Research on World Agricultural Economy
https://journals.nasspublishing.com/index.php/rwae

ARTICLE

Price Spread, Farmer Share, and Marketing Channels in the Pigeon Pea Value Chain in Maharashtra State of India

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ABSTRACT

Pigeon pea is one of the important crops in terms of area and production in Maharashtra, India, contributing about one-third of India's total pigeon pea production. It is also an important source of protein in Indian households. The present study focuses on a comprehensive analysis and mapping of the value chain of pigeon pea in Maharashtra. A multi-stage stratified sampling method was used in the study. Primary data was collected from 560 farmers and 149 other important stakeholders. The value chain mapping technique was used for visualisation and quantification. We found that the average cost of production was Rs. 3785 per quintal, and the benefit-cost ratio was 1.57, indicating economic viability. Five major marketing channels were identified. A majority of farmers (88.8%) sold their produce to commission agents at nearby government-regulated markets. The farmers' share in the consumer's price was between 65–74% across the channels. The price spread range was 35–55%, with the highest value addition (16–34%) occurring at the processor level. The lowest price spread (35%) was reported in a channel, which involves farmer-producer companies (FPC), and this channel not only gives farmers a higher share (74.16%) but also offers consumers a lower price. Our study is one of the few that compares FPC-led and traditional channels, reporting the quantification of benefits across the different marketing channels of pigeon pea.

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ARTICLE INFO
Received: 14 November 2025 | Revised: 23 December 2025 | Accepted: 6 January 2026 | Published Online: 20 July 2026
DOI: https://doi.org/10.36956/rwae.v7i3.2913

CITATION
Kadam, S., Kajale, D., Malik, S., 2026. Price Spread, Farmer Share, and Marketing Channels in the Pigeon Pea Value Chain in Maharashtra State of India. Research on World Agricultural Economy. 7(3): 190–205. DOI: https://doi.org/10.36956/rwae.v7i3.2913

The policy recommendation is that the government should focus on post-harvest management and strengthening of FPCs, through partnering with private sector and non-governmental organisations.

Keywords: Pigeon Pea; Value Chain Analysis; Marketing Channel; Farmer Producer Companies; Price Spread; Farmer's Share

1. Introduction

Pigeon pea (*Cajanus Cajan* L.) is one of the important grain legume crops after Chickpea in India. It plays a significant role in ensuring nutritional food security (with a protein content of 20–22%) and improving soil fertility through nitrogen fixation in the country [1–4]. It is also used as food, fodder, feed and fuel [5, 6]. It is grown in semi-arid areas and tropical regions worldwide [7]. Pigeon pea is grown in 82 countries [8]. However, six countries (India, Myanmar, Malawi, Tanzania, Uganda, Kenya and Haiti) produce 98% of the total [9]. India is the world's major producer, consumer, and importer of pigeon pea, it accounted for 79% of global production and 92.65% of global imports in 2021 [9]. The country imported 7.71 lakh tonnes of pigeon pea during the financial year 2023–2024 [10, 11]. In 2021–2022, the area under cultivation was 5.05 million hectares, with a production of 4.34 million tonnes, accounting for 17% of the country's total pulse production [12]. Maharashtra is the leading pigeon pea-producing state in the country, contributing 30.76% share in the total production, followed by Karnataka (28.68%), Uttar Pradesh (6.89%) and Madhya Pradesh (6.62%) [12].

Area, Production and Yield of Pigeon Pea in Maharashtra

The area under pigeon pea in Maharashtra increased slowly from 1.074 million hectares in 2004–2005 to 1.112 million hectares in 2023–2024 with year-to-year fluctuation, and the compound annual growth rate (CAGR) in the area under pigeon pea in Maharashtra is 0.17%, which shows that the area grew very slowly over the year [13]. Its production varied significantly over the years from 2004–2005 to 2023–2024. The CAGR of production is 1.54%, which indicates that production has increased steadily over the years, despite significant fluctuations [13]. Marathwada and Vidarbha are the leading regions of pigeon pea production in Maharashtra, both together accounting for more than 60% of the total area and production.

The temporal analysis of the area and production of pigeon pea in Maharashtra from 2004–2005 to 2023–2024 is presented in **Figure 1**. It shows the wide fluctuation in area and production of pigeon pea over the year, production shows higher fluctuation than the area. This may be due to the drought situation in some years (2014–2015, 2018–2019 and 2020).

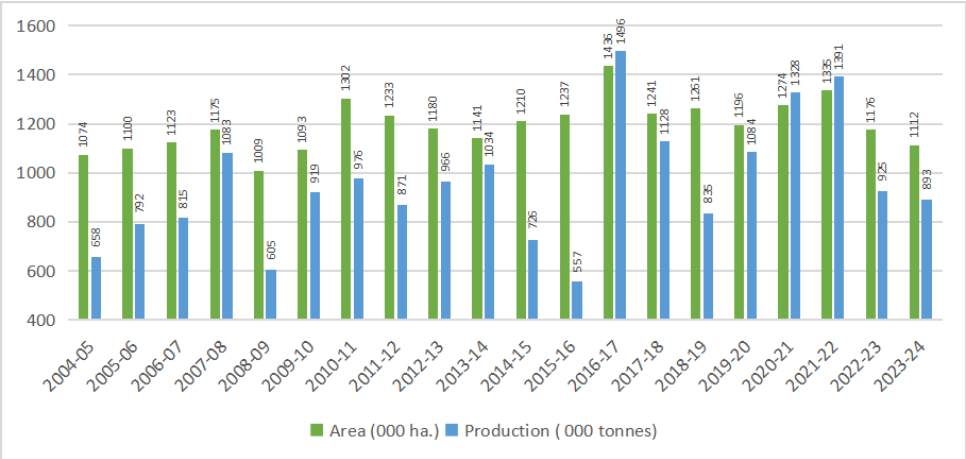

Figure 1. Area and production of pigeon pea in Maharashtra.

Source: Government of Maharashtra [13] and author's calculations.

Figure 2 presents the year-wise yield of pigeon pea in the studied area, reports wide fluctuations over time. In 2015–2016, the yield of pigeon pea was lower due to the drought situation.

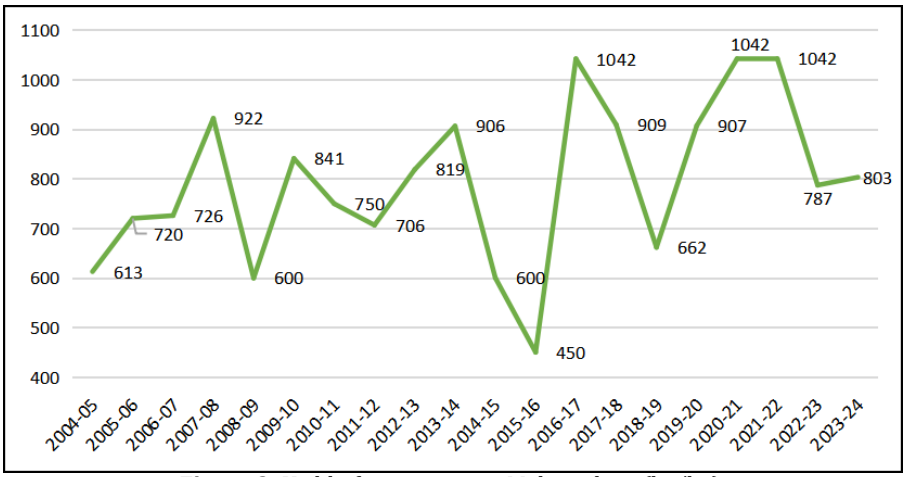

Figure 2. Yield of pigeon pea in Maharashtra (kg/ha).

Source: Government of Maharashtra [13] and author's calculations.

Pigeon pea is an important crop for the economic well-being of the small and marginal farmers in the studied area. Variability in yield, climate change, low market linkages, price fluctuations, a lack of technical knowledge, and limited government support are significant challenges faced by farmers. On the other hand, long and fragmented value chains [14], inadequate storage facilities, inefficient markets, high post-harvest losses, a lack of transport facilities, and limited value addition are major issues in the value chain. Therefore, a comprehensive analysis of the value chain of pigeon pea is required. Additionally, the markets are inefficient due to the presence of multi-layered intermediaries in the pulses value chain, and marketing costs vary across different marketing channels in India [15]. The pulses value chain is a long and complex, with several actors involved in playing specific roles [7]. The farmers' share in the consumer price is 65% in the case of pigeon pea, which is low compared to chickpea (75%) and moong (70%) in India [16]. Access to finance, lack of market intelligence at the farmers' level, infrastructure, non-availability of processing units, low market efficiency, long marketing chain, high-profit margin of intermediaries, knowledge of new technology, branding and market access are key issues in the value chain [7, 17].

Therefore, the present study focuses on mapping the entire value chain of pigeon pea in Maharashtra. It analyses the price spread across its value chain and the activities carried out at each stage, the intermediaries involved, identifies the marketing channels in the studied area, and determines the farmers' share in the consumer price. Despite the significance of pigeon pea in Maharashtra's agrarian economy, limited studies have examined its value chain in a comprehensive manner. The role of different intermediaries, regional variations, and the functioning of FPC-led marketing channels for pigeon pea also remain underexplored. The empirical findings will help farmers and other value chain actors to make informed marketing decisions, gain better returns and knowledge about value addition, and inform policy interventions to improve the performance of the pigeon pea value chain.

2. Literature Review

The value chain concept was introduced first in 1985 by Porter, and the term 'chain' was used to describe a series of value-adding activities, including value-creation opportunities through primary and support activities [18]. Porter distinguished between two important components of the value chain: primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and services), and support activities (strategic planning, human resource management, tech-

nology development, infrastructure, and procurement). The term value chain defines "the full range of activities that are required to bring a product or service from conception through the different phases of production, delivery to final consumers and final disposal after use, which includes all the activities such procurement of raw materials, seed and inputs aggregation, assembly, transformation, transport and other services, and finally consumers"[19, 20]. Value chain analysis is a crucial tool for investigating the relationships between different players in a given industry[21].

A simple value chain refers to the actors those manage a product as it moves through it, including input suppliers, farmers, traders, processors, transporters, wholesalers, retailers and final consumers[20]. Their involvement in performing value-adding activities has remained crucial to the definition of the value chain[19]. Food and Agriculture Organization (FAO)[22] defines a value chain as a set of "interdependent economic activities" and a "group of vertically linked economic agents". The value chain is a distinct and complex concept required to understand its structure, conduct and performance and it helps to know the advantages and disadvantages of firms and countries specializing in production rather than services and how producers are connected to final markets which may influence their ability to gain from participating in markets[19–22]. Over time, several frameworks, guidelines, and approaches have been developed and formulated by both national and international institutions, including the FAO, UNDP, ILO, and the World Bank. These guidelines and methodologies are used to enhance the performance of the value chain across firms, commodities, and different sectors. A value chain typically begins with the production of a primary commodity and ends with the consumption of the final product, encompassing all the economic activities undertaken between phases, such as processing, delivery, wholesaling, and retailing[22, 23]. The concept originated from the supply chain, explaining the value created at each stage of the chain, which is integral to satisfying the consumer's needs[17]. Thus, as Gilbert[24] observes, value chain analysis extends traditional supply chain analysis by assigning values to each stage within the chain.

The value chain analysis comprises both qualitative and quantitative approaches. Hellien and Meijer[20] advocate initiating the analysis with a qualitative approach, followed by semi-structured interviews, focus group discussions, and questionnaires. This approach will help understand the different value chain actors and their interactions within the value chain. Likewise, the value chain mapping technique is widely used in analysing the value chain of agricultural commodities. A value chain map is the visual representation of the flow of products from farmers to the final consumer, actors involved, activities undertaken, role of various actors, value creation and profit earned by actors at each stage[23, 25–27], the recently Ganguly and Gulati[28] used mapping techniques to analyse the value chain of pulses in the context of competitiveness, access to finance, inclusiveness, scalability and sustainability.

Several studies have identified the major challenges within India's pulses value chain which includes long marketing channel, presence of multiple actors and intermediaries high marketing costs, low farmers' share in the consumer price, low marketing margin, lack of adoption of technologies, lack of market access and inadequate infrastructure[7, 15, 17, 27, 28].

Some studies found that price spread is less in the Farmer-Producer Companies (FPC) marketing channel and the producer's share in the consumer price is higher than in other marketing channels[29]. Famer Producer Organisations can take various legal forms like trust, companies, NGO etc., out of which Farmer Producer Companies (FPCs) are companies registered under the amended Companies Act (1956) in the year 2002 and subsequently amended in 2013, and performed activities stated in section 378B, such as production, harvesting, post-harvest handling, grading, packaging, marketing of primary produce, etc.[30]. Also, FPCs have the potential to empower the small and marginal farmers in India[31].

Despite pigeon pea being a major pulse crop in Maharashtra, most studies focus on production aspects and the value chain analysis of cereals, fruits, and vegetable crops, with limited attention given to pulses, especially pigeon pea, in terms of assessing the value addition, price spread at each stage and farmers' share in consumer prices. To address this gap, the present study un-

dertakes a comprehensive analysis of the value chain to trace the flow of pigeon pea from farmers to consumers. This study covers all the actors involved in the value chain of pigeon peas in Maharashtra. Additionally, it employs an integrated approach, utilising primary and economic indicators to examine the price spread, farmers' share, and value addition [32]. It aims to map the flow of pigeon peas from the farmer to the final consumer, examining the actors involved in the value chain, quantifying the price spread, and analysing the farmer's share in the consumer price. This study provides empirical insights for enhancing market transparency, adding value, and strengthening the competitiveness of pigeon peas in Maharashtra's economy.

3. Materials and Methods

The present study uses both primary and secondary data. The qualitative and quantitative data were collected through a field survey and secondary data from various sources to map the value chain. Details of the studied area, sampling procedure and analytical techniques used are presented below.

3.1. Study Area

Maharashtra, a state in India, was selected for the study because it ranks first in both area and production of pigeon peas in India, accounting for a 30.84% share in pigeon pea production in 2021–2022 [12]. The field survey was carried out in four major districts of two regions in Maharashtra: Latur and Nanded from the Marathwada region, and Yavatmal and Amravati from the Vidarbha region. **Figure 3** shows the districts and villages selected for the study.

3.2. Area, Production and Yield of Pigeon Pea in the Studied Districts

The average area, production, and yield of pigeon pea in the studied districts compared with those in Maharashtra state from 2016–2017 to 2020–2021 are presented in **Table 1**.

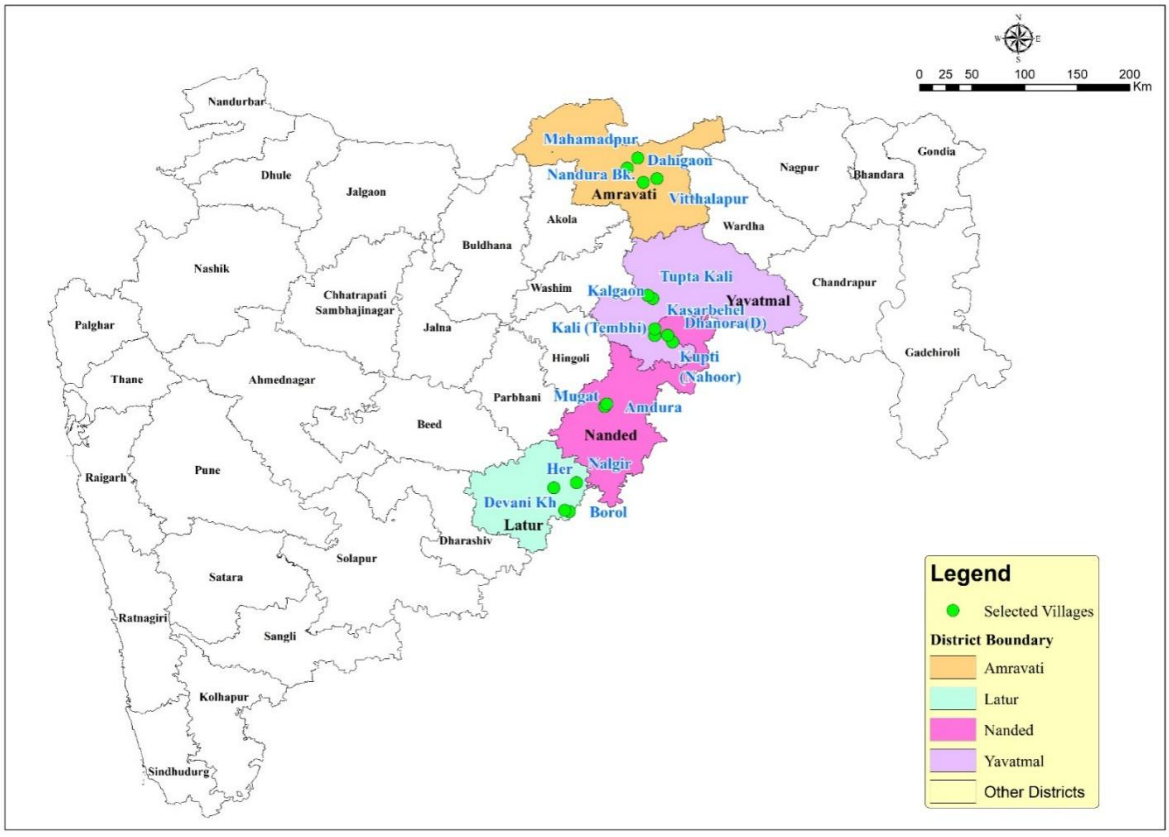

Figure 3. Map of districts and villages selected for the study.

Table 1. Area, Production and Yield of Pigeon Pea in the Studied Area (5-year average from 2016–2017 to 2020–2021).

Sr. No.	Studied Districts	Area (00 ha)	Production (00 t)	Yield (kg/ha)
1	Latur	1098	1761	1604
2	Nanded	781	754	965
3	Amravati	1128	1148	1018
4	Yavatmal	1367	1247	912
Average Total (4 districts)		4374	4910	1123
5	Maharashtra State	13,254	13,302	1004
% to total (Study Area)		33.00%	36.91%	

Source: Government of Maharashtra [13] and authors calculations.

The total average area and production of pigeon pea in Maharashtra were 1325 thousand hectares and 1330 thousand tonnes from 2016–2017 to 2020–2021, respectively. The studied districts, together, accounted for 33% of the area and 36.91% of the pigeon pea production in Maharashtra (**Table 1**). Spatial variability is observed in area, production, and yield. Yavatmal district had the highest area under pigeon pea cultivation. However, in the case of production, Latur district contributed the most to the total production in Maharashtra. The average yield of pigeon pea (1123 kg/ha) in these four districts is higher than the state average yield (1004 kg/ha). The highest average yield of pigeonpea was observed in Latur district (1604 kg/ha), while the lowest yield was recorded in Yavatmal district (912 kg/ha). Despite having the highest area under pigeon pea in Yavatmal district, its yield is lower than that of other districts. The spatial variability observed in yield suggests that there is scope for improvement in the yield.

3.3. Sampling

The multi-stage stratified sampling method was used to select the location and value chain actors for the study. The Marathwada and Vidarbha regions in the state were selected based on two criteria: the highest area under pigeon pea and its production. The top two districts were selected using the same criteria from each of the selected regions. Thus, all four leading districts were chosen. Furthermore, from each selected district, two top talukas/blocks were shortlisted, resulting in a total of eight talukas/blocks. From each selected taluka/block, two villages were selected, totaling sixteen villages. A list of pigeon pea growers was prepared during a field survey of each selected village, and 35 farmers were selected randomly from each selected village. Thus, a sample of 560 farmers was drawn, and data regarding activities performed during marketing channels, price received, marketing and production costs, and storage were collected through semi-structured questionnaires in the study.

Apart from this, the pigeon pea value chain actors, such as commission agents/traders, processors, wholesalers, and retailers, were selected using the random sampling method from available lists obtained from the Agricultural Produce Market Committee (APMC) offices and from a list prepared during the field survey. A sample of eight commission agents/traders, processors, wholesalers and retailers was drawn from each selected district. Thus, 32 commission agents/traders, 32 processors, 32 wholesalers and 32 retailers were chosen. On the other hand, other value chain actors, such as two transporters and FPCs, were selected from each district; thus, eight transporters and farmer producer companies (FPCs) were covered under the study. Farmers from FPCs were chosen randomly from among those engaged in pigeon pea cultivation.

3.4. Data Collection and Analysis

The primary and secondary data are used for the present study. The primary data was collected through a field survey, which was conducted from October 2021 to March 2022; this period covers the cultivation and marketing of pigeon pea in the state. Pulse value chains, especially for pigeon pea, are structurally slow compared to horticulture or other high-value commodities [7, 32]. Additionally, over the last few years, the state of Maha-

rashtra has seen no major changes in infrastructure, policy and institutions.

The data on marketing, processing, storage, transportation operations, prices received, production costs, and challenges faced by pigeon pea farmers, among other aspects, were collected through interviews using semi-structured questionnaires and utilised for analysis. Likewise, data on activities performed by value chain actors during trading, processing, storage, transportation, value additions and prices received were collected using checklists from other value chain actors covered in the study. To ensure reliability and validity, the questionnaires underwent pilot testing. Based on pilot testing, revisions were made to the questionnaires, including the resequencing and merging of questions. Additionally, respondents were assured that their responses would be used solely for research purposes and were not prompted during personal interviews; questions were asked in the local language.

The necessary secondary data on area, production and yield of pigeon pea were collected from published sources such as Agricultural Statistics at Glance, Ministry of Agriculture and Farmers Welfare (MoA & FW), Government of India, website of Department of Agriculture, Government of Maharashtra. Value chain mapping techniques were used to visualise the flow of the product and the actors involved in the value chain of pigeon pea, this helps to identify different activities performed by actors and value-added at each stage [7, 27].

Subsequently, a quantitative analytical method was used to measure the price spread at each stage and the farmers' share in consumer prices. The analysis was conducted using the following formula [33].

$$\mathrm{Fs} = (\mathrm{Pf}/\mathrm{Pc}) \times 100$$

where,

Fs = Farmers' share in consumer prices,

Pf = Farmers' price (Rs/quintal),

Pc = Price paid by the consumers (Rs/quintal).

Price spread: It is calculated as the consumers' price minus the farmers' prices. It is expressed in absolute terms [33].

$$\mathrm{Ps} = \mathrm{Cp} - \mathrm{Fp}$$

where,

Ps = Price spread,

Cp = Consumers' price (Rs/quintal),

Fp = Farmers' price (Rs/quintal).

4. Results and Discussion

This section presents the findings of the empirical analysis, along with a discussion. The average age of the respondents was 47 years, and the gender representation showed that 97% were male. Around 12% belong to the Scheduled Castes (SC), 9% to the Scheduled Tribes (ST), 36% to Other Backwards Classes (OBC), and 43% to the General Category. In terms of educational level, around 6% of respondents were without any formal education, while 7% were with primary schooling, around 72% were with education up to 12th grade, and the remaining 15% were with higher grades (diploma/graduates). Around 40% of the respondents hold less than one hectare of land, 26.8% hold 1–2 hectares of land, 18.2% fall under the semi-medium category (2–4 hectares of land), and 11.3% fall under the medium category (4–10 hectares of land). The average landholding size of the respondents is 1.6 hectares, which is slightly higher than the average landholding of farmers in Maharashtra (1.34 hectares) [34]. The study also reports 23.93% of the respondents are affiliated with various institutions, including gram panchayats, self-help groups, and farmers' producer organisations. The annual average income of farmers was Rs. 106,000, which was lower than the average income of agricultural households in Maharashtra [35], as the study region is less developed in terms of agriculture within the state.

4.1. Cost of Production and Net Returns of Pigeon Pea

The average cost of production and net returns of pigeon pea in Maharashtra were calculated, and the results are presented in **Table 2**. The average cost of pigeon pea cultivation in the studied area was Rs. 18,129 per acre. Out of the total cultivation cost, the operational cost was Rs. 5835, including human labour (both family and hired), animal labour, and machinery. The total input cost of pigeon pea was Rs. 5734. Its average yield was 4.79 quintals per acre. The farmer received an av-

erage price of Rs. 5958 per quintal. Likewise, the average cost of production was Rs. 3785 per quintal, and the total gross income was Rs. 28,539 per acre. However, according to the Commission for Agricultural Costs and Prices (CACP) report, the average cost of production (A2+FL) for pigeon pea was Rs. 3886 per quintal at the all-India level for 2022–2023 [36]. The net return from producing pigeon pea was Rs. 10,409 per acre. The benefit-cost ratio for pigeon pea cultivation was 1.57, which indicates that the cultivation is profitable. These results are aligned with the earlier study [37], which reported a BC ratio of 1.05 for pigeon pea in Maharashtra.

Table 2. Cost of production and net returns of pigeon pea.

Sr. No.	Costs	Sub-Component	Particulars	Average Expenses (Rs/acre)
1	A. Operational costs	Human labour (hired + family)		2521
		Animal labour (hired + owned)		1174
		Machine labour (hired + owned)		2140
	Total operational cost			5835
2	B. Input cost		Seed	963
			Fertilizer	1397
			Manure	1042
			Pesticides (insecticide, fungicide, organic, etc.)	2332
			Total input cost	5734
	Working capital (A + B)			11,569
	Irrigation charges			286
	Miscellaneous			189
	Fixed cost	Rent value of own land (Rs.)		4850
		Land rev. cesses/taxes		57
		Depreciation of farm bldgs. & implements		833
		Interest on fixed capital (6%)		344
	Total fixed cost (Rs./acre)			6085
3	Total cost of cultivation (Rs./acre)			18,129
4	Average yield (quintal/acre)			4.79
5	Cost of production: Rs./quintal			3785
6	Average price received (INR/quintal):			5958
7	Total gross income (Rs/acre):			28,539
8	Net return/income (Rs/acre):			10,409
9	Benefit-cost ratio:			1.57

Source: Field survey.

4.2. Marketing of Pigeon Pea

The marketing of pigeon pea involved various marketing channels from farmers to consumers. The results of where respondents are selling their produce, quantity sold, distance from farm to marketplace, mode of transport used for marketing, activities conducted by farmers before selling the pigeon pea, the price received by the farmers and reasons for selling produce to a particular purchaser, etc., are presented in **Table 3**.

Most respondents (88.8%) sell pigeon pea to commission agents or traders in the APMC markets due to better prices, instant payment, credit facilities and services such as cleaning facilities. Similarly, 3.4% of farmers sell to village traders, who report timely payment and financial support. Additionally, 2.5 respondents sell pigeon peas to FPCs because FPCs are situated in the nearest place, and farmers also receive additional benefits, such as cleaning/grading facilities, inputs, and price information. Additionally, 3.6% of respondents sell to government procurement agencies, when the market prices are lower than the MSP. Only around 2% of farmers sell directly to processors.

Additionally, access to the market is a key aspect

of achieving better prices and a net return for farmers. Most farmers used tractors (52.68%), followed by light motor vehicles (LMVs) with a capacity of 3 to 5 tonnes (36.07%), while a very few used trucks (4.46%) for transporting pigeon peas to the market. Also, most farmers sell their produce immediately after harvest if the market prices are higher. However, 97 % of farmers sell their produce individually, highlighting the scope for farmers' collectivisation. In the case of post-harvest practices done at the farmers' level, 67 % of farmers clean their pigeon peas before selling and the cleaning activities take place at various locations, such as on the farm (12.23%), at the APMC market (74.82%), at the FPC facilities (2.15%) and at the storage place (10.79%).

Table 3. Marketing of pigeon pea in the studied area.

Sr. No.	Farmers' Sale to	Number of Farmers	Percent	Quantity Sold (Quintal)	% to the Total Quantity	Reasons for Selling Produce to the Particular Purchaser
1	Commission agent/arhtiyas	497	88.8	3360	94.89	Credit, instant payment
2	Farmers' producer companies	14	2.5	94	0.94	Nearest place, getting additional benefits
3	Processor	11	2.0	110	1.09	Timely payment
4	Village traders	18	3.2	142	1.41	Timely payment, credit
5	Government procurement centre (National Agricultural Cooperative Marketing Federation (NAFED)/Small Farmers Agri Business Consortium (SFAC)/State)	20	3.6	167	1.66	Received minimum support price (MSP)
	Total	560	100.0	3873	100.00	

Source: Field survey.
Note: Reasons for selling to particular purchasers reported other than a better price received, which was common for all.

The respondents did not adopt the ratooning of pigeon pea. This may be due to the lack of irrigation facilities. Moreover, awareness about the marketing of green pigeon pods remains low. This suggests that marketing of green pods could provide farmers an additional source of income, since there is demand for green pigeon pea pods in the urban market.

4.3. Marketing Channel Identified

The farmers in the studied area sold pigeon pea through five major marketing channels, they are presented in **Figure 4**. The intermediaries range from one to five, however, channel IV was the shortest, involving only one intermediary (**Figure 4**).

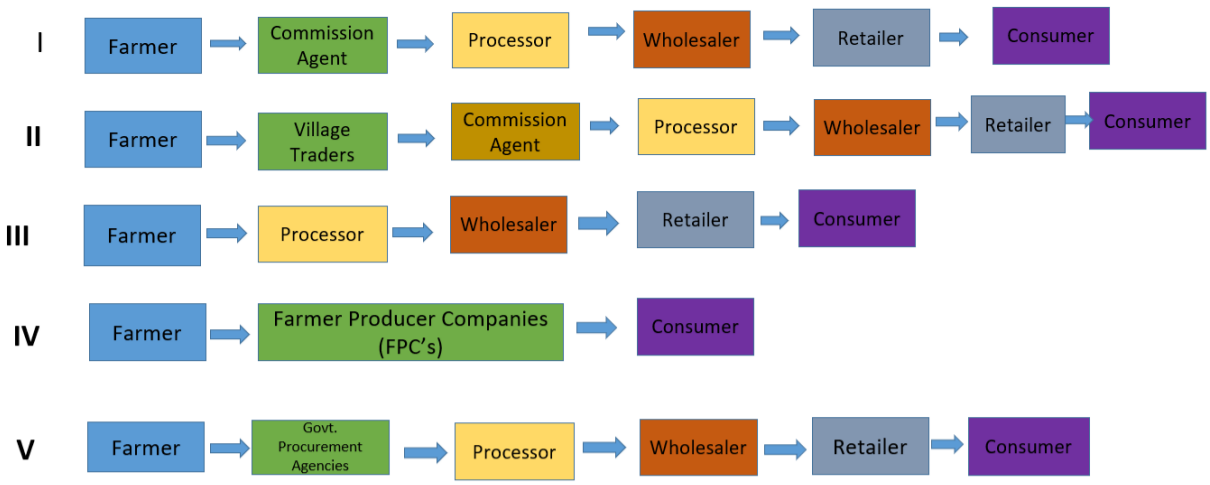

Figure 4. Marketing channels for pigeon pea.

Source: Field survey.

Nearest market for farmer is villages trader (2.1 km), and longest markets for farmers was APMCs and procurement centers (**Figure 5**). While the FPCs are located around 17 km from the farmgate.

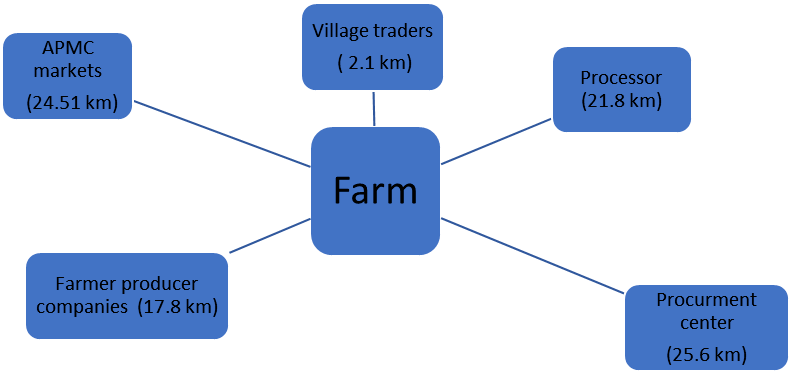

Figure 5. Distance from farm household and markets.

Source: Field survey.

4.4. Activities Performed by Actors Involved in the Value Chain

The activities performed by farmers include production, harvesting, packaging, storage, transportation, marketing, loading, and unloading. Traders/ commission agents at APMC markets act as a facilitator between farmers and processors, providing cleaning and trading facilities, as well as weighing, loading, and unloading services, among others. Similarly, processors undertake tasks such as cleaning, drying, heating, de-husking, splitting, drying, grading, packaging, storage, and marketing. Likewise, wholesalers and retailers are involved in grading, purchasing large quantities, packaging, branding, and storage, and then sell to retailers and consumers. Farmers' Producer Companies (FPCs) are involved in activities such as aggregation, cleaning, packaging, purchasing, processing, direct sales to consumers, providing price information, and participating in government procurement programmes. Together, all these actors influence the price spread and value addition. The details of activities performed by the actors are presented in **Table 4**.

4.5. Marketing Channels, Price Spread and Farmers' Share in Consumers' Prices

Table 5 presents the price spread, value addition, net returns, and farmers' share in consumer prices resulting from selling pigeon peas through various marketing channels to farmers. The farmers realised a higher net return (Rs. 2267 per quintal) while selling through channel III (i.e., farmers–processors–wholesalers–retailers–consumer), followed by channel IV (Rs. 2202 per quintal). In contrast, the net return was lower in the case of channel II (Rs. 1729 per quintal). This indicates that farmers using channels III and IV tend to get better net returns than those using other channels. However, channel I (i.e., farmer-commission agents/arhtiyas, processors, wholesalers, retailers, and consumers) is the most popular, with 88.8% of farmers selling their produce through it.

Table 4. Activities performed by value chain actors.

Sr. No.	Stakeholders	Activities Performed by Value Chain Actors
1	Farmers	Production, harvesting, packaging, storage, transport to market, marketing, loading and unloading.
2	Commission agents/Traders	Act as a facilitator between farmers and processors, provide cleaning and trading facilities, weighment, loading and unloading, and provide price information.

Table 4. *Cont.*

Sr. No.	Stakeholders	Activities Performed by Value Chain Actors
3	Processors	Cleaning, drying, heating, de-husking, splitting, drying, grading, packaging, storage and marketing
4	Wholesalers	Grading, purchasing, packaging, branding and storage. selling dal to retailers and consumers
5	Retailers	Packaging, storage, and selling dal to consumers.
6	Farmers' Producer Companies (FPCs)	Aggregation, cleaning, packaging, purchasing, processing, direct selling to consumers (dal), price information, participation in government procurement programme.
7	Village traders	Aggregation of produce and selling in the nearest market, or processors/bulk buyers/agents.
8	Govt. procurement agencies (centres)	Provide cleaning and grading facilities, aggregation, storage, release and purchase at MSP.
9	Transporters	Transportation of produce from the farm to market and storage place, market to processing place, processing to storage place, at wholesalers' place and retailers' place.
10	Importers	Import of pigeon pea and selling it to agents and dal millers.

Source: Field survey.

Table 5. Marketing channels, price spread and farmers' share in consumers' prices.

Marketing Channel Number	Particulars	Value Chain Actors (Prices in Rs)					
		Farmer	Commission Agents	Processors	Wholesaler	Retailer	Consumers
I	Production cost	3785					
	Cost of marketing	110.07					
	Purchase price		5958	6300	7337	7704	8706
	Price received by farmers	5958					
	Selling price		6300	7337	7704	8706	
	Difference between selling and purchase prices		342	1037	367	1002	
	Net returns	2062	342	1037	367	1002	
	Price spread at each stage (%)		5.74	16.46	5	13.01	
	Farmers' share in consumers' price (%)	68.44					
	Particulars	**Farmers**	**Village Traders**	**Commission Agents**	**Processors**	**Wholesalers**	**Retailers**	**Consumers**
II	Production cost	3785						
	Cost of marketing	117.3						
	Price received by farmers	5631						
	Purchase price		5631	5958	6300	7337	7704	8706
	Selling price		5958	6300	7337	7704	8706	
	Difference between selling and purchase prices		327	342	1037	367	1002	
	Net returns	1729	327	342	1037	367	1002	
	Price spread (%)		5.81	5.74	16.46	5	13.01	
	Farmers' share in consumers' price (%)	64.68						

Table 5. *Cont.*

Marketing Channel Number	Particulars	Value Chain Actors (Prices in Rs)				
		Farmers	**Processors**	**Wholesalers**	**Retailers**	**Consumers**
III	Production cost	3785				
	Cost of marketing	105.7				
	Price received by farmers	6158				
	Purchase price		6158	7337	7704	8706
	Selling price		7337	7704	8706	
	Difference between selling and purchase prices		1179	367	1002	
	Net returns	2267	1179	367	1002	
	Price spread (%)		19.15	5	13.01	
	Farmers' share in consumers' price (%)			70.73		
	Particulars	**Farmers**	**Farmers' Producer Companies (FPCs)**			**Consumers**
IV	Production cost	3785				
	Cost of marketing	97.1				
	Price received by farmers	6100				
	Purchase price			6100		8225
	Selling price			8225		
	Difference between selling and purchase prices			2125		
	Net returns	2218		2125		
	Price spread (%)			34.84		
	Farmer share in consumers' price (%)			74.16		
	Particulars	**Farmers**	**Govt. Procurement Centers**	**Processors**	**Wholesalers**	**Retailers**	**Consumers**
V	Production cost	3785					
	Cost of marketing	113					
	Price received by farmers	6000					
	Purchase price		6000	6100	7337	7704	8706
	Selling Price		6100	7337	7704	8706	
	Difference between selling and purchase prices		100	1237	367	1002	
	Net returns	2102	100	1237	367	1002	
	Price spread (%)		1.67	20.28	5	13.01	
	Farmers' share in consumers' price (%)	68.92					

Source: Field survey, authors calculations.
Note: 1. cost of marketing includes packaging, unloading, weighment and transport borne by the farmers; 2. Selling price includes packaging, unloading, processing, weighment, marketing costs, and transport borne by value chain actors (commission agents/traders, FPCs, processors, Procurement Centers, wholesalers, and retailers); 3. all figures are in Rs/quintal.

Differences in returns across marketing channels for pigeon pea were examined using a bootstrap-based independent samples test with 10,000 replications, given the small number of farmers selling through the processor and FPC channels and highly unequal group sizes. Farmers selling through processor and FPC channels (Channel III & IV; N = 25) earned, on average, Rs. 205 more per quintal than those selling through other marketing channels (N = 535). The estimated mean difference was statistically significant, as the 95% bootstrap confidence interval was below conventional thresholds ($p = 0.009$). The magnitude of this differ-

ence was moderate, with a standardised mean difference (Hedges' g) of −0.45, indicating a substantively relevant gap in returns across channel types.

Channel-wise price spread of pigeon pea varies between 35% and 55%. The highest price spread (55%) is in the marketing channel II (farmer–village traders–commission agents–processors–wholesalers–retailers–consumers). This might be because the number of intermediaries involved in this channel is higher than in other channels. Among the existing channels, the lowest price spread (35%) is in channel IV (farmers–farmers' producer company–consumer). This is because the number of intermediaries is less compared with other marketing channels. Also, the marketing cost for farmers is lower in the FPC channel because of low transportation cost, since the FPCs are closer to farmers than the traditional markets, and no middleman/commission agent charges/fees Similar findings were reported in earlier studies for green gram[38], and for mustard crops[29], marketed through farmer producer organization in India. The highest price spread at the processor level ranged from 16% to 34% in the marketing channels, which may be due to the higher processing and marketing costs associated with pigeon pea at the processor level, followed by the retailer level (13%) and the wholesaler level (5%). The price spread at the village traders' and commission agents' level was around 6%.

The presence of multiple actors and a wider price spread in the value chain reduces the farmers' share in the consumer prices[39]. The present study also found multiple actors' involvement and wider price spread in the value chain. Therefore, the present study analyses the farmers' shares in the consumer prices. The farmers' share in the consumer's price is higher (74.16%) in the case of sale through marketing channel IV, specifically when farmers sell directly to FPCs. Additionally, farmers receive benefits in terms of inputs and cleaning facilities from FPCs, with channel number III (70.73%) and channel V (68.92%) following. However, the lowest farmers' share in consumer price was in the case of channel II (farmers–village traders–commission agents–processors–wholesalers–retailers–consumers) due to a higher number of intermediaries/actors (7) as compared with other channels. According to the RBI's study[40], the farmers' share in the consumer price for pigeon peas was 65%. Our results align with the RBI's study.

5. Conclusions and Recommendations

The present study focuses on a comprehensive analysis and mapping of the value chain of pigeon pea in Maharashtra. The study's results reveal significant variation in farmers' shares of consumer prices and price spreads across different marketing channels. The study indicates wide fluctuation in both the area and production of pigeon pea over the study period. Production seems to be fluctuating more than the area under pigeon pea. The spatial variability in yield suggests ample scope for enhancing pigeon pea yield. The average cost of production was Rs. 3785 per quintal. The benefit-cost ratio for pigeon pea cultivation was 1.57, indicating that pigeon pea cultivation is economically viable. These results align with the findings of an earlier study[37].

Our study reports that farmers used five marketing channels. We found that most of the farmers (88.8%) sell their produce to commission agents/arthritis in the nearest APMC markets. This is the traditional marketing channel (i.e., farmers–commission agents at APMC–processors–wholesalers–retailers–consumers). The major reasons reported by farmers for using this channel are better price realisation, credit facilities, and instant payment. While remaining farmers sell their produce to the processors, village traders, Government procurement centres and FPCs.

The price spread in the pigeon pea value chain ranged from 35% to 55%. The lowest price spread (35%) was observed in Channel IV (farmer–farmer producers' company (FPC)–consumer), while the highest price spread (55%) was found in Channel II (farmer–village traders–commission agents–processors–wholesalers–retailers–consumers). The highest price addition was at the processor level, ranging from 16–34% in the marketing channels, followed by at the retailer level (13%). This suggests that there is scope for establishing processing units at the farm gate, where farmers can increase their share in the consumer price.

Farmers' share in the consumer's price was higher in the case of Channel IV (72.93%), followed by Channel III (70.74%) and Channel V (68.92%). The lowest farmers' share in the consumer price was in the case of Channel II (farmer–village traders–commission agents–processors–wholesalers–retailers–consumers). This is due to the presence of more intermediaries (five) compared to other marketing channels.

The farmers using Channel IV (farmer producers' company (FPC)–consumer) realised higher returns due to the lowest price spread (35%), minimal intermediaries and a higher farmers' share in consumer rupee (74.16%). Farmers also get additional benefits in terms of inputs and cleaning facilities from FPCs. Additionally, the FPCs sell produce to consumers at lower prices than other channels. Therefore, the findings indicate that the FPC channel provides the best option to farmers and consumers. Our findings align with the argument that FPC has the potential to empower small and marginal farmers [31], particularly in post-harvest management. Pulses value chain still suffers from structural barriers and weak market linkages [41]. The results suggest that FPC-led channels in the pigeon pea value chain can reduce the price spread and enhance farmers' share in the consumer price, indicating efficiency gains over traditional channels. Recent policy initiatives, particularly, the Government of India's programme to promote the formation of new FPCs, provide an enabling framework to promote and scale such marketing channels. However, the sustainability of FPC-led channels remains constrained by persistent challenges, including limited working capital, managerial capacity gaps, regulatory compliance and weak market linkages [31].

Therefore, we can say that the government should focus on post-harvest management of the Pigeon pea, especially by providing support for setting up primary processing units at farm gates, which will help farmers to increase their income. This can be achieved through public-private partnerships (PPPs), Corporate Social Responsibility (CSR) projects, and partnerships with non-governmental organisations. It is also important to keep in mind that farmer-managed agroecosystems function as culturally important landscapes, where local institutions and beliefs shape how land, crops and biodiversity are governed [42], therefore, value-chain interventions for pigeon pea need to align with these place-based norms such as an integral part of daily food consumption rather than focusing only on price efficiency.

Moreover, the Indian government is currently promoting FPCs; this appears to be a timely policy intervention. Our study validated that FPCs are beneficial to both farmers and consumers; hence, strengthening the FPCs involved in the Pigeon pea value chain is recommended. This will help to increase the income of small and marginal farmers. One of the limitations of the study is that it is limited to the major pigeon pea-growing regions of Marathwada and Vidharbha in Maharashtra, and the value chain structures in other states may differ.

Author Contributions

Conceptualization, S.K.; methodology, S.K. and D.K.; validation, S.K., D.K. and S.M.; formal analysis, S.K. and D.K.; investigation, S.K., D.K. and S.M.; writing—original draft preparation, S.K. and D.K.; writing—review and editing, S.K., D.K. and S.M.; supervision, S.K., D.K. and S.M. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

The study involved human participants and was conducted as a non-clinical, non-intrusive field survey, consistent with established ethical practices in social science research, and was approved by the Dean's Research Office at the Gokhale Institute of Politics and Economics. Participation was voluntary, and informed consent was obtained prior to data collection. Respondent's anonymity and confidentiality were ensured. No personal identifiers were collected, and the data were used solely for academic research purposes.

Informed Consent Statement

Informed consent was obtained from all participants before the interviews. Respondents were informed about the purpose of the study, the voluntary nature of participation, and their right to decline or withdraw at any stage. Interviews were conducted in the local language to ensure comprehension.

Data Availability Statement

The dataset can be made available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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