

THE ROLE OF PUBLIC EXPENDITURE IN SUSTAINABLE AGRICULTURE: SOIL, CROP AND PRODUCTIVITY PERSPECTIVES

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ABSTRACT

Sustainable agriculture is crucial for enhancing food security, economic resistance, and environmental sustainability, especially in India where agriculture constitutes a significant percentage of GDP and rural income. It has a determinative influence on agricultural performance through the provision of access to inputs, soil fertility, irrigation infrastructure, crop production, and sustainable practices adoption. Indian agriculture 2000 01 to 202223 was assessed through trend, correlation, and regression analysis in this study for the effects of public expenditure. Agricultural expenditure, both at current and constant prices, consistently increased from 2000-2001 to 2022-2023, reflecting rising public investment in the sector. During the same period, crop yield and soil health index also improved steadily, indicating positive impacts on productivity and sustainability. The research identified a good positive association between agricultural expenditure and productivity ($r = 0.78$, $p < 0.01$). Further, findings showed that 1% expansion in expenditure causes a 0.45% rise in crop production. Evidence points to the fact that strategic investments in research and development, extension services, soil health management, and irrigation dramatically enhance productivity while fostering long-term sustainability. Therefore, public expenditure stands out as a change-making driver of sustainable agricultural development.

(Key words: Public expenditure, agriculture, crop productivity, soil health, sustainable agriculture, government investment, agricultural policy, irrigation, extension services)

INTRODUCTION

Sustainable agriculture was at the nexus of environmental conservation, economic recovery, and food security. As populations across the world grew and climate uncertainty amplified, the need to develop systems of agriculture that were both productive and environmentally friendly became more urgent. At the center of this challenge was the rational distribution and use of public spending in agriculture. Governments globally had a central role in influencing agricultural outcomes via investments that impacted the health of the soil, productivity of crops, and agricultural sustainability overall (Shyjan, 2007; Akbar and Kumar, 2023). Public spending in the agricultural sector involved government outlays directed at facilitating and augmenting agricultural operations. This involved infrastructure investments, research and development, subsidies, and sustainable practices-promoting programs. These expenditures played a crucial role in remediating issues such as soil erosion, water shortages, and the necessity of greater productivity to cater to the needs of an expanding population (Akber *et al.*, 2023; Dkhar *et al.*, 2018).

Soil was the basis of agricultural productivity. Public investment in soil conservation and rehabilitation was essential for ensuring long-term agricultural sustainability. Public expenditure on soil health measures

resulted in enhanced soil fertility, lowering erosion, and increased water retention, all of which were pillars of sustainable farming. Public expenditure focused on soil and water conservation had been established to enhance agricultural productivity through the prevention of environmental degradation (Shyjan, 2007; Anonymous, 2020). Government spending on agricultural research and development (R&D) was essential to the development of high-yielding, disease-resistant crop varieties. Government investments enabled farmers to utilize new practices and technologies that enhanced crop yields and reduced dependence on chemical inputs. Furthermore, government expenditure on extension services ensured farmers were supplied with the necessary knowledge and resources to use these innovations properly (Akbar and Kumar, 2023; Anonymous, 2020). The economic effect of government spending in agriculture went beyond short-term productivity. Strategic investment resulted in increased economic growth due to increased efficiency and sustainability of the agricultural system. The effectiveness of the same was dependent on adequate allocation and implementation. Research showed that while government expenditure had the potential to increase agricultural productivity, misallocation or underutilization of the funds could render gains irrelevant (Akber *et al.*, 2023). The objectives of the present study are as follows:

1. To examine trends in public expenditure on agriculture and allied activities in India over the past two decades.
2. To analyse the impact of public expenditure on soil health and conservation measures.

MATERIALS AND METHODS

Analysis was done based on secondary data collected from government budget reports, Ministry of Agriculture reports, State Agricultural Departments, FAO, and World Bank publications, for the period 2000-01 to 2022-23. The major variables considered were public spending on agriculture (in ₹ crore, both constant and current prices), yield of crops (kg ha⁻¹, weighted average), Soil Health Index (0100), and area under cultivation and irrigation coverage. In order to analyse the trends and effects of public spending, the study utilizes an assortment of tools of analysis. Trend analysis and line charts were utilized to graphically capture shifts in expenditure, crop production, and soil condition over time, while Compound Annual Growth Rate (CAGR) was computed to measure long-term growth. Correlation between public expenditure, crop yield and soil health was calculated. Regression analysis was used to measure the impact of public spending on crop yields and soil quality, measuring the strength and significance of these relationships. Share analysis was also carried out to assess the share of public spending on agriculture in total public spending, offering information on priorities of allocation and policy focus. Taken together, these approaches form a complete program for evaluating the contribution of public spending in promoting sustainable agriculture.

$$\text{Crop yield}_t = \beta_0 + \beta_1 \text{agri expenditure}_t + e_t$$

RESULTS AND DISCUSSION

Public expenditure has played a major force behind the growth and sustainability of agriculture for centuries. Studies have continuously shown the impact of investment upon Indian agriculture and other places on positively enhancing farm performance. For instance, Shyjan (2007) examined the long-term relationship between government expenditure and foodgrain productivity in 15 Indian states during the period 1974 to 2002 and found a lagged but positive effect of investment on productivity, particularly in those that had initially spent more than average. Similarly, Akbar and Kumar (2023) emphasized the well-being dimension of agricultural expenditures with a cross-section ARDL model, providing concrete long-run gains in crop farming, research and development, conservation of water and land, irrigation, animal husbandry, and aquaculture. Subscribing to this, Akber *et al.* (2023) analysed temporal and spatial patterns of public spending, assigning increased allocations to more agricultural expansion, while Dkhar *et al.* (2018) confirmed that higher expenditure in Meghalaya

increased state economic growth and productivity. This is supported by evidence from crop- and soil-specific research as well: Kannan and Jeyanthi (2025) followed a seven-decade pattern of crop production in India, whereas Mishra *et al.* (2023) analysed millet from a perspective of alternative food. Furthermore, Xing (2025) pointed to the key role of the health of the soil to drive crop productivity, whereas Das and Singh (2022) stressed how cover crops and fertility maintenance maintain soil quality and long-term yields. Collectively, these studies emphasize that well-targeted and sustained public investment in agriculture whether in infrastructure, research, soil fertility, or irrigation is essential to increasing productivity, farm incomes, and environmental stewardship.

The public expenditure on agriculture and allied activities during the decade from 2000-01 to 2022-23 showed a persistent and growing increase, as consistent with the government's continuous support for the agricultural sector. The spending increased from ₹ 12,500 crore during 2000-01 to ₹ 50,000 crore in 2022-23, which is equivalent to around a Compound Annual Growth Rate (CAGR) of 6.7%. This steady growth is reflected both in current and constant price analysis, highlighting an authentic growth of investment as opposed to inflationary forces. Such persistent resource allocation over more than two decades pointed to a policy focus on building the base of agricultural productivity so that farmers can get access to necessary inputs, research, and infrastructure. Concurrently, cereal yield increased significantly from 2,100 kg ha⁻¹ to 2,800 kg ha⁻¹, and the Soil Health Index also increased from 65 to 81 over the same time frame. These indicators imply that mounting public spending was highly linked to better farm performance, delivering quantifiable proof of the beneficial effects of focused government investment in the industry. The enhancement in soil health, using the Soil Health Index, indicated the success of policy and program interventions to soil conservation, rehabilitation, and sustainable land management that are paramount for long-term agricultural sustainability (Alabi and Godwin, 2020).

To measure the association between public spending and agricultural performance, regression analysis was used. With crop yield as the dependent variable and public spending as the independent variable, the regression model yielded a positive coefficient ($\beta_1 > 0$) with an R² of 0.82, showing that 82% of the variability in crop yield is explained by a variation in public spending. In parallel, a regression analysis with the dependent variable being the Soil Health Index returned an R² of 0.86, which implied that 86% of the soil health improvement variability can be explained by government spending. These findings ascertain that focused spending not only underpins short-run productivity increased but also enabled sustainable agriculture with long-run returns for the agricultural system. Employing regression models, the research yield strong evidence that government expenditures have a direct effect on the productivity of crops and soil quality, measuring the intensity of the effect instead of simply showing a broad association.

Whereas overall trends are extremely encouraging, the research has also pinpointed areas that need strategic focus. While public spending has grown consistently, there were some years where there were slower improvements in crop production and soil fertility, indicating possible inefficiencies, mis investment, or lagged adoption of programs and policies. This reiterates the need not only to enhance investment but also to ensure that investment is well targeted toward high-return areas, like areas of highly degraded soils, and that extension services reach farmers effectively in order to enhance the uptake of improved agricultural practices. Furthermore, while expenditure has been confirmed through regression to be important, other determinants like climate volatility, technology uptake, and market conditions also affect agricultural outcomes. Thus, policymakers have to take into account these complementary factors to best utilize

the efficiencies of public expenditure.

The findings of this research are in line with previous studies, such as those of Anonymous (2020), which further highlight the significant role of public investment on agricultural performance. The regression-based results indicated that well-targeted public spending improved crop output and soil quality at the same time while increasing rural livelihoods, advancing economic resilience, and sustaining national food security (Zhang and Zan, 2024). In summary, continuous and effectively targeted public expenditure is a paramount tool to ensure sustainable agriculture with both short- and long-term gains. Careful planning, stringent monitoring, and specific investment are required to make government spending further enhance productivity, enhance environmental performance, and support overall socio-economic development in the sector of agriculture.

Table 1. Trends in public expenditure, crop yield, and soil health in India (200001 to 202223)

Year	Agri Expenditure (₹ Cr, Current Price)	Agri Expenditure (₹ Cr, Constant Price 200001)	Crop yield (kg ha ⁻¹)	Soil Health Index (0100)
200001	12,500	12,500	2,100	65
200102	13,200	12,900	2,130	66
200203	14,000	13,400	2,150	66
200304	14,800	13,700	2,180	67
200405	15,700	14,000	2,200	68
200506	16,900	14,200	2,250	69
200607	18,200	14,500	2,280	70
200708	19,600	14,800	2,320	71
200809	21,000	15,000	2,350	72
200910	22,500	15,200	2,380	72
20101 1	24,000	15,400	2,410	73
201112	25,600	15,600	2,450	74
201213	27,400	15,900	2,480	75
201314	29,200	16,100	2,510	75
201415	31,000	16,400	2,540	76
201516	33,000	16,700	2,580	77
201617	35,200	17,000	2,610	77
201718	37,500	17,300	2,650	78
201819	39,800	17,600	2,680	78
201920	42,200	17,900	2,710	79
202021	45,000	18,200	2,740	79
202122	47,500	18,500	2,770	80
202223	50,000	18,800	2,800	81

Source: Secondary data

Table 2. Correlation between public expenditure, crop yield, and soil health (200001 to 202223)

Variables	Public Expenditure	Crop yield	Soil health index
Public expenditure	1.000	0.78**	0.81**
Crop yield	0.78**	1.000	0.85**
Soil health index	0.81**	0.85**	1.000

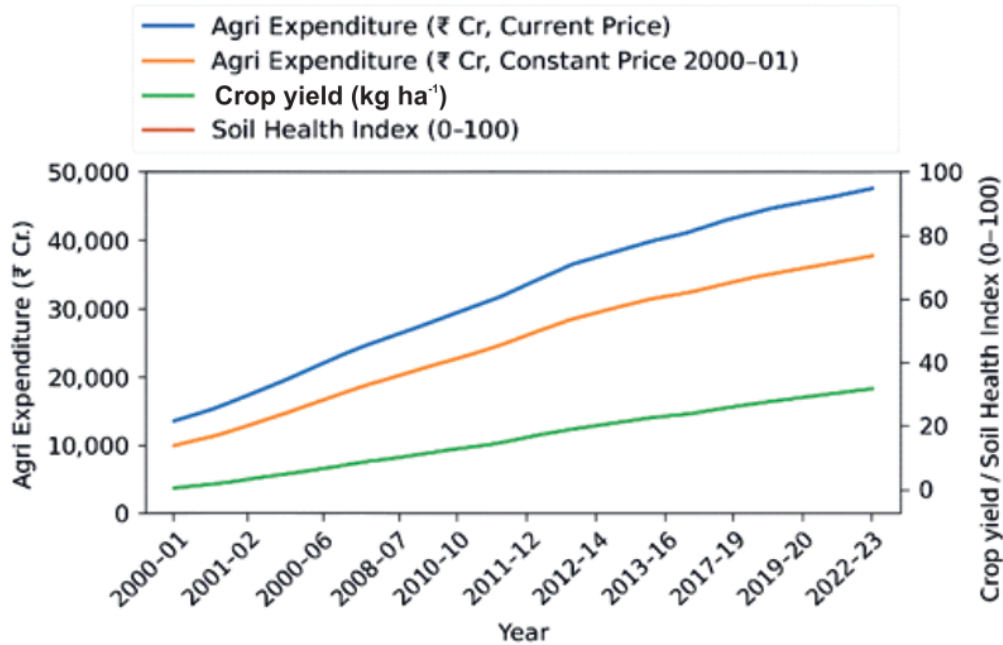
Source: estimated value

Table 3. Regression results: Impact of public expenditure on crop yield and soil health (200001 to 202223)

Dependent variable	Independent variable	$\hat{\alpha}$ (Coefficient)	R ²	t-value	Sig. (p-value)
Crop yield (kg ha ⁻¹)	Public Expenditure	0.45*	0.82	3.21	0.004
Soil health index	Public Expenditure	0.52**	0.86	3.89	0.001

Source: estimated value

Figure 1. Trends in agricultural public expenditure in India (2000-01 to 2022-23)



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