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Growth and Trend Analysis of Agronomic Crop Production and Agricultural Extension Outreach: A Secondary Data Approach

Amlendra Kumar Verma[1*]

[1]*Department of Agriculture Hardoi Uttar Pradesh*

* Corresponding author. E-mail: amlendra8188@gmail.com

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ABSTRACT

Understanding long-term growth patterns in agronomic crop production alongside the parallel expansion of agricultural extension infrastructure is essential for evaluating the effectiveness of India's agricultural development strategy and for informing future policy. This study employs a secondary data approach to analyse growth and trends in foodgrain production (area, production and productivity) and in the reach of the Krishi Vigyan Kendra (KVK) extension network over a period spanning more than seven decades (1950-51 to 2024-25). Time-series data were compiled from official sources, including the Ministry of Agriculture and Farmers Welfare, the Indian Council of Agricultural Research (ICAR), and peer-reviewed secondary-data studies, and analysed using compound annual growth rate (CAGR), sub-period comparison, and descriptive trend analysis. Results show that total foodgrain production in India increased more than six-fold, from 50.82 million tonnes in 1950-51 to an estimated 354 million tonnes in 2024-25, though the pace of growth has varied markedly across sub-periods, with the most recent decade (2010-11 to 2019-20) recording a comparatively modest compound annual growth rate of 1.95% as production approaches a productivity plateau in several staple cereals. Crop-wise analysis indicates that rice and wheat have driven the bulk of historical growth, while pulses have grown more slowly and remain the most volatile major crop group. In parallel, the agricultural extension infrastructure has expanded substantially: the number of KVKs has grown from a single pilot centre in 1974 to 731 by 2025, with farmer outreach - the share of operational holdings directly reached by KVK interventions - rising from approximately 1% in 2003-04 to 18.8% in 2024-25, alongside a reported compound annual growth rate of approximately 5-7.6% in real public expenditure on agricultural research, education and extension between 2000-01 and 2014-15. The parallel, though not perfectly synchronised, expansion of production and extension outreach lends support to the view that institutional extension investment has been an important, if incompletely quantified, contributor to sustained agronomic growth. The study concludes with policy implications for further strengthening extension outreach, particularly for pulses and smallholder-dominated regions where production growth and extension penetration both remain comparatively weak.

INTRODUCTION

Agronomic crop production forms the backbone of food and nutritional security in agrarian economies, while agricultural extension serves as the principal institutional mechanism through which research-generated technology and best management practices reach farmers' fields. Since independence, India has pursued a sustained, if uneven, strategy of simultaneously expanding agricultural research and extension infrastructure and promoting technology-driven growth in crop production, most visibly through the Green Rev-

olution of the 1960s and subsequent phases of technological and institutional deepening.

Assessing whether, and to what extent, these two strands of development - production growth on one hand and extension outreach on the other - have moved in tandem requires systematic, long-term trend analysis grounded in reliable secondary data. Such analysis is valuable both for understanding historical performance and for identifying periods, crops or regions where growth has decelerated or where extension penetration has lagged, information that is directly relevant to targeting future investment and policy attention.

This study adopts a secondary data approach to (i) quantify long-term and sub-period growth trends in the area, production and productivity of foodgrains in India, with disaggregation by major crop group; (ii) quantify the parallel growth of the Krishi Vigyan Kendra (KVK) network and associated farmer outreach as a proxy for agricultural extension infrastructure expansion; (iii) situate observed production growth trends alongside extension outreach trends; and (iv) draw policy-relevant conclusions regarding the alignment, or misalignment, between production growth and extension investment over time.

REVIEW OF LITERATURE

A substantial body of secondary-data-based research has examined growth and instability in Indian foodgrain production using compound annual growth rate and related statistical techniques. Sharma et al. (2006) analysed the extent and sources of instability in Indian foodgrain production using long-run time-series data, finding that instability has generally declined over successive decades as irrigation coverage and input-use efficiency improved, though pulses and coarse cereals remained comparatively more volatile than rice and wheat. Srivastava and Lal (2021) applied compound annual growth rate, Cuddy-Della Valle instability index and correlational analysis to the 2010-11 to 2019-20 period, reporting a CAGR of 1.95% for total foodgrain production and identifying a persistent productivity gap between pulses and the dominant rice-wheat system.

Kannan (2021) examined trends in India's agricultural growth at national and sub-national levels using multi-decade secondary data, employing decomposition analysis to distinguish the relative contributions of area, yield and cropping-pattern change to output growth, and highlighting substantial state-level heterogeneity masked by national aggregate figures. A related state-level study of Uttar Pradesh (Agriculture Journal, 2024) similarly applied CAGR and instability analysis over 1990-91 to 2020-21, reporting a CAGR of 3.32% for total foodgrain production and 1.74% for productivity, with a distinct period of stagnation identified in the intervening years before renewed growth after 2017-18.

On the extension side, Ponnusamy and Padaria (2021) reviewed the contribution of agricultural extension research in India, documenting historical yield gains associated with national demonstration programmes and noting that, despite its demonstrated productivity impact, agricultural extension research and evaluation has received comparatively limited academic and policy attention relative to production-focused agronomic research. Gulati et al. (2018), in a comprehensive institutional review commissioned by ICRIER, quantified trends in public expenditure on agricultural research, education and extension across major Indian states, finding modest but positive real growth in extension spending alongside considerable inter-state variation in extension system performance and its association with state-level agricultural growth rates.

Taken together, this literature establishes both the methodological precedent for secondary-data-based CAGR and instability analysis applied in the present study, and the substantive finding, echoed across multiple independent studies, that Indian foodgrain growth has decelerated in relative terms even as extension infrastructure and expenditure have continued to expand - a juxtaposition that motivates the joint trend analysis undertaken here.

MATERIALS AND LITERATURE

This study is based entirely on secondary data compiled from official and peer-reviewed published sources. Data on the area, production and yield of total foodgrains and major crop groups (rice, wheat, coarse cereals and pulses) in India were compiled for the period 1950-51 to 2024-25 from the Ministry of Agriculture and Farmers Welfare (Government of India), the Directorate of Economics and Statistics, Agricultural Statistics at a Glance, and peer-reviewed secondary-data studies reporting official time-series figures. Data on the number of Krishi Vigyan Kendras and associated farmer outreach were compiled from the Indian Council of Agricultural Research (ICAR) and related government press releases and institutional reports.

Growth was quantified primarily using the compound annual growth rate (CAGR), calculated as CAGR (%) = [(Vend / Vstart)^(1/n) - 1] x 100, where Vstart and Vend are the values of the variable of interest at

the beginning and end of the period under consideration and n is the number of years spanned. CAGR was computed for the full study period as well as for selected sub-periods to capture changes in the pace of growth over time; where a CAGR value for a given sub-period had already been reported in a cited secondary-data source, that reported value is presented directly and referenced accordingly, while CAGR values computed by the authors from compiled endpoint data are indicated as such. Descriptive trend analysis and simple period-wise comparison were used to characterise the growth of the KVK network and its outreach, given the discrete, milestone-based nature of the available institutional data. This combination of CAGR estimation, sub-period decomposition and descriptive trend analysis follows established practice in secondary-data-based agricultural growth studies.

RESULTS AND DISCUSSION

This section presents the compiled secondary-data trends in foodgrain area, production and productivity, followed by the parallel trends observed in agricultural extension infrastructure and outreach.

Long-Term Trend in Foodgrain Production

Total foodgrain production in India rose from 50.82 million tonnes in 1950-51 to an estimated 354 million tonnes in 2024-25 (third advance estimate), representing an approximately seven-fold increase over 74 years. The trajectory of growth, however, has not been linear: production roughly doubled within the first 18 years following the initiation of Green Revolution technologies (from around 72 million tonnes in 1965-66 to 152 million tonnes by 1983-84), before decelerating in subsequent decades as major cereal-growing regions approached higher levels of input use and yield potential under existing technology.

Area, Production and Productivity Trends

Alongside the rise in total production, the gross cropped area under foodgrains expanded much more modestly, from approximately 131.9 million hectares in 1950-51 to around 197.6 million hectares by 2010-11, while net sown area rose from 118.8 to 141.6 million hectares over the same period. This divergence between the roughly seven-fold increase in production and the comparatively modest 50% increase in gross cropped area indicates that the overwhelming majority of historical production growth has been driven by yield improvement rather than area expansion, consistent with the technology- and input-intensive character of India's post-Green-Revolution agricultural growth strategy. Foodgrain productivity rose from approximately 736 kg/ha in 1966-67 to 1,638 kg/ha by 2000-01, and to over 2,070 kg/ha by 2014-15, an increase of more than 150% since the mid-1960s.

Crop-wise Growth Performance and Compound Annual Growth Rates

Disaggregating total foodgrain growth by crop reveals substantial variation in the pace of expansion across rice, wheat, coarse cereals and pulses. Rice production increased steadily from 20.6 million tonnes in 1950-51 to 105.5 million tonnes by 2014-15, an average growth rate of approximately 3.2% per annum over that period. Wheat exhibited even more pronounced growth in the decades immediately following the Green Revolution: during 1965-66 to 1984-85, wheat area and production grew at compound annual growth rates of approximately 9.5% and 4.2% respectively, reflecting rapid adoption of high-yielding dwarf wheat varieties and expansion of assured irrigation in north-western India. Over the more recent decade of 2010-11 to 2019-20, by contrast, total foodgrain production grew at a more modest CAGR of 1.95%, reflecting the transition from an expansion phase to a plateau phase in several major cereal-growing tracts.

Pulses have consistently lagged behind cereals in growth performance and remain the most volatile major crop group in the Indian foodgrain basket, with productivity levels reported to be several-fold lower than those of rice and wheat even in recent years; secondary-data analysis for the 2010-11 to 2019-20 period found pulse productivity to be roughly 3.75 times lower than the combined rice-wheat productivity level, underscoring a persistent structural gap in technology adoption and extension penetration for this crop group relative to the major cereals.

Growth of the Agricultural Extension Infrastructure: Krishi Vigyan Kendras

Agricultural extension infrastructure in India has expanded substantially over the same period as the production trends described above, most visibly through the Krishi Vigyan Kendra (KVK) network, the country's principal district-level, frontline agricultural technology assessment and demonstration institution. The first KVK was established on a pilot basis in 1974 at Puducherry; by the end of the Sixth Five Year Plan (1985), the network had grown to 89 centres, reaching 551 by the end of the Tenth Plan (2007), 721 by mid-2020, and 731 by early 2025, with at least one KVK now present in nearly every rural district of the country.

Table 1: *Trend in total foodgrain production and approximate productivity in India, 1950-51 to 2024-25 (*third advance estimate; yields are indicative, rounded from Ministry of Agriculture and ICAR-AICRP sources).*

Period	Total Foodgrain Production (Million Tonnes)	Approx. Yield (kg/ha)	Key Contributing Factors
1950-51	50.82	~500	Traditional varieties, rainfed cultivation
1965-66	72.0	~640	Pre-Green Revolution baseline
1983-84	152.0	~1,020	High-yielding varieties, irrigation expansion
1999-2000	209.0	~1,640	Consolidation of Green Revolution technology
2010-11	244.49	~1,930	Improved seed, fertiliser and irrigation access
2019-20	296.65	~2,150	Precision inputs, MSP-linked procurement expansion
2023-24	332.22	~2,380	Record wheat and rice output
2024-25*	354.0	~2,430	Favourable monsoon, expanded coverage

Table 2: *Compound annual growth rates (CAGR) of area and production for major crop groups across different periods (compiled from Ponnusamy & Padaria, 2021; Srivastava & Lal, 2021; author's computation for the final row).*

Crop / Crop Group	Period	CAGR - Area (%)	CAGR - Production (%)
Rice	1950-51 to 2014-15	n.a.	~3.2 (implied avg. annual growth)
Wheat	1965-66 to 1984-85	9.5	4.2
Total Cereals	Long-term (multi-decade)	-	~2.34
Total Pulses	Long-term (multi-decade)	-	~2.44
Total Foodgrains	2010-11 to 2019-20	-	1.95
Total Foodgrains	1950-51 to 2023-24 (computed)	-	~2.6 (author-computed from endpoint values)

Growth in Farmer Outreach and Extension Expenditure

Beyond the count of physical extension centres, the depth of farmer outreach achieved by the KVK network provides a more direct indicator of extension system performance. The share of farm households directly reached by KVK interventions rose from approximately 1% in 2003-04 to 5.34% by 2013-14, and further to 18.8% by 2024-25, indicating a substantial acceleration in outreach penetration over the past decade in particular. Independent evaluation has further estimated a strong multiplier effect, with each directly trained farmer estimated to influence practice adoption among approximately 30 additional farmers through informal knowledge diffusion, suggesting that effective outreach considerably exceeds the directly measured contact figures.

Public expenditure on agricultural research, education and extension has grown alongside this physical and outreach expansion, though from a modest base. Real (2004-05 price) expenditure on agricultural research, education and extension activities rose from approximately Rs 31.1 billion to Rs 61.6 billion between 2000-01 and 2014-15, a compound annual growth rate of approximately 5% per annum, while expenditure specifically on extension and training activities grew somewhat faster, from Rs 6.4 billion in 2000-01 at a reported CAGR of approximately 7.6% over the same period. Despite this growth, extension and training expenditure remained a small fraction of agricultural GDP throughout the period, at approximately 0.12-0.16%, indicating that the observed institutional and outreach expansion has occurred against a backdrop of persistently modest overall public investment intensity relative to the scale of the sector.

Farmer Outreach Trend and its Coincidence with Production Growth

Viewed together, the acceleration in KVK farmer outreach over the past decade coincides with a period in which aggregate foodgrain production growth, while still positive, has moderated relative to earlier decades, suggesting that extension outreach expansion has thus far been more closely associated with sustaining incremental gains and improving input-use efficiency than with re-accelerating aggregate output growth in already mature cereal systems.

Table 3: *Growth in Krishi Vigyan Kendra network size, farmer outreach and public extension expenditure (compiled from ICAR, 2025; Gulati et al., 2018).*

Indicator	Earlier Value	Later Value	Approx. CAGR / Change
Number of KVKs	1 (1974)	731 (2025)	Network established over 51 years
Number of KVKs	89 (1985)	731 (2025)	~5.5% CAGR (author-computed)
KVK farmer outreach (% of holdings)	1.0% (2003-04)	18.8% (2024-25)	~18-fold increase over 21 years
Real public expenditure on agri. R&E	Rs 31.1 billion (2000-01)	Rs 61.6 billion (2014-15)	~5.0% CAGR
Real public expenditure on extension & training	Rs 6.4 billion (2000-01)	Higher (2014-15)	~7.6% CAGR

INSTABILITY ANALYSIS AND GROWTH CONSISTENCY

Beyond the average pace of growth, secondary-data studies employing instability measures such as the Cuddy-Della Valle Instability Index have consistently identified pulses, and to a lesser extent coarse cereals, as the most volatile major crop groups in the Indian foodgrain basket, reflecting greater sensitivity to rainfall variability, comparatively lower irrigation coverage, and historically weaker price and procurement support relative to rice and wheat. Studies of state-level foodgrain growth, such as analysis of Uttar Pradesh over 1990-91 to 2020-21, similarly report a period of stagnation or decline in some sub-periods before renewed growth in the years since 2017-18, illustrating that national-level average growth figures can mask considerable sub-national and sub-period variability that has direct implications for the geographic targeting of extension resources.

DISCUSSION: LINKING EXTENSION GROWTH WITH PRODUCTION TRENDS

The parallel expansion of the KVK network and farmer outreach alongside sustained, though decelerating, growth in foodgrain production is consistent with, though does not by itself statistically establish, a contributory role for extension investment in sustaining agricultural growth as the initial technology-driven gains of the Green Revolution matured. The observed deceleration in foodgrain CAGR in the most recent decade (1.95% for 2010-11 to 2019-20) alongside a marked acceleration in KVK farmer outreach (from 5.34% in 2013-14 to 18.8% in 2024-25) suggests that extension penetration, while deepening substantially, has to date been more effective at sustaining incremental productivity gains and improving resource-use efficiency than at re-accelerating aggregate production growth in already high-yielding, input-intensive cereal systems.

The persistent lag in pulses productivity and growth relative to rice and wheat, despite decades of extension infrastructure expansion, points to a more specific policy gap: extension outreach, while numerically extensive, may not yet be adequately calibrated - in terms of crop-specific technology packages, seed system support, and market linkage - to address the particular constraints facing pulse producers, who are disproportionately smallholder and rainfed farmers. This finding aligns with independent assessments noting that the benefits of agricultural extension investment in India have been unevenly distributed across crops, regions and farm sizes, even as aggregate outreach indicators have improved markedly over time.

Complementary Extension Mechanisms: ATMA and Digital Advisory Services

The KVK network operates alongside other major components of India's pluralistic extension system, most notably the Agricultural Technology Management Agency (ATMA) scheme, which supports decentralised, district-level extension planning and a bottom-up Strategic Research and Extension Plan process across the majority of the country's rural districts, and a growing array of digital and mobile-based advisory services, including the Kisan Call Centre network and various state and private-sector mobile advisory platforms. While comprehensive, comparably long time-series data for these complementary mechanisms are less consistently available in the public domain than for the KVK network specifically, their parallel expansion since the early 2000s reinforces the broader picture of a steadily deepening, multi-channel extension system operating alongside the production trends analysed in this study.

The growing role of digital advisory channels in par-

ticular is likely to alter the trajectory of future farmer outreach in ways not fully captured by physical KVK-centred outreach metrics alone, since digital platforms can in principle reach farmers at substantially lower marginal cost than physical extension contact once initial infrastructure is in place. Future secondary-data trend analysis would benefit from incorporating digital outreach metrics - such as registered users, active advisory subscriptions, or recorded farmer queries - as they become more systematically documented, to build a fuller picture of aggregate extension system reach beyond the KVK network considered in detail here.

POLICY IMPLICATIONS

- Sustaining foodgrain production growth beyond the current plateau in major cereals will likely require extension strategies oriented toward resource-use efficiency, diversification and climate resilience, rather than further area or input expansion alone.
- Targeted strengthening of pulses-specific extension packages, seed system support and market linkage is warranted given the persistent productivity and growth gap relative to cereals.
- Continued expansion of KVK farmer outreach, building on the substantial gains achieved since 2013-14, should be prioritised in regions and crop systems where current outreach remains below the national average.
- Given that extension and training expenditure remains a small share of agricultural GDP, there is a continuing case for increasing the intensity, not only the extent, of public investment in agricultural extension infrastructure.
- Future secondary-data monitoring should aim to link crop-specific and region-specific extension outreach data more directly with corresponding production and productivity trends, to allow more rigorous evaluation of extension effectiveness than aggregate national-level trend comparison alone can provide.

Limitations of the Secondary Data Approach

As with any study based entirely on compiled secondary data, several limitations warrant acknowledgement. First, the underlying data points for production and extension indicators were drawn from multiple official and published sources spanning several decades, and minor definitional or methodological differences across sources and time periods - for example, in how 'farmer outreach' or 'foodgrain production' estimates are compiled and revised - cannot be fully reconciled within a study of this scope. Second, the long historical time series necessarily combines provisional, revised and final estimates for different years, particularly for the most recent years where only advance estimates were available at the time of compilation; these are noted where relevant but introduce a degree of measurement uncertainty at the margins of the series. Third, the study's reliance on national-aggregate trends, while appropriate for the stated objective of characterising overall growth trajectories, masks substantial state- and district-level heterogeneity that more granular future research should address. Finally, the observed coincidence between extension outreach expansion and production growth trends is descriptive rather than causal; establishing a rigorous causal link would require econometric approaches - such as panel data models controlling for irrigation, price incentives, and other confounding drivers of production growth - that lie beyond the descriptive trend-analysis scope adopted here.

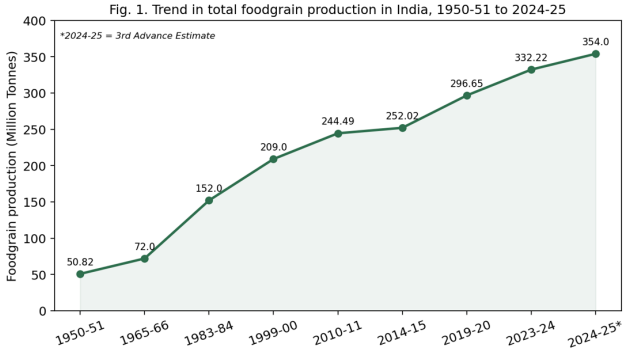

Figure 1: Trend in total foodgrain production in India, 1950-51 to 2024-25 (compiled from Ministry of Agriculture and Farmers Welfare data, PIB, 2022; Deccan Herald, 2024).

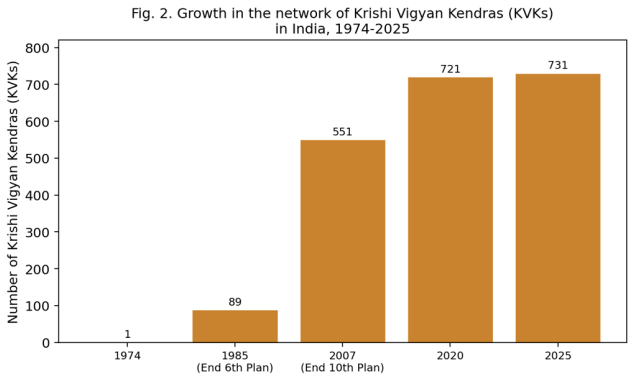

Figure 2: Growth in the network of Krishi Vigyan Kendras (KVKs) in India, 1974-2025 (compiled from ATARI Jodhpur institutional history; ICAR, 2025; PIB, 2022).

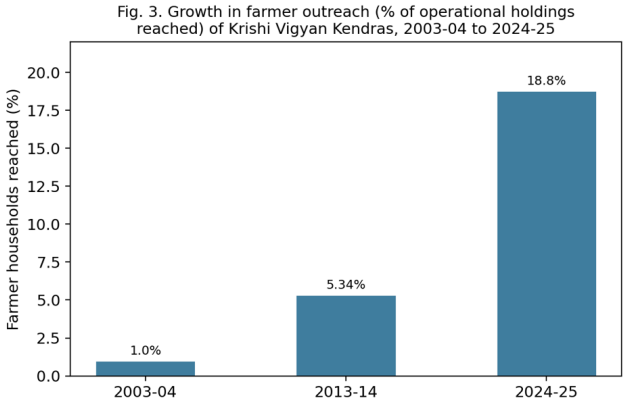

Figure 3: Growth in farmer outreach (% of operational holdings reached) of Krishi Vigyan Kendras, 2003-04 to 2024-25 (data: ICAR, 2025).

CONCLUSION

This secondary-data trend analysis confirms that India's agronomic crop production has grown substantially over more than seven decades, driven overwhelmingly by yield improvement rather than area expansion, but with a clearly decelerating pace of growth in the most recent decade as major cereal systems approach a productivity plateau under existing technology. Over the same period, the Krishi Vigyan Kendra extension network has expanded from a single pilot centre to 731 institutions nationwide, with farmer outreach accelerating particularly sharply over the past decade, even as public expenditure intensity on extension has remained modest relative to the scale of the agricultural sector. The parallel trajectories of production and extension growth, together with the persistent lag in pulses relative to cereals, suggest that continued and better-targeted investment in agricultural extension - calibrated to the specific needs of lagging crops, regions and farm categories - represents an important, evidence-supported priority for sustaining future agronomic growth in India.

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