Indian Journal of Agricultural Sciences **95** (9): 1088–1093, September 2025/Article
https://doi.org/10.56093/ijas.v95i9.164710

Agricultural growth and its impact on gross state value added: An econometric analysis of major crop sectors in Haryana

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Received: 11 February 2025; Accepted: 1 August 2025

ABSTRACT

Agriculture remains a vital primary sector in Haryana and contributes significantly to both the state's economy as well as India's food security. The basic objective of the research was to investigate the relationship between the Gross State Value Added (GSVA) and the output of major agricultural sub-sectors (cereals, pulses, and oilseeds) in Haryana by using an econometric analysis. The study aimed to analyze how changes in the output of key agricultural sectors have impacted the GSVA of the state over the period of 30 years from 1993–94 to 2022–23. The time series data were collected from various issues of the state statistical abstract of Haryana and other government publications related to the objective of the study. Data were analyzed by using the ordinary least square method and the Augmented Dickey Fuller test. The results revealed that output from two sectors (cereals and oilseeds) has a positive and significant relationship with GSVA, whereas pulses have exhibited a negative relationship. Therefore, the study suggested that the Government of Haryana should strengthen their policies and support for cereal and oilseed production and address challenges in the pulse sector for better contribution and agricultural growth in future.

Keywords: Agriculture, ADF test, Econometric analysis, GSVA, OLS

Haryana has become a leading agricultural state in India, playing a crucial role in the country's food production and food security. Despite occupying only 1.3% of India's total land area (Sharma 2016), the state has significantly contributed to the national food supply and has almost produced more than 6% of India's total food grains production. Agriculture remains the backbone of Haryana's economy with approximately 80% of its total geographical area in the state under cultivation (Kumar and Singh 2022). However, Haryana faced several challenges such as depleting groundwater levels, climate variability and the increasing demand for sustainable agricultural practices. Haryana's agricultural sector must adapt to cope with these challenges by adopting advanced farming techniques, efficient resource management and sustainable practices (Chauhan and Jaglan 2021). With an estimated 70% increase in food demand by 2050, it is imperative to enhance agricultural output through improved various policies, developed technology integration and infrastructural advancements (Khan *et al*. 2021).

The availability of staple crops such as wheat, rice, and sugarcane play a crucial role in meeting the food demands of an expanding population (Gehlot and Kaur 2015). To address future needs, Haryana must focus on increasing productivity, ensuring sustainability, and fostering agricultural innovations such as protected cultivation, precision farming, and climate-resilient crop varieties (Dev *et al*. 2023). These strategies will not only enhance efficiency but also secure long-term food and livelihood stability for farmers and rural communities. Gross State Value Added (GSVA) serves as a key economic indicator that measures the contribution of various sectors to the state's overall economy, including agriculture and others i.e. with agriculture and allied sectors accounting for about 16.20% of Haryana's GSVA and it was estimated at around ₹92,862 crore in 2022–23 of which agriculture and livestock contributed about ₹85,973 crore (Chicker and Sahu 2024). The rationale for selecting cereals, pulses and oilseeds lies in their prominence in the state's cropping pattern, policy support and market demand. Therefore, the study has proposed to understand the relationship between GSVA and major agricultural sub-sectors (cereals, pulses and oilseeds) to access the need for balanced approach to

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agricultural development by ensuring that all sub-sectors contribute effectively to the state's economic growth.

MATERIALS AND METHODS

To study the relationship between the GSVA and outputs of major agricultural sub-sectors, i.e. cereals, pulses and oil seeds, the annual time series data from 1993–94 to 2022–23 was used. The data were collected from the various issues of the Statistical Abstract Haryana. The variables used in this study were GSVA per year in ₹ Lakh, and output of all (cereals, pulses and oil seeds) in 000' tonnes.

Model specification: To analyze the relationship between the GSVA and outputs of major crop groups (Rehman and Jingdong 2017), the following model estimated is specified as

$$Y=AX_1^{\beta_1}X_2^{\beta_2}X_3^{\beta_3} \quad (1)$$

Taking the natural logarithm of equation (1) and considering seven explanatory variables, Equation (1) converts to the following form:

$$\ln Y= \beta_0+ \beta_1 \ln X_1+ \beta_2 \ln X_2+ \beta_3 \ln X_3+ \mu \quad (2)$$

where β_0, Natural logarithm of A; A, Intercept; ln Y, Natural logarithm of GSVA/year (₹ Lakh); ln X_1, Natural logarithm of output of cereals (000, tonnes); ln X_2, Natural logarithm of output of pulses in (000, tonnes); ln X_3, Natural logarithm of output of oilseeds in (000, tonnes); μ, Error term.

So, equation (2) can also be written as:

$$\ln (GSVA) = \beta_0 + \beta_1 \text{ In (Cereals)} + \beta_2 \text{ In (Pulses)} + \beta_3 \text{ In (Oilseeds)} + \mu$$

The coefficients β_1, β_2 and β_3 represent the output elasticity of GSVA with respect to cereals, pulses, and oilseeds, respectively. Thus, if there is a 1% increase in the output of cereals, pulses, or oilseeds, the GSVA is expected to change by about β_1, β_2 or β_3 per cent, respectively assuming all other factors remain constant. The present study is based on the time series data from 1993–94 to 2022–23. First of all, we checked the variable's stationarity by using the Augmented Dickey Fuller (ADF) unit root test. After checking the stationarity of the series, the Ordinary Least Square (OLS) econometric method was used to examine the impact of output under cereals, pulses and oil seeds crop groups with their relationship with the GSVA of Haryana for the corresponding period. The OLS method's results will indicate the predictive ability of the model as well as the relative values of the parameters in the short run.

RESULTS AND DISCUSSION

A comprehensive overview of Haryana's agricultural production trends for cereals, pulses, and oilseeds, along with the economic value (GSVA), provided valuable insights into the state's agricultural as well as economic development. The study examined the long-term trends in these variables over the last 30 years (Fig. 1) helped us capture the changes in production patterns and economic growth.

Trends in production of cereals: Haryana continues to be a significant contributor to India's cereal production, particularly in wheat and rice. The production of cereals in Haryana has shown an overall increasing trend over the last three decades (Fig. 1a). This increasing trend has been attributed to improved irrigation, better seed varieties, and favourable government policies. However, a slight decline occurred during 2002–03, when production dropped to 12,246 thousand tonnes, which could possibly have been due to climatic variations or shifts in cropping patterns in the state. After that a significant increase was observed during 2006–07, with production reaching 14,627 thousand tonnes and further increasing to 16,000 thousand tonnes in 2008–09. The highest production recorded during 2011–12 was 18,263 thousand tonnes, after that, slight fluctuations have been observed. During the year 2022–2023, the state produced approximately 12.5 million metric tonnes of wheat, which was about 14% of India's total wheat production (GoH 2023). Rice production was also substantial, with an output of around 4 million metric tonnes, which contributed to both domestic consumption and the central pool for public distribution (Mohidem *et al*. 2022). The state has maintained high productivity levels due to the adoption of high-yielding varieties and effective irrigation practices. However, various challenges such as declining groundwater levels and soil health degradation pose threats to sustainable cereal production.

Trends in production of pulses: Pulses contribute a smaller proportion to Haryana's agricultural landscape compared to cereals. The production of pulses in Haryana has shown a declining trend over the past 30 years (Fig. 1b). This declining trend was attributed to the fact that many progressive farmers shifted away from pulses in favour of more profitable crops like wheat and rice. Between 2000–01 and 2010–11, pulses production fluctuated significantly between 99 thousand tonnes and 178 thousand tonnes. The highest production of pulses (178 thousand tonnes) was recorded during 2008–09, followed by a decline in subsequent years. By 2014–15, pulses production had fallen to 70 thousand tonnes, which indicated a lack of interest among farmers due to lower yields and limited market demand. In the year 2020–2021, the production volume of pulses in Haryana was approximately 72.7 thousand metric tonnes, reflecting a slight increase from the preceding year. Despite this growth, the state remains a net importer of pulses to meet its consumption needs (Kumar *et al*. 2023).

Trends in production of oilseeds: Haryana made progress in oilseed cultivation, especially in crops like rapeseed and mustard. Oilseed production showed an increasing trend despite some fluctuations (Fig. 1c). In the initial years, the production of oilseeds was about 836 thousand tonnes (1993–94), which increased to 985 thousand tonnes in 1996–97. However, there was a steep decline to 456 thousand tonnes in 1997–98, which was likely linked to changing cropping preferences and market mechanisms. Later, a recovery was observed in the early 2000s, when production reached nearly 1,000 thousand tonnes. However, the same inconsistent trend pattern has continued, with

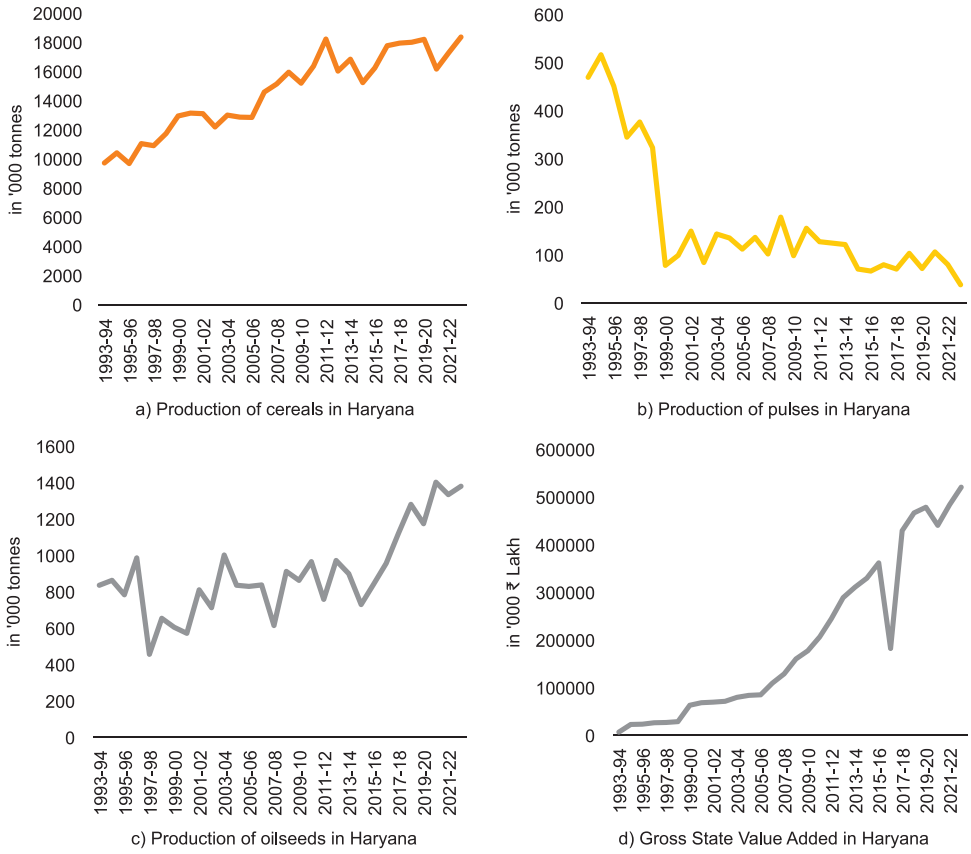

Fig. 1 Trends in production of cereals, pulses, oilseeds and Gross State Value Added (GSVA) in Haryana.

production decline (729 thousand tonnes) in 2014–15. The highest oilseed production was recorded in 2020–21 (1,400.7 thousand tonnes). During the year 2022–23, the production of rapeseed and mustard in the state was recorded at 1.3 million tonnes, representing a slight decrease from 1.4 million tonnes in 2021–22 (GoH 2023) The variation has attributed to various factors such as weather variability and market price changes (Yadav *et al*. 2022).

Trends in GSVA of Haryana: The Gross State Value Added (GSVA) represented the economic condition of the state of Haryana and it exhibited a steady continuous growth with an increasing trend (Fig. 1d). During the late 1900's, the GSVA was nearly ₹6,734.23 crore (1993–94) which increased significantly in the coming years indicating major economic developments in the state. The trend has continued with GSVA reaching its highest growth in the last 5 years. This rapid increase highlighted the growing value of agricultural output in Haryana. However, a decline was recorded in 2020–21 (₹4,41,054.54 crore), which could be likely due to disruptions caused by the COVID-19 lockdown, market fluctuations and supply chain issues. The agricultural (primary) sector in Haryana has undergone significant structural changes over the past three decades. In 1992–93, it contributed 44.41% to the GSVA and remained the dominant sector in Haryana's economy. But soon, the share has gradually declined by 19.75% over the years by 2021–22. The trend reflected the structural transformation of Haryana's economy, which was characterized by developing a reliance on the secondary (manufacturing and industry) and tertiary (services) sectors. While the primary (agriculture) sector's contribution declined, the secondary sector has fluctuated (between 23% to 33%) and the tertiary sector has expanded (about 50%). This shift suggested that Haryana followed a classical economic development pattern which meant that the growth transitioned from agriculture to industry and services (Kuznets 1955). Despite this shift, agriculture remained critical for employment and rural livelihoods in Haryana, necessitating targeted policy interventions to address emerging challenges such as declining productivity and resource depletion.

Fig. 2 has showed how the contribution of different

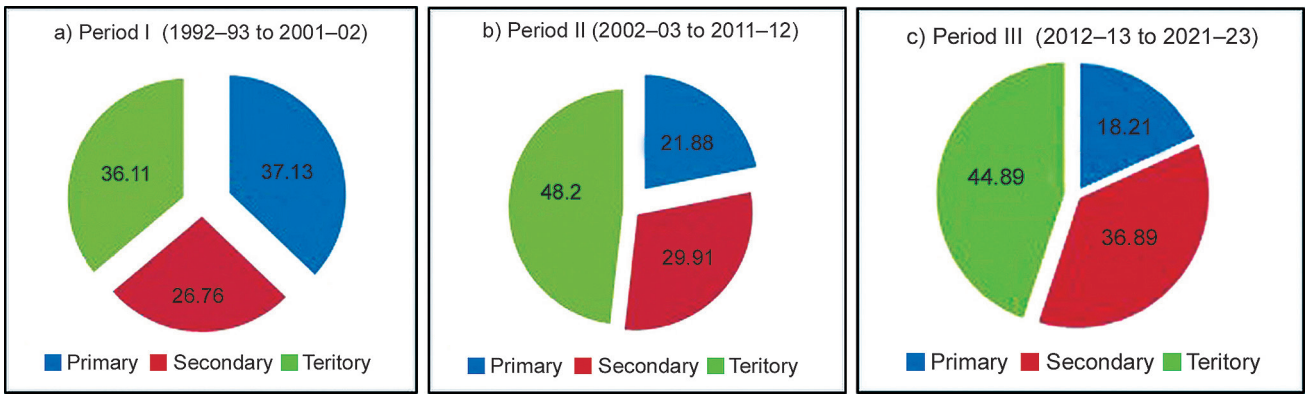

Fig. 2 Sector wise percentage share on GSVA in Haryana over three-decade periods.

Table 1 Augmented Dickey-Fuller (ADF) unit root test for stationarity of selected variables

Variable	At level			At first difference		
	ADF test	P value	Decision	ADF test	*p* value	Decision
ln (GSVA)	-4.193	0.02	NS	-4.489	< 0.01	S
ln (Cereals)	-2.402	0.37	NS	-4.241	< 0.01	S
ln (Pulses)	-3.071	0.16	NS	-4.349	< 0.01	S
ln (Oil seeds)	-4.194	0.02	NS	-4.491	< 0.01	S

NS, Non-stationary; S, Stationary.

sectors to Haryana's GSVA has changed over the past thirty years. The share of the agricultural (primary) sector has steadily decreased from 44.41% in 1992–93 to 28.48% in 2001–02 and then to 19.75% in 2021–22. At the same time, the share of the tertiary sector has increased, reflecting a shift towards a service-based economy. Although agriculture's share in GSVA has declined, the sector has continued to play an important role in the state's economy, especially in terms of rural employment and food production. Cereals, pulses and oilseeds have held a key place in the state's cropping pattern and have received steady policy support and strong market demand. Agriculture has also showed resilience, for example, it has sustained positive growth during the COVID-19 pandemic, even as other sectors have faced sharp declines (Dev 2020).

ADF test for stationarity of selected variables: The Augmented Dickey-Fuller (ADF) test was performed to check the stationarity (Dickey and Fuller 1979) of the selected variables [Gross State Value Added (GSVA), Cereals, Pulses and Oilseeds] at both their level form and first differences, as given in Table 1. The stationarity of a time series is important for econometric modelling, as non-stationary variables may lead to false regression results. The test results were interpreted based on critical *p*-values, where a *p*-value greater than 0.05 indicated non-stationarity (NS) while a *p*-value less than 0.05 indicated stationarity (S).

At the level form, two variables [ln (GSVA) and ln (Oilseeds)] have been found to be stationary at the 5% significance level ($p<0.05$), while remaining two variable [ln (Cereals) and ln (Pulses)] have remained non-stationary. After taking the first difference, all four variables have become stationary with *p*-values less than 0.01. This indicated that the variables have been identified as either stationary in level form [I(0)] or after differencing [I(1)], resulting in a mix of integration orders. Because of this mix, the Autoregressive Distributed Lag (ARDL) model has been considered more appropriate for analyzing long-run relationships, as it has allowed for both I(0) and I(1) variables without requiring them to be of the same order (Pesaran *et al.* 2001). However, in this study, the Ordinary Least Squares (OLS) method has been used to examine short-run relationships, after the non-stationary variables have been transformed into stationary ones through differencing. OLS has remained a valid and widely accepted method for short-term analysis using stationary data (Gujarati and Porter 2009, Wooldridge 2013). This approach has helped to understand the short-term impact of changes in crop output on GSVA without being affected by long-term trends.

Impact of GSVA on agricultural sub-sectors: The regression analysis examined the relationship between Gross State Value Added (GSVA) and key agricultural sub-sectors such as cereals, pulses and oilseeds by using the least squares method for the recent 30 years of data, as presented in the Table 2.

The estimated coefficient for cereals (0.822) with a *p*-value (0.010) and t-statistic (2.795) has indicated a

Table 2 Regression results of agricultural sub-sectors on Gross State Value Added (GSVA) in Haryana

Dependent variable: ln (GSVA)				
Method: Ordinary Least Squares				
Sample count: 1993–2023 i.e. Included observation: 30				
Explanatory variable	Coefficient	Standard error	t-statistic	*p* value
Constant	4.892	3.291	1.486	0.149
ln (Cereals)	0.822	0.294	2.795	0.010
ln (Pulses)	-0.681	0.120	-5.670	0.000
ln (Oil seeds)	1.086	0.350	3.103	0.005
R^2				0.719
Adjusted R^2				0.682
F-statistic				27.346
Standard error of estimate				0.418
Estimated equation				
ln (GSVA) = 4.892 + 0.822 ln (Cereals) + (-0.681) ln (Pulses) + (1.086) ln (Oil seeds) + μ				

statistically significant positive relationship with GSVA at the 5% significance level that means where there will be 1% increase in cereal production may leads to a 0.822% increase in GSVA of state while keeping other factors as constant. The strong positive association described the importance of cereals as a major contributor to Haryana's total agricultural economy. This may be due to high-yielding varieties, efficient irrigation practices and effective government support such as minimum support prices (MSP), which have contributed to cereals being a significant contributor of economic growth (Somanathan *et al*. 2024). However, challenges such as depleting groundwater levels and degradation of soil health due to monocropping (Kumar *et al*. 2023) may threaten the sustainability of this positive contribution in the coming days, which needs to be addressed.

In contrast, pulse production exhibits a strong negative (-0.681) and statistically significant (*p* value of 0.000 and t-statistic of -5.670) inverse relationship with GSVA of the state which means 1% increase in pulse production results in a 0.681% decline in GSVA. The negative impact could be attributed to lower productivity, high production risks, unstable market demand and substitution effects with more profitable crops like wheat and rice. Studies have shown that pulses often suffer from inadequate government support, like MSP and poor mechanization (Reddy *et al*. 2023), despite their ecological and nutritional significance. These findings emphasized that there is a need for targeted policies to stabilize the pulse sector, which includes better price support mechanisms and research into high-yielding varieties like cereals.

Correspondingly, the coefficient for oilseeds (1.086) confirmed a positive impact and was statistically significant (*p* value of 0.005 and t-statistic of 3.103) on the GSVA of the state. The result implied that a 1% increase in oilseed production may lead to a 1.086% increase in GSVA of Haryana. The positive association suggested that investment in high-yielding varieties, farm mechanization and the strong demand for edible oils (Batool *et al*. 2024) may link the oilseed processing industries to support the economic viability of increasing oilseed cultivation in Haryana. The overall model performance is strong with an R^2 value (0.719), which shows that 71.9% of the variation in GSVA was explained by the production of cereals, pulses and oilseeds in the state of Haryana. The adjusted R^2 value (0.682) further confirms that the model's explanatory power after accounting for degrees of freedom, and with the low standard error of estimate (0.418) ensured a high level of precision in the predictions. Further, the F-statistic (27.346) is highly significant, explaining that the explanatory variables collectively influenced the overall GSVA of the state.

The study revealed significant relationships between Gross State Value Added (GSVA) and the output of agricultural sub-sectors (cereals, pulses, and oilseeds) in Haryana over the period from 1993–94 to 2022–23. The findings suggested that an increase in cereal and oilseed production positively impacts the GSVA of Haryana, while pulses exhibited a negative relationship. Specifically, the study reported that a 1% increase in cereal and oilseed production may leads to a 0.822% and 1.086% increase in GSVA, respectively whereas, 1% increase in pulse production is associated with a 0.681% decrease in GSVA. Based on these findings, the policy implications had suggested encouraging for cereal and oilseed production: The positive impact of cereals and oilseeds on GSVA so that the policies should be focus on increasing production through investments and for oilseeds, certain support for oilseed processing industries could further enhance sustainable economic returns; Improvising pulse sector challenges: The negative relationship between pulses and GSVA suggests that the pulse sector faces significant challenges. Policymakers should work on reducing fluctuations/stabilizing market prices and improving farm mechanization in the pulse sector to reduce production risks and enhance its economic contribution to the state of economy; Implementing crop diversification and risk mitigation: Cereal sector has a strong positive contribution to GSVA, while pulses faced risks so that it may suggested to adopt crop diversification along with crop insurance schemes and better risk management practices will help farmers achieve greater stability in income and output, particularly in less predictable markets.

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