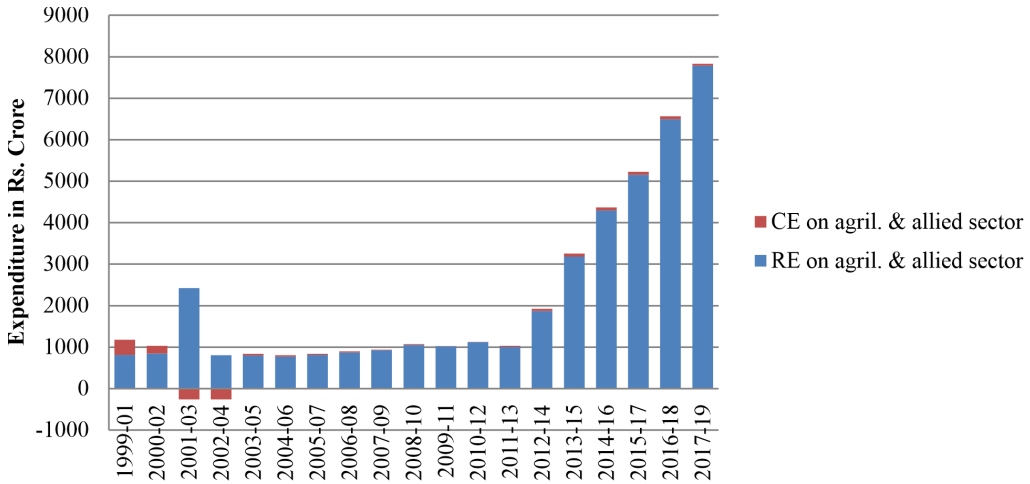

Figure 1 Trends in public expenditure on agriculture & allied activities
Source Authors' compilation

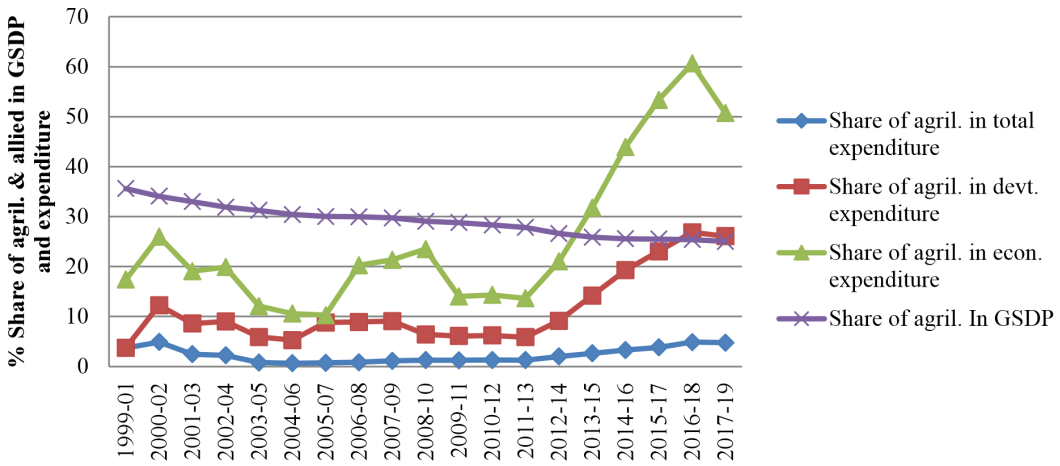

Figure 2 The share of agriculture & allied activities in GSDP and expenditure
Source Authors' compilation

total economic expenditure, and total expenditure at 2011-12 prices. The share of agriculture and the allied sector in GSDP has declined slowly. The share of public expenditure on agriculture and the allied sector as % of the total economic expenditure and total developmental expenditure has shown ups and downs but increased significantly in 2011-13, declining again after 2016-18. The share in the total spending has also established a declining trend till 2004-06, remaining constant from 2004-06 to 2011-13 and showing an increase, later. As a result, the average share of agriculture and the allied sector in the GSDP was 29.15%, and the average share of public expenditure on agriculture and the allied sector in the total expenditure, total developmental expenditure, and total economic expenditure were 2.30, 11.29, and 25.45 %, respectively.

The composition and annual growth rate of the public expenditure on agriculture and allied sectors and agricultural GSDP are shown in Table 2. The agricultural GSDP showed an increasing trend with an annual growth of almost 3.3% during 1990-2009 to 4.08% annually during 2010-2019. The expenditure on crop husbandry showed negative annual growth of -3.07% during 1990-99 but increased at 8.18% annually during 2000-09 and much faster 51.50% per annum during 2010-2019. The growth rate of soil & water conservation, animal husbandry, fisheries and agricultural research & education sectors was also positive but relatively slow. In the dairy development

Table 2 Composition and compound annual growth rate of AgGSDP and public expenditure on agriculture & allied sector (at 2011-12 prices)

Year/sector	Crop husbandry	Soil & water conservation	Animal husbandry	Dairy	Fisheries	Forestry & wildlife	Agril. research & education	AgGSDP
				Public expenditure and GSDP (in Rs. Crores)				
1990-99	170.34	54.04	137.46	7.13	8.17	663.09	125.50	44648.50
2000-09	172.51	58.50	194.48	15.45	10.77	146.49	177.89	57313.53
2010-19	3221.87	80.23	306.92	14.00	14.96	117.11	263.75	854473.13
				CAGR (%)				
1990-99	-3.07	2.76	3.63	-2.73	2.67	7.55	1.96	3.29
2000-09	8.18	1.34	1.71	22.08	2.02	-10.75	0.15	3.30
2010-19	51.43	2.25	3.33	-8.50	1.63	10.32	6.41	4.08

Source Authors' compilation from RBI publications and Economic and Statistical Office, Govt. of Punjab.

sector, the growth rate was negative during 1990-99 and 2010-19. There was a negative growth rate of -10.75% per annum in the forestry & wildlife sector during 2000-09, but it became positive at 7.55% per annum during1990-99 and 10.32% per annum during 2010-19, respectively.

Augmented Dickey-Fuller (ADF) test

To check the stationarity of the variables, the Augmented Dickey-Fuller (ADF) test has been conducted and the results are shown in Table 3. The time series of all the variables are non-stationary at the level. However, at the first difference, all the variables' absolute t-statistic value is found greater than their critical values, with the p-values being significant. This indicates that the series is free from the unit root and is integrated at order one.

Effects on growth

The regression results are presented in Table 4. To avoid multicollinearity, the variables were selected based on the correlation matrix. As animal husbandry and fisheries variables were highly correlated with other variables, these were omitted from the analysis. The regression coefficient of crop husbandry indicates that each percentage increase in expenditure on crop husbandry increases the real agricultural GSDP by 0.09%. These findings are supported by Ighodaro (2006), Faleyimu (2013), and Oyetade and Dewi (2014). Dairy development is also found to have a significant and positive impact; with a 1% increase in public expenditure on dairy development, the real agricultural GSDP of Punjab increased by 0.10%. These findings are consistent with this Revoredo-Giha (2015) and Chandio et al. (2017). Likewise, the public expenditure on agricultural research and education has a significant and positive impact on Punjab's agricultural economy; a 1% increase in public spending increases the real agricultural GSDP by 0.35%. These results are in line with Alston et al. (2000) and Mogues et al. (2012). On the other hand, the variables soil & water conservation and forestry & wildlife are found to have no significant impact on the agricultural GSDP.

The results of the Granger causality tests are shown in Table 5. The VAR Lag Order Selection Criteria was followed to select the appropriate number of lags. Accordingly, a lag of one was selected and used to check the causal relationship between various categories of public expenditures in agriculture and agricultural GSDP. The results reveal that the variables

Table 3 Results of unit root test of the variables

Expenditure	At level & 1st difference	t-statistic value	Critical value	p-value	Remarks
Crop husbandy	Level	-0.06	-3.67	0.95	Non-stationary
	First difference	-5.65	-3.68	0.00*	Stationary
Soil & water conservation	Level	-2.86	-3.67	0.06	Non-stationary
	First difference	-7.07	-3.69	0.00*	Stationary
Animal husbandry	Level	-0.04	-3.67	0.95	Non-stationary
	First difference	-6.37	-3.68	0.00*	Stationary
Dairy development	Level	-2.56	-3.67	0.11	Non-stationary
	First difference	-7.95	-3.68	0.00*	Stationary
Fisheries	Level	-0.69	-3.68	0.83	Non-stationary
	First difference	-9.88	-3.69	0.00*	Stationary
Forestry & wildlife	Level	-1.13	-3.67	0.68	Non-stationary
	First difference	-3.90	-3.68	0.00*	Stationary
Agricultural research & education	Level	-0.95	-3.68	0.75	Non-stationary
	First difference	-7.36	-3.68	0.00*	Stationary
Agricultural GSDP	Level	- 0.30	-3.67	0.91	Non-stationary
	First difference	-5.60	-3.68	0.00*	Stationary

Source Authors' calculations
Note *indicates significance at 1 % level.

Table 4 Regression results of determinants of agricultural growth in Punjab

Explanatory variable	Coefficient	Standard error	t-statistic	p-value
ln Crop	0.09	0.29	3.17	0.00*
ln Soil	0.02	0.13	0.21	0.83
ln Dairy	0.10	0.04	2.41	0.02**
ln Forestry	0.03	0.06	0.63	0.53
ln AgRes	0.35	0.15	2.32	0.02**
Constant	9.84	1.06	9.23	0.00*
R-squared	0.85			
Adj R-squared	0.82			
F-statistic	28.59			

Source Authors' calculations
Note * and ** indicate significance at 1% and 5% levels, respectively.

Table 5 Results of pairwise Granger causality test

Null hypothesis	F-statistics	p-value	Granger	Remarks
Expenditure on crop husbandry does not Granger cause AgGSDP	0.40	0.52	No	Unidirectional
AgGSDP does not Granger cause expenditure on crop husbandry	5.72	0.02**	Yes	
Expenditure on soil & water conservation does not Granger cause AgGSDP	1.18	0.28	No	Unidirectional
AgGSDP does not Granger cause expenditure on soil & water conservation	6.75	0.01**	Yes	
Expenditure on animal husbandry does not Granger cause AgGSDP	2.95	0.09***	Yes	Bidirectional
AgGSDP does not Granger cause expenditure on animal husbandry	16.22	0.00*	Yes	
Expenditure on dairy development does not Granger cause AgGSDP	0.07	0.79	No	None
AgGSDP does not Granger cause expenditure on dairy development	0.85	0.36	No	
Expenditure on fisheries does not Granger cause AgGSDP	3.87	0.05**	Yes	Bidirectional
AgGSDP does not Granger cause expenditure on fisheries	14.75	0.00*	Yes	
Expenditure on forestry & wildlife does not Granger cause AgGSDP	3.28	0.08***	Yes	Bidirectional
AgGSDP does not Granger cause expenditure on forestry & wildlife	3.74	0.06***	Yes	
Expenditure on agril. research & education does not Granger cause AgGSDP	0.55	0.46	No	Unidirectional
AgGSDP does not Granger cause expenditure on agril. research & education	8.05	0.00*	Yes	
Total expenditure on agriculture does not Granger cause AgGSDP	0.40	0.53	No	Unidirectional
AgGSDP does not Granger cause total expenditure on agriculture	5.78	0.02**	Yes	

Source Authors' estimation
Note *, **and *** indicate significance at 1% , 5% and 10% levels, respectively.

of crop husbandry, soil & water conservation, agricultural research and education were Granger caused by agricultural GSDP in a unidirectional way; however, the animal husbandry, fisheries and forestry & wildlife have a bidirectional causal relationship with agricultural GSDP. Again, the pairwise causality test result between the total public expenditure and agricultural GSDP has shown that agricultural GSDP Granger causes total public expenditure in agriculture. These findings support Wagner's law, i.e., economic growth is a determinant of the public sector expenditure (Salih 2012, Srinivasan 2013, Wang et al. 2016, De

2018). Moreover, the lack of reverse causal flow from the total public expenditure in agriculture to agricultural GSDP discloses that agricultural and allied activities in the state have been neglected and are poorly managed. Therefore, the performance and share of agricultural and allied sectors in economic development have been declining in Punjab.

Conclusion and policy implications

This paper studied the impact of public expenditure in agriculture on agricultural growth in Punjab. We found that the GSDP from agriculture granger causes expenditures on crop husbandry, soil & water conservation and agricultural research & education unidirectionally; however, animal husbandry, fisheries and forestry have a bidirectional causal relationship with agricultural GSDP. Again, the pairwise causality test results between the total public expenditure on agriculture and agricultural GSDP have shown the causality of agricultural GSDP to the total public expenditure agriculture sector. This finding supports Wagner's law, i.e., economic growth is a determinant of public sector expenditure. The prevalence of Wagner's law points to the fact that public expenditure is not optimally allocated across various sectors. It calls for a reprioritization of public spending in agriculture to boost future agricultural growth in Punjab. While the public expenditure needs to be curbed across unproductive sectors, it needs to be expanded to the more productive sub-sectors of agriculture such as crop husbandry, dairy development and agricultural research & education.

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