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Marketing performance and factors influencing farmers' choice for agricultural output marketing channels: The case of potato (*Solanum tuberosum*) in India

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Abstract

Efficient agricultural marketing is essential for converting farm output into income for farmers, particularly for perishable crops like potatoes. This study evaluates the performance of four distinct potato marketing channels in the northern state of Himachal Pradesh, in line with the One District One Product (ODOP) initiative. We analysed primary data collected from 150 farmers and 20 intermediaries using cost–margin analysis and employed a Multinomial Logit model to estimate the factors influencing farmers' choices of marketing channels. Four major channels were identified in the study area. Channel IV (Producer → Retailer → Consumer) emerged as the most efficient, providing the highest producer share (84.07%) and the lowest marketing costs. Conversely, Channel III (contracted sales to PepsiCo) incurred the highest marketing costs and demonstrated the lowest efficiency, despite having the highest consumer price. Traditional channels (I and II) exhibited moderate performance but were characterised by delayed payments and wider price spreads. Farmers' selection of marketing channels was significantly influenced by factors such as farming experience, marketable surplus, distance to markets, payment timelines, and access to informal information. The study recommends expanding direct marketing models, strengthening rural infrastructure, and ensuring timely payments to enhance marketing efficiency and support income growth for potato farmers in hilly regions.

Keywords: Value chain analysis, Market margin, Price Spread, Multinomial Logistic regression, Potato

Introduction

Agricultural marketing systems enhance farm incomes, reduce rural poverty, and improve food security outcomes (Pingali, 2012). In recent years, globalisation, evolving consumer preferences, and rapid growth in agri-food processing have driven significant shifts in food value chains worldwide (Reardon et al., 2019). A central strategy emerging from this transformation is the integration of smallholder farmers into high-value markets, with a growing emphasis on the structure and efficiency of agricultural value chains (Barrett et al., 2022; Patel et al., 2025). In this context, potatoes (*Solanum tuberosum*) have become a crop of strategic significance in India, given their dual role as a staple food and a commercial commodity. India ranks as the second-largest producer of vegetables globally, with potato cultivation exceeding 50 million tonnes annually (NHB, 2023). Potatoes serve as a critical source of income and employment for smallholder farmers, especially in northern and eastern states, where rising demand for processed products like chips and frozen fries has accelerated the formation of specialised value chains (Minten et al., 2011; Patel et al., 2025). These emerging channels often bypass traditional mandis, opting for contract farming and digital aggregation models offering better price realisation and market stability (ScienceDirect, 2018).

Potato cultivation has expanded steadily in the hill state of Himachal Pradesh due to favourable agro-climatic conditions and year-round production capabilities. With approximately 15,100 hectares under cultivation and an annual output of 1.95 lakh tonnes, the state has positioned itself as a competitive producer of quality seed and table potatoes (Statistical Abstract of Himachal Pradesh, 2024). Among its districts, Una has emerged as a strategic node, recognised under the Government of India's "One District One Product (ODOP)" initiative, which identified potato as its flagship crop (MoFPI, 2022). The ODOP scheme seeks to catalyse localised development by providing end-to-end value chain support—spanning infrastructure, processing, branding, and market access (Misra & Tewari, 2021). Under this policy framework, promoting efficient and remunerative marketing channels becomes central to enhancing farmers' incomes and enabling agrarian transformation. Modern potato value chains offer several advantages: they reduce intermediation, enhance transparency, and improve risk-sharing mechanisms through aggregation and quality-based pricing (Saha & Iqbal, 2023). Empirical studies in other potato-growing regions have highlighted significant disparities in marketing efficiency and price spread across channels, underscoring the need for targeted value chain interventions (Deep & Girdhar, 2025; Saha & Iqbal, 2023). In Nigeria, Ojumu and Komolafe (2024) calculated a marketing efficiency of 796% among small-scale retailers, pointing to extremely favourable returns relative to costs. Rajavardhan (2020) in Meghalaya observed the highest efficiency (22.85) in direct channels, compared to

intermediary-heavy alternatives. Geremew (2018) also found that traditional chains in Ethiopia were burdened by low competition and reduced producer margins. These empirical insights reinforce the conclusion that channel structure, payment reliability, access to infrastructure, and institutional trust significantly shape value chain performance. In Una, aligning potato value chain development with the ODOP initiative can provide a robust pathway for rural diversification, livelihood security, and resilience to market shocks.

However, despite increased interest in agricultural marketing systems, limited attention has been given to understanding the factors influencing farmers' participation in diverse marketing channels, especially within the ODOP context. Existing research emphasises that such decisions are shaped by economic incentives and access to institutional support, infrastructure, and market information (Frontiers in Sustainable Food Systems, 2023; Agribusiness, 2023; Indian Journal of Agricultural Economics, 2024). In crops like potato—characterised by perishability, price volatility, and asymmetrical information—channel choice directly impacts income outcomes and post-harvest efficiency. Ne This study addresses this gap by evaluating the marketing performance of different potato value chains in the Una district and identifying the socioeconomic and institutional determinants of channel adoption. Employing a Multinomial Logit (MNL) model to assess channel choice, the findings are intended to support evidence-based implementation of the ODOP scheme, inform local agri-food marketing strategies, and contribute to the sustainable commercialisation of agriculture in hilly regions.

Materials and methods

Study location

In the current study, ex-post-facto analysis and a multistage sampling technique were employed to carefully select a cohort of 150 participants from ten distinct villages across five blocks of the selected state. This research was carried out within the northern region of India, encompassing the state of Himachal Pradesh. Himachal Pradesh, a picturesque state in northern India, is divided into four distinct agro-climatic zones, each defined by varying elevations that range from below 650 meters to over 2200 meters above mean sea level (amsl). For this study, we focused on households in the district of Una, which is strategically situated at coordinates 31°17'52" - 31°52'0" (North) to 75°58'2" - 76°28'25" (East) (pmsgy.nic.in). These households were purposefully selected as part of the government's One District, One Product (ODOP) initiative, aimed at bolstering and streamlining the supply chains of key local commodities. In the fertile plains of Una, potatoes are a significant agricultural crop, cultivated across an extensive area of 750 hectares, yielding an impressive total production of approximately 9,860 tonnes, as detailed in the Statistical Abstract of Himachal Pradesh 2023.

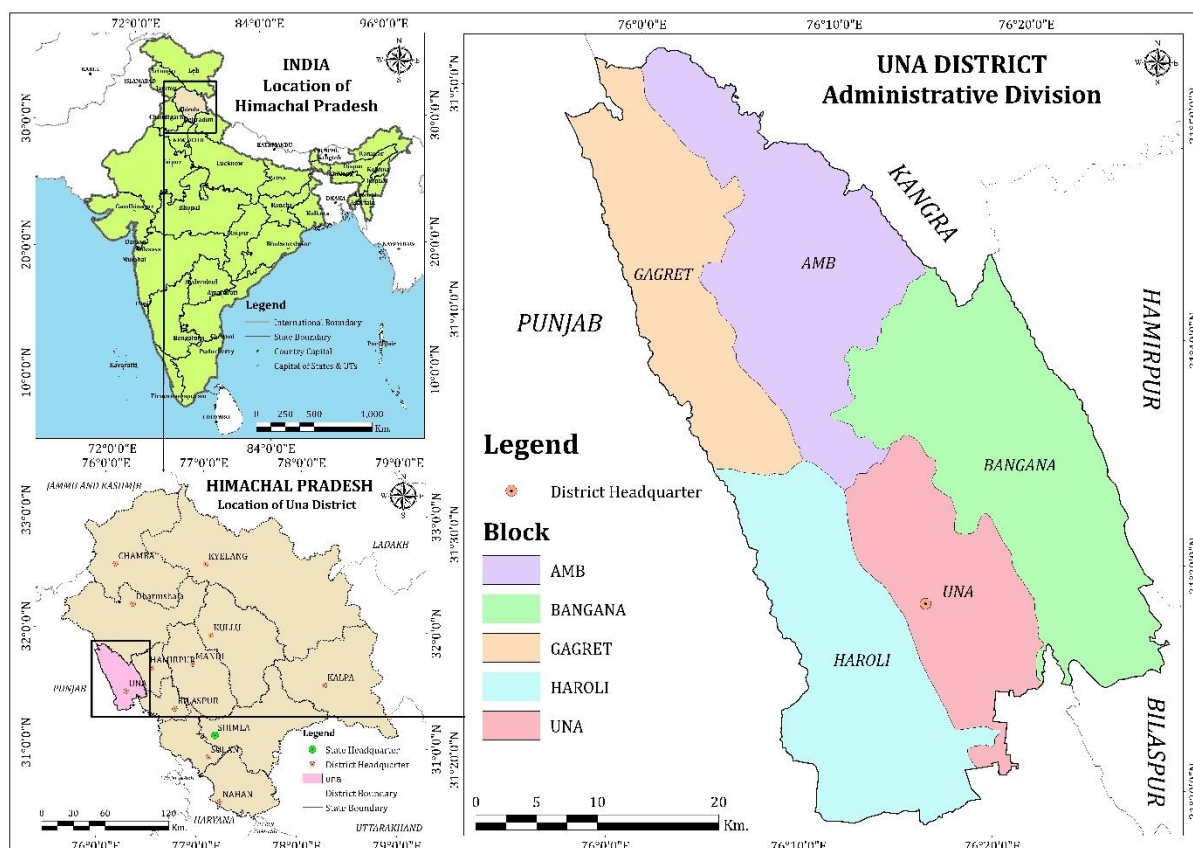


Fig. 1 Map of the study area

Sampling Procedure

Selection of Farmers

A compilation of potato farming villages was created for every chosen block with the help of available agricultural department officials, and from each block, two villages were selected through a random process. A simple random sampling method was used to choose the final sample of farmers. Subsequently, 15 farmers were randomly selected from each of the ten villages of the five blocks—Amb, Bangana, Gagret, Haroli, and Una. Consequently, a total of 150 respondents were randomly chosen for the study.

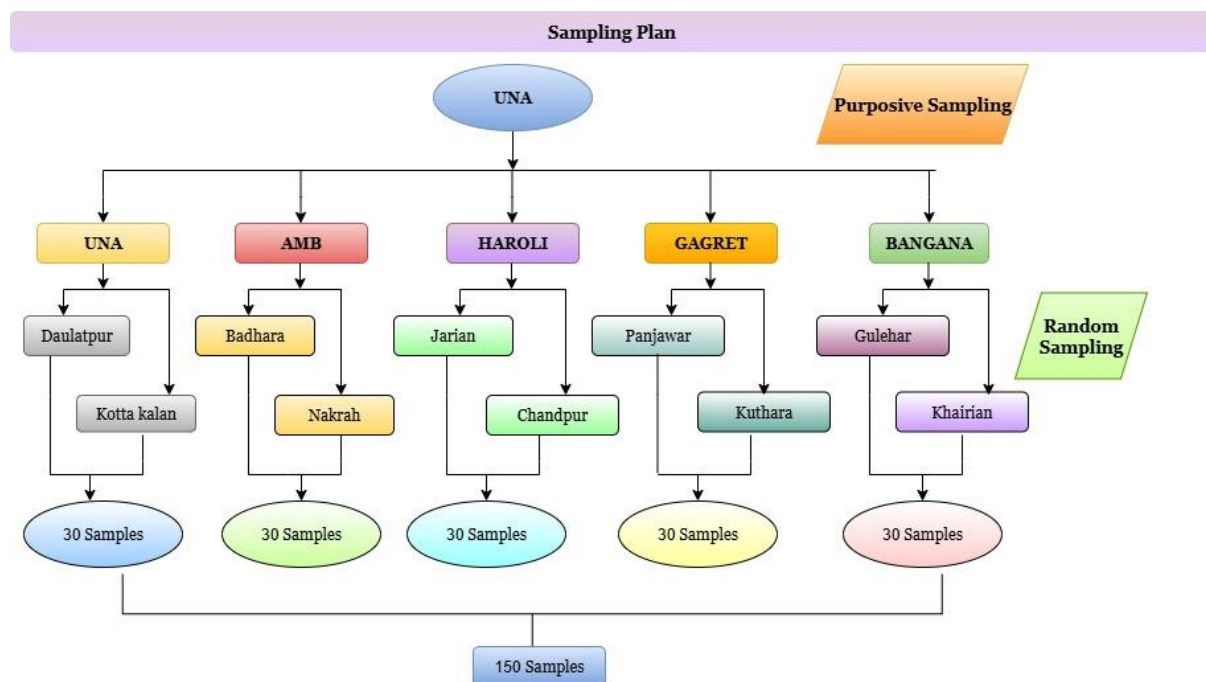


Fig 2: Sampling technique of potato farming villages with a selection of 30 farmers from each village in the selected districts

Selection of Market Intermediaries

The study determined the sample size of market functionaries based on the data acquired from the Agricultural Produce Market Committee (APMC) office. Accordingly, the primary market, Una, was selected. Furthermore, to investigate the various aspects of potato marketing, a total sample size of 20 traders was established by randomly selecting five local traders, four commission agents, one contract farming agent, five wholesalers, and five retailers from the market.

Analytical Framework for Market Performance and Supply Chain Management

Marketing Costs

The marketing expenses were calculated by summing the costs associated with each marketing entity involved in the potato production value chain. The intermediaries' marketing costs included expenses for packaging materials, loading and unloading fees, transportation costs, commission charges, and taxes (Acharya & Agarwal, 2016). The process of calculating involved assessing the total expenses associated with marketing activities in the following manner:

$$TCm = Cg + \sum_{i=1}^n MCi$$

Where,

TCm = Total cost of marketing,

Cg = Cost paid by the grower in the marketing of his produce

MCi = Marketing costs incurred by the i-th middleman.

Marketing Margin

Marketing margin analysis involves assessing price differentials between successive stages of a product's marketing chain over a defined period. This method determines the share of the final consumer price retained by intermediaries in the value chain, often expressed as a percentage of the end price or the amount paid by

consumers (Thakur et al., 2023a, b; Divyanshu et al., 2022). The marketing margin itself is calculated as the gap between the farm-gate price (received by the producer) and the retail price (paid by the end consumer) (Abankwah et al., 2010). To quantify the percentage of margins accrued by each intermediary in potato marketing, the formula proposed by Acharya and Agarwal (2016) was applied:

$$Ami = PRi - (Ppi + Cmi)$$

Where,

Ami = Absolute margin of middlemen

PRi = Total value of receipts per unit (sale price)

Ppi = Purchase value of goods per unit

Cmi = Cost incurred on marketing per unit

Price Spread

Price spread is the difference between the consumers' and producers' prices. The price spread was calculated using the formula established by Acharya (1988).

Producer's Share in Consumer's Rupee

It represents the producer's revenue as a percentage of the retail price (i.e., the price paid by the consumer) (Singh et al., 2020). The calculation of the producer's share in the consumer's rupee has been determined as follows:

$$PS = \frac{PF}{RP} \times 100$$

Where,

PS = Producer's share in the consumer's rupee

PF = Price received by the farmer per unit of output

RP = Retail price per unit of output

Marketing Efficiency of the Marketing Channels

In the realm of marketing channels, marketing efficiency pertains to the process of transferring goods from producers to consumers at the lowest possible cost, all while fulfilling consumer service expectations. In this study, the marketing efficiency of different channels has been assessed using Acharya's method (Acharya & Agarwal, 2001) as follows

$$ME = \frac{RP}{MC + MM} - 1$$

Where,

ME = Marketing efficiency

RP = Retailer's price

MC = Total marketing costs

MM = Total marketing margins

Analytical Framework for Factors Influencing Farmers' Choice

The Random Utility Model serves as a valuable framework for examining how various marketing channels influence farmers' decisions when selling their agricultural produce. This model has been utilised in several

noteworthy studies, including those conducted by Mtimet and Albisu (2006), Geoffrey et al. (2015), Ma and Abdulai (2016), and Espinosa-Goded et al. (2021). At the heart of the model is the concept that farmers make their marketing channel choices by evaluating the expected values to maximise their overall utility (Greene, 2003; Train, 2009). Farmers carefully analyse the anticipated benefits and associated costs of each available channel, weighing factors such as market accessibility, price fluctuations, and logistical considerations. Ultimately, they opt for the channel that promises the highest overall utility, which is denoted as U_{ij} . This value encapsulates the perceived benefits of selling through a specific channel, reflecting the intricate decision-making process that farmers engage in to optimise their sales outcomes and enhance their livelihoods.

$$U_{i(j=k)} = \beta_{j=k}X_{ij} + e_{ij} \quad \forall j \in N$$

The farmer's decision regarding which output channel to use is based on utility, representing the difference between the benefits and costs of each channel. While utility cannot be directly observed, the farmer's decision indicates which marketing channel offers the most utility (Greene, 2012). If the expected utility from selling agricultural produce through a particular marketing channel exceeds all other options, the farmer will choose that channel. The probability of selecting a specific option depends on the likelihood that its utility will be higher or at least equal to the utilities of every other alternative in the decision set (Mariel et al., 2022). The farmer will select the $j = k$ market channel for agricultural output if the utility of that channel is greater than the utility of all other channels, as expressed in equation (2).

$$U_{i(j=k)} > U_{i(j \neq k)} \quad \forall k \neq j$$

The random utility associated with a specific market channel (when $j = k$) is denoted as U_{ij} . The index function $\beta_{(j=k)} X_{ij}$ represents the average utility that the producer derives from this choice. Additionally, the term e_{ij} signifies a random error that is unique to the producer's utility decision, as highlighted by Louviere et al. (2000) and Tafesse et al. (2020). Moreover, drawing from the empirical evidence discussed in the theoretical background section, Figure 1 illustrates the conceptual framework of the dependent variables influencing farmers' decisions regarding the marketing channels for their potato produce. The factors that shape these decisions can be grouped into three categories:

1. Household factors: This includes elements such as education, farm income, and farm experience.
2. Sales factors: These consist of considerations like distance to the market, advance payment, financial urgency, sale delays, and storage facilities.
3. Sources of market information: This encompasses government sources as well as referrals from friends.

Together, these categories play a significant role in guiding farmers' choices about their marketing channels.

Multinomial Logit Regression Model

The multinomial logistic regression uses maximum likelihood estimation to evaluate the probability of belonging to different categorical groups. This model is commonly applied when there are multiple alternatives for the variable being studied (Bardhan et al., 2012; Martey et al., 2012; Gulati et al., 2019; Asante & Weible, 2020; Goncalves et al., 2022). This methodology is particularly effective for analysing unordered responses with more than two options (Chung et al., 2011; Mgale & Yunxian, 2020; Olutumise, 2022).

Formula of MNL

$$P_{ij} = \frac{\exp(\beta_j x_i)}{1 + \sum_{j=1}^3 \exp(\beta_j x_i)} \quad \text{for } j = 1, 2, 3$$

Where x_i is a different characteristic of the i^{th} farmer

β_j is a vector of regression parameter estimates associated with alternative j , and 3 is the number of the output market channel in the choice set.

The probabilities of the i^{th} farmer being in the other three categories ($j = 2$ or 3) can be estimated as:

$$P_i(j = m | x_i) = \frac{\exp(\beta_j x_i)}{1 + \sum_{j=1}^3 \exp(\beta_j x_i)} \quad \text{for } m > 1$$

199

200 The marginal effects of the individual characteristics on the probabilities can be estimated as follows:

201
$$\frac{\delta P_j}{\delta x_i} = P_j [\beta_j - \sum_{j=0}^3 P_j \beta_j] = P_j [\beta_j - \bar{\beta}]$$

202 P_j is the probability of the farmer choosing market channel j , and

203 β_j is a vector of regression parameter estimates associated with alternative j

204 The empirical MNL for factors affecting the farmers' choice of output marketing channels is specified as
205 follows:

206 $P_{ij} = \ln(P_i / P_1) = \beta_0 \dots \dots \dots \beta_{13}$ are the parameters to be estimated

207 P_{ij} Is the probability of output marketing channel j being chosen by farmer i ?

208 **RESULTS AND DISCUSSION**

209 **Profile of Potato Growers**

210 Table 1 presents a profile of potato growers categorised into four groups: marginal, small, semi-medium, and
211 medium farmers, summarising data for 150 farmers. Marginal farmers, with an average landholding of 0.82
212 hectares, produce an average of 15.10 quintals per farm, resulting in a surplus of 13.06 quintals. In contrast,
213 small farmers, who maintain an average of 1.90 hectares, yield 16.66 quintals per farm with a surplus of 15.73
214 quintals. Semi-medium farmers, averaging 3.55 hectares, produce 19.05 quintals per farm and achieve a surplus
215 of 18.49 quintals, while medium farmers, holding an average of 6.63 hectares, generate 17.72 quintals and a
216 surplus of 16.93 quintals. Overall, the combined average landholding for all farmers is 3.22 hectares, yielding an
217 average of 17.13 quintals and a marketable surplus of 16.05 quintals. The potato varieties cultivated across all
218 categories include Kufri Pukhraj, FC-3, and Santana.

219 **Table 1. Profile of sampled Potato Growers in the Una district**

Particulars	Marginal	Small	Semi-medium	Medium	Overall
Number of sampled farmers	29	28	59	34	150
Average number of land holdings	0.82	1.90	3.55	6.63	3.22
Average Production (Quintals/farm)	15.10	16.66	19.05	17.72	17.13
Marketable surplus (Quintals/farm)	13.06	15.73	18.49	16.93	16.05
Potato varieties cultivated	Pukhraj	Pukhraj, Santana potato	FC-3, Pukhraj, Santana potato	Santana potato, Pukhraj	Pukhraj

220

221 **Table 2. Farm category-wise quantity of potatoes sold through various marketing channels**

Marketing channel	Marginal	Small	Semi-medium	Medium	Overall
Channel I	49.52 (55.18)	134.57 (42.94)	218.98 (35.77)	110.26 (11.53)	145.82 (35.36)
Channel II	27.82 (24.30)	103.5 (35.80)	251.88 (41.54)	0 (0.00)	123.77 (27.72)
Channel III	0 (0.00)	0 (0.00)	127.46 (16.81)	929.74 (84.94)	260.87 (25.87)
Channel IV	21.12 (20.52)	55.04 (21.26)	31.35 (5.88)	34.47 (3.53)	34.5 (11.05)

222 Note: Figures in parentheses are percentages of the total.

223 **Agricultural output marketing channels of the potato crop**

Table 2 indicates that farmers in the study area utilised four distinct marketing channels to sell their table potato produce. Producer-Commission Agent- Wholesaler-Retailer-Consumer (Channel-I) was the most used channel, accounting for 35.36% of transactions. This was followed by Producer-Local Trader-Wholesaler-Retailer-Consumer (Channel-II) at 27.72% and Producer-PepsiCo company-wholesaler- Retailer- Consumer (Channel-III) at 25.87%. A smaller proportion, 11.05%, was sold through Producer-Retailer-Consumer (Channel-IV).

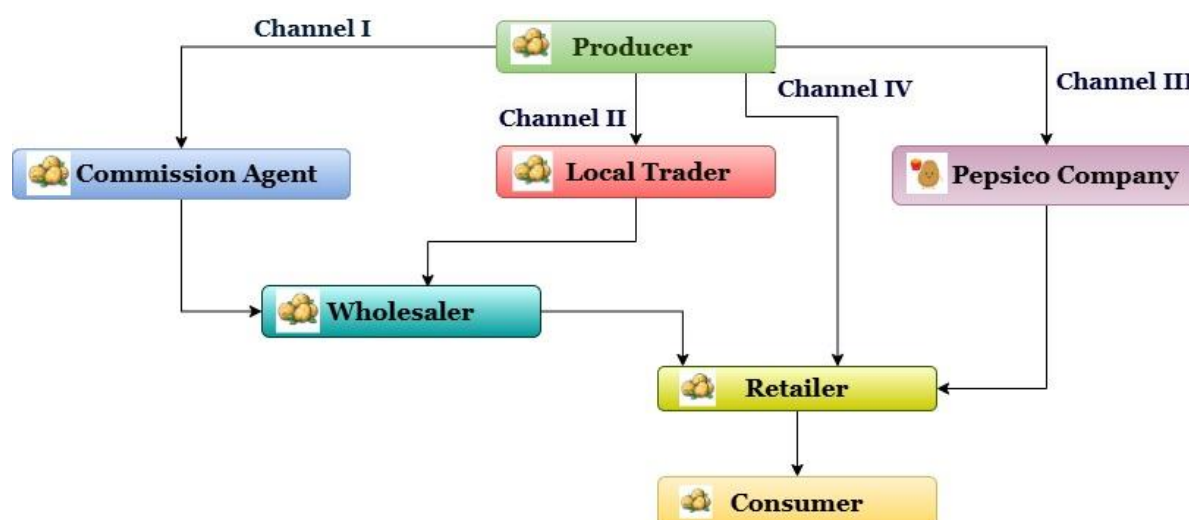


Fig 3: Marketing channels selected for the study

Channel I: Producer → Commission Agent → Wholesaler → Retailer → Consumer

This was the most used marketing channel among marginal farmers in the study area, accounting for 35.36% of total table potato sales. In this channel, farmers bring their produce to regulated market yards, where commission agents facilitate the transaction between the producers and wholesalers. The potatoes are subsequently sold to retailers and finally reach the consumers. This channel is characterised by its formal structure and wide acceptance among farmers due to the perceived assurance of market access and the opportunity for competitive price realisation through open auctioning. However, the involvement of multiple intermediaries often increases marketing costs and reduces the farmer's share of the consumer price.

Channel II: Producer → Local Trader → Wholesaler → Retailer → Consumer

Comprising 27.72% of the total marketing share, this channel represents an alternative route whereby semi-medium farmers sell their produce to local traders within the village or nearby marketplaces. These traders then distribute the produce to wholesalers, who supply it to retailers and consumers. Small and semi-medium holder farmers favour this channel because of its convenience and lower transportation costs. Additionally, transactions are generally faster, providing immediate cash flow to farmers. However, due to limited price transparency and the absence of open auctions, farmers often receive lower prices than Channel A.

Channel III: Producer → PepsiCo Company → Retailer → Consumer

This channel, utilised by 25.87% of the farmers, involves direct procurement by the PepsiCo company, typically under contract farming arrangements. The company enters into pre-harvest agreements with farmers in this model, specifying quality standards, quantity, and price. The channel is advantageous to farmers as it offers price stability, assured market access, and often includes input support and technical guidance from the company. This reduces both price and marketing risk, making it particularly attractive to farmers seeking stability and predictability in returns. However, such agreements may limit farmers' flexibility in choosing alternative buyers and involve stringent quality compliance.

Channel IV: Producer → Retailer → Consumer

The least utilised channel, accounting for 11.05% of total sales, involves direct sales by producers to retailers, who then sell the produce to consumers. This direct marketing approach eliminates multiple intermediaries, allowing farmers to capture a higher proportion of the consumer price. It also facilitates greater control over product handling and allows quicker market feedback. Despite these advantages, this channel is less popular due

259 to its high logistical and marketing demands on individual farmers and limitations in the volume of produce sold
260 through direct retail channels.

261 **Marketing costs and margins of various market functionaries**

262 **Table 3. Marketing costs and margins of different functionaries in the marketing channels of the potato**
263 **crop**

SN	Particulars	Channels			
		I	II	III	IV
A	Marketing cost incurred by producers				
I	Net price received by the farmer	1860.00	1780.00	2600.00	2100.00
II	Cost Components				
a	Transportation cost	25.00	20.00	0.00	50.00
b	Cost of packaging bags	25.00	25.00	0.00	25.00
c	Loading/unloading	15.00	15.00	0.00	15.00
d	Mandi fee	18.60	0.00	0.00	0.00
	Total	83.60	60.00	0.00	90.00
	Farmer's selling price	1943.60	1840.00	2600.00	2190.00
B	Marketing cost incurred by the Commission Agent/Pepsico Agent				
I	Gross price paid by Commission Agent	1943.60	1840.00	2600.00	2190.00
II	Cost components				
a	Transportation cost	20.00		120.00	
c	Loading/unloading	15.00		25.00	
d	Grading	20.00		80.00	
e	Room rent			50.00	
f	Processing cost			950.00	
g	Mandi fee (1%)	19.44		0.00	
h	Commission Charges (6%)	116.62		0.00	
	Total	191.05	0.00	1225.00	0.00
	Commission Agent's Margin	120.00	0.00	350.00	0.00
	Commission agent Selling price	2254.65	1840.00	4175.00	2190.00
C	Marketing cost incurred by wholesaler/ Distributor				
I	Gross price paid by Wholesaler	2254.65	1840.00	4175.00	2190.00
II	Cost components				
a	Transportation cost	50.00	80.00	150.00	0.00
b	Cost of packaging bags	0.00	20.00	40.00	0.00
c	s	15.00	15.00	80.00	0.00
d	Room rent	50.00	50.00	50.00	
e	Mandi fee (1%)	22.55	18.40		0.00
f	Commission Charges	135.28	110.40		0.00
	Total	272.83	293.80		0.00
	Wholesaler's /Processor Margin	118.06	140.00	150.00	0.00
	Wholesaler Selling price/ Retailer purchase price	2645.54	2273.80	4325.00	2190.00
D	Wholesaler Selling price/ Retailer purchase price				
I	Gross price paid by Retailer	2645.54	2273.80	4325.00	2190.00
II	Cost components				
a	Transportation cost	35.00	45.00	20.00	50.00
b	Cost of packaging bags	15.00	15.00	10.00	20.00
c	Loading/unloading	20.00	20.00	10.00	20.00

d	Room rent	30.00	22.74	15.00	18.00
e	Commission Charges	0.00	0.00		0.00
	Total	100.00	102.74	55.00	108.00
	Retailer's Margin	146.05	150.00	120.00	200.00
E	Retailer Selling price/Consumer's Purchasing price	2891.59	2526.54	4500.00	2498.00

Table 3 presents a detailed breakdown of marketing costs and margins incurred by various functionaries across four distinct potato marketing channels. It captures cost components such as transportation, packaging, mandi fees, grading, and commissions at each stage—from producer to retailer. The table also highlights the selling and purchase prices at each node, net price received by the farmer, and profit margins retained by intermediaries. The data provide a comprehensive view of how costs accumulate, and margins are distributed across channels, helping identify the most efficient and equitable marketing structure.

The comparative analysis of marketing costs and margins across four distinct potato marketing channels is presented in Table 3. The results reveal significant differences in marketing costs, producer prices, and margins among intermediaries across the channels.

Producer's Net Price

The highest net price received by farmers was observed in Channel III (₹2600.00/quintal), where producers directly sold to PepsiCo processors, bypassing intermediaries. This was followed by Channel IV (₹2100.00), involving direct sales to retailers. Channel I, with the highest number of intermediaries, offered the lowest net price to farmers (₹1860.00), due to deductions such as mandi fee and intermediary commissions. These findings are consistent with those of Deep and Girdhar (2025), who observed reduced price realization with an increase in the number of market layers.

Marketing Costs

Total marketing costs incurred by producers were highest in Channel IV (₹90.00) and Channel I (₹83.60), largely due to transportation, packaging, and mandi-related expenses. In contrast, Channel III reported zero producer-level marketing costs, with Pepsico bearing the full post-harvest cost structure, indicating an integrated model favorable to growers.

Across all channels, commission agents and wholesalers bore significant costs, particularly in Channel III, where the Pepsico agent incurred ₹1225.00 in marketing costs, including processing (₹950.00) and grading (₹80.00), reflecting the value addition in this integrated chain. Similar observations were made by Sahu et al. (2024), who emphasized the role of processing firms in enhancing efficiency while absorbing marketing burdens.

Margins of Intermediaries

The highest commission agent margin was recorded in Channel III (₹350.00), while Channel I also showed a notable margin of ₹120.00. Channels II and IV excluded commission agents. Wholesaler margins peaked in Channel III (₹150.00) and Channel II (₹140.00), which reflected both handling costs and market power. Retailers earned the highest margin in Channel IV (₹200.00), likely due to the direct interface with consumers and no intermediary leakage. These patterns corroborate with the findings of Singh and Chauhan (2023), highlighting that retailers in direct channels accrue better profits due to lower upstream costs.

Consumer Price and Marketing Efficiency

The highest consumer price was found in Channel III (₹4500.00), attributed to value addition through processing. However, it also had the highest producer share in consumer rupee. Channel I, though traditional, showed high price spread with a low farmer's share, making it the least efficient in terms of marketing. Direct-to-retailer (Channel IV) proved more equitable, balancing moderate consumer price with a better producer margin. This aligns with FAO (2022) recommendations for shortening value chains to improve farmer welfare.

Several recent studies strengthen the contextual understanding of marketing efficiency and value chain dynamics in potato production systems.

306

307 **Table 4. Price spread and marketing efficiency of the potato crop**

Particulars	I	II	III	IV
Producer Price	1860.00	1780.00	2600.00	2100.00
Consumer Price	2891.59	2526.54	4500.00	2498.00
Gross Marketing Margin	1031.59	746.54	1900.00	398.00
Total Marketing Cost	647.48	456.54	1280.00	198.00
Net Market Margin	384.11	290.00	620.00	200.00
Total Gross marketing margin (%)	35.68	29.55	42.22	15.93
Marketing Cost (%)	22.39	18.07	28.44	7.93
Marketing Margin (%)	13.28	11.48	13.78	8.01
Producer's Share (%)	64.32	70.45	57.78	84.07
Marketing efficiency (Acharya's Approach)	1.80	2.38	1.37	5.28
Marketing efficiency (Shephard's Approach)	4.47	5.53	3.52	12.62
Price Spread	1031.59	746.54	1900.00	398.00
Producers share in the consumer's rupee	0.64	0.70	0.58	0.84

308

309 **Channel-wise Marketing Performance Indicators**

310 The performance of the four marketing channels was further evaluated using key indicators such as gross
 311 marketing margin, marketing costs, producer's share in consumer rupee marketing efficiency, and price spread
 312 (Table 4). These metrics provide deeper insights into the relative efficiency and equity of each channel.

313 Channel III, despite fetching the highest consumer price (₹4500.00), had the lowest producer share in the
 314 consumer rupee (57.78%). The gross marketing margin was highest in this channel (₹1900.00), primarily due to
 315 significant value addition and processing costs (₹1280.00). However, the net marketing margin (₹620.00) was
 316 also the highest, indicating a profitable but cost-intensive supply chain. Consequently, marketing efficiency was
 317 lowest in Channel III using both Acharya's approach (1.37) and Shephard's approach (3.52), highlighting
 318 inefficiencies despite higher consumer prices.

319 In contrast, Channel IV (Farmer → Retailer → Consumer) emerged as the most efficient channel, with a
 320 marketing efficiency of 5.28 (Acharya) and 12.62 (Shephard). It also showed the highest producer share
 321 (84.07%) and lowest price spread (₹398.00). This indicates a more equitable and cost-effective structure,
 322 offering both better returns to farmers and affordability to consumers.

323 Channel II demonstrated moderate performance, with a producer share of 70.45%, and marketing cost
 324 accounting for 18.07% of the consumer price. Its marketing efficiency (2.38, Acharya) was higher than
 325 Channels I and III, making it relatively more efficient despite involving a traditional intermediary.

326 Channel I showed the highest price spread after Channel III (₹1031.59) and the lowest producer share (64.32%)
 327 among traditional channels. While its net marketing margin (₹384.11) was moderate, the efficiency indicators
 328 (1.80 by Acharya; 4.47 by Shephard) placed it behind Channel II and IV, indicating that multiple intermediaries
 329 contributed to cost inflation and reduced benefit to the producer.

330 These results reaffirm that shorter and more direct marketing chains enhance efficiency, reduce consumer prices,
 331 and improve producer margins, echoing the findings of FAO (2022) and Singh and Chauhan (2023). Putri et al.
 332 (2024) applied Data Envelopment Analysis in Indonesian potato supply chains, highlighting a marked difference
 333 in efficiency between partnership and non-partnership channels. Raina et al. (2024) conducted an economic
 334 analysis in Kangra district of Himachal Pradesh and found direct-to-consumer channels to be the most efficient,
 335 with producer shares exceeding 90%. Similarly, Kyomugisha et al. (2017) in Uganda reported that formalized
 336 buyer relationships yield higher marketing efficiency, underlining the significance of structured contracts and
 337 group marketing.

338 **Factors Affecting Farmers' Choice of Marketing Channel in the Potato Crop**

339 The descriptive statistics of the variables used in the study are presented in Table 5. The average age of the
 340 sampled farmers was 48.15 years, with a standard deviation of 9.21, indicating relatively low variability (CV =
 341 19.14%). The education level, measured on a discrete scale from illiterate (0) to post-graduate (6), had a mean
 342 of 3.28, suggesting that the average respondent had an education up to matric level. However, the high
 343 coefficient of variation (57.24%) reflects substantial differences in educational attainment across the sample.

344 The average household size was 6.73 members, with moderate variability (CV = 30.01%). About 57% of the
 345 farmers were cooperative or farmer society members, indicating moderate institutional participation.

346 The farmers reported a mean marketable surplus of 718.70 quintals, but with a considerable variation (CV =
 347 55.84%), showing significant differences in production scale. Farming experience averaged 16.29 years (CV =
 348 51.77%), implying a relatively experienced farming population. The average distance to the nearest agricultural
 349 market was 7.87 km, with a wide range observed (CV = 73.29%). Nearly 47% of farmers reported having a
 350 relationship with known and trusted buyers, and 41% had access to a personal or shared vehicle for transporting
 351 produce, both variables showing high variation (CVs > 100%), indicating disparities in market access and
 352 logistics.

353 Additionally, 91% of the respondents experienced payment delays after the sale of produce, reflecting a
 354 systemic issue in the marketing system. Only 45% of farmers had access to on-farm storage facilities, and 59%
 355 received market information from formal sources such as government departments, TV, radio, or social media.
 356 In contrast, 46% relied on informal sources like relatives and friends for such information. The high coefficients
 357 of variation in these dummy variables (ranging from 82.94% to 121.45%) highlight notable disparities in
 358 farmers' access to infrastructure, institutional support, and market-related information across the study area.

359 **Table 5. Descriptive statistics of the variables used in the multinomial regression model**

Variables	Variable description/ measurement	Mean	SD	CV (per cent)
Age	Continuous variable (Age in years)	48.15	9.21	19.14
Education	Discrete variable (Education status of sampled farmers) 0-illiterate 1- middle 2-eighth 3-matric 4-higher secondary 5- graduation 6-post graduation	3.28	1.87	57.24
Household Size No.	Continuous variable (Size in numbers)	6.73	2.02	30.01
Membership with the Society	Membership with society Dummy variable yes=1, no=0	0.57	0.50	86.73
Marketable Surplus (qtls)	Continuous variable (Quantity in quintals)	718.70	401.33	55.84
Farming Experience yrs	Continuous variable (Farming experience in years)	16.29	8.43	51.77
Distance to the market (km)	Continuous variable (Distance to the agricultural market in km)	7.87	5.77	73.29
Relationship with buyers	Farmers trading with known and trusted buyers Dummy variable yes =1, no= 0	0.47	0.50	106.36
Availability of a vehicle for transport	A vehicle available for taking produce to market Dummy variable yes =1, no= 0	0.41	0.49	121.45
Payment duration	Delay in payment after the sale of potatoes Dummy variable yes =1, no= 0	0.91	0.78	86.33
A storage facility with a farmer	Storage facility for harvested produce Dummy variable yes =1, no= 0	0.45	0.50	111.12
Govt Dept. /TV/Radio	Farmers received market information through Govt.Dept/ TV/Radio/social media	0.59	0.49	82.94

	Dummy variable yes =1, no= 0			
Relatives/friends	Farmers received market information through relatives' and friends Dummy variable yes =1, no= 0	0.46	0.50	107.92

Maximum likelihood estimates

Table 6. Multinomial logistic regression estimates for factors affecting the choice of marketing channel for the potato crop

Particulars	Channel I Coefficient	P- value	Channel III Coefficient	P- value	Channel IV Coefficient	P- value
constant	-8.5543** (4.279)	0.046	-9.3415** (4.091)	0.022	17.1071 (17.178)	0.319
Age	-0.0193 (0.067)	0.772	-0.0833 (0.07)	0.232	-0.1628 (0.211)	0.439
Education	-0.3796 (.294)	0.197	-0.1884 (.306)	0.539	-0.7402 (0.765)	0.333
Household Size No.	0.2681 (.222)	0.228	-0.2585 (.263)	0.326	-1.1912* (0.723)	0.099
Membership with the Society	-0.6205 (1.1)	0.573	1.2829 (1.098)	0.243	4.5772 (2.854)	0.109
Marketable Surplus (qtls)	0.0002 (.001)	0.861	0.0055** (.002)	0.002	-0.0208** (0.01)	0.038
Farming Experience yrs	0.2737** (.098)	0.005	0.2941** (.107)	0.006	0.2225* (0.132)	0.093
Distance to the market (km)	0.4045** (0.152)	0.008	0.5356*** (.162)	0.001	-0.2191 (0.361)	0.544
Relationship with buyers	-0.9085 (1.108)	0.412	-2.8805** (1.281)	0.025	0.3817 (1.471)	0.795
Availability of a vehicle for transport	-1.4906 (1.067)	0.162	0.7463 (1.101)	0.498	-3.1555 (2.541)	0.214
Payment duration	3.8405*** (.859)	0.00	2.6829** (.874)	0.002	-0.4358 (1.243)	0.726
A storage facility with a farmer	-0.0623 (0.99)	0.95	-0.3167 (1.036)	0.76	-4.3549 (2.734)	0.111
Govt Dept. /TV/Radio	-1.4723 (1.091)	0.177	-1.9644 (1.201)	0.102	2.4973 (2.263)	0.27
Relatives/friends	0.649 (1.082)	0.549	2.0969* (1.184)	0.076	4.4216** (2.182)	0.043
N	120					
Log-Likelihood:	-52.400					
Pseudo R-squ.:	0.6556					

Note: ***, **, and * denote significance at 1, 5, and 10 per cent level, respectively. The figure in parentheses is the standard error.

The multinomial logit regression analysis revealed important insights into the determinants influencing farmers' choice of potato marketing channels in Una district, Himachal Pradesh. Taking Channel II (Producer → Wholesaler → Retailer → Consumer) as the reference category, the model evaluated the likelihood of choosing Channel I, Channel III and Channel IV.

A key finding was that farming experience significantly increased the likelihood of farmers choosing all three alternate channels. Specifically, farmers with more years of experience were more likely to engage in traditional and modern channels ($p < 0.10$), suggesting that accumulated knowledge and negotiation skills enhance their ability to access more structured or efficient marketing systems. This is consistent with findings by Magesa et al.

(2014) and Birthal et al. (2007), who emphasised that experienced farmers tend to explore diversified marketing opportunities and are more adaptive to market demands.

Distance to the market was also statistically significant and positive for Channels I ($p = 0.008$) and III ($p = 0.001$), implying that farmers farther from urban centres prefer channels that involve intermediaries or companies capable of aggregating produce and managing transportation logistics. This observation supports the argument by Barrett (2022) that distance constraints often push farmers toward market arrangements that reduce individual transaction costs. In contrast, marketable surplus exerted a positive influence on the selection of Channel III ($p = 0.002$) and a negative influence on Channel IV ($p = 0.038$). Farmers with higher surplus volumes tended to prefer formal buyers such as PepsiCo, who demand bulk and standardised quality for processing. In contrast, smallholders with lower surplus quantities were more inclined toward direct-to-retail outlets. Similar conclusions were drawn by Jaleta et al. (2009) and Wang et al. (2021), who noted that commercial output levels critically determine market outlet decisions.

The payment duration variable showed a strong positive association with both Channel I ($p < 0.001$) and Channel III ($p = 0.002$), underscoring the importance of prompt payment in shaping channel preferences. Channels that ensure timely cash flow appeal to farmers facing liquidity constraints, corroborating findings by Reardon et al. (2019) and Narayanan (2014) on the salience of payment terms in value chain participation.

Notably, the variable representing social networks specifically, advice from relatives and friends had a positive and statistically significant impact on the selection of Channel IV ($p = 0.043$), and a marginally significant impact on Channel III ($p = 0.076$). This indicates that informal information-sharing networks play a critical role in marketing decisions, as Fafchamps and Minten (2011) reported, who stressed the trust and relevance embedded in peer networks for smallholder farmers.

A somewhat unexpected finding was the negative and significant effect of farmers' relationship with buyers on the likelihood of choosing Channel III ($p = 0.025$). While vertical coordination typically builds trust and reliability in modern value chains, this result may reflect perceived power asymmetries or dissatisfaction with contract conditions in the PepsiCo-dominated supply chain, warranting further qualitative investigation. Narayanan (2014) and Michelson et al. (2012) documented similar concerns regarding contract farming arrangements.

On the other hand, variables such as education level, household size, ownership of vehicles, storage infrastructure, and access to formal information channels (such as TV, radio, or government agencies) were not statistically significant across most models. This suggests that in the present context, these factors may not have a decisive role in determining channel selection, or that their effects are mediated through other variables. While previous studies (e.g., Guleria et al., 2024; Ghosh, 2020) have shown these factors to be important in other crop or regional settings, their limited influence here may indicate institutional constraints or homogeneity among the sampled population.

The model's goodness-of-fit, with a pseudo R-squared value of 0.6556, indicates a strong explanatory power of the selected variables in capturing the variation in farmers' marketing decisions.

Table 7. Marginal effect (potato) estimates for factors affecting farmers' choice of marketing channel

Particulars	Channel A		Channel C		Channel D	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Age	0.003 (0.003)	0.334	0.0004 (0.004)	0.903	-0.0035 (0.003)	0.314
Education	0.0088 (0.012)	0.48	0.0029 (0.015)	0.845	-0.0118 (0.015)	0.437
Household Size No.	-0.0007 (0.012)	0.953	0.0414** (0.014)	0.002	-0.0407** (0.016)	0.011
Membership with the Society	-0.0769 (0.054)	0.151	-0.0227 (0.06)	0.707	0.0996* (0.059)	0.09
Marketable Surplus (qtls)	-0.0001** (0.000069)	0.043	-0.0002** (0.0000943)	0.008	0.0004*** (0.0000871)	0.00

Farming Experience yrs	-0.0108** (0.004)	0.006	0.0041 (0.004)	0.362	0.0067 (0.004)	0.127
Distance to the market (km)	-0.0334** (0.007)	0.002	0.0096* (0.005)	0.052	0.0238*** (0.005)	0.00
Relationship with buyers	0.0677 (0.051)	0.184	0.1266** (0.06)	0.035	-0.1943** (0.065)	0.003
Availability of a vehicle for transport	0.0565 (0.048)	0.24	-0.1278** (0.063)	0.041	0.0713 (0.063)	0.257
Payment duration	-0.1837*** (0.022)	0.001	0.1907*** (0.031)	0.00	-0.007 (0.035)	0.843
A storage facility with a farmer	0.0601 (0.047)	0.198	-0.0237 (0.059)	0.687	-0.0363 (0.058)	0.534
Govt Dept. /TV/Radio	0.0598 (0.051)	0.242	0.0146 (0.057)	0.797	-0.0743 (0.06)	0.212
Relatives/friends	-0.0466 (0.049)	0.345	0.0012 (0.058)	0.983	0.0453 (0.059)	0.444

Note: ***, **, and * denote significance at 1, 5, and 10 per cent level, respectively. The figure in parentheses is the standard error.

The estimated marginal effects from the multinomial logistic regression model are reported in Table 7. These effects provide insights into the change in the probability of selecting a given marketing channel associated with a unit change in each explanatory variable, holding other variables constant. Household size emerged as a significant determinant of channel choice. An additional household member increased the likelihood of selecting Channel III by 4.14%, while reducing the likelihood of selecting Channel II by 4.07%. This suggests that labour availability influences participation in marketing channels that require more operational effort or volume management. These findings are consistent with Mutenje et al. (2011), who highlighted the influence of household labour on market engagement strategies. Marketable surplus had statistically significant and contrasting effects across channels. A marginal increase in the quantity of potatoes available for sale decreased the probability of Channels I and III by 0.01% and 0.02%, respectively, while increasing the likelihood of choosing Channel IV by 0.04%. This implies that farmers with larger surpluses are more inclined to bypass traditional and intermediary channels in favour of more direct or profitable avenues, supporting Fafchamps and Hill's (2005) findings on market intensity and direct sales. Farming experience negatively affected Channel A participation, suggesting that more experienced farmers avoid traditional marketing routes, possibly due to their awareness of price inefficiencies or delays. However, experience had no significant influence on the probability of choosing Channels III and IV. Distance to the market significantly influenced channel selection. A one-kilometre increase in distance reduced the likelihood of selecting Channel I by 3.34%, while increasing Channel III by 0.96% and Channel IV by 2.38%. This reflects the logistical advantage offered by alternative marketing channels to farmers in remote locations, aligning with Jagwe et al. (2010), who reported similar spatial influences on market participation.

Relationship with buyers increased the probability of using Channel III by 12.66%. However, it decreased the likelihood of selecting Channel IV by 19.43%, indicating that established trust networks foster greater reliance on semi-formal or contract-based marketing routes. This is supported by Matuschke and Qaim (2009), who emphasised buyer trust as a key enabler of market access. Availability of a transport vehicle significantly decreased the probability of selecting Channel III by 12.78%, suggesting that farmers without personal transport might depend more on intermediaries or aggregated sales. This result mirrors Murphy et al. (2020), who found that access to transport shapes channel dependency. Payment duration had opposite effects on Channels I and

III. A longer payment delay decreased the probability of using Channel I by 18.37%, while increasing the likelihood of using Channel III by 19.07%. This indicates that while immediate payments are preferred in traditional channels, farmers may accept longer payment terms under formal arrangements with perceived price or security benefits, in line with observations by Negi et al. (2018). Other variables, including age, education, media access, and storage facilities, did not exhibit significant marginal effects across the channels, suggesting their limited role in channel selection in the current context.

Conclusion

This study evaluated the marketing performance and determinants of channel choice among potato growers in Una district, Himachal Pradesh, within the framework of the One District One Product (ODOP) initiative. The results indicate that the structure of marketing channels has substantial implications for producer price realisation, marketing costs, and overall efficiency. Channel IV was found to be the most efficient and equitable, offering the highest producer share in the consumer rupee (84.07%) and the most significant marketing efficiency according to both Acharya's and Shepherd's approaches. In contrast, Channel III, though associated with significant value addition and the highest consumer price, exhibited low producer margins and high marketing costs, underscoring the inefficiencies in processor-driven supply chains. The multinomial logistic regression analysis further revealed that marketable surplus, farming experience, distance to market, payment timing, and informal information networks significantly influenced the likelihood of choosing particular channels. Notably, timely payments and access to transportation emerged as critical determinants, reflecting the role of institutional and infrastructural constraints in channel participation.

The findings underscore the importance of promoting direct and short value chains to enhance farmer welfare and marketing efficiency. In light of these results, the following policy recommendations are proposed:

- **Promotion of Direct-to-Retailer and Farmer-Led Marketing Models:** Initiatives supporting producer-retailer linkages, FPO-run retail outlets, and farmer markets should be prioritised to ensure better price realisation and reduced intermediation.
- **Facilitation of Inclusive Contract Farming:** While contract farming with processors such as PepsiCo can offer price stability, safeguards regarding price transparency, input support, and dispute resolution are essential to encourage broader participation.
- **Improvement of Rural Market Infrastructure:** Investments in on-farm storage, primary processing units, and subsidised transport services can enable participation in higher-efficiency channels, especially for marginal and smallholder farmers.
- **Ensuring Prompt Payments:** Enforcement of standard payment timelines and promotion of digital transactions can address liquidity concerns and reduce dependency on exploitative intermediaries.
- **Enhancement of Market Information Systems:** Strengthening formal and digital channels for market intelligence dissemination can bridge the information gap and improve market participation decisions.

Policy efforts can support the development of equitable, resilient, and sustainable agricultural marketing systems by addressing these key areas. Such transformation is critical not only for achieving the goals of the ODOP initiative but also for enhancing income security and rural prosperity in India's hill regions.

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Competing Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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