

ANALYSIS OF CONTRACT FARMING AND ITS IMPLICATION ON PROFITABILITY; EVIDENCE FROM POTATO FARMERS IN PUNJAB, INDIA

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ABSTRACT: Contract farming has become an essential institution for modern value chains but with controversies. Hence, the present study sought to understand whether contract farming is a boon or a bane for farmers. To unravel this, 120 farmers were sampled from the Moga district of Punjab state, India. The data was subjected to inferential analysis, profitability analysis, and qualitative discussion. It was found that areas under potato cultivation, potato farming experience, and having a secondary school education positively affect farmers' decision to participate in contract farming. The profitability estimates revealed that potato cultivation under no contract is more profitable than cultivation under a contract. Likewise, the impact assessment revealed that contract farming negatively affects farmer's gross returns. The qualitative discussion revealed myriad terms and conditions followed by the potato farmers under contract, including pre-price fixation, written contract, farm size requirement, quality and quantity requirement, input supply, no credit, farm visits, and cheque payment. Therefore, compensation in the event of crop failures, the provision of crop insurance, credit facilities, and advance payments needs immediate attention from policymakers.

KEYWORDS: Contract farming, Potatoes, Profitability, Impact assessment

INTRODUCTION

India holds 2.3% of the world's land and 4.2% of its freshwater resources, making agriculture a crucial sector contributing over 20% of the GDP in 2020-21. Despite its importance, the sector faces challenges, particularly for smallholder farmers who dominate the landscape but are often trapped in low-yield, subsistence farming cycles. These farmers struggle with low bargaining power, unstable markets, fluctuating prices, and exploitation by intermediaries, leading to limited profits and investment capacity. The adoption of modern inputs, better market access, and infrastructure

have the potential to enhance agricultural growth.

Globalization and privatization have increased private sector involvement, shifting focus from low-value subsistence crops to higher-value commercial crops. However, Indian agricultural markets remain largely unorganized, with inadequate infrastructure limiting their ability to meet urban consumers' demands. Addressing these challenges requires reducing transaction costs and intermediary influence, which can lead to a more efficient and profitable supply chain. Collaboration among producers, consumers, and public-private partnerships is essential

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for tackling future challenges and ensuring sustainability in the agricultural sector. This multi-faceted approach can drive growth, improve productivity, and benefit all stakeholders involved in the agricultural economy.

Market-oriented production is a key component of rural development strategies, particularly in developing countries where agriculture remains a major source of income and employment for rural populations (Girma and Gardebreek, 2015). In addition, market access is also a critical factor in determining the income of agricultural households and incentivizing the cultivation of diverse crops. The diversification of traditional cereal-based agriculture into high-value food commodities has led to the emergence of both horizontal and vertical integration (Mishra *et al.*, 2018). Producing these commodities requires significant capital investment and access to information, but small-scale farmers typically lack resources such as technology, quality inputs, and agricultural extension services. To address this issue, it is crucial to strengthen institutional mechanisms such as contract farming. Contract farming is a system where farmers enter into agreements with agribusiness companies to produce a specific crop or livestock product according to certain quality and quantity standards (Narayanan, 2025). In exchange, the company typically provides the farmers with inputs such as seeds, fertilizers, credit, insurance and technical assistance and offers guarantees a price for their crops (Patil *et al.*, 2011b; Balram *et al.*, 2012; Ray *et al.*, 2020). Most often the contract company provides extension specialists that relay good agronomic practices and technologies to farmers (Biswas, Singh, and Singh, 2014). This company intervention makes the farmers more skilled and technologically sound in crop production.

After the National Agricultural Policy was released in 2000 by the Union Government, contract farming has been supported by successive governments and international development agencies. They view it as an important way to encourage private-sector investment in Indian agriculture. The policy aims to promote private sector involvement through contract farming, land leasing, direct marketing, and setting up private markets. These efforts are intended to speed up technology transfer, bring in more capital, and provide secure markets for crop production. Since 2015, policy reforms have been implemented in 16 Indian states to legalize and promote contract farming by the private sector (Vicol, 2018). This has paved the way for greater private capital investment in the agricultural sector, which was previously highly protected.

By the early 1990s, contract farming had been established in Punjab following the involvement of multinational corporation PepsiCo's subsidiary, Pepsi Foods, in tomato and chilli production, as well as the participation of local company Nijjer Agro Foods Limited in tomato farming (Singh, 2020). Under the Punjab Contract Farming Act of 2013, farmers can enter into contracts with companies to produce crops. The state government of Punjab has been actively promoting contract farming to enhance agricultural productivity and improve farmers' incomes through cropping patterns, production techniques, and crop diversification (Kaur and Singla, 2021). The Department of Agriculture and Farmers Welfare reported that the Government of India, India produced 60.14 million tons of potato in 2022-23. Punjab was India's sixth largest producer of potatoes after Uttar Pradesh, West Bengal, Bihar, Gujarat, and Madhya Pradesh, and accounted for 5 % of total production in the country.

Since the inception of contract farming, it has emerged as a contentious and widely discussed subject in India. Therefore, an in-depth analysis of the terms of contracts in contract farming is essential to understand the potential benefits and drawbacks of these agreements promote fair, sustainable agricultural practices, and improve the agricultural landscape in general. It can provide a comprehensive understanding of the contractual obligations, rights, and responsibilities of each party involved in the agreement. This evidence can help identify potential areas of conflict or disagreement between farmers and buyers, and enable stakeholders to develop strategies for addressing these issues. It will also provide insights into the level of risk and uncertainty associated with contract farming for farmers and the potential benefits and drawbacks of participating in these agreements. Analyzing the cost and return structure between contract and non-contract farming methods will provide insights into the profitability of different farming methods, help identify potential areas for cost savings or efficiency improvements, and inform decision-making about whether to engage in contract farming or pursue alternative farming methods. Furthermore, this analysis can assist policymakers in understanding the benefits and drawbacks of contract farming for farmers and the overall agricultural sector, and guide the development of policies and regulations to ensure fair and equitable outcomes for all stakeholders involved.

MATERIALS AND METHODS

Study area and sampling

A multistage sampling approach was used to select the study area and the participants. Initially, the Moga district in the state of Punjab was selected purposively due to the predominance of potato production

under contract and non-contract regimes. Afterwards, a list of potato farmers under contract was obtained from a contract farming company (name withheld for confidentiality). From the list, 60 potato farmers were selected randomly. Similarly, the same number of farmers who cultivated potatoes under no contract were sampled from the district. In this way, 120 farmers were selected for this study. It is worth noting sample size of 120 or more is sufficient for empirical analysis according to the central limit theorem (Bannor et al., 2020). Therefore, the sample unit used in this study is justified. Cross-sectional data was sourced from the sampled participants with the aid of a well-designed and pre-tested questionnaire.

Method of data analysis

Binary logit regression

The determinants of farmer's participation in potato contract farming were examined using logistic regression. Thus, the outcome variable is binary, to participate in contract farming or otherwise. Rooted in the utility maximization theory, this study posits that farmers will prefer contract farming supposing participating will provide satisfaction better than non-participation. In econometric modelling involving binary outcome variables, the binary probit or logit regressions are considered suitable (Gujarati *et al.*, 2022). However, the two models provide almost similar parameter estimates. Hence, the choice of either model is subjective. In this study, the binary logit regression was used to examine the determinants of participating in contract farming. The binary logit model is specified as:

$$p = P(Y_i = 1|X_i = x_i) \quad (1)$$

$$= \frac{\exp(\beta_0 + \beta_1 x_i)}{1 + \exp(\beta_0 + \beta_1 x_i)} \quad (2)$$

$$P_i = F(Z_i) = F(\alpha + \beta x_i) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-(\alpha + \beta x_i)}} \quad (3)$$

Where e denotes the base of natural logarithms. P_i is the likelihood of participating

in contract farming; X_i is the set of covariates that predict contract farm participation. β is the coefficient of the covariates to be estimated. Equation (3) can be restated as:

$$\log_e \frac{P_i}{1-P_i} = Z_i = \alpha + \beta x_i \quad (4)$$

The binary logistic model estimated in this study is given as;

$$\text{Contract farming} = \beta_1 \text{ Age} + \beta_2 \text{ Education} + \beta_3 \text{ Marital status} + \beta_4 \text{ Family size} + \beta_5 \log \text{ Income} + \beta_6 \text{ Experience} + \beta_7 \text{ Farm size} + \beta_8 \text{ Borrowed} \quad (5)$$

Profitability and Risk Analysis

Profitability

The tabular analysis was employed for estimating the costs and returns under various regimes of contract farming. The formula for various cost and returns concepts used in the study are as follows:

1. Gross Returns = Yield * Price
2. Net Return over Variable Cost = Gross Returns – Total Variable Cost
3. Net Returns over Total Cost = Gross Returns – Total Costs
4. Cost of production per kg= Total Variable Cost / Yield
5. Net Returns over Variable Cost per kg = Total Variable Cost / Yield
6. Net Returns over Total Cost per kg = Net Returns Over Total Cost / Yield
7. Returns per Rupee of Expenditure= Gross Returns / Total Cost
8. Return per Rupee on Variable Cost= Gross returns / Total Cost
9. Return per Rupee on Total Cost= Gross Return / Total Cost

Production and Price Risk

To analyze the extent of production and price differences between contract and non-contract farmers, their respective production and price risks were estimated. The pricing

and production risks were determined by calculating the standard deviation (SD) and coefficient of variation (CV) using the following formula:

$$s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \quad (6)$$

Where x = the value in the data distribution, \bar{x} = the sample mean, and n = total number of observations.

$$\text{Coefficient of Variation} = \frac{\text{Standard deviation}}{\text{Mean}} * 100 \quad (7)$$

Inverse Probability Weighted Regression Adjustment Model (IPWRA)

The IPWRA model was used to assess the impact of contract farming on the gross profit of potato farmers. Since its proposal by Wooldridge (2010), this approach has been widely applied to impact evaluations (Lu *et al.*, 2021; Israel *et al.*, 2020). Reweighting and joint regression-adjustment techniques are used by the IPWRA, which is recognized as a doubly robust estimator, to estimate the mean treatment effects on the treated (ATT) and possible mean outcomes (Lu *et al.*, 2021). Two sturdy properties make up the IPWRA estimator, which offers a dependable remedy for potentially skewed estimations (Israel *et al.*, 2020). Furthermore, IPWRA remains consistent with at least one correctly described result even in cases when an outcome or treatment is misspecified (Bannor *et al.*, 2023). The IPW and RA components make up the IPWRA model. Weighing the data according to the inverse probability that is being handled yields the inverse probability weights (IPWs). The likelihood of receiving treatment or propensity scores in the IPW is expressed as follows:

$$p(G) = \Pr(W_i = 1 | G) = H\{z(G)\} = E(W_i | G) \quad (8)$$

Where G represents pre-treatment covariates' multidimensional vector from observable attributes and $H\{z(G)\}$ represents the function of cumulative distribution. The vector G represents farmers observed characteristics used in attaining treatment effects.

In addition, the RA part uses linear regression for treated and non-treated units (contract farmers and non-contract farmers)

and averages the estimated outcome (gross profit) to obtain treatment effects. In simple terms, RA focuses on outcomes, and IPW emphasizes more on treatment in computing treatment effects. Following Lu *et al.* (2021), the RA model for the ATT is stated as follows:

$$ATT_r = a_s^{-1} \sum_{i=1}^a W_i [r_s(G, \varphi_s) - r_j(G, \varphi_j)] \tag{9}$$

Where a_s represents contract farmers, $r^{(G)}$ denotes the regression model for producers and non-producers anchored on observed covariates G and parameters $\varphi_i = (\delta_i, \nu_i)$. The IPWRA model is established after merging the IPW and RA models. Thus, the IPWRA estimator expresses the ATT as:

$$ATT_{IPWRA} = a_s^{-1} \sum_{i=1}^a W_i [r_s^*(G^*, \varphi_s^*) - r_j^*(G, \varphi_j)] \tag{10}$$

Where $\varphi_s^* = (\delta_s^*, \nu_s^*)$ is attained from a procedure in estimating the weighted regression.

$$\min_{\varphi_s^*, \nu_s^*} \sum_{i=1}^a \frac{W_i (f_i - \varphi_s^* - G\nu_s^*)^2}{\hat{p}(G, \hat{\beta})} \tag{11}$$

$$\min_{\varphi_j, \nu_j} \sum_{i=1}^a \frac{(1-W)_i (f_i - \varphi_j - G\nu_j)^2}{\hat{p}(G, \hat{\beta})} \tag{12}$$

RESULTS AND DISCUSSION

Socioeconomic profile of farmers

Table 1 presents the background information of the sampled respondents. Accordingly, all the farmers were males. Again, the contract farmers are slightly older than their counterparts. However, the test statistics show that the average ages of these categories of farmers do not differ. Again, contract farmers have relatively smaller family sizes than their counterparts but the test statistics prove otherwise. Moreover, there are more married contract farmers than non-contract farmers but the test statistic refutes this claim. Further, there are more illiterate non-contract farmers than contract farmers. Relatively, contract farmers have less land holding than their counterparts but the test statistic disapproves this claim. Importantly, the test statistics revealed that there are no significant

Table 1. Background information of farmers

Variable	Description	Contract farmers (60)	Non-contract farmers (60)	Test statistics	Aggregate (120)
Gender	Male	60 (100)	60 (100)	NA	120 (100)
	Female	0 (0.00)	0 (0.00)		0 (0.00)
Age	Mean	38.57	38.16	7.17	38.367
	Std. dev.	9.37	9.54		9.377
Family size	Mean	7.23	8.93	2.93	8.083
	Std. dev.	2.93	3.57		3.351
Marital status	Single	14 (23.23)	10 (16.67)	0.10	24 (20)
	Married	46 (76.67)	50 (83.33)		96 (80)
Education	Illiterate	32 (53.33)	38 (63.33)	0.93	70 (58.33)
	Primary/metric	4 (6.67)	8 (13.33)		12 (10)
	Secondary	14 (23.33)	4 (6.67)		18 (15)
	Graduation	10 (16.67)	10 (16.67)		20 (16.67)
Landholding	Mean	11.63	12.03	0.09	11.83
	Std. dev.	5.01	7.41		6.27
Potato farm size	Mean	7.68	6.80	3.601	7.24
	Std. dev.	3.01	4.64		3.91
Experience	Mean	2.23	2.80	3.53***	2.52
	Std. dev.	0.97	0.89		0.97

Notes: *, ** and *** denote significance at 10%, 5% and 1% respectively. Figures in brackets are percentages.

differences in the acreages of potato cultivation for contract farmers and non-contract farmers. In addition, contract farmers have fewer years of experience in potato cultivation than non-contract farmers.

The terms and conditions surrounding the potato contract farming are presented in Table 2. It was stated that a formal contract governs their business relationship. Once more, there were no middlemen in the contractual procedure between the firm and the farmers. The contractual agreement stipulated the predetermined quality, quantity, and price of the output. Farmers needed to have access to

suitable irrigation infrastructure and produce potatoes on a minimum of 5 acres to be eligible for the company's contract farming programme. Additionally, the business gave the farmers access to virus-resistant and high-yielding potato seed variants. The requirement was for the farmers to pay for half of the seeds up front; the other half would be subtracted from their earnings. The company offer packages like fungicides, insecticides, and herbicides to control weeds, pests, and illnesses. The pre-agreed pricing and quality parameters were disclosed to the farmers before assenting to the contract.

Table 2. Terms and modalities surrounding the contract farming

No.	Term/modality	Description
1.	The requirement to allow farmers to enter into a contract	Farmers need to cultivate potatoes on a minimum of 5 acres of land and must have proper irrigation facilities
2.	Method of approaching farmers	Direct meeting with farmers
3.	Any middleman between the farmer and the company	No
4.	Type of contract (Oral/Written)	Written
5.	Supply of agri inputs to the farmers	Seeds, Kit (Weedicide, Insecticide, and Fungicide) on a demand basis.
6.	Pre-agreed price fixation	Yes
7.	Prices range for various grades.	Grade A and B = Rs. 14.35/Kg Grade C = Rs. 10.75 /Kg Grade D = Rs. 7.5/Kg Grade Z = Rs. 1/Kg All the produce of every grade was procured from the farmers.
8.	Facilities Provided by the company	Seed, grading machine, transportation, technical guidance, bags.
9.	Frequency of visits by company officials	Two times a week (Also addresses farmers queries over the phone)
10.	Quality parameters considered by the company	Yes
11.	Planned quantity of procurement obtained by the company	Yes
12.	Payment mode	Payment is made through a bank.
13.	Form of payment	Cheque
14.	Advance payment	No
15.	Credit amenities provided by the company	No
16.	Action if the farmer refuses to supply produce to the company	Legal action be taken against that farmer
17.	Compensation in the event of failure	The farmer is responsible for the loss.
18.	Incentive	50 paisa/kg, if farmers had adopted the drip irrigation method 50 paisa/kg, if farmers had stored their potatoes in sheds immediately after harvest 25 paisa/kg, if a farmer had used a grading machine Rs 1/kg, if the yield of grade A and B potatoes exceeded 80%

The firm supplied seeds, grading equipment, bags, transportation, and technical advice, among other things. Twice a week, a technical expert would visit farmers' fields to assess crop conditions, recommend appropriate agronomical techniques, identify and prevent pests and diseases, etc. The firm only pays farmers via cheque. The company did not provide a credit facility or advance payment. If the crop failed, there was no compensation. To entice farmers to produce high-quality potatoes, the contracting firm provided them with four different kinds of incentives. The initial incentive was a payout to the farmers of 50 paise for every kilogram of potatoes produced under drip irrigation. A reward of 50 paise was given to farmers who put their potatoes in sheds right after harvesting as the second incentive. For the third incentive, a payout of 25 paise per kg was offered to farmers who graded their crops using grading equipment that the firm provided. Finally, the company offered a payment of Rs 1/kg if the yield of grade A+B potatoes exceeded 80%.

Determinants of Contract Farming Participation

Table 3 presents the determinants of participating in potato contract farming by farmers in the Moga district of Punjab. The model diagnostics show that the model is fit under various specifications. Thus, the Chi-square is significant which shows the model fits the data well. Again, the Pseudo R-square indicates that farmers' socioeconomic variables explain around 26% of the decision to enrol in potato contract farming. Variables like education, farming experience, and potato farm size were significant determinants of contract farming participation at a 5% level or less. Specifically, secondary education is significant and positively predicts participation in potato contract farming. This is plausible because most of the contract agents require farmers to document and have records of their

Table 3. Determinants of participation in potato contract farming

	Coef.	St. Err.	p-value
Age (years)	1.031	0.052	0.54
Education			
Primary/metric	1.997	2.545	0.587
Secondary	7.758	8.609	0.050*
Graduation	0.855	0.861	0.876
Marital status (1=Married)	0.459	0.559	0.522
Family size (number)	0.853	0.089	0.127
Income (Rs)	1.189	0.65	0.751
Experience (years)	0.304	0.131	0.006***
Potato farm size (acres)	4.359	3.336	0.049**
Borrowed (1= Yes)	0.523	0.361	0.348
Log-likelihood	-30.769		
Pseudo R-squared	0.260		
Chi-square	21.639		
Prob > Chi ²	0.017**		

Note: *, **, and ***denote significance at 10%, 5%, and 1% respectively. The reference category for education is illitera

routine activities on the farm. As such, farmers who have secondary education can fulfil this requirement unlike those who are illiterate. Likewise, education has been reported to influence contract farming (Ganewo *et al.*, 2022; Bidzakin *et al.*, 2019). Further, farming experience is significant and positively influences participation in potato contract farming. This means that experienced farmers are more likely to participate in contract farming. Probably, experienced farmers have the knowledge and understanding of contract farming policies and requirements and can produce to meet the quality requirement of the contract. Hence, farmers who possess higher experience are likely to participate in contract farming. Elsewhere, it has similarly been asserted that the farming experience favours contract farming (Loquias *et al.*, 2022; Ganewo *et al.*, 2022). Lastly, potato farm size is significant and positively influences participation in contract farming. Thus, potato farmers with large farm sizes are more likely

to participate in contract farming. An intuitive reason could be that contract companies give preferences to commercial farmers. This finding is congruent to the assertion of Bidzakin *et al.* (2019).

Profitability analysis of potato production

Table 4 illustrates the profitability analysis of potato cultivation under contract and non-contract regimes. The highest contribution to

the total cost of production was from seed cost, which accounted for 58.98% in contract farming and 41.62% in non-contract farming. In potato farming, contract farmers used seeds supplied by the contract company, requiring 1173 kg per acre, compared to 1312 kg used by non-contract farmers. While the contract farmers received high-quality seeds, their costs were higher at Rs. 35,186, versus Rs. 25,041 spent by non-contract farmers who bought seeds from the market. The higher

Table 4: Cost and returns for contract and non-contract farming (per acre)

S. No.	Particulars	Units	Contract farming		Non-Contract farming	
			Qty	Amt (Rs.)	Qty	Amt (Rs.)
A	Returns					
1	Production	Quintal		65.86		132.1
2	Price per kg of Potato	Rs.		12.33		6.96
3	Gross returns	Rs.		81234		91801
4	Net returns over variable cost	Rs.		23200		32737
5	Net returns over the total cost	Rs.		21574		31646
6	Cost of production per kg	Rs.		9.06		4.55
7	Net returns over total cost per kg	Rs.		3.28		2.39
8	Returns per rupee of variable cost	Rs.		1.34		1.55
9	Returns per rupee of the total cost	Rs.		1.36		1.53
B	Cost					
1	Land preparation and seed sowing cost	Rs.		2718		2230
2	Seed (50 Kg Bag)	Bags	23.46	35186	26.23	25041
3	FYM	Trolley	4.6	4613	3.97	3173
4	Chemical fertilizer	Kg	435	6409	417	6068
5	Fertilizer application	Rs		435		417
6	Irrigation labor	Rs.		595		595
7	Pesticides	Rs./acre	-	1932	-	2497
8	Pesticide application	Day	-	673	-	657
9	Harvesting cost	Rs.	-	4485	-	8213
10	Transportation cost	Rs.	-	0	-	855
11	Bag cost	Rs./Bag	-	0	31	8190
12	Interest on W. C.(7% of VC)	Rs.	-	984	-	1125
13	Variable costs	Rs.	-	58034	-	59064
14	Depreciation	Rs.	-	1626	-	1101
15	Fixed cost	Rs.	-	1626	-	1101
16	Total cost	Rs.	-	59660	-	60166

Note: WC = working capital, Rs= rupees, Qty= Quantity, Amt= Amount, VC= variable cost, FYM= farmyard manure

cost for contract farmers likely reflects factors such as seed quality, transportation, storage, handling, and research and development. In contract farming, chemical fertilizers, farmyard manure, harvesting costs, and land preparation and seed sowing costs contributed to the total cost of production of potatoes by 10.74%, 7.73%, 7.52%, and 4.56%, respectively. On the other hand, in non-contract farming, harvesting, bag, chemical fertilizer, and FYM contributed to the total cost of production of potatoes by 13.65%, 13.61%, 10.09%, and 5.27%, respectively. Contract farmers used more FYM (4.6 trolleys) than non-contract farmers (3.97 trolleys) due to guidance from the company, which promoted organic farming and reduced chemical fertilizers. This increased FYM use was encouraged to enhance crop size and quality, although it was not mandatory. Moreover, non-contract farmers spent more on pesticides, incurring Rs. 2,497 per acre, compared to Rs. 1,932 for contract farmers. This cost difference arose because the contracting firm supplied pesticide kits at a 20% discount. Again, contract farming yielded lower harvests (65.86 quintals/acre) and reduced harvesting costs (Rs. 4,485) compared with their counterparts. Moreover, the noticeable differences in the cost of bags and transportation could be attributed to the fact that contract farmers had their bags and transportation costs covered by the company, unlike non-contract farmers, who spent Rs. 35-40 per bag and required 200-220 bags. The company also eliminated transportation costs by purchasing produce directly from the farm gate.

Overall, contract farmers experienced a lower total cost of production (Rs. 59,660) compared to non-contract farmers (Rs. 60,165), benefiting from better technology, technical guidance, and economies of scale. Despite producing lower yields (65.86

quintals per acre) due to earlier harvesting as instructed by the company, contract farmers received a significantly higher price per kg of potatoes (Rs. 12.33) than non-contract farmers (Rs. 6.96), who harvested later (Geetanjali *et al.*, 2021). This higher price was due to pre-determined contract prices, shielding contract farmers from market price volatility. However, non-contract farmers achieved higher gross returns (Rs. 91,801) and net returns over variable cost (Rs. 32,737) and total cost (Rs. 31,646), compared to contract farmers (Rs. 81,234 gross returns, Rs. 23,200 net returns over variable cost, and Rs. 21,574 net returns over total cost). Non-contract farmers incurred higher costs due to increased pesticide use and harvesting expenses, and they bore the costs of bags and transportation. Despite lower net returns, contract farmers benefited from stable prices, guaranteed markets, access to quality inputs, and reduced risks, fostering loyalty and a willingness to expand contract farming (Patil *et al.*, 2011a). The findings highlight that while non-contract farmers might earn more during favourable market conditions, contract farming offers stability and reduced risk, crucial for farmers facing market inefficiencies and price volatility.

Implication of contract farming on gross profit

The impact of contract farming participation on potato farmer's gross profit is presented in Table 5. Figure 1 shows the overlap test. The overlap assumption is not violated since the propensity scores show a fair distribution. In addition, the results revealed that participating in contract farming aggravates farmer's gross profit. In other words, contract farming decreases a farmer's gross margin. Specifically, participants of contract farming have an average gross profit of Rs 81296 (\$975)

Table 5. Impact of contract farming on potato farmer’s gross profit

Outcome variable	Outcome means		ATE
	Contract farmers	Non-contract farmers	
Gross profit	81296.92 (348.1887)***	94581.05 (2680.937)***	-13284.13 (2667.13)***

Note: Numbers in parentheses are standard errors. ***denotes significance at 1%.

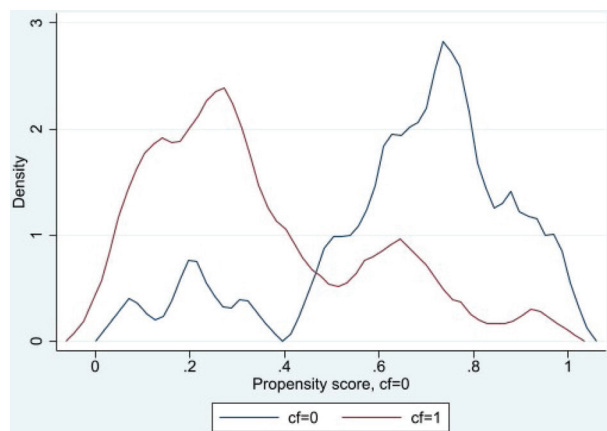


Fig. 1. Overlapping test results

relative to a gross profit of Rs 94581 (\$1135¹) for non-participants. The average treatment effects revealed that participating in contract farming decreases farmers' gross profit by Rs 13284 (\$159). Generally, contract farming has been attributed to an increase in profitability and farm performance (Bannor *et al.*, 2022; Kosoe and Ahmed, 2022). However, the current finding is contradictory. Intuitively, contract farmers are slapped with numerous production requirements and instructions, which are usually costly. For instance, contract farmers are required to purchase recommended seeds, which are costly. Likewise, they are requested to apply more FYM, which is also costly. The costly requirements at the end inflate contract farmer's cost of production and decrease their anticipated profits.

¹Note: \$1 = Rs 83.35 as at 05/04/2024

Risk assessment for potatoes under contract and non-contract regime

Table 6 shows that non-contract farmers face greater production risk compared to contract farmers, with a coefficient of variation of 11.87 % and 3.76 % respectively. Similarly, the results for price risk demonstrate that non-contract farmers face higher risk compared to contract farmers, with a coefficient of variation of 9.07 % and 3.40 % respectively. It must be understood that contract farming has become a vital strategy for farmers to reduce exposure to market risks. The current findings highlight its role in mitigating production and price risks, ensuring better income security and stability. Studies by Ray *et al.* (2021) and Behera *et al.* (2021) confirm that contract farming offers protection against price fluctuations, while Paul *et al.* (2019) emphasize its role in minimizing risks of price volatility and crop failure.

CONCLUSION

Contract farming has become an essential institution for modern value chains in India, helping to increase efficiency, reduce transaction costs, and promote the integration of farmers into global supply chains. The present study was an attempt to understand whether contract farming is a boon or a bane for the farmers. To unravel this, 30 contract

Table 6. Production and price risk for contract and non-contract farmers

Particulars	Contract farmers	Non-Contract farmers
Production risk		
Mean (Quintal)	65.87	132.1
SD (kg)	2.47	15.68
CV (%)	3.76	11.87
Price risk		
Mean Rs. (kg)	12.34	6.96
SD Rs. (kg)	0.42	0.63
CV Rs.(%)	3.40	9.07

and non-contract farmers making 60 farmers were sampled from the Moga district of Punjab state, India. Inferential analysis, profitability analysis, and qualitative discussion were used to make meaning from the cross-sectional data gathered. The results showed that potato farm size, farming experience, and having a secondary school education have significant and positive influences on a farmer's decision to participate in contract farming. The profitability analysis revealed that contract farming offers lower total production costs compared to non-contract farming, despite higher seed expenses. In addition, contract farmers benefit from reduced pesticide costs, free bags, and transportation and also receive higher prices per kg. Nonetheless, non-contract farmers achieve higher gross and net returns. The impact assessment shows that participation in contract farming harms farmer's gross returns. Thus, contract farming reduces farmer's potential gross returns. It was observed that farmers with less than 5 acres of land are generally excluded from contract farming since the minimum requirement for participation is 5 acres of irrigated land. To manoeuvre this barrier, small and marginal farmers are allowed to join contract farming by forming groups of 2 or 3 to collectively meet the 5-acre land requirement, with one farmer handling the contractual agreements and transactions. In addition, it was noted that prices are pre-agreed before cultivation with the company supporting with inputs like seeds. Concerning risk, contract farmers have lower production and price risk compared to non-contract farmers. This suggests that while non-contract farmers tend to earn more than their counterparts, contract farming provides stable production and guaranteed markets.

It is therefore recommended that provisions should be made to compensate farmers in the event of crop failure. In addition, there is a need to enhance support mechanisms within

contract farming to boost farmer returns. This could involve policies promoting more favourable contract terms, such as better pricing structures, increased transparency, and shared benefits from market premiums. Additionally, integrating farmer training on yield optimization and sustainable practices could improve productivity and profitability, aligning contract farming returns better than with those of non-contract farming.

CONFLICT OF INTEREST

All authors declare no conflict of interest with this article.

ETHICAL STATEMENT

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

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- (MS Received : November 8, 2024; Accepted : June 25, 2025)