Organic chilli production in the North Eastern Hill Region, India: value chain analysis for doubling farmers' income

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Abstract Cultivars of spices, like chilli, that are local to the North Eastern Hill Region (NEHR) of India are famous for their chemical properties. We examine the economics of chilli cultivation (organic and conventional), supply chain arrangements, and value addition options. We find that chilli cultivation is profitable and organic cultivation more so. The value addition analysis suggests the technological interventions that would add value to the local cultivars. Farmers' income can be increased by organically cultivating chilli and adding value.

Keywords Organic, dale, naga, bird's eye, chilli, income, map, value

JEL Codes P32, Q15

Chilli (*Capsicum annuum* L.), a member of the *solanaceous* family, is grown worldwide—over an area of 19.89 million hectare—and especially in India, China, Myanmar, Bangladesh, Pakistan, Thailand, Vietnam, Romania, Nigeria, and Mexico. The world trade in chilli accounts for 16% of the total spice trade, the largest share after black pepper (Geetha and Selvarani 2017). Around 33.52 million metric tons (MT) of chilli are produced annually worldwide (Patel, Sahu, and Siwana 2017).

India is the largest producer, consumer, and exporter of chilli. The country's output of almost 50 varieties, totalling 13 million MT, accounts for 36.00% of the global production. China produces 3 million MT (8.30%) (Patel, Sahu, and Siwana 2017; Horticulture Statistics Division 2018). Chilli is grown over 31,647 hectares in India, the largest area cultivated with chilli worldwide (Rao and Rao 2014). India contributes

25.00% of the worldwide exports; chilli constituted 24.21% of India's spice exports by value in 2015–16 (Geetha and Selvarani 2017).

India has a variety of agroclimatic zones, and it is a prominent producer of many types of spices (Bhardwaj et al. 2011). Spices are a low-volume, export-oriented commodity, and have great economic significance in India (Sugasini et al. 2018). Chilli is one of the most important vegetable spices and an indispensable household condiment—used in vegetables, sauces, pickles, and chutneys. Dried chilli is used in curry powder. Chilli contains capsaicin, an alkaloid of medicinal value that gives chilli its pungency.

Chilli grows in a warm, humid climate in tropical and sub-tropical areas and at altitudes up to 2,000 metres (Patel, Sahu, and Siwana 2017). Madhya Pradesh is the leading producer in India; its production of 363,399 MT of chilli makes up a 20.64% share (Horticulture

Statistics Division 2018). The other chilli-producing states are Karnataka (19.54%), Bihar (13.12%), Andhra Pradesh (12.64%), and Maharashtra (9.90%).

The north-eastern hilly region (NEHR) of India, considered a major hub for spices (Singh et al. 2020a), is home to niche spice crops, like Lakadong turmeric, bird's eye chilli, king chilli, and Nadia ginger. Their features are unique, and the demand is high (Momin et al. 2018). Inorganic fertilizers and chemicals are used sparingly in the region, and its spices are considered organic and high-quality worldwide (Wani et al. 2017). Nearly 90,500 hectares of land in the region is under organic cultivation, according to an estimate of the Agricultural and Processed Food Products Export Development Authority (APEDA) (Department of Commerce 2017), and around 63.74% of the area in the region under organic farming lies in Sikkim (Table 1).

In north-eastern India, organic farming is practised also in Assam (over 23.71% of the land in the region), Nagaland (5.16%), Meghalaya (3.84%), and Arunachal Pradesh (3.49%) (APEDA 2018), but Sikkim is the only state in the north-east that has been conferred the title of "organic state", in 2016. Sikkim practices indigenous cultivation and produces high-quality spices in large quantities, but less than in the other parts of the country (Das 2016; Momin et al. 2018). In the peak season, many farmers are compelled to sell their produce in the local market at floor prices or to commission agents (Planning Commission 2005).

Table 1 Chilli-growing states in the NEHR, 2017–18

State	Area ('000 ha)	Production ('000 MT)
Meghalaya	2.32 (9.71)	2.35 (2.74)
Mizoram	11.20 (46.88)	10.92 (12.75)
Manipur	0.56 (2.34)	3.70 (4.32)
Nagaland	5.98 (25.04)	44.50 (51.96)
Arunachal Pradesh	0.17 (0.71)	0.21 (0.25)
Tripura	2.49 (10.42)	19.49 (22.76)
Sikkim	1.17 (4.90)	4.47 (5.22)
Total (NEH)	23.89 (100)	85.64 (100)
Total (India)	308.67	3,592.17
% Share of NEH in India	7.74	2.38

Note Figures in parentheses indicate percentage to the total in the NEHR
Source Horticulture Statistics Division (2018)

Chilli is cultivated over an area of 20,750 ha in the north-eastern hilly region (NEHR); the NEHR contributes about 2.12% to the country's production. The demand for processed chilli is increasing, creating opportunities and challenges alike. Fostering rapid growth in agriculture is necessary to augment the income and employment opportunities of the rural people in the region (Birthal et al. 2006). Chilies are exported in the form of chilli powder, dry chilies, pickled chilies, and chilli oleoresins; exports can be improved by meeting the international quality demands, but few growers practise value addition. Most spice-growers are resource-poor; they lack storage facilities and access to market information, and they are compelled to sell their produce to wholesalers immediately after the harvest at local markets at the prevailing prices. The NEHR urgently needs a value chain. This paper attempts to capture the economic benefits of value addition in chilli from production to consumption.

Study area

The study was conducted in the NEHR as part of a project funded by the ICAR. The top chilli producers in the NEHR are Nagaland (51.96%), Tripura, and Mizoram. The area cultivated is highest in Mizoram (46.88%), Nagaland (25.04%), Tripura (10.42%), Meghalaya (9.71%), Sikkim (4.90%), and Manipur (2.34%).

Based on the largest area cultivated with chilli, we selected Mizoram, Meghalaya, and Manipur as non-adopters and Sikkim as the organic adopter (control) (Table 1). We selected from each state two districts with the highest area under chilli cultivation; and we chose from each district two to four major collection centres or blocks. We chose three chilli collection centres from Mizoram and four each from Nagaland and Sikkim (Table 2).

We prepared a list of all the villages in the collection centres and blocks, households, and chilli producers. We selected 243 chilli producers: 75 from Sikkim, 91 from Mizoram, and 77 from Nagaland. Each sample of chilli growers represented at least 10% of the population in the study area (Table 3). To study the chilli value chain, we selected 48 value chain actors: 19 from Mizoram, 16 from Nagaland, and 13 from Sikkim.

Table 2 Sampling plan for major chilli value chain actors

States	Major chilli collection centre/ market	Actors involved in chilli value chains					
		VT	W/WR/VW	R	VPW	FPO	Total
Mizoram	Aizawl	2	2	1	2	1	8
	Champhai	2	2	-	2	1	7
	Khawzawl	1	1	1	1	-	4
	Sub-total	5	5	2	5	2	19
Nagaland	Niuland	-	2	2	-	-	4
	Dimapur	-	2	3	-	-	5
	Jalukie	-	2	3	-	-	5
	Tening	-	1	1	-	-	2
	Sub-total	-	7	9	-	-	16
Sikkim	Ravangla	-	-	-	-	1	1
	Singtam	-	2	2	-	-	4
	Hee Martam (Bermoik)	-	1	3		-	4
	Chongrang	-	2	2	-	-	4
	Sub-total		5	7		1	13
Grand total		5	17	18	5	3	48

Note VT–village merchant; W–wholesalers; WR–wholesaler-cum-retailer; VW-village trader-cum-wholesaler; R–retailers; VPW–village trader-cum-processor-cum-wholesaler; FPO–farmer producer organization

Table 3 Sampling of chilli respondents

States	Districts selected	Villages selected	Chilli respondents	
			Total growers	Selected growers
Sikkim	2	12	751	75
Mizoram	2	14	909	91
Nagaland	2	8	767	77
Total	6	34	2,427	243

Source Household survey 2017–20

Data and analysis

We collected primary data for three years, from 2017 to 2020, using the personal interview approach and a well structured pre-tested schedule. We collected data on land preparation, seed quantity, cultivar used, grower's cost, and cultivation method (adopter or non-adopter of organic farming practices).

We collected data also on the forms in which chilli is disposed of from the farm to value chain actors, and the quantity, price, and cost. Additionally, we ascertained the value added by chilli growers, the conversion ratio of raw chilli into dried and powder chilli, and the determinants of organic cultivation.

To study the apparent economic benefits, we worked out the simple cost and returns by comparing the yield and returns for adopters and non-adopters through a paired t-test. We calculated the factor share input by (1) multiplying the physical quantity of each factor input with its price and (2) dividing the product by the value of the total produce (Dhondyal 1977).

$$FS\_X_i = (P_i X_i)/V_i)$$

Where,

FS_X_i is factor share of ith input

X_i is quantity of ith input

P_i is per unit price of ith input

V_i is total value of produce

We ran a logit regression analysis using SPSS 21 to determine what influences producers to adopt organic farming:

$$\text{logit}(y) = \ln \frac{p}{1-p} = \beta_0 + \beta_1 * x$$

Where,

Y is binomial independent variable, where 1 is 'organic' and 0 'otherwise', and *P* is the probability that a farmer will adopt organic farming.

Mapping the actors in the value chain

Chilli may be raw (green), or dried, or in powder form; the value chain actors dispose of chilli in all these forms to the intermediaries between producers and consumers. We used semi-structured questionnaires to interview the value chain actors, and the producers, and estimate the quantity of the chilli each actor disposed of in each form; and we mapped these quantities by actor in the value chain.

Each actor in the value chain incurs costs in washing, transportation, packaging, packing, loading, unloading, weighing, slicing/cutting, drying, and grinding. We recorded and analysed each cost, by actor and by value added at each stage, and the distribution of margin in the consignment of the commodity along the chain (Acharya and Aggarwal 2004).

Value addition

We categorize value addition into cultivation, processing, disposal, and logistics. Selecting disease-free seeds, spacing plants, and using plant protection measures comprise pre-harvesting value addition—reflected in the yield. Value addition takes place mainly after the harvest. Raw chilli does not attract any form of value addition; it is categorized by variety or cultivar and sold by weight.

Dried chilli needs to be packed (in a variety of sizes), weighed, loaded, unloaded, and transported. Value is added also by grinding the dried chilli and packaging the powder for final consumption. We estimate the costs incurred by the actors, including producers, in performing the activities at each stage of the value chain.

Yield and returns

The yield was higher in Sikkim (2.92 MT/ha) than in the non-adopter states of Mizoram (0.96 MT/ha) and Nagaland (2.61 MT/ha). The break-even point (BEP) was estimated at 0.03 MT (INR 4,624.62), in Mizoram, 0.02 MT (INR 3,100.45) in Nagaland, and 0.02 MT (INR 2,980.20) in Sikkim (Table 4).

A lower BEP signifies better returns. The BEP of chilli was higher (33%) in Mizoram than in Sikkim, the control organic state, and the same as in Nagaland. The Naga chilli is famous worldwide for its high pungency, more than the dale of Sikkim and the bird's eye chilli of Mizoram. Organic cultivation was more beneficial in Sikkim—its BEP was 0.02 MT—and it has enhanced the income of chilli growers (Singh et al. 2020b).

Costs and returns

Chilli is a low-volume crop; farmers earn a higher return, but it varies by state. The production cost per kg in Sikkim, INR 16.35, is 85.00% less than in Mizoram (INR 46.69) but 3.42% more than in Nagaland (INR 15.79). Farmers in Sikkim sold their produce at INR 196.00 per kg, 27.16% more than in Mizoram (INR 143.29 per kg) and 3.50% more than in Nagaland (INR 189.95 per kg), earning a net return of INR 180.85 per kg—46.53% more than in Mizoram

Table 4 Chilli yield and break-even point

Costs	Mizoram	Nagaland	Sikkim
Yield (MT per ha)	0.96 (–67.12)	2.61 (–10.62)	2.92
Break-even price (INR)	4,624.62 (35.56)	3,100.45 (3.88)	2,980.20
Break-even output (MT)	0.03 (33.33)	0.02 (Nil)	0.02

Note Figure in parentheses are percentage differences (increase or decrease) with Sikkim
Source Household survey 2017–20

Table 5 Costs and returns (INR per kg)

Particulars	Organic adopter	Non-adopter	
	Sikkim	Mizoram	Nagaland
Total production cost	16.35	46.69 (64.98)	15.79 (–3.42)
Selling price	196.85	143.39 (–27.16)	189.95 (–3.50)
Net return	180.85	96.69 (–46.53)	174.16 (–3.70)

Note Figures in parentheses are percentage difference (increase or decrease) with Sikkim
Source Household survey 2017–20

(INR 96.69 per kg) and 3.70% more than in Nagaland (INR 174.16 per kg). Organic produce fetched better prices, therefore (Singh et al. 2020a), and farmers in Sikkim benefited more (Table 5).

The paired t-test suggests that the difference in yield and return between organic adopters and non-adopters is significant at 1% level. The difference may be due to the variety, soil type, disease and pest infestation, or cultivation method. The yield and net returns of organic chilli is higher, probably because chili is farmed organically in Sikkim and the demand for its varieties of chilli is higher (Table 6). Singh et al. (2020a) found similar results for another spice crop in Sikkim. Hence, it is concluded that organically produced chilli yields higher net returns.

The difference in yield and return between Sikkim and Mizoram is significant (p≤0.00) (Table 7). The difference in yield between Nagaland and Sikkim is significant, at 5% level of significance. The positive mean difference signifies that the yield was higher in Sikkim, and that organic farming raised net returns and benefited chilli growers.

Factor share analysis

Productivity depends on the factors of production: human labour, seeds, and manure. Human labour has a major weight on yield. The factor share of human labour was highest in Mizoram, where family labour contributes the most to the output. Seeds and manure, too, affected productivity (Table 8), in line with the findings on ginger (Singh et al. 2020 a) and turmeric (Singh et al. 2020 b).

All the crop cultivation activity—from land preparation to harvesting—are performed manually. The high human labour consumption leads to drudgery, and small-size machinery should be developed. Moreover, the share of depreciation in the productivity of chilli was very low in all the selected states, indicating that

Table 6 Organic and conventional chilli farming—yield and returns

Particular	Conventional method		Organic method	Difference (%)	
	Mizoram	Nagaland	Sikkim	Mizoram vs Sikkim	Nagaland vs Sikkim
Yield (MT per ha)	0.96	2.61	2.92	–67.12	–10.62
Returns (INR per kg)	96.69	174.16	180.85	–46.53	–3.70

Table 7 Yield (organic and conventional)

States	Yield			Economic returns		
	Mean difference (kg per ha)	t-value	p-value	Mean difference (INR per ha)	t-value	p-value
Sikkim *vs* Mizoram	1,992.57	15.37	0.000***	440,116.86	13.72	0.000***
Sikkim *vs* Nagaland	336.03	2.47	0.016***	13,005.97	0.38	0.698

Note *** significant at 1% level of probability

Table 8 Factor share analysis of chilli production

Factors of production	Mizoram			Nagaland			Sikkim		
	Value (INR per ha)	INR 143,386.74 per MT	Factor share (%)	Value (INR per ha)	INR 189,954.26 per MT	Factor share (%)	Value (INR per ha)	INR 196,848.20/ MT	Factor share (%)
Output	137,651.27	0.96	100	495,780.61	2.61	100	574,796.75	2.92	100
Seed	11,064.07	0.08	8.03	82,529.61	0.43	16.65	78,116.32	0.40	13.59
Manure	9,372.62	0.06	6.51	11,440.25	0.06	2.31	43,403.69	0.22	7.55
Hired labour	19,522.46	0.14	14.18	63,904.54	0.34	12.89	29,003.54	0.15	5.05
Imputed value of family labour	84,733.46	0.59	61.56	291,299.79	1.53	58.76	379,574.38	1.93	66.03
Depreciation	696.33	0.01	0.50	4,692.51	0.02	0.95	4,502.83	0.02	0.78
Interest on working capital	3,049.16	0.02	2.21	12,192.51	0.06	2.45	11,626.94	0.06	2.03
Rental value of land	9,213.16	0.06	6.69	29,721.75	0.16	5.99	28,569.03	0.14	4.97

tools and implements were not used in the study area, and that farmers should be trained in new techniques and made aware of their importance.

Value chain map of chilli in the NEHR

We discuss the value chain map of chilli in Mizoram, Nagaland, and Sikkim.

Mizoram

Bird's eye chilli was preferred raw, dried, and in powder form, and it was disposed of from producer to consumer (Channel 1); producer to wholesaler or village trader outside Mizoram (to Assam) (Channel 2); producer to wholesaler to retailer- to consumer (Channel 3); and producer to consumer (Channel 4). Most of the chilli was disposed of through Channel 2 (16.33%) and Channel 3 (16.29%).

The dried chilli was disposed of from producer to consumer (Channel 1); producer to village trader-cum-processor-cum-wholesaler to outside Mizoram (Assam) (Channel 2); and producer to retailer to consumer (Channel 3). Most of the dried chilli was disposed of through Channel 2 (12.14%).

The chilli powder was disposed of from producer to consumer (Channel 1) (10.02%) and producer to retailer to consumer (Channel 2) (9.44%).

Therefore, most of the chilli was disposed of raw (53.37%), to meet the high local demand; 27.17% was disposed of dried and only 19.46% in powder form (Figure 1).

Nagaland

Naga chilli is disposed of, and consumed, green (raw) and dried. Through the value chain actors, three marketing channels were identified for disposing of green chilli and two marketing channels for dried chilli. About 68.28% of the produce is disposed of raw just after the harvest from producer to village trader-cum-wholesaler to retailer to consumer (Channel 1, 45.87%); producer to retailer to consumer (Channel 2, 18.76%); and producer to consumer (Channel 3, 3.65%).

The remaining quantity (31.72%) was disposed of dried from producer to village trader-cum-wholesaler to retailer to consumer (Channel 1, 24.43%) and producer to retailer to consumer (Channel 2, 7.29%).
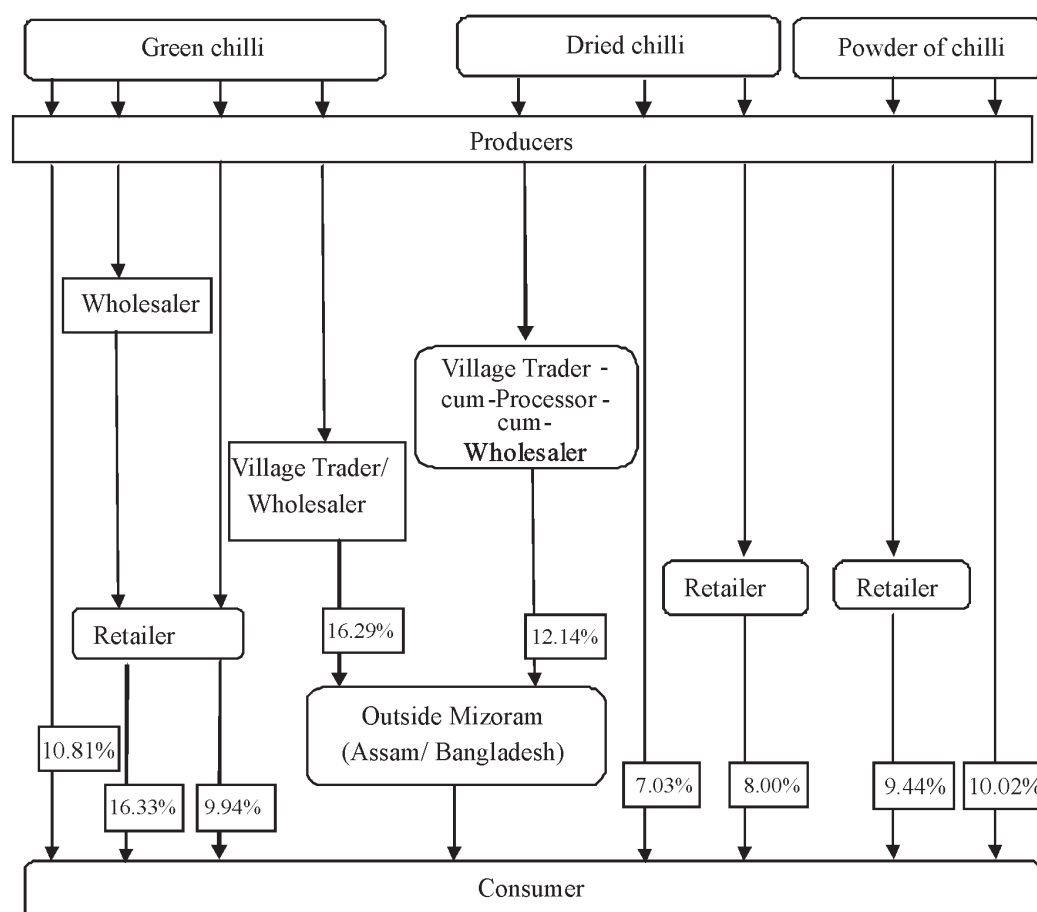
Figure 1 Value chain map of chilli in Mizoram

Channel 1 was most preferred and popular for dry chilli in Nagaland (Figure 2). Hence, there is a huge opportunity in the state for value addition by making powder chilli.

Sikkim

Dale chilli is disposed of green (93.91%) and in pickle form (6.09%). Most producers dispose of green dale chilli at village markets or the roadside or to local companies on contract. In West Sikkim, green chilli is disposed of from producer to wholesaler-cum-retailer to retailer to consumer (Channel 1, 36.36%); producer to retailer to consumer (Channel 2, 19.44%); producer to consumer (Channel 3, 14.41%); and producer to Sikkim Supreme (government agency) (Channel 4, 23.70%). Channels 1, 4, and 2 were preferred for marketing chilli.

Chilli in pickle form (6.09%) is disposed of directly by one channel from producer to consumer (Channel

1). Dale chilli is popular in pickle form (Figure 3).

The value chain map analysis, thus, indicates that bird's eye chilli is preferred green, dried, and in powder form; the Naga chilli of Nagaland is preferred both green and in dried form; and the dale of Sikkim both green, for direct consumption, and in pickle form. Therefore, value chain actors need to tailor their business plan to the forms of the local cultivars preferred in each state.

Value addition and income

Raw (green) chilli

Most growers sell their chilli raw just after the harvest; they or intermediaries do not add value. The producer's share in consumer's rupee was estimated to be higher for chilli growers in Sikkim (84.85%) than in Mizoram and Nagaland (Table 9)—because the chilli of Sikkim is recognized as being organic.
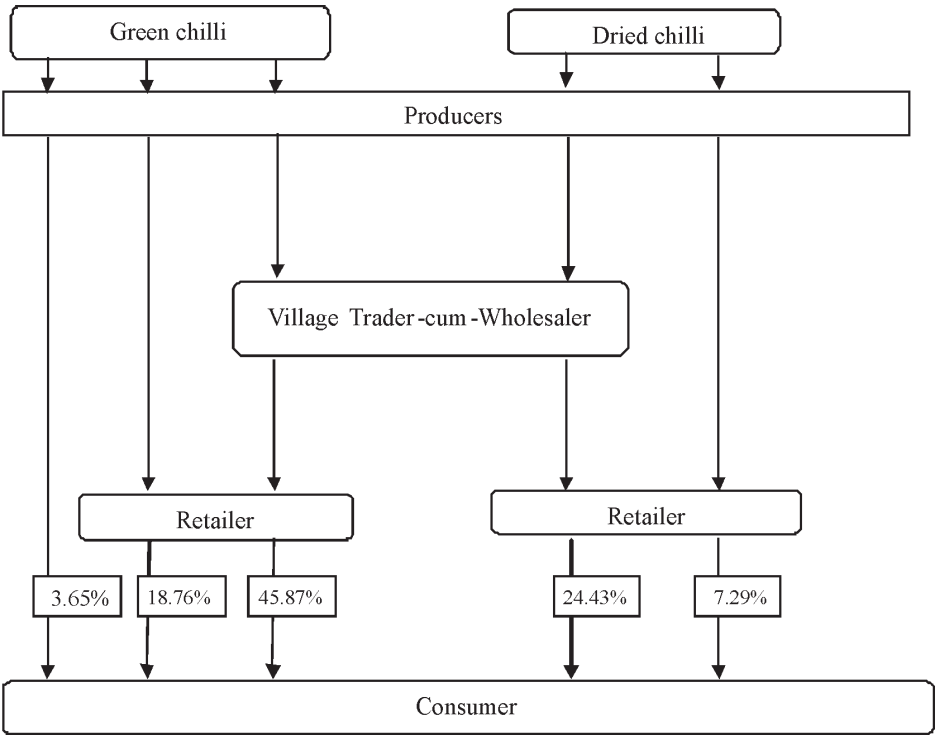
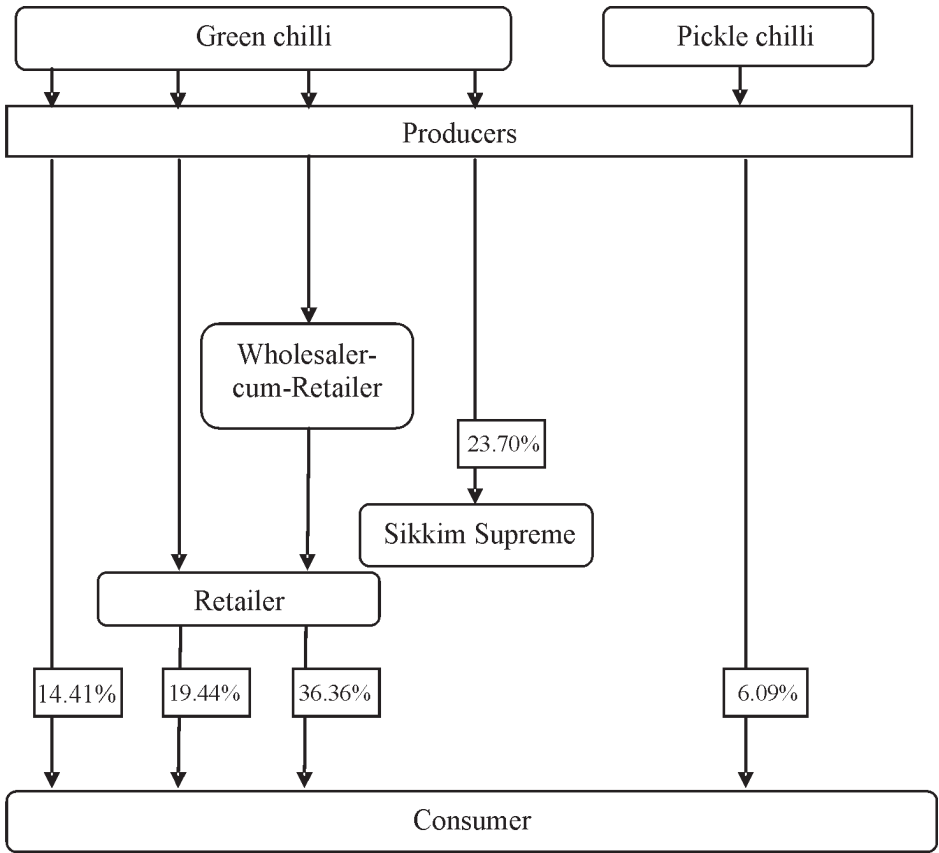**Figure 2 Value chain map of chilli in Nagaland**

Figure 3 Value chain map of chilli in Sikkim

Table 9 Value addition in raw chilli (INR per kg)

Particular	Sikkim	Mizoram	Nagaland
Net price of farmer	208.46	108.11	209.44
Marketing cost	4.31	8.30	4.36
Marketing margin	32.91	67.51	39.82
Consumers' price	245.68	183.92	253.61
Price spread	37.22	75.81	44.18
Producer's share in consumer rupee	84.85	58.78	82.58

Source Singh et al. (2021)

Table 10 Value addition in dry chilli (INR per kg)

	Mizoram	Nagaland
Net price of farmer	405.56	1,271.70
Marketing cost	9.87	5.67
Marketing margin	28.06	197.63
Consumers' price	443.49	1,475
Price spread	37.93	203.30
Producer's share in consumer rupee	91.45	86.22

Source Singh et al. (2021)

Dried chilli

Some growers in Mizoram and Nagaland sell dried chilli, which fetches a higher price than raw chilli. The producer's share in consumer's price was estimated to be higher for growers in Mizoram (91.45%) than in Nagaland (86.22%) (Table 10), but the price spread, or value addition cost, was higher in Nagaland. Consequently, the share was low, but Naga chilli growers fetched a higher price than Sikkim dale growers.

Chilli powder and pickle

The scope for earning more profit is ample for dale chilli (in pickle form) and bird's eye chilli (in powder form). The producer's net price for pickle, INR 400.26 per kg, has a 85.87% share in consumer price (INR 466.11 per kg). The net price of chilli powder, INR 424.36 per kg, has a 93.86% share in consumer price (Table 11).

The raw chilli produced organically in Sikkim fetched a higher price, and value addition, irrespective of the state, raises the price. Therefore, processing, and organic farming, can enhance farmer income.

Table 11 Value addition in powder chilli and pickle (INR per kg)

Particulars	Pickle (Sikkim)	Powder chilli (Mizoram)
Net price of farmer	400.26	424.36
Marketing cost	65.86	15.37
Marketing margin	-	12.40
Consumer's price	466.11	452.13
Price spread	65.86	27.77
Producer's share in consumer rupees	85.87	93.86

Source Singh et al. (2021)

Conclusion

In the NEHR, the cultivation of local cultivars of chilli is profitable: the BEP for dale and naga is only 0.02 MT and for bird's eye 0.03 MT. The net return on organically cultivated chilli is 46.53% higher in Sikkim than in Mizoram and 3.70% higher than in Nagaland. Hence, organically cultivated chilli can enhance the income of farmers in the region.

The factor share analysis suggests that human labour be replaced with machinery. The value chain map analysis suggests that the value chain actors tailor their business plan to the local cultivars and add value to the forms of chilli that have potential in local, regional, and national markets.

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