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Yield gap analysis and economic evaluation of soybean cultivation in northern Telangana zone in Telangana

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Abstract

The present study analyses yield gaps and cost structures in soybean cultivation across the Northern Telangana Zone (NTZ) in Telangana state in India, aiming to assess economic performance and to identify opportunities to enhance productivity. Primary data were collected from 30 normal farmers and 5 progressive farmers in Tamsi and Sirpur mandals of Adilabad district during the 2024-25 crop season. Data from the Agricultural Research Station, Adilabad, served as a benchmark to compare field-level and potential yields. The study employed cost concepts (Cost A1, A2, B, C), along with gross and net returns and benefit-cost ratio (BCR) to evaluate profitability. Results revealed that progressive farmers incurred higher total cultivation costs (Rs. 29,248.72/acre) than normal farmers (Rs. 24,254.95/acre), yet they achieved better returns due to higher productivity (8.17 quintal/acre versus 6.20 quintal/acre) and better prices (Rs. 4776/quintal versus Rs. 4134.73/quintal). The net return for progressive farmers was Rs. 9771.20/acre compared to Rs. 1519.55/acre for normal farmers, and the BCR was also more favourable (1.33 versus 1.06). Higher investment in quality seeds and plant protection chemicals by progressive farmers contributed to this enhanced performance. The yield gap analysis showed that the Research Station Yield (RSY) was 10 q/acre, while Average Farmer Yield (AFY) was 6.20 quintal/acre and Progressive Farmer Yield (PFY) was 8.17 quintal/acre. Accordingly, Yield Gap-I (RSY - PFY) was 1.83 quintal/acre, Yield Gap-II (RSY - AFY) was 3.80 q/acre, and Yield Gap-III (PFY - AFY) was 1.97 q/acre. The significant Yield Gap-II highlights a large unrealized production potential, while Yield Gap-III underlines the impact of improved practices. The study emphasizes that bridging these gaps through adoption of scientific techniques, better input use, and farmer training can significantly enhance soybean productivity and farm profitability in NTZ.

Keywords: Soybean, Yield gap, Benefit-Cost Ratio, Economic analysis.

Introduction

Soybean (*Glycine max*) is one of the most important oilseed crops globally, valued for its high protein content, soil-enriching properties, and wide-ranging industrial applications. In India, soybean occupies a prominent position among kharif crops, contributing significantly to the livelihoods of millions of small and marginal farmers, particularly in rain fed regions. However, the productivity of soybean in India remains suboptimal when compared to global standards, largely due to wide yield disparities among farmers (Gai *et al*., 2025) [5].

The Northern Telangana Zone (NTZ), with its distinct agro-climatic conditions, offers substantial potential for soybean cultivation. Despite the conducive environment, the region continues to witness a significant gap between research station yields and farmers' field-level yields. The concept of yield gap the difference between potential yield and actual yield is a critical indicator of untapped production potential and inefficiencies in current farming systems. Identifying and analyzing such gaps are essential for policy interventions aimed at improving food security and farm profitability (FAO and DWFI, 2015) [4].

Various socio-economic and agronomic factors contribute to yield gaps, including limited access to quality seeds, inadequate use of fertilizers and plant protection inputs, poor pest management, and suboptimal mechanization (Awuni *et al*., 2024) [1]. Progressive farmers, who adopt improved technologies and scientific management practices, often achieve significantly higher yields compared to their peers (Bass *et al*., 2020) [3]. Studying the cost structures, input use efficiency, and yield outcomes of these farmers offers valuable insights for bridging the yield gap at a broader scale (Guilpart *et al*., 2017) [6]. In this context, the present study was undertaken in the Adilabad district of Northern Telangana Zone (NTZ), Telangana, India to assess the extent of yield gaps in soybean production, compare

economic outcomes between progressive and normal farmers, and identify key constraints affecting productivity.

Methodology

This study is based on primary data collected through structured questionnaires, The sample included 30 normal farmers and 5 progressive farmers, selected across the Tamsi and Sirpur mandals of Adilabad district in NTZ, Telangana state during *kharif* 2024-25. Additionally, data was gathered from Agricultural Research Station (ARS), Adilabad, PJTAU to study yield gaps in NTZ in Soybean during *kharif* 2024-25.

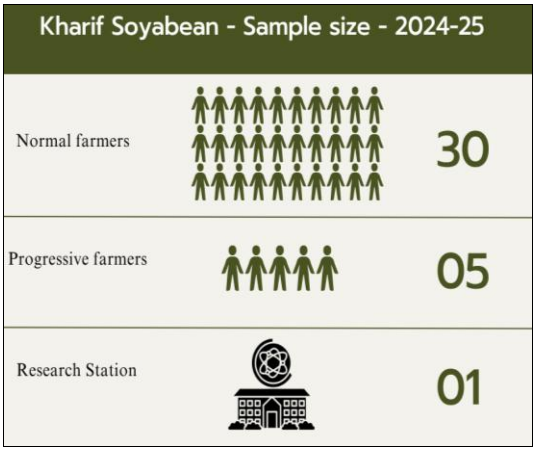

Fig 1: Sample selection

Cost of cultivation

In the study cost A1, cost A2, cost B, cost C and fixed and variable costs were estimated for progressive and non-progressive farmers. Besides these, gross return and net return, benefit to cost ratio were estimated. Cost A1 = All actual expenses in cash and kind incurred in production by the producers. The items included in cost A1 are costs of Hired human labour, Hired bullock labour, Owned bullock labour, Seeds, Plant protection chemicals, Manures (owned & purchased), Fertilizers, Insecticides and Pesticides, Irrigation, Depreciation on farm machineries, equipments, farm building and farm implements, Land revenue, Cesses and other taxes, Interest on working capital and Miscellaneous expenses; Cost A2 = Cost A1 + Rent paid for leased-in land, Cost B = Cost A2 + Interest on value of owned capital assets (excluding land) + Rental value of owned land, Cost C = Cost B + Imputed value of family labour.

Yield Gap

Potential Yield (Yd) represents the maximum yield that can be achieved under ideal experimental conditions, as observed at the research stations. These yields are considered to be the benchmark for determining gaps in productivity. Progressive Farmers Yield (Ypf) represents the non-progressive yield achieved by progressive farmers who apply modern farming techniques and practices in natural environmental conditions. These farmers are considered to be more efficient and technically adept in managing their farmers. Actual Yield (Ya) refers to the yield realized by the farmers on their farmers, taking into account their management practices and environmental factors. Yield Gap-I measures the difference between the Potential Yield (Yd) and the yield achieved by Progressive Farmers (Ypf). It reflects the disparity between the best achievable yield under experimental conditions and the yield obtained by the most efficient farmers in the natural environment.

$$YG\text{-}I = Yd - Ypf$$

Yield Gap-II measures the difference between the Potential Yield (Yd) and the Actual Yield (Ya) observed by the farmers. It reflects the overall yield inefficiency at the farm level.

$$YG{-}II = Yd - Ya$$

Results and Discussion

Table 1: Cost and Return Analysis of Soybean in Telangana

Cost components (Soybean)	Normal Farmer (Rs./acre) (n=30)	Progressive farmer (Rs./acre) (n=5)
Human labour Family	1622.67	796.05
Hired Human labour	2823.17	4335.52
Total bullock labour	781.75	188.34
Total Machine power	4302.59	4832.67
Seeds	2633.51	3174.29
FYM	0.00	0.00
Fertilizers	1332.09	1181.14
Plant protection chemicals	376.18	2437.86
Interest on working capital @ 12.5% (WC*0.125*0.25)	433.50	529.56
Total Variable Cost (TVC)	14305.45	17475.42
Rental value of owned land	8500.00	10000.00
Depreciation	545.00	703.00
Interest on fixed capital @ 10%	904.50	1070.30
Total Fixed Cost (TFC)	9949.50	11773.30
Total Cost (TVC + TFC)	24254.95	29248.72
Main product (q/acre)	6.20	8.17
By Product (value/acre)	139.18	202.94
Main product price (Rs. per q)	4134.73	4776.00
Gross return (Rs./acre)	25774.51	39019.92
Net return (Rs./acre)	1519.55	9771.20
Benefit Cost Ratio	1.06	1.33

Table 1 reveals the significant economic disparities between normal and progressive farmers in the soybean in the study area. The total cost of cultivation per acre was observed to be higher among progressive farmers (Rs.29,248.72) as compared to normal farmers (Rs. 24,254.95). However, the returns and profitability also followed an upward trend for progressive farmers, reflecting better resource use efficiency and yield optimization. Among the cost components, machine power and hired human labour constituted the major variable cost segments for both groups. Progressive farmers incurred a higher cost on plant protection chemicals (Rs. 2437.86/acre) compared to normal farmers (Rs. 376.18/acre), indicating more intensive pest and disease management practices, possibly resulting in better crop health and yield. This aligns with findings by O'Reilly *et al*., (2025) [9], who reported that investment in pest management significantly boosts productivity in soybean crops. The seed cost was also higher among progressive farmers (Rs. 3174.29/acre) than normal ones (Rs. 2633.51/acre), possibly due to the use of certified or hybrid seeds with better yield potential. As supported by Tufa *et al*., (2019) [10], access to improved seed varieties is positively correlated with increased productivity and profitability in oilseed cultivation. The Total Variable Cost (TVC) for progressive farmers stood at Rs.17,475.42/acre, which was 22.15% higher than that of normal farmers (Rs. 14,305.45/acre). Likewise, Total Fixed Costs (TFC) were also more among progressive farmers (Rs. 11,773.30/acre) due to higher rental value of land, depreciation, and fixed capital interest.

Despite the elevated input costs, progressive farmers realized a significantly higher yield of the main product (8.17 quintal/acre) compared to normal farmers (6.20 quintal/acre). Additionally, the market price received was better for progressive farmers (Rs. 4776/quintal) than for normal farmers (Rs. 4134.73/quintal), possibly indicating better market linkage or post-harvest management. This resulted in a gross return of Rs. 39,019.92/acre for progressive farmers, nearly 51% higher than that of normal farmers (Rs. 25,774.51/acre). In terms of profitability, the net return for progressive farmers was substantially higher at Rs. 9771.20/acre compared to Rs. 1519.55/acre for normal farmers. The Benefit-Cost Ratio (BCR), a critical measure of farm efficiency, was 1.33 for progressive farmers, indicating profitable soybean cultivation, whereas it was marginally profitable for normal farmers (1.06). These findings corroborate the results of Awuni *et al*. (2020) [2], who also highlighted better economic returns and BCRs among adopters of improved agronomic and pest management practices in soybean farming. The results collectively indicate that progressive farmers benefited from better agronomic practices, input use, and market accessibility, leading to higher productivity and economic gains. The adoption of scientific farming techniques, particularly the use of improved seeds, timely application of fertilizers and plant protection chemicals, and efficient use of machinery, significantly contributed to the observed yield and return differences.

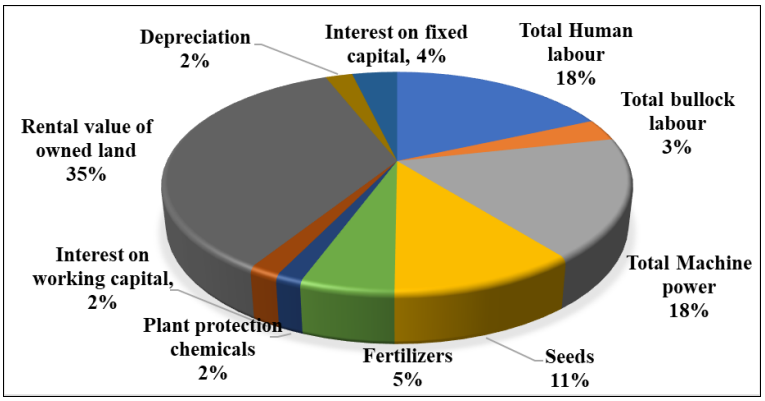

Fig 2: Share of Cost components to total cost (Soybean) for Normal farmers

The cost structure analysis (Fig. 2) reveals the proportional contributions of various cost components to the total cost of soybean cultivation among normal farmers. The rental value of owned land accounted for the largest share at 35%, highlighting the significant role of land ownership and its imputed cost in overall farm economics. This is consistent with the findings of Nayak *et al*. (2023) [8], who emphasized the influence of land rental value on the profitability of field crops. Among operational costs, total human labour and machine power each contributed 18% to the total cost. The reliance on both hired labour and mechanization suggests a semi-modernized production environment. However, this labour cost also reflects the challenge of rising wage rates in rural areas, as observed in studies by Lal *et al*., (2015) [7]. Seed cost formed 11% of the total cost, indicating the importance of quality seed material in soybean cultivation. Progressive farmers, as earlier discussed, incurred even higher seed costs due to their preference for improved or certified varieties, which translated into better yields. Other components such as fertilizers (5%), bullock labour (3%), plant protection chemicals (2%), interest on working capital (2%), interest on fixed capital (4%), and depreciation (2%) made relatively smaller contributions. The low investment in plant protection and fertilizer use could partially explain the lower productivity (6.2 q/acre) among normal farmers compared to progressive ones. Fig. 2 underscores the cost intensiveness of land and labour, suggesting that interventions aimed at improving input-use efficiency such as precision farming, integrated nutrient and pest management, and use of subsidized quality seeds could potentially enhance profitability.

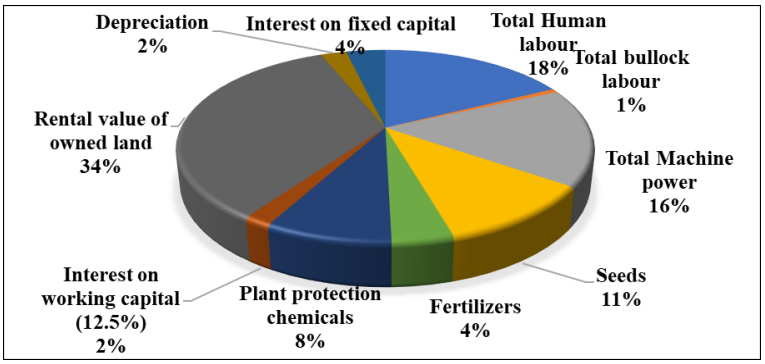

Fig 3: Share of Cost components to total cost (Soyabean) for Progressive farmers

Fig. 3 illustrates the cost distribution for soybean cultivation among progressive farmers in NTZ, Telangana. The rental value of owned land contributed the largest share at 34%, followed by human labour (18%) and machine power (16%), reflecting both land value and semi-mechanized operations. Notably, plant protection chemicals accounted for 8% of total cost higher than in normal farms indicating better pest and disease management. This aligns with higher productivity (8.17 quintal/acre). Inputs like seeds (11%) and fertilizers (4%) also reflect greater investment in quality inputs. Lower shares for bullock labour (1%), interest, and depreciation (2-4%) suggest efficient and modern practices. These cost patterns helped progressive farmers achieve higher profitability and a better BCR (1.33) compared to normal farmers (1.06), as supported by Awuni *et al*., (2020) [2].

Table 2: Yield Gap Analysis of Soybean

Particulars	Yield (quintal per acre)		
Research Station Yield (RSY)	10		
Progressive Farmer Yield (PFY)	8.17		
Average Farmer Yield (AFY)	6.20		
Yield gap	**Quintal per acre**	**Kg per acre**	**Rs. per acre**
Yield gap-I (RSY-PFY)	1.83	183 kg/acre	8740.08
Yield gap-II (RSY-AFY)	3.80	380 kg/acre	15711.97
Yield gap-III (PFY-AFY)	1.97	197 kg/acre	8145.42

Table 2 highlights the significant difference between research potential and actual field level productivity of soybean in the NTZ of Telangana. The Research Station Yield (RSY) is 10 q/acre, while the Average Farmer Yield (AFY) is only 6.20 q/acre, indicating considerable under performance. Yield Gap-I (RSY - PFY) is 1.83 q/acre, showing that even progressive farmers lag behind potential yield by 183 kg/acre, valued at Rs. 8740.08/acre. Yield Gap-II (RSY - AFY) is the widest at 3.80 q/acre (380 kg/acre), equivalent to a monetary loss of Rs. 15,711.97/acre. This reflects the total untapped yield potential under field conditions. Yield Gap-III (PFY - AFY) is 1.97 q/acre, or 197 kg/acre, valued at Rs. 8145.42/acre, emphasizing the gap due to non-adoption of improved practices by average farmers. The large Yield Gap-II suggests a need for interventions in seed quality, pest management, and agronomic practices. The Yield Gap-III clearly shows the scope for improvement if average farmers adopt the techniques used by progressive ones.

Conclusion

The analysis of soybean cultivation in the Northern Telangana Zone underscores significant inefficiencies in realizing the crop's full production potential. The presence of substantial yield gaps particularly Yield Gap-II of 3.80 quintal/acre indicates that average farmers are not fully benefiting from the region's favourable agro-climatic conditions. Economic comparisons between normal and progressive farmers highlight the role of improved practices, timely input use, and better farm management in enhancing both productivity and profitability. Progressive farmers' higher returns were not merely due to greater input use, but more importantly, to strategic investment in quality inputs and efficient resource allocation. This suggests that closing the productivity gap does not necessarily require higher costs, but rather better-informed decision-making and timely interventions. The limited adoption of these practices by average farmers highlights the need for targeted extension services, farmer training programs, and improved input delivery mechanisms. Bridging the yield gaps requires a multi-pronged approach that includes strengthening the seed supply system, promoting integrated pest and nutrient management, and supporting mechanization suited to smallholders. In addition, improving access to credit and market linkages can enable more farmers to shift toward economically viable soybean production systems. Addressing these gaps can contribute significantly to raising income levels among rain fed farmers, reducing import dependency in oilseeds, and enhancing the sustainability of soybean cultivation in Telangana and beyond.

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