Potato J (2025) 52 (2): 213-220

A COMPARATIVE STUDY OF POTATO FARMERS' EARNINGS IN CONTRACT FARMING AND OPEN MARKET OPERATION

Abhijit Das[1*], Antonio Richard[2] and Debjani Das[3]

ABSTRACT: Contract farming has gained attention as a market mechanism to stabilize farm incomes and reduce risks, yet its effectiveness remains debated. This study examines the economic differences between contract and open-market potato farmers in Punjab, focusing on profitability, yield, and market dynamics. Using primary data collected over two years, the analysis applies Propensity Score Matching (PSM) and Difference-in-Differences (DID) to assess financial outcomes. The findings indicate that while contract farming offers stability and input support, open-market sales may provide higher price flexibility. Policy recommendations emphasize the need for balanced contract terms, better price transparency, and institutional support to enhance farmers' economic benefits.

KEYWORDS: Contract farming, Farmers' earnings, Market price, Open-market sales, Sustainable agriculture

INTRODUCTION

Agriculture continues to play a central role in the economy of Punjab, where potato cultivation represents an important commercial activity contributing significantly to farm income and rural employment. In the 2023–24 agricultural season, Punjab recorded potato production of approximately 3.24 million tonnes over an area of about 117,066 hectares, with major production concentrated in districts such as Jalandhar, Hoshiarpur, Kapurthala, Ludhiana, Amritsar, Bathinda, and Fatehgarh Sahib (PAU, 2024). Despite the expansion of cultivated area and improvements in productivity, potato farmers frequently face challenges related to market price volatility, uncertain demand conditions, and fluctuating input costs, which often lead to unstable farm incomes.

Contract farming has emerged as an institutional marketing arrangement intended to address these risks by providing assured procurement, access to quality inputs, and technical advisory support (Tripathi *et al*., 2005; Khan *et al*., 2019). Such arrangements are expected to enhance production efficiency while reducing marketing uncertainty. However, the actual economic outcomes of contract participation remain debated. While some farmers benefit from reduced production risk and organized supply chains, others express concerns regarding limited bargaining power, restricted price flexibility, and the possibility of receiving lower output prices compared to open-market sales (Das and Mishra, 2019). Empirical evidence across regions also presents mixed conclusions, suggesting the need for localized assessments that consider both production efficiency and income dynamics over time.

While several previous studies have examined the economic implications of

*Corresponding author; email: aviplusavi@gmail.com
[1]School of Agriculture, Lovely Professional University, Phagwara, Punjab -144411, India
[2]Agriculture Officer, Dodoma 41101, Tanzania
[3]Royal School of Medical & Allied Sciences, Assam Royal Global University, Guwahati, Assam - 781035, India

contract farming, most analyses rely on cross-sectional comparisons that do not adequately control for selection bias or time-varying income dynamics. The present study contributes new empirical evidence by combining Propensity Score Matching with a panel-based Difference-in-Differences framework using two-year primary data from major potato-growing districts of Punjab. This integrated approach enables simultaneous correction of selection bias and estimation of dynamic income effects, providing district-level empirical insights that remain limited in existing literature.

In this context, a systematic comparative evaluation of contract and open-market potato farming systems becomes essential to understand whether contractual participation generates measurable economic advantages for farmers. The present study therefore examines the differences in cost of cultivation, yield performance, market price realization, and net income between contract and non-contract farmers in Punjab using panel data collected over two agricultural years. By integrating Propensity Score Matching (PSM) to address selection bias and a Difference-in-Differences (DiD) framework to measure income changes over time, the study aims to provide a robust empirical assessment of the income and productivity implications of contract farming. The findings are expected to support evidence-based policy design aimed at improving contractual market systems, strengthening farmer bargaining capacity, and enhancing income stability in the potato sector.

MATERIALS AND METHODS

Study Area and Sampling

The study is conducted in five districts of Punjab: Jalandhar, Ludhiana, Amritsar, Patiala and Bathinda selected based on potato production and market structure. A stratified random sampling method was used, with a total sample of 400 farmers: 200 contract farmers and 200 open-market farmers, approximately proportionally distributed across districts according to regional potato cultivation intensity. A comprehensive list of potato growers was obtained from district agriculture offices, farmer producer organizations, and contracting firms operating in the selected districts. Contract farmers were verified through company procurement records and farmer agreements, while open-market farmers were confirmed as non-contract participants through cross-verification with procurement agencies and self-reported marketing channels. The same farmers were surveyed in both years, thereby forming a balanced panel dataset. Data on cost of cultivation, yield, and prices were collected through structured interviews supported by farm records wherever available, while recall information was limited to the most recent production season to minimize recall bias.

Data Collection

Primary data is collected over two years through structured surveys and interviews, covering input costs, yield levels, price realization, and income variability.

Analytical Framework

Propensity Score Matching (PSM): Because farmers self-select into contract farming, simple comparison between contract and open-market farmers may produce biased estimates. Therefore, Propensity Score Matching (PSM) was employed to construct a comparable control group of open-market farmers based on observable pre-treatment characteristics. Nearest-neighbour matching with replacement was employed using one-to-one matching within the region of common support. Matching quality was assessed through standardized mean difference reduction and t-tests of covariate balance before and after matching. Bias reduction (%) was calculated as the percentage decline in standardized mean differences following matching.

The probability of participation in contract farming was estimated using a logistic regression model, where the dependent variable took the value 1 for contract farmers and 0 for open-market farmers. Explanatory variables included farm size, education level, access to credit, input cost per acre, and yield level. Based on the estimated propensity scores, nearest-neighbor matching was performed within the common support region to match each contract farmer with a statistically similar open-market farmer, and the matched sample was used for subsequent impact analysis.Das *et al.,* 2024; Munshi *et al.,* 2024 also adopted PSM for impact analysis.

$$log\ (P_i\ /\ 1\text{-}P_i) = \beta_0 + \beta_1\ (Farm\ Size_i) + \beta_2\ (Education_i) + \beta_3\ (Credit\ Access_i) + \beta_4\ (Input\ Cost_i) + \beta 5\ (Yield_i) + \epsilon_i$$

Where:

P_i represents the probability of a farmer adopting contract farming.

β_0 is the intercept.

β_1, β_2, β_3, β_4, β_5 are coefficients estimating the effect of explanatory variables.

ϵ_i is the error term.

Difference-in-Differences (DID): To measure the dynamic income impact of contract farming, a Difference-in-Differences (DiD) framework was employed using panel data collected over two agricultural years. The DiD method compares the change in income of contract farmers (treatment group) before and after participation with the corresponding change observed among open-market farmers (control group). This approach helps isolate the effect of contract participation by removing time-specific shocks that may simultaneously influence both groups, such as climatic variations, price fluctuations, or macroeconomic changes.

The empirical specification is represented as:

$$Y_{it} = \alpha + \beta_1 D_i + \beta_2 T_t + \beta_3 (D_i T_t) + \epsilon_{it}$$

Where:

Y_{it} = farm income of farmer *i* in period *t*

D_i = Contract farming dummy (1 = contract, 0 = open-market)

T_t = Time dummy (1 = post-contract, 0 = pre-contract)

$D_i T_t$ = Interaction term capturing contract impact

RESULTS AND DISCUSSION

Sample Distribution

The study was conducted across five major potato-producing districts in Punjab: Jalandhar, Ludhiana, Amritsar, Patiala, and Bathinda. A total of 400 farmers were selected using a stratified random sampling approach, ensuring equal representation of contract and open-market farmers (Table 1).

Jalandhar and Ludhiana had the highest number of respondents, given their prominence in contract farming and well-established market linkages. Amritsar and Patiala were chosen to represent regions with both contract and open-market sales, while

Table 1. Sample Distribution Across Districts

District	Total Farmers	Contract Farmers	Open-Market Farmers
Jalandhar	90	45	45
Ludhiana	85	42	43
Amritsar	75	38	37
Patiala	80	40	40
Bathinda	70	35	35
Total	400	200	200

Bathinda was included for its dominance in open-market transactions. The sample was structured as follows:

The selection of these districts ensures regional diversity in the study, capturing variations in farming practices, market access, and pricing mechanisms. Data collection spanned two years, allowing for a comprehensive assessment of both seasonal and annual trends in contract and open-market sales.

Propensity Score Matching (PSM) analysis

The Propensity Score Matching (PSM) Balance Test ensures comparability between contract and open-market farmers by minimizing selection bias. Before matching, significant differences existed in farm size, education, credit access, input costs, and yield. After matching, these differences became statistically insignificant, confirming a reliable comparison (Das *et al.,* 2024).

From the Table 2 it is evident that before matching, contract farmers had 1.25 acres larger farms (p = 0.022), 2.4 more years of education (p = 0.003), and 18.5% higher credit access (p = 0.007). Post-matching, differences reduced to 0.18 acres (p = 0.496), 0.5 years (p = 0.267), and 2.1% (p = 0.362), achieving bias reductions of 85.6%, 79.2%, and 88.6%, respectively. Similarly, the input cost difference of ₹3,200 (p = 0.014) dropped to ₹450 (p = 0.385), and yield disparity of 16.8 quintals (p = 0.004) declined to 2.3 quintals (p = 0.351), ensuring an unbiased impact evaluation.

The common support zone analysis (Fig.1) further validates the matching process by illustrating the density distribution of propensity scores for both contract and open-market farmers. The graph shows that before matching, contract farmers had a higher likelihood of being in structured farming agreements, while open-market farmers had lower propensity scores. After matching, both distributions overlap significantly within the common support range, marked by the vertical dashed lines, ensuring that only comparable farmers were included in the impact analysis. The common support zone eliminates outliers who could have biased the results, making the findings more robust and reliable (Munshi *et al.,* 2024).

Cost, Yield, Market Price, and Net Income Comparison

A comparative analysis was conducted to evaluate the differences in cost of cultivation,

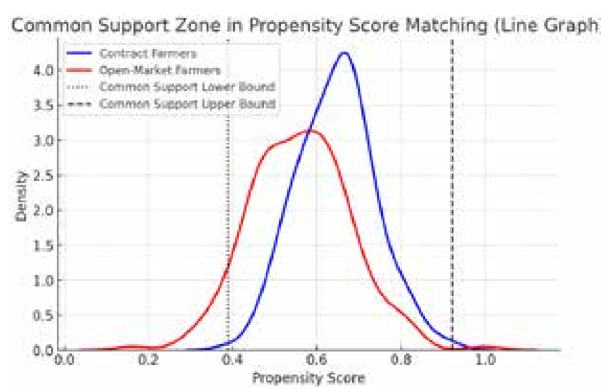

Fig. 1. Common Support Zone

Table 2. PSM Balance Test Results

Variable	Before Matching (Mean Difference)	t-Statistic (Before)	p-Value (Before)	After Matching (Mean Difference)	t-Statistic (After)	p-Value (After)	Bias Reduction (%)
Farm Size (Acres)	1.25	2.31	0.022	0.18	0.68	0.496	85.6%
Education (Years)	2.4	3.05	0.003	0.5	1.12	0.267	79.2%
Credit Access (%)	18.5	2.74	0.007	2.1	0.91	0.362	88.6%
Input Cost (₹/Acre)	3,200	2.48	0.014	450	0.87	0.385	85.9%
Yield (Quintals)	16.8	2.89	0.004	2.3	0.93	0.351	86.3%

yield, market price, and net income between contract and open-market potato farmers (Table 3). The results indicate statistically significant differences in cost, yield, and market price, while the net income difference was not statistically significant. Mishra *et al.*, 2018 also reported similar finding in their research.

Cost of Cultivation: The cost of cultivation per acre was significantly lower for contract farmers (₹45,500) than for open-market farmers (₹48,700) ($p = 0.038$, $p < 0.05$). This 6.6% cost reduction can be attributed to bulk procurement discounts, technical guidance, and reduced input price fluctuations for contract farmers. Open-market farmers faced higher input costs due to fragmented purchases and exposure to market volatility.

Yield: Contract farmers achieved a higher yield of 195 quintals per acre, compared to 178 quintals per acre for open-market farmers ($p = 0.014$, $p < 0.05$). This 9.6% yield advantage is primarily due to access to superior seed varieties, recommended agronomic practices, and timely input supply under contract agreements. In contrast, open-market farmers faced yield variability due to inconsistent input quality and limited technical support.

Market Price: Contract farmers received a lower average market price of ₹1,200 per quintal, whereas open-market farmers secured ₹1,350 per quintal ($p = 0.071$, $p < 0.10$). This 11.1% price difference reflects the trade-off in contract farming, where price stability and assured sales come at the cost of slightly lower prices. Open-market farmers, while benefiting from potentially higher prices, were more vulnerable to market fluctuations and price uncertainty.

Net Income: The net income for contract farmers (₹1,89,000 per acre) was slightly lower than for open-market farmers (₹1,92,300 per acre), but this difference was not statistically significant ($p = 0.364$). The cost savings and higher yields in contract farming compensated for the lower market price, leading to comparable profitability. However, open-market farmers, despite earning a slightly higher income, faced greater financial risk due to unpredictable price variations.

The statistical significance in cost, yield, and market price differences confirms that contract farming enhances production efficiency and reduces cost burdens, while the insignificant difference in net income suggests that both systems can be financially viable depending on risk tolerance and market conditions. Net income per acre was calculated as the difference between gross revenue and total cost of cultivation. Gross revenue was obtained by multiplying yield per acre by the average realized market price.

The pattern of higher yields but relatively lower output prices among contract farmers reflects a commonly observed trade-off in contract farming systems. Previous studies have shown that contracting firms often provide improved seed varieties, extension

Table 3. Cost, Yield, Market Price, and Net Income Comparison

Category	Contract Farmers (Avg. per Acre)	Open-Market Farmers (Avg. per Acre)	Difference (%)	t-Statistic	p-Value	Significance Level
Cost of Cultivation (₹)	45,500	48,700	-6.6%	-2.10	0.038	$p < 0.05$ (Significant)
Yield (Quintals)	195	178	+9.6%	2.48	0.014	$p < 0.05$ (Significant)
Market Price (₹/Quintal)	1,200	1,350	-11.1%	-1.82	0.071	$p < 0.10$ (Moderately Significant)
Net Income (₹)	1,89,000	1,92,300	-1.7%	-0.91	0.364	Not Significant

support, and timely input supply, which enhance productivity and reduce production risk, leading to higher yields (Mishra *et al.*, 2018; Khan *et al.*, 2019). However, procurement prices under contracts are typically pre-determined, limiting farmers' ability to benefit from peak market prices. Similar evidence has been reported in developing-country contract farming contexts where productivity gains compensate for reduced price flexibility. The present findings therefore align with existing empirical literature while providing localized evidence from Punjab's potato sector.

Logistic Regression Analysis

A logistic regression model was applied to estimate the probability of adopting contract farming, considering key socio-economic and farm-specific factors.

The logistic regression model estimates the probability of a farmer adopting contract farming based on key factors (Table 4). The intercept is negative (-1.562, p = 0.017), indicating that without considering other factors, the likelihood of contract farming adoption is low.

Farm size has a significant positive effect on contract farming participation, with a coefficient of 0.865 (p = 0.021). This means that for each additional acre of land, the odds of adopting contract farming increase by 2.38 times. Larger farms may provide better economies of scale, making contract agreements more viable.

Table 4. Logistic Regression Analysis

Variable	Coefficient (β)	Standard Error	p-Value	Odds Ratio
Intercept	-1.562	0.654	0.017	-
Farm Size (Acres)	0.865	0.374	0.021	2.38
Education (Years)	0.195	0.071	0.006	1.22
Credit Access (%)	0.029	0.013	0.026	1.03
Input Cost (₹/Acre)	-0.00048	0.00019	0.011	0.99
Yield (Quintals)	0.071	0.028	0.011	1.07

Education level also plays a crucial role, with a coefficient of 0.195 (p = 0.006), meaning that an additional year of schooling increases the odds of contract farming participation by 1.22 times. Educated farmers are more likely to comprehend contract terms, manage risks, and engage with contracting firms effectively. Similar findings reported by Trey and Brindal, 2015.

Credit access positively influences adoption, as shown by the coefficient of 0.029 (p = 0.026). Farmers with better access to credit are 1.03 times more likely to enter contract farming. This suggests that financial support reduces liquidity constraints, allowing farmers to meet contract requirements.

Input cost per acre negatively impacts contract farming participation, with a coefficient of -0.00048 (p = 0.011). Though small, this suggests that higher input costs reduce the likelihood of contract adoption, possibly because some contracts require farmers to purchase specific inputs at fixed prices. The odds ratio of 0.99 indicates a slight decline in participation as costs increase. Kawsar *et al.,* 2013 also reported parallel findings.

Yield levels have a positive and significant impact, with a coefficient of 0.071 (p = 0.011). This means that for every additional quintal of yield, the odds of adopting contract farming increase by 1.07 times. Higher yields may make contract farming more attractive by ensuring stable production and profitability. Das and Mishra, 2020 reported similar trend in their research on tea.

Overall, the results highlight that farm size, education, credit access, and yield positively influence contract farming adoption, while higher input costs act as a deterrent. Addressing cost concerns and improving credit accessibility could further encourage participation in contract farming models.

Long-Term Impact Using Difference-in-Differences (DID)

The Difference-in-Differences (DiD) approach was employed to examine whether income changes over time differed significantly between contract and open-market farmers after controlling for baseline differences. This method isolates the net income effect attributable to contract participation by comparing the change in income of the treatment group with the corresponding change observed in the control group (Nguyen *et al*., 2015).

The estimates presented in Table 5 indicate that although open-market farmers recorded slightly higher income levels in both years, the magnitude of income growth during the study period was nearly similar for the two groups. Contract farmers experienced an income increase of ₹60,000, while open-market farmers reported an increase of ₹62,000 over the same period. The DiD estimator therefore indicates a marginal differential change of ₹2,000 in favour of open-market farmers, which was statistically insignificant.

The results imply that participation in contract farming did not generate a statistically significant additional income gain over time compared to open-market sales. Nevertheless, the relatively stable income growth observed among contract farmers reflects the role of contractual arrangements in reducing marketing uncertainty and income variability, even when price advantages occasionally favour open-market transactions (Khan *et al*., 2019; Mishra *et al*., 2018).

CONCLUSION

The study compared the economic performance of contract and open-market potato farmers in Punjab using Propensity Score Matching and Difference-in-Differences approaches based on two-year panel data. The empirical results demonstrate that contract farming significantly reduces cultivation costs and improves yield performance, reflecting the role of input support, technical guidance, and organized production practices provided under contractual arrangements. However, contract farmers received relatively lower output prices compared with open-market farmers, which offset the gains achieved through higher productivity and lower costs. The analysis shows that differences in net income between contract and open-market farmers were statistically insignificant. Difference-in-Differences estimates further indicate that income growth over time was similar across both groups, suggesting that contract participation did not generate an additional measurable income advantage during the study period. These findings provide statistical evidence that contract farming improves production efficiency but does not necessarily enhance farm income under existing pricing structures. From an interpretive perspective, contract farming appears to function primarily as

Table 5. Difference-in-Differences Analysis

Year	Contract Farmers (₹/Farmer)	Open-Market Farmers (₹/Farmer)	Difference (DID Impact, ₹)	t-Statistic	p-Value	Significance Level
Year 1	3,20,000	3,30,000	-10,000	-1.48	0.139	Not Significant
Year 2	3,80,000	3,92,000	-12,000	-1.67	0.097	$p < 0.10$ (Moderately Significant)
Change	+60,000	+62,000	-2,000	-0.55	0.584	Not Significant

a risk-management and market-assurance mechanism rather than a guaranteed income-enhancing strategy. The relative stability offered through assured procurement and input access may still be valuable for farmers facing price uncertainty, even when average income gains remain comparable to open-market participation. Policy efforts should therefore focus on improving transparency in contract pricing, incorporating flexible price-linking mechanisms with market trends, and strengthening institutional monitoring to ensure equitable agreements between farmers and contracting firms. Enhancing farmer awareness and bargaining capacity may further improve the long-term effectiveness and sustainability of contract farming systems in the potato sector.

ACKNOWLEDGEMENT

I would like to acknowledge the co-authors who generously gave their time and shared their experiences, as their contributions were fundamental to the success of this study. Their willingness to participate and provide valuable insights has greatly enriched our research findings.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL STATEMENT

This article does not contain any studies with human participants or animal performed by any of the authors.

LITERATURE CITED

Das A, and Mishra RR (2019). Value chain analysis of tea and constraints faced by the small tea growers in India with special reference to state Assam. *International Journal of Current Microbiology and Applied Sciences* **8**(12): 1592-1601.

Das A, and Mishra RR (2020). Economics Related to Tea (Camellia sinensis) Sector-an Overview. *Agriallis* **2**(12): 18-23.

Das A, Deka N, Munshi SA, Barman B, Mondal I, and Hemanth DB (2024). Economic Impact of Biotech and Nanotech Approaches in Chickpea (*Cicer arietinum* L.) Cultivation. Indian Journal of Agricultural Research 1-8. doi: 10.18805/IJARe.A-6313.

Kawsar MH, Chowdhury SD, Raha SK, and Hossain MM (2013). An analysis of factors affecting the profitability of small-scalebroiler farming in Bangladesh. *World's Poultry Science Journal 69*(3): 676-686.

Khan MF, Nakano Y, and Kurosaki T (2019). Impact of contract farming on land productivity and income of maize and potato growers in Pakistan. *Food Policy* **85**: 28-39.

Mishra AK, Kumar A, Joshi PK, and D'Souza A (2018). Impact of contract farming on yield, costs and profitability in low-value crop: Evidence from a low-income country. *Australian Journal of Agricultural and Resource Economics* **62**(4): 589-607.

Munshi SA, Das A, Shivaswamy G, Devi MA, Subash S, Jeyakumar S, and Sivaram M (2024). Socio-economic impact of COVID-19 pandemic on dairy farm households in West Bengal state. *The Indian Journal of Animal Sciences* **94**(2): 179-184.

Nguyen AT, Dzator J, and Nadolny A (2015). Does contract farming improve productivity and income of farmers?: A review of theory and evidence. *The Journal of Developing Areas* **49**(6): 531-538.

PAU (2024). Web-Based Decision Support System for Late Blight Disease of Potato. Retrived from https://www.pau.edu/potato/Potato_cult.php?

Tey YS, and Brindal M (2015). Factors influencing farm profitability. *Sustainable Agriculture Reviews* **15**: 235-255.

Tripathi, RS, Singh R, and Singh S (2005). Contract farming in potato production: an alternative for managing risk and uncertainty. *Agricultural Economics Research Review* **18**: 47-60.

(MS Received : March 5, 2025; Accepted : February 16, 2026)