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Economic Analysis of Chilli Processing and Value Addition Across Domestic and Export Value Chains in Andhra Pradesh

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Abstract

The experiment was conducted during the months of August to March, 2023–24 to examine the cost structure and value addition across different chilli processing units, small, medium, and large-and maps value chains in both domestic and export markets. Primary data were collected from 135 chilli farmers and 10 processing firms across NTR, Prakasam, and Kurnool districts between August, 2023 and March 2024. The study estimated processing recovery, cost per kilogram, and the distribution of value addition costs among key stakeholders such as farmers, traders, commission agents, wholesalers, retailers, and exporters.Results revealed that small units had the highest chilli powder recovery (92.5%) and the lowest processing cost (₹ 16.61 kg^{-1}), while large units, despite higher processing volumes, incurred the highest costs (₹ 29.45 kg^{-1}), mainly due to labor and energy expenses. Value addition was most prominent at the farmer level in domestic dry chilli chains, while processing firms dominated in chilli powder chains for export markets, contributing up to 69.54% of total value addition.The findings highlight the critical role of processing efficiency and stakeholder coordination in enhancing profitability and competitiveness of the chilli sector. The study underscores the need for targeted interventions to improve value chain integration, promote Good Agricultural Practices (GAP), and upgrade processing technologies, especially for small and medium enterprises.

Keywords: Value addition, cost analysis, processing, domestic, export markets

1. Introduction

Chilli (*Capsicum* spp.) holds prime importance in India's agriculture, underpinning rural livelihoods, export revenues, and agro-industrial growth. India leads global production (~38% of dried chilli output) and exports (~25%) (Anonymous, 2023; Anonymous, 2023; Reddy and Ponnam, 2026; Bey et al., 2024). Within India, Andhra Pradesh-particularly the Guntur region-is renowned for its high-quality, pungent Guntur Sannam variety, which holds a Geographical Indication (GI) tag and garners international demand (Sudeepthi et al., 2025; Bonigala et al., 2024; Singh et al., 2023).

The chilli value chain encompasses cultivation, drying, grading, grinding, packaging, and marketing-steps that collectively generate income and enhance profitability (Singh et al., 2023; Thakur et al., 2024). Value addition is essential to minimize postharvest losses and ensure compliance with domestic and export quality standards (Anonymous, 2022; Sandeep and Thimmaiah, 2020). Rising global demand for processed products like chilli powder and oleoresin positions processing firms as vital intermediaries linking farmers to premium markets (Jalgonkar et al., 2022; Mishra and Supriya, 2024; Sandeep and Thimmaiah, 2023; Soni and Modi, 2024; Anonymous, 2024; Kumar et al., 2021; Meena et al., 2006).

However, processing costs and efficiencies vary significantly across scales. Small units achieve ~92.5% recovery at ₹ 16.61/kg, while medium and large units incur significantly higher costs- ₹ 23.10 and ₹ 29.45 per kg, respectively-driven by labor, energy, and mechanization differences. This highlights the economies and diseconomies of scale present in the sector (Byadagi/Karnataka case studies show similar trends) (Divya et al., 2014; Bhagawath and Shelke, 2012; Shivaraja, 2012; Lakshmi et al., 2014; Asha and Umadevi, 2020; Bollam, 2019).

Value addition also differs by actor and channel: farmers capture maximum value in domestic chains by drying, sorting, grading, and packing; in contrast, processing firms capture over 69% of value in export chilli powder, via grinding, packaging, and certification. Among domestic channels, the farmer–wholesaler–retailer chain offers farmers the highest

share (~44.5%), illustrating the advantages of reduced intermediaries. Chains involving village traders display inflated margins, decreasing farmer income. (Sachin and Doddamani, 2018; Lakshmi, 2022; Ramesh, 2019; Anonymous, 2022)

Recent studies underscore the need for granular actor-cost analyses, capacity-enhancing interventions, and agri-business inclusivity. Magesh et al. (2022) advocate innovative business models; Sharma and Rani (2021) and Ghosh et al. (2022) stress the importance of branding and certification in export markets.

Andhra Pradesh is advancing Farmer Producer Organizations (FPOs), Good Agricultural Practices (GAP), post-harvest infrastructure (dryers, grading units), and digital market linkages (e-NAM, ITC e-Choupal). However, challenges remain: climate shocks, pest outbreaks, price unpredictability, and infrastructural delays hinder efficiency. Cold storage anti-season price slumps further expose farmers. (Royal et al., 2024; Kumar et al., 2023; Anonymous, 2024; Anonymous, 2025; Anonymous, 2024 and Somasekar, 2019)

Genetic and agronomic advancements-such as drip irrigation, heterosis breeding of hybrids, and solar-biomass dryers-enhance yield, quality, and cost-effectiveness (Verma et al., 2022; Kumar et al., 2021). Supply-chain optimization and forecasting tools-like ARIMA/GARCH models-can help farmers better manage pricing cycles and reduce risk .

The state's horticulture growth (17.5 lakh ha, ~301 lakh t output) positions it as India's spice and vegetable export hub, with high potential for integrated processing and foreign market expansion . But policy must reconcile scale-up with cost-efficiency, maintain quality, reduce logistics bottlenecks, and strengthen FPO and SME capacities (Rao and Aruna, 2023).

This study taps into a critical research gap-actor-level cost and recovery analysis across processing scales and value chains-using primary data from NTR, Prakasam, and Kurnool districts. Its insights aim to guide targeted interventions: boosting farmer bargaining power, incentivizing GAP, upgrading SME processing units, easing certification and traceability, promoting direct marketing, and digitizing price and yield analytics.

With India's global chilli ambitions and rising input costs, linking production, processing, and markets via integrated value chains is vital. Support for FPOs, quality-driven infrastructure, financing mechanisms, and export-grade compliance can help farmers capture a fair share of value while enhancing sector competitiveness and sustainable development.

2. Materials and Methods

The study relied exclusively on primary data, which was collected between August, 2023 and March, 2024. A total of 135 chilli farmers were randomly selected from nine villages: Ramireddypalli,Jonnalagadda,Peddavaram/Cherukumpalem, Vengalareddypalli, Jayaramapuram, Yerragondapalem, Ralladoddi, Kadimetla, and Sugur. These villages are located in the Nandigama, Markapur, and Adoni blocks of NTR, Prakasam, and Kurnool districts in Andhra Pradesh. In addition, ten chilli processing firms were selected using a simple random sampling method.

The study assessed value addition costs, i.e., the costs incurred during the processing of chillies. Three major categories of value addition costs (VAC1, VAC2 and VAC3) were considered, covering key activities such as drying, grading, sorting, packing, assembly, and handling. These activities were analyzed based on the involvement of five key actors in the value chain: farmers, village traders, wholesalers, commission agents, and retailers. At each stage, the value of chillies was calculated and added to assess the cumulative value addition.

3. Results and Discussion

3.1. Processors

According to Meena et al. (2006) processors were classified into three categories on the basis of per day capacity to process the chillies, viz., small units (capacity up to 5 q day^{-1}), medium units (capacity 5-10 q day^{-1}) and large units (above 10 q day^{-1}).

Table 1 shows that, on average, 85.50% of the processed chillies were recovered as chilli powder, while the remaining 14.50% was waste by Meena et al. (2006). The recovery percentage varied across different processing unit sizes. Small processing units had the highest recovery rate (92.50%), followed by large units (84.00%) and medium units (83.33%). This indicates that the size of the processing unit influenced

Table 1: Processing recovery of chilli powder in small, medium and large firms (Quantity in q month^{-1})

Sl. No.	Size of processing units	Small	Medium	Large	Total (Avre-rage)
1.	Chillies purchased forpro-cessing	4000.00 (100.00)	6000.00 (100.00)	10000.00 (100.00)	6666.67 (100.00)
2.	Loss dur-ing drying	100.00 (2.50)	300.00 (5.00)	400.00 (4.00)	266.67 (4.00)
3.	Lossing rinding and han-dling	200.00 (5.00)	700.00 (11.67)	1200.00 (12.00)	700.00 (10.50)
4.	Chilli pow-der recov-ered	3700.00 (92.50)	5000.00 (83.33)	8400.00 (84.00)	5700.00 (85.50)
5.	Material-loss during processing (2+3)	300.00 (7.50)	1000.00 (16.67)	1600.00 (16.00)	966.67 (14.50)

the recovery rate of chilli powder from dry chillies.The results differed from those reported by Ulemale et al. (2023) and Divya et al. (2017).

In small processing units, the total cost of processing was ₹ 66,454, of which 21.14% was fixed cost and 78.86% was working cost (Table 2). The major component of fixed costs was interest on fixed capital. Among working costs, electricity charges accounted for the highest share (23.26%), followed by purchase taxes, Agmark certification, labor wages, license fees, repair and maintenance, and interest on working capital. The processing cost was estimated at ₹ 16.61 per kg by Divya et al. (2017) Meena et al. (2006).

For medium-sized units processing 6,000 quintals of chillies per month, the total cost incurred was ₹ 1,38,598, with fixed costs accounting for 21.67% and working costs for 78.33%. This percentage distribution was similar to that of small units. Interest on fixed capital was the major fixed cost, contributing 7.47% of the total cost. Among working costs, electricity charges, purchase taxes, and Agmark certification fees were the highest, followed by labor wages, packing, and labeling charges. The total processing cost per kg was ₹ 23.10, which was higher than that of small units due to a greater proportion of fixed costs. Small units had better resource utilization, leading to lower costs by Divya et al. (2017) and Meena et al. (2006).

For large processing units handling 10,000 quintals, the total processing cost was ₹ 2,94,462, with 21.83% as fixed cost and 78.17% as working cost. The primary fixed cost components were wages for permanent labour (5.18%) and insurance premiums (4.88%). Among working costs, the major expenses were labour wages and purchase tax. The total processing cost per kg was ₹ 29.45. If labor costs were excluded, the per-quintal processing cost would be reduced. However, labor costs, purchase taxes, and electricity charges remained significant expenses for large processors. The higher processing costs in large units were primarily due to increased labor expenses. The results were not consistent with those reported by Ulemale et al. (2023), Divya et al. (2017), Vennilaand Murthy (2021) and Sandeep and Thimmaiah (2020).

Table 2: Comparison of actual capacity and associated cost of processing units (Monthly average)

Sl. No.	Items of cost	Small		Medium		Large	
		₹	%	₹	%	₹	%
1. Fixedcost							
	Depreciationonl and and buildings @ 5%	2023.00	3.04	3069.00	2.21	11786.00	4.00
	Equipments @ 5%	1526.00	2.30	2286.00	1.65	9635.00	3.27
	Insurance premium	4835.00	7.28	9236.00	6.66	14365.00	4.88
	Interest on fixed capital @ 10%	5065.00	7.62	10355.00	7.47	13235.00	4.49
	Wages to permanent labour	600.00	0.90	5085.00	3.67	15250.00	5.18
	Total fixed cost	14049.00	21.14	30031.00	21.67	64271.00	21.83
2. Working cost							
	Electric charges	15456.00	23.26	25258.00	18.22	40635.00	13.80
	Wages to labour	6000.00	9.03	11000.00	7.94	51046.00	17.34
	Administrative charges	2150.00	3.24	3523.00	2.54	5863.00	1.99
	Repair and maintenance charges	2524.00	3.80	5565.00	4.02	8587.00	2.92
	License charges	2565.00	3.86	3589.00	2.59	7850.00	2.67
	Interest on working capital @ 10%	2050.00	3.08	5455.00	3.94	9335.00	3.17
	Purchase tax @ 1.6%	12000.00	18.06	24565.00	17.72	43585.00	14.80
	Agmarking of powder charges	9660.00	14.54	18956.00	13.68	31696.00	10.76
	Packing and labeling charges	0	0.00	10656.00	7.69	25968.00	8.82
	Branding and advertising charges	0	0.00	0.00	0.00	5626.00	1.91
	Total working cost	52405.00	78.86	108567.00	78.33	230191.00	78.17
	Total cost (Fixed+working cost)	66454.00	100.00	138598.00	100.00	294462.00	100.00
	Total quantityprocessed	4000		6000		10000	
	Total cost ofprocessing perkg	16.61		23.10		29.45	
	BCR	2.11		1.52		1.19	

3.2. Value addition cost in chillies value chain

Value addition practices in chillies included different activities like drying, sorting, grading, and packing were done by the farmers themselves or traders or brokers. The farmers dried the chillies after harvest and the moisture content was reduced from 60–70% to 10–12%. Grading was usually done at farmer's level before bringing it to markets. It included sorting out discoloured, white and spoiled chillies in order to get premium price.

Table 3 showed that Value Chain I, the value addition cost incurred by farmers accounted for 38.22%, followed by wholesalers (36.22%) and commission agents (16.92%). The total value addition cost borne by farmers varied from 31.41% in Value Chain II to 44.45% in Value Chain III. A significant portion of value addition took place at the farm level, with drying costs being the highest, followed by packing, grading, and sorting. Since commission agents primarily handled the produce, and village traders did not contribute to value addition, they incurred no such costs by Sandeep and Thimmaiah (2020).

In Value Chain II, village traders acted as intermediaries between farmers and wholesalers. They incurred value addition expenses such as assembly and packing, which accounted for 25.55% of the total cost. Village traders purchased dry chillies, assembled and packed them, and then transported them to wholesalers for saleby Sandeep and Thimmaiah (2020).

In Value Chain III, farmers gathered at auction centers and sold their produce directly to wholesalers. The value addition activities were carried out by both farmers and wholesalers, with their respective cost shares at 44.45% and 43.06%. The overall expenditure on value addition was higher in Value Chain III compared to the first two chains. Additionally, retailers repacked the chillies before sale by Sandeep and Thimmaiah (2020).

Processing firms procured dry chillies from farmers under a contract system. Farmers followed Good Agricultural Practices (GAP) and post-harvest handling techniques such as drying. The contracted farmers supplied high-quality dry chillies

Table 3: Value addition cost across different actors for dry chillies in domestic market (₹ q^{-1})

S.No	Participants	Proportion of value addition cost					
		Value chain I		Value chain II		Value chain III	
		Cost	%	Cost	%	Cost	%
1. Farmer							
	Drying	127.45	13.54	156.26	17.24	135.14	17.32
	Grading	80.18	8.52	57.21	6.31	68.33	8.76
	Sorting	59.96	6.37	71.23	7.86	63.74	8.17
	Packing	92.20	9.79		0.00	79.49	10.19
	Subtotal	359.79	38.22	284.70	31.41	346.70	44.45
2. Village trader							
	Assembly	-	-	99.33	10.96	-	-
	Packing	-	-	132.23	14.59	-	-
	Subtotal	0.00	0.00	231.56	25.55	0.00	0.00
3. Commission agent							
	Handling	159.24	16.92	-	0.00	-	
	Subtotal	159.24	16.92	0.00	0.00	0.00	0.00
4. Wholesaler							
	Assembly	88.66	9.42	83.86	9.25	88.36	11.33
	Drying	98.38	10.45	89.22	9.84	88.63	11.36
	Grading	67.63	7.18	47.23	5.21	59.28	7.60
	Packaging	86.33	9.17	83.32	9.19	99.62	12.77
	Subtotal	341.00	36.22	303.63	33.50	335.89	43.06
5. Retailer							
	Packing	81.33	8.64	86.44	9.54	97.45	12.49
	Totalcost	941.36	100.00	906.33	100.00	780.04	100.00

for chilli powder production. These value addition practices enhanced the quality of the produce, allowing farmers to receive a fair price. Additionally, processing firms played a crucial role in adding value to chillies (Table 4).

Table 4: Value addition cost across different actors for chilli powder in domestic market (₹ q^{-1})

Sl. No.	Participants	Proportion of value addition cost			
		Value chain I		Value chain II	
		Cost	%	Cost	%
1. Farmer					
	GAPractices	352.42	24.33	0	0.00
	Drying	86.83	5.99	83.36	7.22
	Grading	75.55	5.21	66.42	5.75
	Sorting	59.36	4.10	47.33	4.10
	Packing	84.65	5.84	60.28	5.22
	Subtotal	658.81	45.48	257.39	22.29
2. Commission agent					
	Handling/ storage	0	0	124.55	10.79
3. Processing firm					
	Drying	64.46	4.45	77.63	6.72
	Grinding	556.44	38.41	528.36	45.76
	Grading	33.35	2.30	33.35	2.89
	Packaging and labeling	135.66	9.36	133.47	11.56
	Subtotal	789.91	54.52	772.81	66.92
	Totalcost	1448.72	100.00	1154.75	100.00

In Value Chain I, processing firms accounted for 54.52% of the total value addition, while farmers contributed 45.48% by Sandeep and Thimmaiah (2020). The primary value addition activities at the processor level included grinding, packaging, and labelling. In Value Chain II, processing firms were responsible for 66.92% of the value addition, while farmers contributed 22.29%.

Table 5 inferred that the export value chain of dry chillies, farmers involved in exports incurred a higher value addition cost (59.07%) compared to wholesalers (40.93%). At the farmer level, the cost of Good Agricultural Practices (31.01%) was the highest, followed by expenses for drying, grading, sorting, and packing. Good Agricultural Practices were considered an essential component of export-oriented chilli cultivation. Among wholesalers, grading (14.73%) and assembly costs (13.18%) played a significant role in value addition.

Table 6 indicated that the export value chain of chilli powder, processing firms accounted for the highest value addition

Table 5: Value addition cost across different actors for dry chillies (export market) (₹ q^{-1})

Sl. No.	Participants	Proportion of value addition cost	
		Value chain I	
		Cost	%
1. Farmer			
	GA Practices	400.54	31.01
	Drying	135.64	10.50
	Grading	88.68	6.87
	Sorting	78.82	6.10
	Packing	59.33	4.59
	Subtotal	763.01	59.07
2. Wholesaler cum exporter			
	Assembly	170.23	13.18
	Grading	190.28	14.73
	Packaging	168.22	13.02
	Subtotal	528.73	40.93
	Total cost	1291.74	100.00

(69.54%). Among the value addition costs, packaging and certification (32.57%) and powdering (30.77%) were the major contributors. The cost of adopting Good Agricultural Practices was 18.42%, followed by drying (4.51%) and grading (3.93%).

Table 6: Value addition cost across different actors for chilli powder (export market) (₹ q^{-1})

Sl. No.	Participants	Proportion of value addition cost	
		Value chain I	
		Cost	%
1. Farmer			
	GAPractices	406.24	18.42
	Drying	99.43	4.51
	Grading	86.56	3.93
	Sorting	79.42	3.60
	Subtotal	671.65	30.46
2. Processing firm			
	Packing	70.45	3.19
	Drying	66.34	3.01
	Grinding	678.42	30.77
	Packaging and certification	718.28	32.57
	Subtotal	1533.49	69.54
	Totalcost	2205.14	100.00

4. Conclusion

This study analyzes chilli processing economics and value addition in Andhra Pradesh using data from 135 farmers and 10 processors. Small-scale units had the highest recovery (92.5%) and lowest cost (₹ 16.61/kg). Farmer-level value addition was highest in domestic chains, while processors dominated in export chains. Value Chain III offered better returns to farmers. To boost competitiveness, policy should support FPOs, Good Agricultural Practices, processing infrastructure, branding, and certification to enhance efficiency, reduce intermediary costs, and improve global market access.

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