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Agricultural Produce Supply Chain Network of Capsicum: Empirical Evidence from India

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Abstract: Vegetables are important for both nutritional and economic stability and contribute significantly to the agricultural landscape of India. The demand for vegetables is rising, driven by population growth and increased awareness of their benefits. This empirical study highlights the dynamics of agricultural production supply chain networks of capsicum crops in the northwestern Himalayan region, specifically Himachal Pradesh, India. The study employs the Acharya approach to analyse the various marketing channels utilized by farmers in the capsicum supply chain. This methodology sheds light on the economic nuances at each stage and examines marketing channels, costs, margins, price spread and marketing efficiency. Simultaneously, the Garrett ranking method is applied to discern and prioritize constraints faced by farmers. This comprehensive approach ensures a nuanced understanding of the economic and logistical intricacies of capsicum marketing. The analysis of marketing channels reveals five distinct pathways employed by farmers, with Channel-C (Producer–Commission Agent–Retailer–Consumer) standing out as the most dominant, representing 47.25% of the total quantity. Moreover, Channel-A (Producer–Consumer) proves to be the most cost-effective for producers and boasts the highest producer price, while Channel-C, involving commission agents, incurs higher costs. This suggests a preference for intermediaries, emphasizing factors like market access and negotiation skills, whereas Channel-D (Producer–Local Trader–Wholesaler–Retailer–Consumer) has the highest gross marketing margin, emphasizing the trade-offs between efficiency and transaction volume. The results indicate that while Channel-A is the most efficient, it is not the preferred choice due to the lower transaction quantity. Further, the absence of market consultation services, inadequate road infrastructure, high commission charges, nonremunerative prices and untimely availability of vehicles are the major constraints in marketing. The findings of the study call for targeted interventions to create a more robust and farmer-friendly marketing environment for capsicum crops in the region. The study proposes targeted recommendations, emphasizing collaborative efforts between stakeholders, government bodies and farmers. This research contributes to the academic discourse and also offers actionable insights for researchers and policymakers, fostering sustainability, profitability and equity within the capsicum supply chain.

Keywords: supply chain; marketing channel; performance; efficiency; logistics; marketing constraints

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1. Introduction

Vegetables hold a significant position in the Indian economy, yielding greater returns per unit area and time. They serve as crucial contributors to both nutritional and economic stability. The demand for vegetables is on a steady rise, driven by factors such as population growth, a heightened awareness of their nutritional benefits and a rise in per capita income. Vegetables boast higher productivity, shorter growth cycles and increased value and, consequently, they yield higher income, which positively impacts livelihoods (Rai et al. 2019). Moreover, vegetable crops promote enhanced diversification and intensification within the realm of crop cultivation. The farming of vegetables plays a vital role in poverty alleviation by generating employment, improving dietary habits and providing new opportunities for impoverished farmers. Due to the bulkiness and perishable nature of vegetable products, their sustained market demand results in the creation of high-productivity employment (Gebrehiwot et al. 2018). The increase in horticultural production and marketing plays a pivotal role in promoting the commercialization of the rural economy, resulting in the creation of numerous off-farm employment opportunities (LeRoux et al. 2010). In India, vegetables are cultivated across an expanse of 11,065 hectares, yielding a total production of 199,882 metric tonnes. West Bengal leads the nation as the largest producer of vegetables, accounting for 15.35% of the total, followed by Uttar Pradesh (14.46%), Madhya Pradesh (10.18%), Bihar (8.91%), Maharashtra (7.84%), Gujarat (6.74%), Odisha (4.55%), Karnataka (3.69%) and Himachal Pradesh (0.94%) (National Horticultural Board 2022). Capsicum, scientifically known as *Capsicum annum* L., holds significant agricultural and commercial value in India. Additionally, their nutritional richness, abundant in vital nutrients such as Vitamin C and Vitamin A, serves a medicinal purpose and antioxidants play a pivotal role in enhancing the local diet, thereby improving overall nutrition and health outcomes. Their subtle taste, pleasing aroma, diverse array of colours and nutritional benefits contribute to their worldwide popularity (Olutumise 2022; Schipmann and Qaim 2011). In India, capsicum production share is highest in West Bengal followed by Karnataka, Haryana, Jharkhand and Himachal Pradesh (APEDA 2023).

Himachal Pradesh is a state located in the heart of the northwestern Himalayan region, amidst pristine valleys and rugged terrain. It is a state famous for its picturesque landscapes and vibrant agricultural practices. The varied agroclimatic conditions of Himachal Pradesh facilitate the cultivation of a wide range of vegetables, encompassing both temperate and subtropical nature. Among the myriad crops that thrive in this region, capsicum stands as a vital component of the agrarian landscape, contributing significantly to the state's agricultural economy. In Himachal Pradesh, it is extensively grown as a cash crop in agroclimatic zones-II (mid-hills, subhumid) and -III (high hills, temperate wet) (Bala et al. 2011; Thakur et al. 2022b). Therefore, commercial cultivation of capsicum yields substantial income through domestic sales and exports to neighbouring regions. Moreover, capsicum cultivation diversifies the agricultural portfolio of the state, ensuring sustainability and offering a buffer against climate-induced uncertainties and market fluctuations. Its versatile use in various culinary traditions ensures a steady and consistent demand in both local and regional markets (Devkota and Sharma 2014; Maspaitella et al. 2018). Additionally, through processing and preservation techniques, there exists a potential for value addition, creating opportunities for agro-industries and entrepreneurial ventures. Therefore, with escalating global demand for fresh and high-quality produce, the agricultural sector plays an indispensable role in sustaining economies and nourishing populations (Manjunath and Girish 2016; Marine et al. 2016; Verano et al. 2023). The cultivation and marketing of capsicum, however, are not without their challenges. The marketing of vegetable crops presents a multifaceted challenge due to factors like the perishability of the produce and seasonal fluctuations in production. Given the perishable nature of vegetables like capsicum, a swift and well-organized supply chain in marketing becomes imperative (Bukar et al. 2015; Bhattarai et al. 2013). An efficient agricultural produce supply chain system holds great significance for economic development as it stimulates production, prevents unnecessary swings in output and prices, lowers production costs and ensures a fair

distribution of consumer prices. The supply chain network forms the lifeline of this sector, serving as the conduit through which produce traverses from the hands of the diligent farmer to the discerning consumer (Lenne and Ward 2010; Zhang et al. 2019; Thakur et al. 2021). The present research is set to address important aspects of capsicum marketing by undertaking a comprehensive exploration of the key actors involved from farmers to local traders, wholesalers, commission agents, retailers and consumers. Therefore, this empirical research attempts to highlight the dynamics of the agricultural produce supply chain network of capsicum in Himachal Pradesh, its marketing performance and the constraints hindering its seamless flow from farm to fork (Chand et al. 2020; Thakur et al. 2022a).

Simultaneously, the present research holds paramount importance in the context of the local economy and livelihoods. Himachal Pradesh is renowned for its diverse agricultural practices, with capsicum cultivation representing a significant portion of the agricultural output. Therefore, understanding the nuances of marketing performance and constraints in this specific crop's supply chain is crucial for the economic sustenance of the region. By delving into the intricacies of capsicum marketing, this research offers practical insights for farmers, intermediaries, policymakers and other stakeholders in the region, whereas the study's methodologies, findings and recommendations provide valuable contributions to the broader field of agricultural business management, supply chain management and rural development. The challenges faced in capsicum marketing in the northwestern Himalayan region are not isolated; they resonate with similar issues encountered in agricultural supply chains worldwide. Furthermore, this research fills a critical gap in the existing literature by offering a detailed case study of a specific crop within a unique geographical context. The existing literature often provides general insights into agricultural supply chains, but this study focuses on the capsicum crop in a region with unique challenges and opportunities. The methodologies employed and the insights gained can be used as a model for similar studies in diverse agricultural regions globally, promoting a better understanding of the complex dynamics between farmers, intermediaries and consumers. Further, the study's emphasis on identifying and addressing constraints in the supply chain network aligns with broader global agendas, including sustainable agriculture, food security and poverty alleviation. Moreover, the present research work contributes to the literature by offering actionable insights for researchers, policymakers and stakeholders involved in the agricultural sector, fostering sustainability, profitability and equity within the capsicum supply chain. Therefore, methodologies and strategies developed in this research can be adapted and applied in different regions, contributing to a more resilient and efficient global agricultural ecosystem (Sidhu et al. 2010; Wang et al. 2014; Krafft et al. 2015; Thakur et al. 2023b; Sakas et al. 2023).

This article is structured as follows: The review of the literature is presented in Section 2. Section 3 discusses the study area, data and methodology. Section 4 of the document contains the presentation of both the results and the discussion. Section 5 moves the emphasis to the policy implications for decision makers in developing countries, particularly in relation to agricultural supply chain management. The paper ends by concluding its findings.

2. Review of Literature

The agricultural produce supply chain is a critical component of the agricultural sector, ensuring the efficient movement of goods from producers to consumers. The review of the literature presented in this section aims to provide a comprehensive overview of relevant studies and research pertaining to marketing performance and constraints in the agricultural produce supply chain network. An effective understanding of existing marketing channels is crucial for streamlining the supply chain network. Previous research has made significant strides in this area. Thakur et al. (2023c) conducted a comprehensive study on marketing costs and price spreads of vegetable crops in India. Their research sheds light on the various channels through which produce flows, the associated costs and the economic implications for farmers, whereas Panda and Sreekumar (2012) highlight

the impact of intermediaries and the advantages of direct sales. Their study provides practical considerations for improving marketing practices in the agricultural sector. As the number of intermediaries increases, the producer's share in the consumer's price tends to decrease (Chand et al. 2020). This finding resonates with the existing literature on supply chain dynamics, where excessive intermediation can lead to reduced returns for primary producers. The study underscores the advantage of direct sales channels for producers. When producers have the ability to sell their produce directly to consumers or retailers, they tend to receive higher net returns (Mishra et al. 2014).

Furthermore, the studies by Kumar et al. (2004) and Sidhu et al. (2010) applied metrics like marketing cost, price spread and market margin to assess the market performance of vegetable crops. Their research offers a foundational understanding of the metrics used to gauge marketing performance, which can be directly applied to the context of capsicum cultivation. Acharya's approach, outlined in Acharya and Agarwal (2016), offers a valuable framework for evaluating marketing efficiency in agricultural produce. This approach has been successfully applied in studies focused on diverse Indian crops, providing a proven tool for assessing capsicum's marketing efficiency. Additionally, Thakur et al. (2023a) applied Acharya's approach to assess marketing performance in agricultural supply chains. Their study showcases the applicability and efficacy of this framework in evaluating marketing performance, providing a relevant precedent for capsicum cultivation, whereas Aliyi et al. (2021) provide a comprehensive and insightful analysis of smallholder vegetable production in Ethiopia. By addressing profitability, market performance and constraints, the study not only contributes valuable empirical evidence but also offers pertinent policy recommendations for advancing the vegetable sector and promoting rural economic growth and poverty reduction. This research used various techniques such as marketing cost, price spread and marketing efficiency to study the market performance of marketing channels. Moreover, the study conducted by Mgale and Yunxian (2020) offers critical insights into the dynamics of rice marketing among smallholder farmers in rural Tanzania. They used Acharya and Agarwal's method to evaluate marketing efficiency, which is a robust approach. This method provides a comprehensive view of the efficiency levels across different marketing channels, enabling evidence-based policy interventions (Acharya 2016). Simultaneously, Chand et al. (2020), focusing on the marketing efficiency of vegetables in Rajasthan, India, provide critical insights into the challenges faced by farmers in the vegetable supply chain. The research contributes significantly to the discourse on agricultural marketing in developing economies. The comprehensive methodology employed, involving data collection from farmers, wholesalers and retailers, ensures a well-rounded analysis of the vegetable supply chain (Thakur et al. 2023b). The researchers used the Acharya approach to study marketing efficiency. Further, research revealed that the assessment of the farmer's share in consumer expenditure is a key indicator of the distribution of benefits along the supply chain, whereas the calculation of the marketing efficiency serves as a critical metric for evaluating the effectiveness of the marketing system. Moreover, analysing market constraints is essential for identifying and prioritizing challenges within the supply chain network. The research conducted by Kumari and Chauhan (2021) employed Garrett's ranking to identify and prioritize constraints in cash crop marketing. Their work provides a methodological precedent for the analysis of marketing constraints in the capsicum supply chain in Himachal Pradesh. Further, a study conducted by Kumar et al. (2019) provides valuable insights into the constraints faced by farmers in vegetable marketing. Their research contributes to the broader discourse on agricultural development and highlights the need for targeted interventions to address the specific constraints faced by stakeholders in the vegetable supply chain.

The above-reviewed literature provides a robust foundation for the proposed study on marketing performance and constraints in the agricultural produce supply chain network of capsicum crops in the northwestern Himalayan region of Himachal Pradesh, India. The studies discussed offer valuable insights into existing marketing channels, performance

metrics and constraint analysis techniques that will be instrumental in achieving the research objectives.

3. Materials and Methods

3.1. Study Area

The study was conducted in Himachal Pradesh, India, situated in the foothills of the northwestern Himalayas. Himachal Pradesh is separated into four distinct agroclimatic zones, each characterised by varying elevations that span from below 650 to over 2200 metres above mean sea level (amsl). The study selected farm households from two distinct agroclimatic zones in the state: mid-hills subhumid, Zone-II, and high hills temperate wet, Zone-III. The decision was made based on the maximum area under the vegetable crops, according to JICA (2021). As a result, the research region was divided into two distinct strata, as shown in Figure 1.

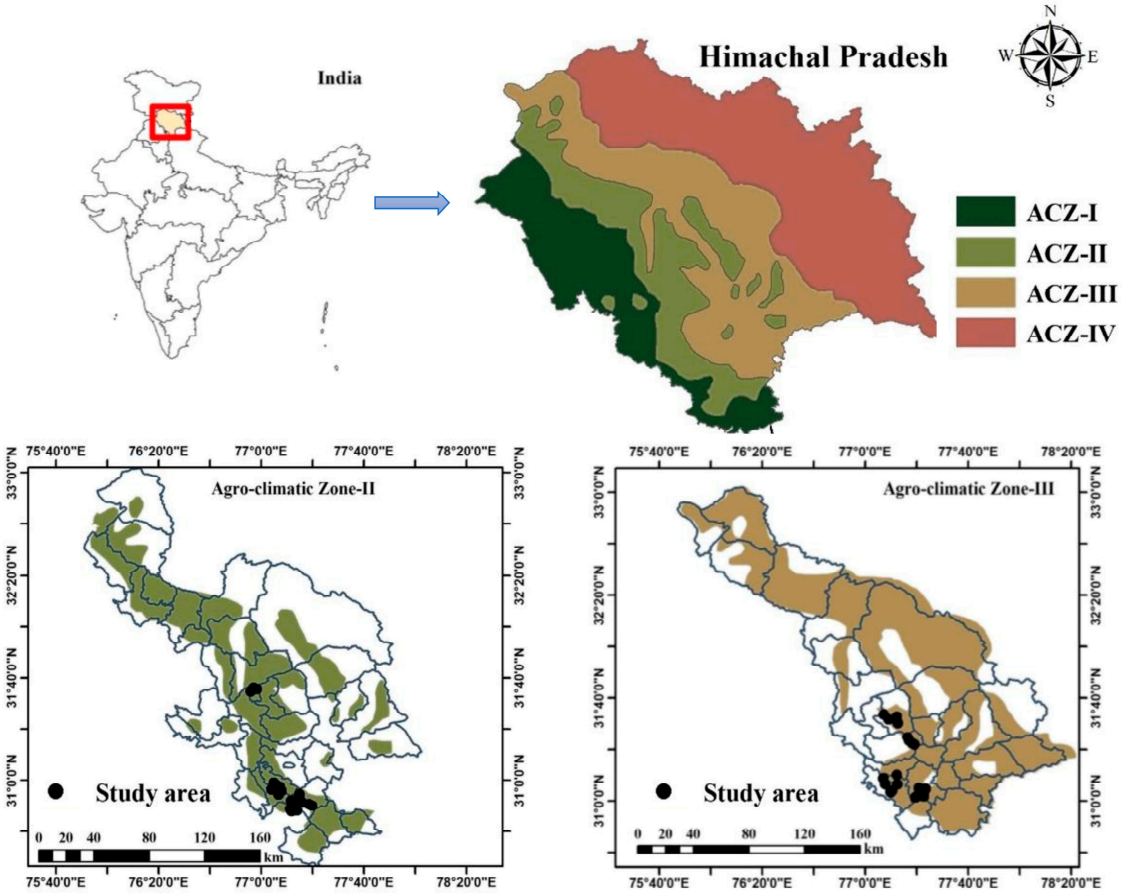

Figure 1. Location map of study area. ACZ, agroclimatic zone.

3.2. Sampling Procedure

3.2.1. Selection of Farmers

A multistage stratified random sampling approach was implemented to form a representative sample of farmers' households. In the initial stage, agroclimatic zones were categorized into blocks, with five blocks chosen based on the maximum vegetable cultivation area. Subsequently, from each selected block, four Gram Panchayats were randomly selected. The final stage involved randomly choosing ten farmers from each selected Gram Panchayat, culminating in a comprehensive sample of 400 farmers. This meticulous use of stratification and randomization was pivotal in guaranteeing the sample's fidelity to the broader target population in the study area.

3.2.2. Market Intermediaries Selected in Supply Chain Network

The determination of the sample size for market functionaries within the supply chain network was informed by insights gathered from the agricultural produce market committee office. This process led to the purposeful selection of two primary markets in each designated agroclimatic zone. Specifically, in the mid-hills subhumid Zone-II, the Solan and Mandi markets were deliberately chosen, while in the high hills temperate wet Zone-III, the Shimla and Theog markets were purposively selected.

To comprehensively explore various dimensions of capsicum output marketing, a total sample size of 80 traders was established. This was achieved by randomly selecting 5 local traders, 5 commission agents, 5 wholesalers and 5 retailers from each market within every agroclimatic zone. This meticulous approach ensures a representative and diverse sampling of market functionaries, contributing to a robust understanding of capsicum marketing dynamics across different regions.

3.2.3. Data Source and Collection

In the present research, a comprehensive dataset was meticulously assembled from both primary and secondary sources. Primary data were procured through the use of self-structured questionnaires, administered via interviews with both capsicum farmers and diverse stakeholders in the supply chain network. The questionnaires were specifically designed to extract detailed insights into the production and marketing activities of capsicum farmers. Moreover, information on marketing costs, market margins and market efficiency was systematically gathered to assess the overall performance of capsicum marketing channels. Additionally, relevant details were gathered to investigate the various challenges encountered by farmers within the capsicum supply chain network.

Simultaneously, secondary data pertinent to the study were sourced from a variety of reputable forms, including books, journals, university reports and publications from government departments such as horticulture, agriculture and the directorate of statistics and land records.

3.3. Analytical Framework for Marketing Performance in Supply Chain Network

In the subsequent section detailing the analytical framework for marketing performance in the supply chain network, the assessment focuses on analysing costs and margins associated with marketing agents operating through diverse channels. An established methodology for evaluating performance involves examining key measures such as marketing costs, market margins, price spreads and the overall market efficiency within the supply chain network (Acharya and Agarwal 2016; Thakur et al. 2023a; Gori and Kharkwal 2016).

3.3.1. Marketing Cost

Expanding on the analysis of marketing costs, the calculation method involved consolidating the expenditures borne by each marketing functionary engaged in the capsicum produce supply chain. These costs exhibited variation contingent upon factors such as the nature of specific marketing activities, the types of marketing institutions in play and the geographic location of marketing. Prominent components within the spectrum of intermediary marketing costs included outlays associated with packaging materials, fees for loading and unloading, transportation costs, commission charges and taxes (Chand et al. 2020; Mishra et al. 2014; Hailegiorgis and Hagos 2016).

The computation involved determining the total cost of marketing activities in the following way:

$$TC_m = C_g + \sum_{i=1} MC_i, \quad (1)$$

where

TC_m = The overall cost linked with the marketing of capsicum produce.

C_g = The expenses borne by the farmer in the marketing of capsicum produce.

MC_i = The marketing costs incurred by the ith middleman.

3.3.2. Marketing Margin

The analysis of marketing margins involves comparing prices at different levels within the supply chain network concurrently. It evaluates the proportion of the final selling price captured by a specific agent in the supply chain and is expressed as a percentage of the final price or the amount paid by the end consumer (Ghorbani 2008). Consequently, in this study, marketing margins were employed as a crucial indicator to assess the market performance of the supply chain network (Devkota and Sharma 2014). The marketing margin represents the difference between the price paid to the initial seller, often referred to as the farm-gate price, and the price paid by the ultimate buyer, commonly known as the retail price (Thakur et al. 2023c).

In this research study, marketing margins were computed by establishing the absolute margin. This process involves subtracting the cost price (comprising the purchase price and marketing cost) from the selling price of capsicum by a market agent. Various factors, such as the length of the supply chain, the number of economic activities during marketing and the profit expectations of each marketing agency, influence the magnitude of marketing margins in different marketing channels for capsicum. To determine the percentage of marketing margins for each intermediary involved in the supply chain of capsicum produce, the formula provided by Acharya and Agarwal (2016) was employed.

$$A_{mi} = P_{Ri} - (P_{pi} + C_{mi}), \quad (2)$$

where

A_{mi} = Middlemen's absolute margin.
P_{Ri} = Total value per unit (selling price).
Pp_i = Price per unit of goods purchased.
C_{mi} = Per unit cost associated with marketing.

$$TGMM = \frac{\text{Consumers' Price} - \text{Producers' Price}}{\text{Consumers' Price}} \times 100 \quad (3)$$

Here, TGMM represents the total gross marketing margin. Additionally, it is worthwhile to take into account the concept of the producer's gross margin (GMMP), which signifies the percentage of the consumer price received by the producer. The calculation for the producer's margin is outlined as follows:

$$GMM_p = \frac{\text{Consumers' Price} - \text{Gross marketing margin}}{\text{Consumers' Price}} \times 100, \quad (4)$$

where GMMp = The portion of the consumer price received by the producer.

The net marketing margin (NMM) pertains to the share of the final price that intermediaries receive as their net income, considering the subtraction of their marketing costs.

$$NMM = \frac{\text{Gross margin} - \text{Marketing Cost}}{\text{Consumers' Price}} \times 100 \quad (5)$$

The percentage of net income considered as pure profit, representing the return on capital, fluctuates based on factors like the intermediaries' individual costs, which encompass working capital. The equation demonstrates that an elevated marketing margin diminishes the producers' share, while a reduced marketing margin augments their share. This equation further provides an understanding of the distribution of welfare among production and marketing entities. A higher net marketing margin (NMM) or profit for marketing intermediaries signals a reduction in inequitable income distribution. Such circumstances may discourage market participation for smallholders.

3.3.3. Price Spread

Price spread denotes the difference between the price paid by the consumer and the price received by the producer. The computation of the price spread was executed utilizing the formula advocated by Acharya (2016).

$$PS = \frac{PF}{PC} \times 100, \quad (6)$$

where

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

PF = Price of produce received by farmer and PC = Price of produce paid by consumer.

3.3.4. Marketing Efficiency

Marketing efficiency centres on the effective movement of goods from producers to consumers, striving to attain the most cost-effective method while delivering desired services to consumers. The evaluation of marketing efficiency in various channels in the study area was conducted using Acharya's approach, as recommended by Acharya and Agarwal (2016).

$$\text{Marketing Efficiency} = \frac{FP}{MC + MM} - 1, \quad (7)$$

where

FP = Price received by the farmer.

MC = Total marketing cost.

MM = Net market margins.

3.4. Analytical Framework for Marketing Constraints in Supply Chain Network

To explore the marketing constraints encountered by capsicum growers in the supply chain network, researchers employed Garrett's ranking method (Kumari and Chauhan 2021; Kumar et al. 2019; Thakur et al. 2023a). This method provides a notable advantage compared to a simple frequency distribution, as it enables constraints to be ranked according to their perceived severity from the farmers' perspective. Farmers were tasked with assigning a rank to each category of constraints presented to them through this methodology. The percentage position for each rank was subsequently calculated using the following formula:

$$\text{Percent Position} = \frac{(R_{ij} - 0.5)}{N_j}, \quad (8)$$

where:

R_{ij} = Rank given to ith position by the jth individual.

N_j = Numbers of problems ranked by jth individual.

The percentile rankings were converted into scores utilizing the reference table outlined by Garrett and Woodworth (1969). Subsequently, the scores provided by each respondent were combined and divided by the total number of respondents who provided scores. These resultant average scores for each factor were then arranged in descending order, streamlining the discernment of the most influential factors by assigning ranks. Factors demonstrating the highest mean value scores were acknowledged as the most significant constraints encountered by farmers in the study area (Thakur et al. 2023c; Kenjit et al. 2021; Thakur et al. 2017).

4. Result and Discussion

4.1. Capsicum Production Share Status in India

Figure 2 provides a clear representation of the share percentages of capsicum production in various states in India, offering insights into the relative contributions of each state to the overall production. West Bengal leads with a substantial share of 29.61%, signifying a prominent role in the capsicum cultivation landscape. Karnataka, Haryana and Jharkhand

closely follow, contributing 10.54%, 10.49% and 10.10%, respectively. Himachal Pradesh, with an 8.68% share, further emphasizes the significant cultivation of capsicum in the northern regions. It is observed that Himachal Pradesh is on top among all hill states of India. Madhya Pradesh, Punjab and Maharashtra contribute 6.16%, 5.06% and 4.76%, respectively, reflecting the diverse regional distribution of capsicum cultivation. Jammu and Kashmir, Uttarakhand and Andhra Pradesh contribute moderately, with shares of 3.69%, 2.94% and 1.46%, respectively, whereas the states, including Orissa, Chhattisgarh, Tamil Nadu, Meghalaya, Assam, Mizoram, Telangana, Tripura, Arunachal Pradesh, Manipur and Nagaland, collectively contribute around 5.96%, each having relatively smaller individual shares. Further, Telangana, Tripura, Arunachal Pradesh, Manipur and Nagaland make minimal contributions, each having shares below 0.2% (APEDA 2023). This distribution of capsicum production shares provides valuable information for agricultural planning, market strategies and policy decisions. It highlights the regional specialization in capsicum cultivation, with certain states playing a more dominant role in production, while others make more modest contributions. The data aid in understanding the geographical diversity of capsicum cultivation in India, enabling stakeholders to make informed decisions related to market dynamics, resource allocation and potential areas for agricultural development.

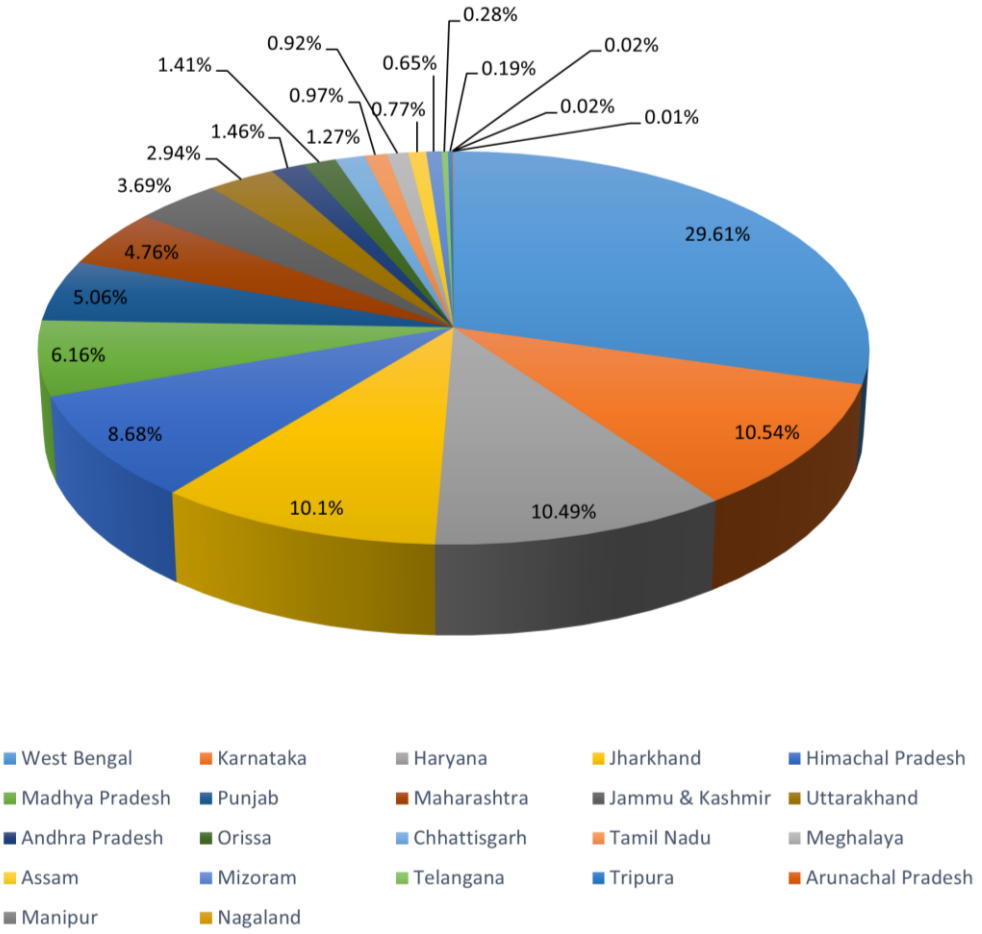

Figure 2. Capsicum production share status in India (Adopted from APEDA 2023, Agri Exchange).

4.2. Agricultural Produce Supply Chain Network of Capsicum

The detailed analysis of the capsicum agricultural produce marketing channels provides valuable insights into the dynamics of the supply chain network in the study area. Figure 3 revealed that there were five agricultural produce marketing channels used by farmers for the marketing of capsicum crops. The figure also presents the supply chain network along with the percentage share of the total quantity of each marketing channel. The total quantity of agricultural produce was high, 47.25%, in the Producer–Commission Agent–Retailer–Consumer channel (Channel-C). Channel-C stands out with the highest percentage, signifying its dominance in the marketing of capsicum crops. The involvement of a commission agent between the producer and retailer suggests that many farmers find value in using intermediaries to facilitate transactions. This could be attributed to factors such as market access, negotiation skills and efficiency in reaching end consumers. Further, 21.5% of trade uses the Producer–Local Trader–Wholesaler–Retailer–Consumer channel (Channel-D) involves multiple intermediaries, including local traders and wholesalers, before reaching the end consumer. The percentage suggests that a considerable portion of capsicum output follows this complex marketing route. Similar to Channel-D, the Producer–Wholesaler–Retailer–Consumer channel (Channel-E) incorporates a wholesaler in the marketing process. The percentage of use, 19%, indicates a substantial but slightly lower use of this channel compared to Channel-D. Moreover, in Producer–Retailer–Consumer (Channel-B), used for 8.50% of trade, the producer sells the capsicum to a retailer, who then sells it to the end consumer. The moderate percentage indicates that some farmers prefer to involve retailers in the marketing process, whereas Producer–Consumer (Channel-A), used for 2.75%, represents a direct transaction between the producer and the end consumer. The low percentage suggests that a small proportion of capsicum produce is sold directly from the producer to the consumer without intermediaries. In this way, it is observed that the high percentage in Channel-C indicates that it is the most prominent and widely used marketing channel in the study area. The fact that the maximum capsicum output is transacted through this channel emphasizes its significance. The observed preference for intermediaries in the supply chain suggests that farmers value the roles played by commission agents in enhancing market reach and transaction efficiency. These findings are consistent with the previous studies conducted by Chand et al. (2020) and Thakur et al. (2023b) who emphasize that commission agents may play a crucial role in assisting farmers by identifying potential buyers for their crops, negotiating prices and managing the logistical aspects of transporting the produce to the market. Nevertheless, each marketing channel comes with its own set of advantages and disadvantages. Farmers may opt for different channels depending on variables such as crop quality, market demand, transportation expenses and competition from fellow farmers. Therefore, it is imperative for farmers to carefully evaluate all available options and select the marketing channel that aligns with their specific needs and maximizes their overall profits. These insights contribute to a better understanding of the complex decision-making processes of farmers in the region and provide a foundation for future interventions and policy recommendations to enhance the efficiency and sustainability of the capsicum supply chain.

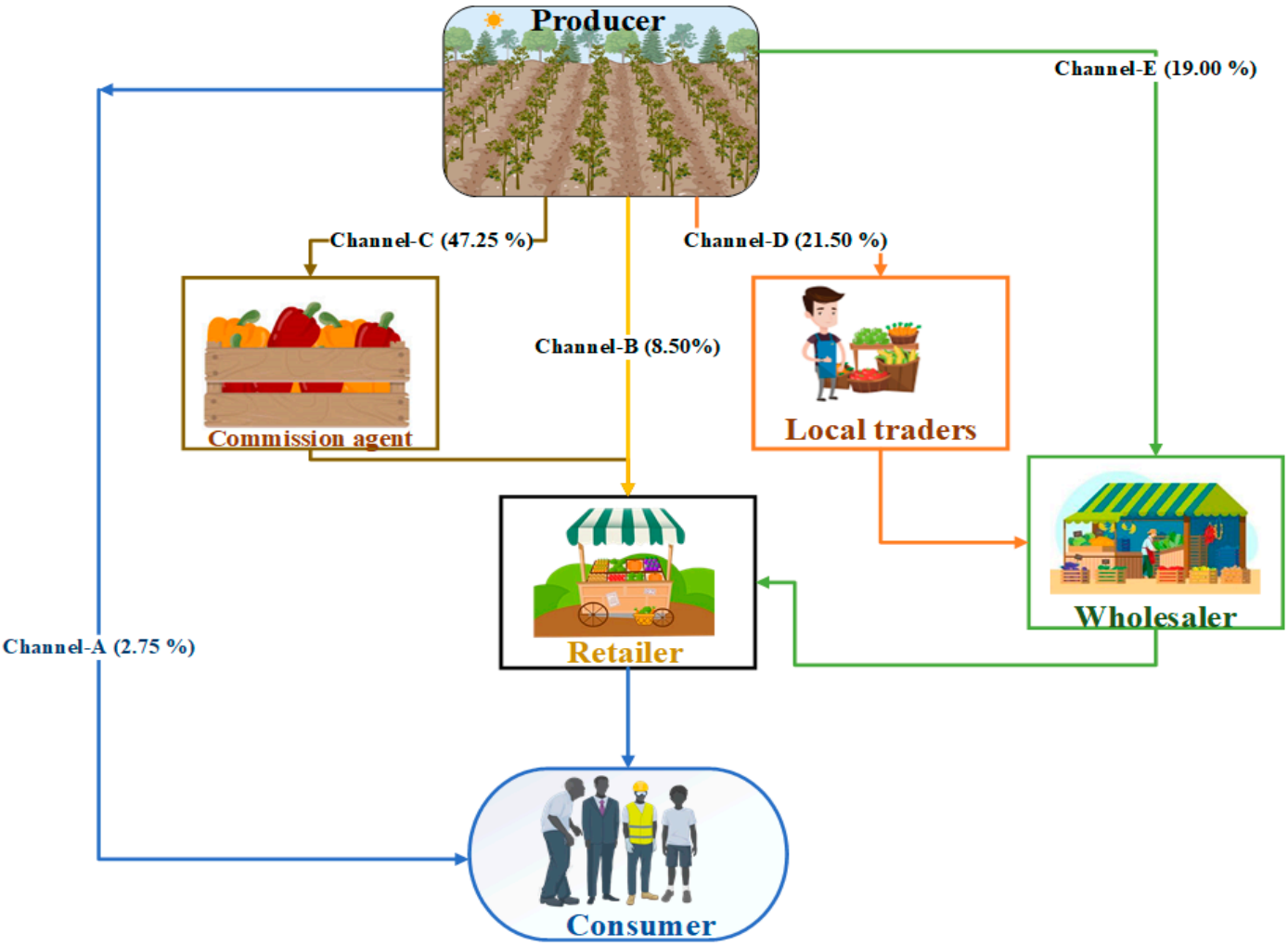

Figure 3. Agricultural produce supply chain network of capsicum crop.

4.3. Marketing Costs and Margins of Various Functionaries in the Different Marketing Channels of Supply Chain Network

The data presented in Table 1 outlining the marketing costs and margins in the capsicum supply chain network offer a comprehensive view of the financial dynamics across various marketing channels. The data reveal a notable variation in the total marketing costs incurred by producers across different marketing channels. These costs are expressed in rupees (INR) per quintal of capsicum. These costs consist of commission charges, transportation costs, packaging material costs, loading/unloading costs and Mandi tax. In Channel-A, where the produce is directly sold to the consumer, the total marketing cost amounts to INR 61 per quintal. Channel-B, involving sales to retailers, incurs a slightly higher cost at INR 70 per quintal. Channel-C, where producers sell to commission agents, stands out with a significantly higher marketing cost of INR 112.50 per quintal. Channel-D, where the farm output is sold to local traders, incurs a marketing cost of INR 85 per quintal, while in Channel-E, where produce is sold to wholesalers, the cost amounts to INR 90 per quintal. The observed variation in marketing costs across channels underscores the intricate nature of the capsicum supply chain. Channel-A, involving direct consumer sales, appears more cost-effective for producers, presumably due to fewer intermediaries. Channel-C, where commission agents play a significant role, demonstrates a higher cost burden on producers. This may be attributed to the intermediary's services and the associated expenses incurred in facilitating transactions. Channel-D and Channel-E, involving local traders and wholesalers, respectively, fall in between on the cost spectrum. Understanding these cost dynamics is crucial for informed decision making, enabling producers to assess

the trade-offs between market access and the associated expenses, ultimately influencing their profitability.

Table 1. Marketing costs and margins of various functionaries in the different marketing channels of supply chain network.

Sr. No.	Particulars	Agricultural Produce Marketing Channels of Capsicum Crop in Supply Chain Network (INR/Qtl.)				
I.	Cost associated with marketing borne by producers	A	B	C	D	E
A	Net price received by producer	3384.25	3333.00	3217.85	3150.25	3220.95
1	Costs associated with transportation	13.50	22.50	65.00	37.50	42.50
2	Costs associated with packing material	35.00	35.00	35.00	35.00	35.00
3	Costs associated with loading/unloading	12.50	12.50	12.50	12.50	12.50
4	Commission charge	-	-	-	-	-
5	Mandi tax	-	-	-	-	-
	Total	61.00	70.00	112.50	85.00	90.00
B	Farmer's selling price	3445.25	3403.00	3330.35	3235.25	3310.95
II.	Cost associated with marketing borne by local trader					
A	Gross price paid by local trader	-	-	-	3235.25	-
1	Costs associated with loading/unloading	-	-	-	14.25	-
2	Costs associated with transportation	-	-	-	37.50	-
3	Mandi tax	-	-	-	64.71	-
4	Commission charge	-	-	-	194.12	-
	Total	-	-	-	310.57	-
B	Local trader margin	-	-	-	137.50	-
C	Wholesaler purchase price	-	-	-	3683.32	-
III.	Cost associated with marketing borne by commission agent					
A	Gross price paid by commission agent	-	-	3385.7	-	-
1	Costs associated with loading/unloading	-	-	15	-	-
2	Costs associated with transportation	-	-	0	-	-
3	Mandi tax	-	-	67.71	-	-
4	Commission charge	-	-	203.14	-	-
	Total	-	-	285.86	-	-

Table 1. *Cont.*

Sr. No.	Particulars	Agricultural Produce Marketing Channels of Capsicum Crop in Supply Chain Network (INR/Qtl.)				
B	Commission agent margin	-	-	142.5	-	-
C	Commission agent selling price	-	-	3814.056	-	-
IV.	Cost associated with marketing borne by wholesaler					
A	Gross price paid by wholesaler	-	-	-	3683.32	3310.95
1	Costs associated with loading/unloading	-	-	-	16.00	16.00
2	Costs associated with transportation	-	-	-	52.50	52.50
3	Mandi tax	-	-	-	73.67	66.22
4	Commission charge	-	-	-	221.00	198.66
	Total	-	-	-	363.17	333.38
B	Wholesaler margin	-	-	-	173.25	157.50
C	Wholesaler selling price	-	-	-	4219.74	3801.83
V.	Cost associated with marketing borne by retailer					
A	Gross price paid by retailer	-	3403.00	3748.23	4219.74	3801.83
1	Costs associated with loading/unloading	-	17.38	17.38	17.38	17.38
2	Costs associated with transportation	-	56.75	56.75	56.75	56.75
3	Mandi tax	-	68.06	74.96	84.39	76.04
4	Commission charge	-	204.18	224.89	253.18	228.11
	Total	-	346.37	373.99	411.71	378.28
B	Retailer margin	-	145.25	168.75	182.75	168.75
C	Retailer selling price	-	3894.62	4290.97	4814.19	4348.85
VI.	Consumer purchase price	3445.25	3894.62	4290.97	4814.19	4348.85

In the study area, retailers play a significant role in four distinct marketing channels, namely Channel-B, Channel-C, Channel-D and Channel-E. The observed participation of retailers in multiple marketing channels underscores their pivotal role in connecting producers with end consumers. Channel-B, involving sales directly to retailers, incurs a total cost of INR 346.37 per quintal. Channel-C, where retailers operate within the framework of commission agents, shows a slightly higher total cost at INR 373.99 per quintal. In Channel-D and Channel-E, where retailers interact with local traders and wholesalers, respectively, the total costs are INR. 411.71 and INR. 378.28 per quintal. These costs provide a detailed understanding of the financial aspects involved in each channel. The variation in costs across channels indicates the diverse challenges and expenses retailers face depending on the specific marketing context. These costs are crucial considerations for retailers in assessing the viability of different channels and making informed decisions. Furthermore, retailers in the study area exhibit varying margins across different marketing channels. In Channel-B, the retailer margin is INR. 145.25 per quintal, while in Channel-C and Channel-E, it stands at INR. 168.75 per quintal for each. Notably, Channel-D presents the highest retailer margin among all functionaries, amounting to INR 182.75 per quintal. The observed differences in retailer margins highlight the economic considerations and profit potential for retailers in each marketing channel. Channel-D, where retailers engage

with local traders, offers the highest margin, indicating potentially favourable returns. This suggests that despite the potentially higher costs associated with this channel, the profit margin for retailers is also maximized. These results indicate that retailers have a greater degree of market influence and the ability to extract more value from the transaction. It is essential to acknowledge that the elevated retailer margin might also signify increased expenses borne by the retailer, encompassing commission charges, transportation and handling costs. Further, retailers occupy the final touchpoint between agricultural produce and consumers, granting them more negotiating leverage and enabling them to command higher prices for the produce. Moreover, retailers frequently enhance the product's value by offering services such as product display, marketing and customer service (Chand et al. 2020; Thakur et al. 2023c; Aliyi et al. 2021). In Channel-C, the commission agent emerges as a crucial market functionary. The commission agent incurs marketing costs encompassing commission charges, loading/unloading expenses and Mandi tax. The detailed breakdown reveals that the total marketing cost associated with the commission agent in Channel-C is INR 285.86 per quintal. However, the margin retained by the commission agent is INR 142.5 per quintal. This may be due to the fact that the role of the commission agent extends to assisting buyers in locating the desired goods and aiding sellers in connecting with potential buyers for their agricultural produce. Additionally, the commission agent contributes to the efficient functioning of the market by facilitating transactions and delivering crucial market information to both buyers and sellers.

Further, the data in Table 1 clearly indicate that local traders exclusively participate in one output marketing channel, specifically Channel-D. This shows the distinct role within the capsicum supply chain, acting as intermediaries between producers and wholesalers. The cumulative marketing cost incurred by the local trader in Channel-D amounts to INR 310.57 per quintal. This delineation of costs provides a detailed understanding of the financial considerations involved in this specific marketing channel. The absence of local traders dealing directly with consumers in the present study highlights a streamlined supply chain structure. Instead, local traders focus on facilitating transactions between producers and wholesalers, potentially contributing to efficiency and cost-effectiveness within the marketing process. This specific role may be influenced by factors such as market dynamics, geographical considerations and the preferences of local traders. Moreover, the examination of Table 1 reveals the significant role played by wholesalers as essential market functionaries, operating in marketing Channel-D and Channel-E. In both Channel-D and Channel-E, wholesalers incur marketing costs amounting to INR 363.17 and INR 333.38 per quintal, respectively. Notably, within these costs, critical components include commission charges, Mandi tax and transportation expenses. Channel-D involves wholesalers obtaining produce through local traders, while in Channel-E, wholesalers directly receive produce from farmers. In both channels, the ultimate destination of the produce is the retailer. These results show the significance of wholesalers as key intermediaries in these specific marketing channels. Similar findings were observed by Mgale and Yunxian (2020) who revealed that understanding the dynamics of each channel allows stakeholders to assess the efficiency and transparency of the supply chain. This information is valuable for policymakers aiming to enhance the overall functionality of the capsicum marketing network.

4.4. Price Spread and Marketing Efficiency of Capsicum Crop in Supply Chain Network

The perusal of data in Table 2 illustrates the variability in the prices received by producers for capsicum crops across different output marketing channels. The producer's price ranged from INR 3150.25 in Channel-D, followed by Channel-C (INR 3217.85), Channel-E (INR 3220.95), Channel-B (INR 3333) and the highest being INR 3384.25 in Channel-A among the various channels. The total gross marketing margin exhibited the highest percentage in Channel-D (34.56%), followed by Channel-E (25.94%), Channel-C (25.01%), Channel-B (14.42%) and the least in Channel-A (1.77%). Furthermore, the percentage share of the producer in the consumer's rupee was the highest in Channel-A (98.23%), where the producer assumed the role of a retailer in direct sales to consumers. This was followed

by Channel-B (85.58%), Channel-C (74.99%), Channel-E (74.06%) and the lowest at 65.4% in Channel-D. Marketing margins varied, with Channel-A exhibiting 0.00%, followed by Channel-B (3.73%), Channel-C (7.17%), Channel-E (9.57%) and 13.85% in Channel-D. Meanwhile, marketing costs ranged from 1.77% in Channel-A to Channel-B (10.69%), Channel-C (17.84%), Channel-E (18.43%) and the highest at 24.31% in Channel-D. The observed variability in producer prices across channels highlights the influence of different marketing strategies on the compensation received by producers. The result suggests that Channel-A, involving direct sales to consumers, offers the highest producer price. The gross marketing margin serves as an indicator of the efficiency of the supply chain. Channels with higher margins, such as Channel-D, suggest potentially more efficient and profitable operations. Channel-A, with the lowest margin, implies a more direct transaction with minimal intermediaries. The percentage share of the producer in the consumer's rupee provides insights into the equitable distribution of revenue along the supply chain. Channel-A, where producers act as retailers, ensures the highest share for the producer, emphasizing the importance of considering direct-to-consumer sales. The variation in marketing margins across channels indicates the impact of different supply chain structures on intermediary profits. Channel-D, despite having the highest marketing margin, also incurs the highest marketing cost. These findings reinforce those of Panda and Sreekumar (2012), which emphasize the need for a balanced assessment of efficiency and cost considerations within the supply chain.

Table 2. Price spread and marketing efficiency of capsicum crop in supply chain network.

Particulars	**Agricultural Produce Marketing Channels of Capsicum**				
Price Spread	**A**	**B**	**C**	**D**	**E**
Producer price (INR/quintal)	3384.25	3333.00	3217.85	3150.25	3220.95
Consumer's price (INR/quintal)	3445.25	3894.62	4290.97	4814.19	4348.85
Gross marketing margin (GMM) (INR/quintal)	61.00	561.62	1073.12	1663.94	1127.90
Net marketing cost (INR/quintal)	61.00	416.37	765.42	1170.44	801.65
Net market margin (INR/quintal)	0.00	145.25	307.7	666.57	416.25
Total gross marketing margin (%)	1.77	14.42	25.01	34.56	25.94
Marketing cost (%)	1.77	10.69	17.84	24.31	18.43
Marketing margin (%)	0.00	3.73	7.17	13.85	9.57
Producer's shares (%)	98.23	85.58	74.99	65.44	74.06
Marketing Efficiency	A	B	C	D	E
Net marketing cost (INR/quintal)	61.00	416.37	765.42	1170.44	801.65
Consumer's price (INR/quintal)	3445.25	3894.62	4290.97	4814.19	4348.85
Net marketing margin (INR/quintal)	0.00	145.25	307.70	666.57	416.25
Marketing efficiency	55.48	5.93	3.00	1.62	2.57

Further, Table 2 reveals varying levels of efficiency in the different output marketing channels for capsicum. Channel-A stands out as the most efficient with a percentage efficiency of 55.48%, followed by Channel-B (5.93%), Channel-C (3%), Channel-E (2.57%) and Channel-D (1.62%). Despite its high efficiency, Channel-A is not the preferred choice, likely due to the lower quantity of produce sold compared to other channels. Notably, Channel-B emerges as the most efficient among the remaining four channels, attributed to the consumer paying the least (INR 3894.62) and farmers receiving the maximum prices (INR 3333). The efficiency rankings highlight the comparative performance of each channel in the capsicum supply chain. High efficiency in Channel-A suggests optimal utilization of resources, although the lower quantity of transactions may impact its overall preference.

Moreover, the most efficient channel is not the preferred choice, underscoring the trade-off between efficiency and transaction volume. Stakeholders may prioritize channels that ensure a higher quantity of transactions, even if efficiency is slightly compromised, whereas Channel-B's efficiency is attributed to a balance in pricing dynamics, with consumers paying the least and farmers receiving the maximum prices. This equilibrium contributes to the channel's overall efficiency and attractiveness. The inverse relationship between consumer and farmer prices in Channel-B highlights a key consideration for stakeholders. Achieving a fair balance in pricing structures is crucial for optimizing efficiency while ensuring favourable returns for farmers and affordability for consumers. These findings agree with the earlier research of Mishra et al. (2014) and Thakur et al. (2023a) who argued that various factors, including the number of intermediaries, transaction quantities and pricing strategies, contribute to the efficiency of each channel. Understanding these factors enables stakeholders to make informed decisions in selecting and optimizing their preferred marketing channels.

4.5. Marketing Constraints Faced by Farmers in Agricultural Produce Supply Chain Network Channels of Capsicum Crop

The analysis presented in Table 3 highlights the significant marketing constraints faced by farmers in the agricultural produce supply chain network channels of capsicum crops. The most prominent constraint, identified by farmers with an average Garrett per cent score of 62.94, is the absence of market consultation services, ranking first in the hierarchy of constraints. Lack of access to up-to-date information on market trends, pricing and consumer preferences can result in inefficient marketing strategies and reduced profits for farmers. However, the utilization of market consultancy services offers farmers valuable insights into market conditions, encompassing dynamics of supply and demand, trends and price fluctuations. Such information enables farmers to make well-informed decisions regarding the timing and locations for selling their crops, as well as effective packaging and promotional strategies to appeal to consumers. Furthermore, market consultancy services provide guidance to farmers on aspects like quality control and standards compliance, essential factors in ensuring that their crops align with the expectations of buyers and consumers. This underscores a crucial gap in the support system available to farmers, indicating a need for accessible and tailored advisory services to enhance their marketing strategies (Thakur et al. 2023a). The second-ranked constraint, inadequate all-weather roads (60.98), highlights the vital link between road infrastructure and successful market access. The correlation between road accessibility and the reach of produce is evident, as insufficient road facilities contribute to post-harvest losses and marketing inefficiencies. This places an imperative on governments to invest in and improve road infrastructure, ensuring timely and efficient transportation of agricultural produce to markets. Further, the high commission charges (56.45), ranked third, pose a significant burden on farmers in the capsicum supply chain. Therefore, related stakeholders should consider measures to regulate and potentially reduce these charges to ease the financial strain on producers, contributing to a more economically viable agricultural marketing system. Moreover, non-remunerative prices for the produce (58.45), ranked fourth, highlight a pervasive issue that directly affects the income of farmers. Therefore, it is suggested that policymakers and market regulators should explore mechanisms to ensure fair and remunerative pricing for agricultural produce, creating a more sustainable and equitable market environment for farmers. The fifth-ranked constraint, the unavailability of vehicles in a timely manner (59.25), points to logistical challenges that hinder the efficient transportation of capsicum crops. These findings highlight the constraints faced by farmers in ensuring the timely transportation of their crops to the market, resulting in potential quality and value reduction for their capsicum produce. Moreover, delays in transportation are attributed to several factors, encompassing insufficient road infrastructure, adverse weather conditions and a scarcity of available vehicles. Additionally, farmers encounter difficulties in coordinating with transportation providers and negotiating equitable prices for their transportation services

in certain instances. These results are in line with those of (Kumari and Chauhan 2021; Kumar et al. 2019; Kenjit et al. 2021) who emphasize the need for improved transportation infrastructure and better coordination in the supply chain to mitigate delays and losses associated with untimely transport. Thus, addressing these identified constraints requires a multifaceted approach. The governments should prioritize investments in road infrastructure to facilitate better market access, while market advisory services should be promoted to far-flung areas to empower farmers with relevant knowledge. Additionally, efforts to regulate commission charges, ensure fair pricing and improve logistics coordination will collectively contribute to a more resilient and farmer-friendly agricultural supply chain for capsicum crops.

Table 3. Marketing constraints faced by farmers in agricultural produce supply chain network channels of capsicum crop.

Particulars	Average Percent Score	Rank
Absence of market consultation service	62.94	I
Inadequate all-weather road	60.98	II
High commission charges	60.50	III
Nonremunerative price for the produce	58.45	IV
Vehicle unavailability on time	58.39	V
Delay in payment	55.39	VI
Unfair practices by intermediaries	52.49	VII
Distant market	52.16	VIII
Insufficient storage facility	47.61	XI
Insufficient technical expertise	46.66	X
Price instability	42.82	XI
Insufficient market information	41.21	XII
High transportation cost	39.63	XIII
Inaccurate weighing instruments	39.00	XIV
Inadequate packing material	30.70	XV

5. Policy Implications

The empirical evidence on the marketing performance and constraints in the agricultural produce supply chain network of capsicum crops in India provides crucial insights for policymakers and industry stakeholders. To enhance the efficiency and effectiveness of the capsicum supply chain, policymakers may consider implementing targeted interventions. Firstly, there is a need to encourage, prioritize and incentivize direct-to-consumer initiatives, leveraging the efficiency observed in channels where producers sell directly to consumers. This could involve providing financial incentives and creating a supportive regulatory environment for farmers engaging in direct sales, thereby enhancing their income and reducing dependence on intermediaries. Moreover, there is a need to emphasize the importance of balancing efficiency with transaction volume. While efficient channels like Channel-A may have lower transaction quantities, policymakers can design interventions that strike a balance, ensuring that both efficiency and transaction volumes are optimized for a sustainable and effective supply chain. Additionally, streamlining the involvement of local traders, addressing constraints in their role and promoting transparency in transactions can contribute to a more robust supply chain. Encouraging the adoption of digital technologies for transparent transactions and real-time information sharing could play a pivotal role in achieving this objective. Moreover, policymakers should explore strategies to integrate wholesalers more seamlessly into the supply chain, fostering direct relationships with farmers and mitigating constraints in the current distribution networks. The

establishment of fair pricing guidelines is crucial for achieving a delicate balance between consumer affordability and equitable returns for farmers. Policymakers can collaborate with industry stakeholders to set standards for pricing mechanisms that prioritize fairness and sustainability. Furthermore, targeted policy support for efficient channels, such as those where producers act as retailers, can drive the adoption of best practices and promote their widespread use. However, technology adoption should be a focal point, with policies encouraging the implementation of digital solutions to enhance efficiency in various stages of the supply chain. This may include the use of blockchain technology for transparent record-keeping, mobile applications for real-time market information and online platforms for direct transactions between producers and consumers. Further, regular monitoring mechanisms should be instituted to evaluate the effectiveness of implemented policies and to make adjustments as needed. The government, policymakers and related stakeholders should remain adaptable, responsive to evolving market dynamics and open to refining strategies to optimize the overall performance of the capsicum supply chain. Moreover, education and awareness initiatives are vital components of a successful policy framework. Stakeholders, including farmers, traders and consumers, should be equipped with the knowledge needed to make informed decisions and navigate the complexities of the supply chain. Furthermore, training programs, workshops and outreach efforts can contribute to building a more informed and empowered participant base.

To address the constraints identified in the agricultural produce supply chain network channels of capsicum, there is a pressing need to enhance market consultancy services, providing farmers with tailored advice on market dynamics and pricing strategies. For this, governments may collaborate with extension services in the private sector to establish and expand such services, offering financial incentives to encourage private entities to participate actively. Moreover, the second constraint, inadequate road infrastructure, demands substantial investment in the development and maintenance of all-weather roads. Therefore, related stakeholders should allocate dedicated funds to improve accessibility, reducing transportation delays and post-harvest losses. Additionally, measures to regulate and potentially reduce high commission charges should be implemented, ensuring a fair distribution of costs within the supply chain. Market regulatory bodies need to regularly review commission structures and establish guidelines to prevent the exploitation of farmers. Lastly, addressing the constraints of the untimely availability of vehicles for transportation calls for improved logistics coordination. Therefore, establishing logistics hubs and coordination centres and incentivizing private sector participation can optimize the movement of agricultural goods. Moreover, extending market advisory services to far-flung areas is vital and governments should design outreach programs, mobile advisory services and workshops specifically targeting remote regions. Further, successful implementation will require collaborative efforts between government bodies, private sector entities and farmers. These recommendations collectively aim to create a policy framework that fosters transparency, efficiency and equity in the marketing of capsicum crops in India, ensuring sustainable growth for all participants in the agricultural supply chain.

6. Conclusions

The comprehensive analysis of the agricultural produce supply chain network of capsicum provides valuable insights into the intricate dynamics of the capsicum supply chain. The dominance of Channel-C (Producer–Commission Agent–Retailer–Consumer) as the most widely used marketing channel, representing 47.25% of the total quantity. Therefore, it can be concluded that these results highlight the significance of intermediaries in facilitating transactions attributed to factors such as market access and negotiation skills. The subsequent examination of marketing costs and margins across different functionaries provided a nuanced understanding of the financial intricacies at each stage. Channel-A, involving direct sales to consumers, emerges as the most cost-effective for producers, while Channel-C, with commission agents, demonstrates a higher cost burden. The pivotal role of retailers is evident across multiple channels, with varying costs and margins, emphasizing

the economic considerations and profit potential for retailers in each marketing channel. Furthermore, the price spread and marketing efficiency analysis shed light on the variability in producer prices, gross marketing margins and overall efficiency across different channels. However, Channel-A, despite being the most efficient, is not the preferred choice, highlighting the trade-off between efficiency and transaction volume, whereas Channel-B stands out as the most efficient among the remaining channels, emphasizing a balance in pricing dynamics that contributes to overall efficiency and attractiveness. Moreover, the absence of market consultation services emerged as the foremost constraint, emphasizing the need for tailored advisory support to empower farmers with market insights. Insufficient road infrastructure, high commission charges, nonremunerative pricing and logistical constraints further compounded the complexities faced by farmers in the capsicum supply chain. Each constraint represents a formidable barrier to the smooth functioning of the supply chain, impacting the livelihoods of farmers and the overall efficiency of the market. To address these constraints systematically, a set of targeted recommendations, suggestions and policy implications is proposed. These recommendations advocate for enhancing market consultancy services, investing in road infrastructure, regulating commission charges, ensuring remunerative pricing and improving logistics coordination. The overarching theme emphasized collaborative efforts between government bodies, the private sector and farmers to create a resilient, efficient and equitable agricultural supply chain. The transformative potential embedded in the findings presents an opportunity to foster a more inclusive, transparent and prosperous agricultural ecosystem for capsicum crops in India. This endeavour not only promises enhanced profitability for farmers but also contributes to the overall sustainability and transparency of the agricultural ecosystem, ensuring the vibrancy and prosperity of vegetable farming in the years to come.

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References

Acharya, S. S. 2016. Policy analysis-what and how: A case of agricultural price and marketing policies in India. *Indian Journal of Agricultural Marketing* 30: 26–47.

Acharya, S. S., and N. L. Agarwal. 2016. *Agricultural Marketing in India*. New Delhi: Oxford and IBH Publishing Corporation Private Limited.

Aliyi, I., Abduselam Faris, Assefa Ayele, Alemayehu Oljirra, and Mulubrihan Bayessa. 2021. Profitability and market performance of smallholder vegetable production: Evidence from Ethiopia. *Heliyon* 7: e08008. [CrossRef] [PubMed]

APEDA. 2023. Agri Exchange. Available online: https://agriexchange.apeda.gov.in/ (accessed on 15 November 2023).

Bala, Brij, Nikhil Sharma, and R. K. Sharma. 2011. Cost and return structure for the promising enterprise of off-season vegetables in Himachal Pradesh. *Agricultural Economics Research Review* 24: 141–48.

Bhattarai, Salil, Michael C. Lyne, and Sandra K. Martin. 2013. Assessing the performance of a supply chain for organic vegetables from a smallholder perspective. *Journal of Agribusiness in Developing and Emerging Economies* 3: 101–18. [CrossRef]

Bukar, U., Dauda Mohammed, R. Wakawa, B. G. Shettima, and S. T. Muhammad. 2015. Analysis of market structure, conduct and performance for pepper in Borno state, Nigeria: A review. *Journal of Agricultural Economics, Environment and Social Sciences* 1: 181–90.

Chand, Khem, Shalander Kumar, A. Suresh, and M. B. Dastagiri. 2020. Marketing efficiency of vegetables in developing economies: Evidences for critical intervention from Rajasthan, India. *Indian Journal of Agricultural Sciences* 90: 55–63. [CrossRef]

Devkota, Rachana, and Krishan Dutt Sharma. 2014. Conduct and performance of vegetable marketing system in Kangra district of Himachal Pradesh in India. *International Journal of Agricultural Innovation and Research* 3: 737–44.

Garrett, Henry Edward, and Robert Sessions Woodworth. 1969. *Statistics in Psychology and Education*. Mumbai: Bombay, Vakils, Feffer and Simons Pvt. Ltd.

Gebrehiwot, Nahusenay Teamer, Hossein Azadi, Fatemeh Taheri, and Steven Van Passel. 2018. How participation in vegetables market affects livelihoods: Empirical evidence from Northern Ethiopia. *Journal of International Food and Agribusiness Marketing* 30: 107–31. [CrossRef]

Ghorbani, Mohammadreza. 2008. The efficiency of saffron marketing channel in Iran. *World Applied Sciences Journal* 4: 523–27.

Gori, Usha Rani, and Sheela Kharkwal. 2016. Comparative study of the structure and performance of two major fruits and vegetables markets under Uttarakhand APMC. *Indian Journal of Economics and Development* 4: 1–15.

Hailegiorgis, Dawit Setegn, and Fitsum Hagos. 2016. Structure and performance of vegetable marketing in East Shoa zone, Oromia Region, Ethiopia. *Journal of Marketing and Consumer Research* 26: 7–16.

JICA. 2021. *The Preparatory Survey of Himachal Pradesh Crop Diversification Promotion Project Phase-II (HPCDP-II) in Republic of India*. Tokyo: Japan International Cooperation Agency (JICA).

Kenjit, Tongbram, Y. Chakrabarty Singh, and Oinam Krishnadas Singh. 2021. A study on production and marketing constraints of french bean (*Phaseolus vulgaris* L.) growers in Bishnupur district of Manipur. *Asian Journal of Agricultural Extension, Economics and Sociology* 39: 37–41.

Krafft, Manfred, Oliver Goetz, Murali Mantr Barrett, Francesca Sotgiu, and Sebastian Tillmanns. 2015. The evolution of marketing channel research domains and methodologies: An integrative review and future directions. *Journal of Retailing* 91: 569–85. [CrossRef]

Kumar, Ajay, Sumit, Mukesh Kumar Yadav, and Anil Kumar Rohila. 2019. Constraints faced by the farmers in production and marketing of vegetables in Haryana. *Indian Journal of Agricultural Sciences* 89: 153–60. [CrossRef]

Kumar, Ganesh B., S. C. Pramanik, and Shakila Nawaz. 2004. Economics of Production & Marketing of vegetables in the Andaman &Nicobar Islands. *Indian Journal of Agricultural Marketing* 18: 16–22.

Kumari, Rita, and S. K. Chauhan. 2021. Garrett's ranking analysis of problems and constraints in the cultivation of cash crops in Sirmour district of Himachal Pradesh. *Himachal Journal of Agricultural Research* 47: 61–65.

Lenne, J. M., and A. F. Ward. 2010. Improving the efficiency of domestic vegetable marketing systems in east Africa constraints and opportunities. *Outlook on Agriculture* 34: 225–32. [CrossRef]

LeRoux, Mathew N., Todd M. Schmit, M. Roth, and Deborah H Streeter. 2010. Evaluating marketing channel options for small-scale fruit and vegetable producers. *Renewable Agriculture and Food Systems* 25: 16–23. [CrossRef]

Manjunath, V., and M. R. Girish. 2016. An analysis of private vegetable market vis-à-vis public vegetable market in Karnataka-a study in Kolar district of Karnataka state. *Agriculture Update* 11: 173–77. [CrossRef]

Marine, Sasha C., David A. Martin, Aaron Adalja, Sudeep Mathew, and Kathryne L. Everts. 2016. Effect of market channel, farm scale, and years in production on mid-Atlantic vegetable producer's knowledge and implementation of Good Agricultural Practices. *Food Control* 59: 128–38. [CrossRef]

Maspaitella, Marcus, Elena Garnevska, Muhammad I. Siddique, and Nicola Shadbolt. 2018. Towards high value markets: A case study of smallholder vegetable farmers in Indonesia. *International Food and Agribusiness Management Review* 21: 73–88. [CrossRef]

Mgale, Yohana James, and Yan Yunxian. 2020. Marketing efficiency and determinants of marketing channel choice by rice farmers in rural Tanzania: Evidence from Mbeya region, Tanzania. *Australian Journal of Agricultural and Resource Economics* 64: 1239–59. [CrossRef]

Mishra, Snehal, Rakesh Singh, and O. P. Singh. 2014. Economic analysis of marketing of major vegetables in varanasi district of Uttar Pradesh, India. *Economic Affairs* 59: 649–52. [CrossRef]

National Horticultural Board. 2022. Available online: https://nhb.gov.in (accessed on 29 October 2022).

Olutumise, Adewale Isaac. 2022. Determinants of market participation and preference for production of pepper (*Capsicum* spp.) among farmers in southwest, Nigeria. *Heliyon* 8: e10585. [CrossRef] [PubMed]

Panda, Rajeev Kumar, and Sreekumar. 2012. Marketing channel choice and marketing efficiency assessment in agribusiness. *Journal of International Food and Agribusiness Marketing* 24: 213–30. [CrossRef]

Rai, Mohan Kumar, Basanta Paudel, Yili Zhang, Narendra Raj Khanal, Pashupati Nepal, and Hriday Lal Koirala. 2019. Vegetable farming and farmers' livelihood: Insights from Kathmandu Valley, Nepal. *Sustainability* 11: 889. [CrossRef]

Sakas, Damianos P., Nikolaos T. Giannakopoulos, Nikos Kanellos, Christos Christopoulos, and Kanellos S. Toudas. 2023. Determining Factors for Supply Chain Services Provider Selection and Long-Term Relationship Maintenance: Evidence from Greece. *Logistics* 7: 73. [CrossRef]

Schipmann, Christin, and Matin Qaim. 2011. Supply chain differentiation, contract agriculture, and farmer's marketing preferences: The case of sweet pepper in Thailand. *Food Policy* 36: 667–77. [CrossRef]

Sidhu, R. S., Sanjay Kumar, Kamal Vatta, and Parminder Singh. 2010. Supply chain analysis of onion and cauliflower in Punjab. *Agricultural Economics Research Review* 23: 445–54.

Thakur, Pankaj, Piyush Mehta, Amit Guleria, Divyanshu, Pardeep Singh, and Prashant Sharma. 2022a. Farmers' Choice for Output Marketing Channels of Cauliflower in Himachal Pradesh, India: A Multinomial Logit Model Analysis. *Economic Affairs* 67: 731–38. [CrossRef]

Thakur, Pankaj, Piyush Mehta, Amit Guleria, Divyanshu, Pardeep Singh, Prashant Sharma, Rahul Kumar Tiwari, Milan Kumar Lal, and Ravinder Kumar. 2023b. Determinants of farmers' choice for agricultural output marketing channels of tomato (*Solanum lycopersicum*): Empirical evidence from north-western Himalayan region. *Environment, Development and Sustainability, preview*. [CrossRef]

Thakur, Pankaj, Piyush Mehta, Amit Guleria, Pardeep Singh, and Prashant Sharma. 2023c. Study on Marketing Performance and Constraints of Pea (*Pisum sativum*) Output in High Hills Wet Temperate Zone of Himachal Pradesh, India. *Indian Journal of Ecology* 50: 129–35. [CrossRef]

Thakur, Pankaj, Piyush Mehta, and Krishan Kumar. 2021. Existing Status and Changing Scenario of Agricultural Produce Marketing in India. *Indian Journal of Extension Education* 57: 28–38. [CrossRef]

Thakur, Pankaj, Piyush Mehta, and Nikhil Gupta. 2017. An Impact Study of Food Product Packaging on Consumer Buying Behaviour: A Study Premise to Himachal Pradesh-India. *International Journal of Bio-resource and Stress Management* 8: 882–86. [CrossRef]

Thakur, Pankaj, Piyush Mehta, Chhaya Devi, Prashant Sharma, Krishna Kumar Singh, Shikha Yadav, Priyanka Lal, Yashpal Singh Raghav, Promil Kapoor, and Pradeep Mishra. 2023a. Marketing Performance and Factors Influencing Farmers Choice for Agricultural Output Marketing Channels: The Case of Garden Pea (*Pisum sativum*) in India. *Frontiers in Sustainable Food Systems* 7: 1270121. [CrossRef]

Thakur, Pankaj, Piyush Mehta, Prashant Sharma, and Divyanshu. 2022b. Determinants of Farmers' Adoption Behaviour towards Farm Business Management Practices for Vegetable Farming in Mid-Hills of Himachal Pradesh, India. *Economic Affairs* 67: 117–22. [CrossRef]

Verano, Thiago de Carvalho, Carlos de Melo e Silva Neto, and Gabriel da Silva Medina. 2023. Family Farmers in Short and Long Marketing Channels: Lessons for Rural Development in Goiás, Brazil. *Logistics* 7: 69. [CrossRef]

Wang, Huaiyu, Paule Moustier, and Nguyen Thi Tan Loc. 2014. Economic impact of direct marketing and contracts: The case of safe vegetable chains in northern Vietnam. *Food Policy* 47: 13–23. [CrossRef]

Zhang, Xiaoheng, Ping Qing, and Xiaohua Yu. 2019. Short supply chain participation and market performance for vegetable farmers in China. *Australian Journal of Agricultural and Resource Economics* 63: 282–306. [CrossRef]