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Economic Analysis of Ginger Cultivation and Determinants of Farm Income under the One District One Product Framework: Case Study of Himachal Pradesh, India

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ABSTRACT

Background: Ginger is a commercially significant spice crop in the Western Himalayan region, serving as a key source of livelihood for smallholder farmers. In recognition of its economic potential, the Sirmour district of Himachal Pradesh has been designated under India's One District One Product (ODOP) initiative for ginger, aiming to promote value chain upgrading, processing and market expansion. However, empirical assessments of cost structures, profitability and determinants of income in this ODOP context remain scarce. This study examines the economics of ginger cultivation and identifies the factors that influence net farm income, aiming to inform evidence-based policy and value-chain development.

Methods: A multistage purposive-random sampling approach was employed to survey 300 ginger-growing households across major production clusters in Sirmour. Primary data for the agricultural year 2023-24 were collected using a pre-tested structured schedule. Production costs were estimated following the Commission for Agricultural Costs and Prices (CACP) framework. Profitability indicators, including gross and net returns, family labour income, farm business income and output-input ratios, were compared across marginal, small and semi-medium farmers. Determinants of net farm income were identified through an Ordinary Least Squares (OLS) regression model incorporating socioeconomic, input-use, farm-structural and institutional variables.

Result: Semi-medium farmers achieved the highest productivity (153.71 q/ha), lowest unit cost of production (₹ 1,566/q) and the highest output-input ratio (2.51). The mean net farm income from ginger cultivation was ₹ 295,394 per farm, indicating economic viability, though income variability was high. The OLS results show that household size, hired labour use and area under ginger cultivation exert a positive and significant influence on net farm income. In contrast, seed cost negatively affects income, confirming it as a major profitability constraint. Expenditure on fertilisers and chemicals shows weakly diminishing returns, while varietal choice and market access variables, price information, transport and storage are statistically insignificant. The model explains about 50 per cent of the variation in net farmmo income. Overall, the findings highlight that production efficiency and crop-specific scale, rather than total landholdings or existing market infrastructure, are the principal drivers of farm income. The study offers strong empirical evidence for ODOP strategies to prioritise input cost reduction and production-side interventions to enhance the incomes of ginger growers in Himalayan regions.

Key words: Cost of cultivation, Farm income determinants, Ginger cultivation, Hill agriculture, ODOP, OLS regression, Profitability.

INTRODUCTION

Ginger (*Zingiber officinale* Roscoe) is a high-value spice and medicinal crop that contributes significantly to farm incomes and export earnings in India. The rising demand from the food processing, pharmaceutical and nutraceutical industries has further enhanced the economic importance of ginger, particularly in smallholder-dominated production systems (Food and Agriculture Organisation 2022; Spices Board of India, 2023). High-value spice crops play an important role in enhancing farm income and livelihood security in smallholder farming systems, particularly in hill regions where diversification toward commercial horticulture is increasingly promoted (Rajanbabu *et al*., 2022). In response, recent policy discourse has shifted increasingly from production enhancement toward value-chain strengthening, product differentiation and income stabilisation for farmers. The hill and sub-hill regions of Himachal Pradesh offer favourable agro-climatic conditions for ginger cultivation, including moderate temperatures, adequate rainfall and well-drained soils. Within the state, Sirmour district, particularly the Trans-Giri belt, has emerged as a specialised ginger-growing region dominated by small and marginal farmers (Singh and

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Dhillon, 2015). Ginger cultivated in Sirmour is recognised for its strong aroma, higher dry recovery and suitability for dried ginger (*sonth*), attributes that enhance its commercial and processing value. Traditional products such as Hatti Sonth have received scientific and institutional recognition, strengthening the scope for product differentiation and geographical indication (GI) potential (Palampur University, 2022). These production and quality advantages have led to the selection of ginger as the priority agricultural commodity for Sirmour district under the One District One Product (ODOP) framework. The ODOP initiative promotes district-level specialisation through cluster development, value addition, branding and improved market linkages, to enhance farm incomes and reduce marketing inefficiencies (Ministry of Food Processing Industries (MoFPI), 2020). Despite this policy emphasis, systematic micro-level evidence on the economic performance of ginger cultivation under an ODOP-oriented framework remains limited.

Earlier empirical studies on ginger cultivation in India have largely focused on cost-return structures and profitability across regions, confirming ginger as a remunerative crop under smallholder conditions (Gaikwad *et al*., 1998; Shinde *et al*., 2020). Evidence from Himachal Pradesh further indicates that ginger cultivation contributes substantially to household income, particularly in Sirmour district, although income variability persists across farm-size categories (Singh and Dhillon, 2015). However, these studies provide limited insights into the determinants of farm income, such as landholding size, scale of production, marketable surplus and varietal choice and rarely examine these relationships within a policy-driven commercialisation framework such as ODOP. Against this backdrop, the present study was conducted during 2023-2024 in the Sirmour district of Himachal Pradesh, based on a sample of 300 ginger-growing households across marginal, small and semi-medium farm categories. The study aims to:

(i) Analyse the cost structure, production, marketable surplus and profitability of ginger cultivation.

(ii) Identify the key factors affecting ginger production and farm income using an ordinary least squares (OLS) regression framework.

The findings provide empirical evidence to support ODOP implementation and policy interventions aimed at enhancing farmer incomes in hill agriculture.

MATERIALS AND METHODS

Study area and period

The study was conducted during the agricultural year 2023-2024 as part of the PhD research programme at Banaras Hindu University. The selected study area was the Sirmour district, a major ginger-producing region of the Western Himalayas characterised by its high-quality ginger. The district is characterised by mid-hill agroecological conditions and a high dependence on labour-intensive farming systems typical of mountain agriculture. Ginger is a principal commercial crop in the district and has been identified as the priority commodity under the One District One Product (ODOP) framework.

Sampling design and data collection

A multistage purposive-random sampling technique was adopted. In the first stage, major ginger-growing blocks were purposively selected based on production concentration. In the second stage, leading ginger-producing villages were identified from the selected seven blocks, namely, Nahan, Pachhad, Paonta sahib, Shillai, Rajgarh, Sangrah and Tirlordhar. In the final stage, 300 ginger-growing households were selected through probability proportional to size (PPS) sampling. Farmers were classified into marginal (<1 ha), small (1-2 ha) and semi-medium (2-4 ha) categories following standard farm-size classification practices (Birthal *et al*., 2020). Primary data were collected through personal interviews using a structured and pre-tested schedule covering socio-economic characteristics and other relevant information. Secondary data were obtained from the Department of Horticulture, Government of Himachal Pradesh and relevant published literature.

Analytical framework

Cost and profitability analysis

The cost of ginger cultivation was estimated using standard cost concepts prescribed by the Commission for Agricultural Costs and Prices (CACP), incorporating both variable and fixed cost components (Nair, 2013; Chand *et al*., 2022). Costs were computed on a per-hectare basis and returns were valued at prevailing farm-gate prices. Profitability indicators, including gross returns, net returns, farm business income and net farm income, were calculated to assess the economic viability of ginger cultivation, following established analytical frameworks for high-value horticultural crops (Chand *et al*., 2022; Tiwari and Joshi, 2021).

Econometric analysis

To identify the determinants of net farm income from ginger cultivation, an Ordinary Least Squares (OLS) regression model was estimated following standard econometric practice (Wooldridge, 2019; Gujarati and Porter, 2009). The model is expressed as:

$$NFI_i = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ji} + \varepsilon_i$$

Where,

NFI_i= The net farm income of the i^{th} household.

β_0= The intercept.

β_j= The partial regression coefficients.

X_j= The j^{th} explanatory variable.

ε_i= The stochastic error term capturing unobserved heterogeneity.

Explanatory variables included

- **Socioeconomic characteristics:** Gender, education, household size, farming experience.

- **Farm and production variables:** Total landholding, area under ginger, proportion of area under ginger, family labour, seed cost, organic manure, fertilisers and chemicals, hired labour.
- **Institutional and market access indicators:** Access to credit, farmer-group membership, crop insurance, price information, storage access, initial payment received, transport means and distance to the nearest market.

Ordinary Least Squares (OLS) estimation was employed due to its suitability for analysing cross-sectional farm-level data and its robustness in estimating marginal effects of explanatory variables on income outcomes (Wooldridge, 2019). Data processing, cost computations and regression modelling were performed using Microsoft Excel and R software, following analytical procedures commonly applied in agricultural economics research (Koirala *et al*., 2019; Tiwari and Joshi, 2021).

RESULTS AND DISCUSSION

Table 1 outlines the profile of 300 ginger growers in Sirmour district, which includes 138 marginal, 96 small and 66 semi-medium farmers. Landholding sizes increase from marginal (0.51 ha) to semi-medium (2.07 ha), reflecting the fragmented land structure in Himalayan agriculture (Birthal *et al*., 2020). Semi-medium farmers achieved the highest average yield (122.59 q/farm), with an overall average yield of 116.61 q/farm, highlighting ginger's productivity under mid-hill conditions (Chand *et al*., 2022). Marketable surplus also followed a similar trend, with semi-medium farmers reporting the highest surplus (115.82 q/farm), compared to small (102.67 q/farm) and marginal farmers (105.65 q/farm). Marginal farmers, despite lower production, maintained a high marketable surplus, underscoring ginger's importance as a cash crop for smallholders (Tiwari and Joshi, 2021). Himachal Local was the dominant cultivar across all groups, while small farmers also adopted 'Himgiri,' indicating some varietal diversification. This preference for Himachal Local aligns with findings that farmers choose regionally adapted varieties for their suitability and stable market demand (Nair, 2013; Oudhia and Tripathi, 2021).

Table 2 presents the detailed cost structure of green ginger cultivation across different farm-size groups in Sirmour district. The cost pattern reveals considerable variation in both paid-out and imputed cost components, reflecting differences in input intensity, labour dependence and scale of operations, typical features of Himalayan smallholder agriculture (Birthal *et al*., 2020). Seed emerged as the dominant cost component across all categories, accounting for nearly two-thirds of Cost A1. This finding aligns with earlier studies that report seed rhizomes constitute the largest share of total variable costs in ginger production due to high planting material requirements (Nair, 2013; Chand *et al*., 2022). Seed expenditure ranged from ₹ 92,253/ha among marginal farmers to nearly ₹ 98,456/ha among medium farmers, indicating limited variation because most growers rely on similar locally available planting material.

Organic manure constituted the second major cost component, with relatively higher investments among small and semi-medium farmers. This pattern is consistent with studies on ginger production systems in hill regions where organic inputs and planting materials account for a major share of variable costs (Mathew *et al*., 2018; Singh and Dhillon, 2015). Expenditure on hired labour increased with farm size, indicating a gradual shift from family labour to hired labour as operational holdings expand. Similar labour-use patterns have been documented in hill farming systems, where larger farms demonstrate higher dependence on market labour (Birthal *et al*., 2019).

Small farmers face the highest Cost B2 due to higher fixed-capital intensity per unit area, a trend seen in small-scale hill farms (Birthal *et al*., 2020). Family labour significantly adds to production costs, particularly for marginal farmers (₹ 62,358/ha), who rely on household labour due to limited finances for hiring. This aligns with studies showing that smallholders in the Himalayas use family labour to reduce cash expenses (Tiwari and Joshi, 2021). Marginal farmers incur higher per-hectare costs due to limited economies of scale and greater imputed costs, as noted in ginger production studies (Chand *et al*., 2022). Consequently, their total costs are higher because of reliance on family labour and limited distribution of fixed costs, while semi-medium and medium farmers benefit from better scale efficiency, achieving lower Cost C2 and C3 values.

Table 3 shows that the yield and profitability of green ginger increase with farm size. Semi-medium farms recorded the highest yield (153.71 q/ha) and net returns (₹ 430,681.54/ha), while marginal farms had lower yields (120.62 q/ha) and net returns (₹ 267,922.17/ha). Although total cultivation costs were comparable across categories, the cost of production per quintal declined sharply with

Table 1: Profile of sampled ginger growers in the Sirmour district.

Particulars	Marginal	Small	Semi-medium	Overall
Number of sampled farmers	138	96	66	300
Average number of land holdings	0.51	1.09	2.07	1.22
Average production (Quintals/farm)	111.32	115.92	122.59	116.61
Marketable surplus (Quintals/farm)	105.65	102.67	115.820	108.05
Ginger varieties cultivated	Himachal local	Himachal local, Himgiri	Himachal local	Himachal local

Authors own calculations.

farm size from ₹ 2,146.57 on marginal farms to ₹ 1,565.87 on semi-medium farms, indicating economies of scale and greater cost efficiency on larger holdings. Overall, ginger cultivation was profitable across all farm size categories; however, semi-medium farmers benefited the most from higher yields and lower per-unit costs.

Table 4 indicates that farm profitability in ginger cultivation improves consistently with farm size. Semi-medium farms achieved the highest yield (153.71 q/ha) and gross returns (₹ 603,345.57/ha), resulting in superior farm business income (₹ 447,266.01/ha), family labour income (₹ 419,558.57/ha) and net farm income (₹ 362,655.65/ha). In contrast, marginal farms recorded comparatively lower income measures, reflecting scale-related inefficiencies. The output-input ratio increased from 1.83 on marginal farms to 2.51 on semi-medium farms, indicating higher

Table 2: Cost of cultivation of green ginger in the study area (₹/hectare).

Particulars	Marginal	Small	Semi-medium	Overall
Cost A1				
Seed	92253.07	98526.24	97405.18	96660.20
Fertilizers	1453.53	1568.52	1654.23	1558.71
Organic manure	20568.25	21856.23	21856.35	20384.30
Seed and crop protection chemicals	3284.25	3245.52	2865.25	3146.16
Hired labour	11562.35	12564.85	15365.25	13486.24
Bullock labour/machine used	4256.42	5762.87	5489.76	5067.98
Miscellaneous	0.00	0.00	0.00	0.00
Total	133377.87	143524.23	144636.02	140303.59
Interest on working capital	3288.77	3538.95	3566.37	3459.54
Land revenue	32.05	32.05	32.05	24.04
Depreciation	8242.85	9804.13	7845.12	8285.54
Sub total	144941.54	156899.36	156079.56	152072.71
Cost B1				
Cost A1	144941.54	156899.36	156079.56	152072.71
Interest on fixed capital (9%)	1401.62	1589.65	1027.23	1335.09
Sub total	146343.16	158489.01	157106.79	153407.80
Cost B2				
Cost B1	146343.16	158489.01	157106.79	153407.80
Rental value of owned land	26680.21	26680.21	26680.21	26680.21
Sub total	173023.37	185169.22	183787.00	180088.01
Cost C1				
Cost B1	146343.16	158489.01	157106.79	153407.80
Imputed value of family labour	62357.95	48210.25	35022.02	47432.58
Sub total	208701.11	206699.26	192128.81	200840.38
Cost C2				
Cost B2	173023.37	185169.22	183787.00	180088.01
Imputed value of family labour	62357.95	48210.25	35022.02	47432.58
Sub total	235381.32	233379.47	218809.02	227520.59
Cost C3				
Cost C2	235381.32	233379.47	218809.02	227520.59
Value of management input (10% of Cost C2)	23538.13	23337.95	21880.90	22752.06
Sub total	258919.45	256717.42	240689.92	250272.64

Authors own calculations.

Table 3: Cost of green ginger production among various farm categories (₹/hectare).

Particulars	Marginal	Small	Semi-medium	Overall
Total cost of cultivation	258919.45	256717.42	240689.92	252108.93
Yield (quintal per hectare)	120.62	144.12	153.71	141.49
Gross returns	473460.04	565702.71	603345.57	547502.77
Net returns	267922.17	372767.03	430681.54	357123.58
Cost of production per quintal	2146.57	1781.28	1565.87	1831.24

Authors own calculations.

economic efficiency on larger holdings. The results indicate a clear improvement in profitability and economic efficiency of ginger cultivation with increasing farm size. Similar evidence has been reported in studies on high-value crops, where larger operational holdings tend to achieve better economic performance due to improved input utilisation and economies of scale (Yadav *et al*., 2022). Higher yields and income measures observed on semi-medium farms are consistent with earlier studies that document economies of scale in ginger production, particularly through more efficient use of labour and planting material (Kandiannan *et al*., 2012; Nair, 2013). Larger holdings are better able to manage high initial input costs and adopt timely agronomic practices, resulting in lower unit costs and higher net returns. The superior farm business income, family labour income and net farm income recorded on semi-medium farms also align with the findings of Tiwari and Joshi (2021), who reported that improved labour management and access to capital significantly enhance returns from ginger cultivation. Similarly, Chand *et al*. (2022) noted that smallholders often face cost disadvantages due to limited scale and higher dependence on family labour, which constrains profitability. The rising output-input ratio with farm size corroborates evidence from spice-based farming systems, where better market access and resource-use efficiency contribute to higher economic performance (Hegde and Zaman, 2018). Overall, the results reinforce existing literature and highlight the need for scale-neutral interventions, such as collective input procurement, shared post-harvest infrastructure and cluster-based marketing under ODOP, to improve profitability for small and marginal ginger farmers, reflecting stronger profitability driven by higher outputs and economies of scale (ICAR-NRCSS, 2021; Hegde and Zaman, 2018).

Table 5 summarises the key variables used in the econometric analysis of ginger farm income. The mean net farm income of ₹ 295,393.84 indicates that ginger cultivation is economically viable in the study area; however, the large dispersion around the mean highlight's substantial heterogeneity in income outcomes. Such variability is typical of high-value, input-intensive crops grown under hill conditions, where differences in scale, cost exposure and market engagement strongly influence returns (Singh and Dhillon, 2015; Chand *et al*., 2022). Input-use patterns reveal that seed cost is the most dominant and variable cost component, underscoring the capital-intensive nature of ginger cultivation. Similar findings have been reported in earlier studies, which identify seed rhizomes as the primary driver of cost escalation and income risk in ginger production systems (Shinde *et al*., 2020). In contrast, relatively lower expenditure on fertilisers

Table 4: Farm profitability in the ginger crop per hectare on different farm categories (₹/hectare).

Particulars	Marginal	Small	Semi-medium	Overall
Yield (Quintal per hectare)	120.62	144.12	153.71	141.49
Gross returns	473460.04	565702.71	603345.57	547502.77
Farm business income	328518.50	408803.34	447266.01	394862.62
family labour income	300436.67	380533.48	419558.57	366842.91
Net farm income	214540.59	308985.29	362655.65	295393.84
farm investment income	266160.55	360593.09	412243.99	346332.54
Output/input ratio	1.83	2.20	2.51	2.18

Authors own calculations.

Table 5: Summary statistics for key variables used in the analysis.

Variable	Mean	Standard deviation	Min	Max
N=300				
Net farm income (₹/ha)	295393.84	2556583.76	214540.59	362655.65
Household size (No.)	4.85	1.36	2.00	8.00
Seed cost (₹/ha)	927146.83	895062.41	88752.25	9485215.00
Organic manure (₹ ha)	20246.03	18901.27	15844.15	21856.00
Hired labour (Mandays)	37.65	33.34	28.85	40.00
Fertilisers and chemicals (₹/ha)	1488.78	1341.23	870.50	1780.00
Variety (1= Himachal local, 0= Himgiri)	0.77	0.42	0.00	1.00
Area under ginger (ha)	1.33	2.58	0.25	8.00
Total holdings (ha)	2.22	4.99	1.00	12.00
Access to price information (1=Yes, 0=No)	0.60	0.49	0.00	1.00
Own means of transportation (1=Yes, 0=No)	0.39	0.49	0.00	1.00
Storage facility with farmer (1=Yes, 0=No)	0.39	0.49	0.00	1.00

and chemicals reflects the continued reliance on organic or low-input practices in hill agriculture. The average hired labour use confirms the labour-intensive character of ginger cultivation, consistent with terrain-induced mechanisation constraints in mountain regions (Chand *et al*., 2022). Farm structure indicators show that ginger occupies a substantial share of operational holdings, reinforcing its role as a principal commercial crop rather than a subsidiary enterprise. Varietal choice is clearly skewed toward the Himachal Local variety, indicating farmer preference for locally adapted cultivars with stable yields and better market acceptance. This preference aligns with evidence suggesting that traditional varieties often offer lower production risk and superior price realisation in hill environments (Singh and Dhillon, 2015). Market access indicators point to structural constraints faced by ginger growers. While most farmers reported access to price information, ownership of transportation and storage facilities remains limited. Such asymmetries are likely to affect marketing flexibility and price realisation, particularly during peak harvest periods, as observed in smallholder market participation studies (Negi *et al*., 2018). Overall, the summary statistics reveal pronounced heterogeneity in resource endowment, input intensity and market access among ginger farmers, providing a strong empirical basis for examining the determinants of farm income through econometric analysis. Regression analysis identified key determinants of net farm income among ginger growers in Sirmour. A log-linear model revealed that household size and hired labour were the most significant income predictors, with cost and acreage variables enhancing explanatory power.

Table 6 presents the estimates of the ordinary least squares (OLS) model explaining variations in net farm income from ginger cultivation. The model demonstrates satisfactory explanatory power, with an R^2 of 0.503 and an adjusted R^2 of 0.490, indicating that nearly half of the variation in farm income is explained by the included socio-economic, production and market-related variables. Such goodness-of-fit is comparable to earlier empirical studies on farm income determinants in high-value horticultural crops (Negi *et al*., 2018; Chand *et al*., 2022). Household size has a positive and statistically significant influence on net farm income ($p<0.01$), suggesting that the availability of family labour contributes to improved operational efficiency in labour-intensive ginger cultivation. This finding is consistent with evidence from smallholder production systems where family labour plays a critical role in income generation (Singh and Dhillon, 2015). Hired labour expenditure also shows a positive and significant effect ($p<0.05$), reflecting the labour-intensive nature of ginger cultivation in hill regions with limited mechanisation (Chand *et al*., 2022).

Seed cost is negatively and significantly associated with net farm income ($p<0.05$), indicating that higher expenditure on seed rhizomes reduces profitability. Given the substantial share of seed cost in total cultivation expenditure, inefficiencies in seed use or high seed prices can markedly erode net returns. This result corroborates earlier findings highlighting seed cost as a key driver of income variability in ginger cultivation (Shinde *et al*., 2020). Expenditure on fertilisers and chemicals is weakly significant and negative ($p<0.10$), suggesting diminishing marginal returns to chemical inputs under the prevailing production conditions, while organic manure expenditure does not exert a significant effect on income. The area under ginger cultivation exerts a positive and statistically significant effect on net farm income ($p<0.05$), underscoring the importance of crop-specific scale in enhancing income outcomes. In contrast, total landholdings are not significant, implying that income gains are driven more by allocation toward ginger rather than overall farm size. Market-related variables, including access to price information, ownership of transport and availability of

Table 6: Estimates of the OLS model for determining the effects of variables on net farm income.

Variable	Coefficient	Std. error	t-value	p-value
Intercept	14.9008	0.2317	64.31	0.0000***
Household size (No.)	0.1075	0.0363	2.96	0.0030***
Hired labour (₹)	0.0404	0.0176	2.30	0.0215**
Variety (Dummy)	0.1828	0.1249	-1.46	0.1434
Seed cost (₹)	-0.0018	0.0008	-2.205	0.027**
Organic manure (₹)	-0.000014	0.000038	-0.367	0.713
Fertilizers and chemicals (₹)	-0.000001	0.000001	-1.664	0.096*
Area under ginger (ha)	2.0830	0.8770	2.374	0.017**
Total landholdings (ha)	-0.01053	0.01755	-0.600	0.548
Access to price information (Dummy)	0.1279	0.1044	1.225	0.220
Own means of transport (Dummy)	-0.0459	0.1062	-0.433	0.665
Storage facility (Dummy)	0.01018	0.1088	0.094	0.925
	R^2= 0.503	Adjusted R^2= 0.490		

Note *Significant at 10 % level; **Significant at 5% level; ***Significant at 1% level.

Authors own calculations.

storage facilities, do not show statistically significant effects, indicating that production-side factors currently dominate income determination at the farm level despite policy emphasis on market linkage under the ODOP framework. The limited influence of market-related variables on farm income aligns with findings from studies on hill agriculture and spice-based farming systems, which highlight persistent structural constraints in marketing, despite policy initiatives and improvements in production technology (Prasath *et al*., 2017; Oudhia and Tripathi, 2021; Sharma and Rana, 2021; Spices Board India, 2022, 2023; National Horticulture Board, 2023; OECD-FAO, 2021). Similarly, varietal choice does not significantly influence income once other factors are controlled for, suggesting limited income differentiation between the commonly cultivated varieties. The observed income variability, positive scale effects of ginger cultivation and the dominant role of input costs-particularly seed and labour are consistent with earlier empirical evidence on ginger and spice crop economics reported across different regions of India and neighbouring countries (Gaikwad *et al*., 1998; Rahman and Rahman, 2014; Reddy and Devi, 2019; Shinde *et al*., 2020; Tiwari and Joshi, 2020). Overall, the results highlight that labour availability, scale of ginger cultivation and cost efficiency particularly seed cost are the primary determinants of net farm income, while market infrastructure and information variables play a relatively limited role in the present context. This underscores the need for policy interventions under ODOP to complement market-linkage efforts with measures aimed at reducing input costs and improving production efficiency.

To ensure the robustness of these findings, standard diagnostic checks were conducted. Multicollinearity among explanatory variables was examined using variance inflation factors, which were within acceptable limits. Residual diagnostics indicated no serious violations of normality or homoscedasticity assumptions. Overall, the diagnostic results support the reliability of the estimated coefficients and the validity of the inferences drawn from the OLS model.

Policy implications

The results indicate that production efficiency, scale of ginger cultivation and seed cost are the primary determinants of net farm income in Sirmour district. ODOP interventions should therefore prioritise reducing seed rhizome costs through local seed multiplication, certified planting material and targeted input support for small and marginal farmers, as high seed expenditure significantly erodes profitability. The positive effect of area under ginger cultivation, coupled with the insignificance of total landholdings, suggests that income gains depend more on enterprise-level specialisation than farm size. Policies should encourage optimal land allocation to ginger within existing holdings through technical guidance, risk mitigation and crop planning support rather than promoting land expansion. The significant role of labour availability highlights the urgent need to promote labour-efficient practices, including appropriate mechanisation, development of crop-specific farm tools, and establishment of custom hiring centres for access to high-cost machinery during peak operations. Skill development and organised labour arrangements should complement these interventions to enhance operational efficiency. Strengthening last-mile implementation, particularly in price discovery and aggregation, is therefore essential. Overall, the findings suggest that ODOP strategies should adopt a production-focused approach, complemented by targeted market interventions, to achieve sustained income enhancement for ginger growers in hill regions.

CONCLUSION

The study analysed the economics of ginger cultivation and the determinants of net farm income in Sirmour district of Himachal Pradesh under the One District One Product (ODOP) framework. The results confirm that ginger cultivation is economically viable but characterised by substantial income variability across farm households. Econometric evidence indicates that labour availability, area under ginger cultivation and cost efficiency, particularly seed cost, are the key determinants of net farm income, while market access variables exert a limited influence at the farm level. These findings suggest that income gains are driven more by production-side efficiency and enterprise-level specialisation than by overall farm size or existing market infrastructure. Strengthening ODOP implementation, therefore, requires a balanced strategy that prioritises reducing input costs, improving production efficiency and enhancing last-mile market linkages. Such an approach is essential for achieving sustained income enhancement for ginger growers in hill agriculture and increasing the ODOP benefits.

Conflict of interest

The authors declare that they have no conflict of interest.

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