Crop Diversification and Crop Disposition in India : An Inter - State Analysis

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Abstract

Given the low productivity and earnings of Indian farmers, especially small and marginal landholders, it is pertinent to understand the constraints under which they operate and correspondingly address the same. Amongst several factors, farmers' earnings can also improve through crop diversification and conducive crop disposition channels, which involve fewer middlemen. This way, farmers can capture a greater share of value addition in the supply chain from farm-gate to consumer. With this backdrop, the present paper analyzed two specific objectives. First, to estimate the degree of crop diversification and the prominent ways in which crop disposition takes place across states and union territories (UTs) in India, and second, to analyze the relationship between crop diversification and variants of crop disposition in India. Four crop diversification indices were calculated, namely Gibbs and Martin, Herfindal – Hirschman Index, Simpson Diversity Index, and Bhatia's Index. The paper primarily used GM Index for further analysis. Channels of crop disposition were analyzed through six agencies, that is, local private agents, *mandis*, input dealers, co-operatives and government agencies, processors, and others. Our findings indicated the following : First, crop diversification remained 'low' to 'moderate' for most of the Indian states and UTs. Second, though crop diversification increased for several states and UTs during the two Rounds, the pace of improvement was slow. Third, crop disposition is generally undertaken through private agents. Fourth, the relationship between crop diversification and sale to 'mandis' was positive and significant, while that between crop diversification and 'sale to local private agents' was negative and significant.

Keywords : **crop diversification, crop disposition, agricultural economics, economic policy, and development, India**

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Agriculture plays an important role in employment generation ; however, its contribution to gross domestic product (GDP) remains less, indicating low productivity and well-being of Indian farmers. Amongst several factors, crop diversification and crop disposition also impact the financial well-being of landholding farmers. Their earnings can improve substantially if crop production is diversified, and farmers are able to capture a greater share of value addition in the supply chain from farm-gate to consumer. With this backdrop, in the present paper, we have two specific objectives : First, to estimate the degree of crop diversification and the ways in which crop disposition takes place at the sub-national level in India, and second, to analyze the relationship between crop diversification and variants of crop disposition, wherein it is hypothesized that risk-averse farmers, who sell more in private *mandis* vis-à-vis government agencies shall adopt crop diversification techniques as a risk-mitigation strategy. Crop diversification is primarily a shift from traditionally

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grown less remunerative crops to more remunerative crops, popularly known as high-value crops (HVCs).[1] It helps improve not just farm productivity but also assists the farmers to manage climatic and market risks. Additionally, it helps to maintain a general equilibrium of four important F's, that is, food, fodder, fibre, and fuel (Joshi, Gulati, Birthal, & Tewari, 2004). Undoubtedly, crop diversification is imperative for transforming and reorienting agricultural systems for ensuring food security amidst changing climate conditions (Birthal, Roy, & Negi, 2015).

Presently, local rural markets for diversified crops (also referred to as HVCs) are thin, and trading in distant urban markets is not lucrative due to greater marketing and transaction costs connected with insignificant marketable surpluses (Birthal, Hazrana, & Negi, 2020). Notably, Indian agricultural markets are imperfect, characterized by inadequate infrastructure and information asymmetry, making farmers exposed to exploitation by the intermediaries (Negi, Birthal, Roy, & Khan, 2018). As such, disposing crops through private agents and input dealers is less preferred due to information asymmetries. In fact, disposition of surplus directly in the market/government agencies is preferred.

Though there is a wide array of research on patterns of crop diversification, yet inter-temporal analysis remains largely unexplored. Further, to the best of our knowledge, there have been no studies assessing the relationship between crop diversification and crop disposition. With this backdrop, the present paper aims to study the intertemporal crop diversification patterns at national and sub-national levels over the period from 2003 – 2013, and thereafter, analyze its relation with crop disposition. The paper uses household data from the National Sample Survey Organization (NSSO) database for the 59th (2003) and 70th (2013) Rounds.

Review of Literature

In this section, literature is reviewed from two perspectives, namely the rationale and measurement of crop diversification followed by the relevance of crop disposition.

(1) Crop Diversification : Agriculture is a risky enterprise in most of the developing countries. Agricultural production is highly volatile due to extreme climatic shocks, dynamic markets, and inadequate availability of inputs. Thus, crop diversification may be seen as a hedge against production or market risks. Several studies have suggested that economies with highly diversified cropping patterns tend to have higher agricultural growth (Birthal et al., 2015 ; Kulshrestha & Agrawal, 2019). It can alleviate poverty by reducing the effect of uncertainties, particularly for small and marginal farmers. Crop diversification towards HVCs can help generate higher net returns per unit as compared to food crops (Weinberger & Lumpkin, 2007). It is relevant in the context of small and marginal farmers, who are abundant in labour, but scarce in the availability of land. Small farmers usually prefer HVCs as economies of scale are relatively less significant in comparison to food crops (Birthal et al., 2015). Crop diversification also serves as a climate-smart agriculture practice, especially for the small farmers, and helps them in managing production and price risk. For large farms, diversification may not necessarily be welfare-enhancing due to higher returns associated with specialization.

Crop diversification varies greatly in India between states and households. Studies in India have been conducted with both national-level data (Sudhakar & Gurupandi, 2008) as well as sub-national survey data (Birthal et al., 2015 ; Chhatre, Devalkar, & Seshadri, 2016) using various estimation methods. While some studies measure the land allocated to individual crops (Bittinger 2010), other studies measure the number of crops grown in a particular area (Cavatassi, Lipper, & Winters, 2012). Based on land allocated, studies have constructed indices either based on intra-specific (among crop varieties) or inter-specific (among different crops) crops. Studies that

[1] HVCs include vegetables, fruits, flowers, tea, and coffee that yield higher net returns per unit of land in comparison to staples.

have used the SI index to calculate crop diversification are by De and Chattopadhyay (2010) and Barrett, Reardon, and Webb (2005). Many studies have applied the Composite Entropy Index for assessing the variation in cropping systems, such as Stoeffler (2016) for Austria and Jadhav and Deshmukh (2014) for the Marathwada region of Maharashtra in India. Similarly, few studies, such as by Adjimoti and Kwadzo (2018) and Biswas (2016) estimated the BI of crop diversification. Several studies also adopted the GM technique to analyze the shift from mono - cropping to diversification in cropping patterns across India (Das & Milli, 2012 ; Xu, 2017).

(2) Crop Disposition : Selection of marketing channels remains a crucial decision, especially for small and medium farmers. An efficient market to dispose of the produce has significance for the crop mix as well. Farmers need a conducive environment that allows them to trade directly in the market and understand the demands of the consumers. Efficient crop disposition can increase the farmers' earnings by ensuring better returns on the HVCs portfolio. There is growing evidence that disposing of crops through private agents and input dealers leads to information asymmetry, especially on prices. The middlemen occupy the entire space between the production of crops and the ultimate sale of their produce, putting farmers at a disadvantage (Dutta, 2011 ; Gulati, Kapur, & Bouton, 2020 ; Kaur, Jha, & Mandal, 2014).

Mandis, on the other hand, remain a viable alternative for private trade, providing enhanced marketing options to the farmers. The Government of India launched the Agricultural Produce Marketing Committee (APMC) Act in 2003, with a focus on eradicating farmers' exploitation by intermediaries. However, literature has examined several constraints operational at mandis, such as proximity to mandis and weak bargaining power (Birthal et al., 2015 ; Kaur et al., 2014). Thus, mandis place the small producers with less marketing surplus in a disadvantageous position (Chand, 2012). Rao, Birthal, and Joshi (2006) concluded that farmers located nearer to mandis, via roads, are more engaged in the cultivation of HVCs. Literature confirms that in developing countries, where institutional framework for risk products are under-developed, crop diversification is one of the widely used ex-ante adaptation measures to cope with climatic shocks (Chhatre et al., 2016 ; Negi et al., 2018). Many studies have assessed that in recent technological times, farmers and traders across the country are capable of integrating digital technology and online platforms such as e-Choupal into their marketing practices. When farmers can access various market sites, their bargaining power increases, not only in terms of the selling price, but also in other crucial ways such as lower commissions, precise judgment, and faster payments (Gulati et al.,2020 ; Kaur et al., 2014). Government procurement too is good for the farmers as it provides a sense of security against price volatility. In such institutional settings, though farmers are price takers, they remain covered against price risks. Based on the literature, it can largely be stated that cooperatives and government agencies are better forms of crop disposition followed by mandis with proximity to the villages. Private agents, on the other hand, are the least preferred modes of crop disposition.

Data and Methodology

Crop diversification has been estimated using the following four indices :

(1) Gibbs and Martin Index,

(2) Herfindal – Hirschman Index,

(3) Simpson Diversity Index, and

(4) Bhatia's Index.

Each of the indices are calculated as follows :

(1) Gibbs and Martin's Index (GM) : GM index is calculated by using the following equation :

$$GM_D = \sum_{j=1}^{J}\left(\frac{Y_j^2}{\Sigma_{j=1}^{J}(Y_j)^2}\right) \quad (1)$$

wherein, GM_D represents the Gibbs and Martin crop diversification index, and Y_j represents the percentage of area occupied by each crop in total area. Higher value of the index represents greater crop diversification.

(2) Herfindal – Hirschman Index (HI) : It is calculated by taking the sum of squares of acreage proportion of each crop to the total cropped area. The index is calculated as follows :

$$H_D = \sum_{j=1}^{J}\left(\frac{Y_j}{\Sigma_{j=1}^{J} Y_j}\right)^2 \quad 0 \le H_D \le 1 \quad (2)$$

where,

Y_j represents the area share occupied by the j^{th} crop in total area, and J is the total number of crops. Bounded by zero and one, the HI index decreases with an increase in diversification. Alternatively, it is highest when there is zero diversification (complete concentration).

(3) Simpson Diversity Index (SI) : Simpson Diversity Index is also known as the transformed Herfindahl index. It is determined by subtracting the HH index from 1.

$$SI_i = 1 - \Sigma_{n=1}^{N} (P_n)^2 \quad 0 \le S_D \le 1 \quad (3)$$

where,

SI_I is the Simpson index. N is the number of crops grown by the i^{th} household, P_n is the share of the crop in the total cropped area of the n^{th} crop for the i^{th} household. Bounded between zero and one, a higher index implies greater crop diversification.

(4) Bhatia Index (BI) : It is calculated by taking the sum of squares of acreage proportion of each crop to the total cropped area :

$$BI = \frac{Percent\ of\ sown\ area\ under\ x\ crops}{Number\ of\ x\ crops}$$

BI is inversely proportional to the degree of diversification, that is, higher is the value of the index, lower is the degree of diversification, and vice versa. For identification of '*x*,' only those *'x'* crops are identified whose proportion in overall cultivation is greater than 10%.

For the micro-trends, the paper uses farm-level household data from a nationally representative survey conducted by the National Sample Survey Office (NSSO). Crop diversification indices from NSSO (2003) and NSSO (2013) have been calculated. The surveys focus on the status of farmers and farming in India. For our study, the Situation Assessment Survey (SAS) for both the NSSO Rounds has been used. The unit of measurement is the sample 'household.' The sample size comprised of 51,700 households from 59th Round and 35,200 households

from the 70th Round. The Debt and Investment Survey is a decadal dataset released by the Ministry of Statistical Implementation (MOSPI). The survey adopted stratified random sampling method for choosing households from the selected villages. For the macro trends, data pertaining to the overall area, production, and yield were collated from the Directorate of Economics and Statistics, Ministry of Agriculture.

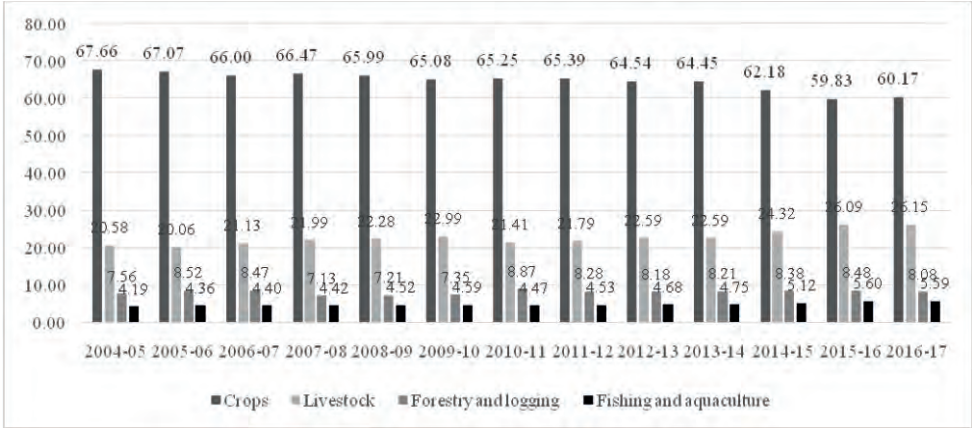
Crop Diversification and Disposition in India : An Inter - State Analysis

India's cropping patterns have changed over time. Changes in dietary preferences, urbanization, socioeconomic factors, government policies, and trade liberalization reforms have led to a shift towards high-value agriculture. In this section, we analyze the crop diversification and crop disposition patterns at the national and state levels.

(1) Crop Diversification - Macro and Micro-Level Trends : The agricultural sector, which consists of crops, livestock, forestry, and fishery contributed about 17% of the total value of output in India in 2017–18 (Ministry of Finance, Government of India, 2017). Within the agricultural sector, crop cultivation dominates. Its share, though declining, has remained high and even presently contributes over 60% (Figure 1). Contribution of livestock, with its share, in general, steadily rising, is followed by the forestry and logging sector. Fishing and aquaculture have been contributing the least to the agricultural sector's output (around 5%). However, inter-state variations exist. For instance, during the period from 2004 – 2017, while the share of the crop sector increased in states and UTs such as Himachal Pradesh, Assam, Delhi, Meghalaya, Lakshadweep, and Nagaland, in other states such as West Bengal and Madhya Pradesh, it remained stagnant. Within the crop sector, 'cereals' had the largest, though declining share, in the crop output. Over the period from 2004 – 2017, their share reduced from 35% to 27%. This decline was often matched by a rise in contribution of the 'fruits and vegetables' sector, especially since 2011.

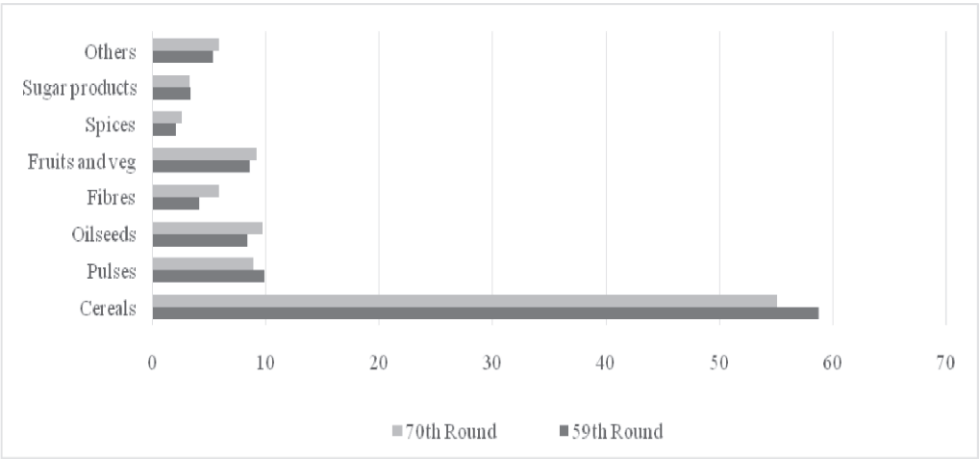
Next, we calculate and analyze the micro-level trends in crop diversification based on evidence from NSSO 59th and 70th Rounds. Figure 2 shows the contribution of various crops in India over the period from 2002-03 – 2012-13. Analysis of Figure 2 reveals that cereal cultivation was dominating the farmers' engagement over the stated period, with the contribution being in excess of 50% in both time-periods. This is followed by pulses. However, the contribution of both cereals and pulses was on a decline. Alternatively, contribution of crops such as oilseeds, fruits, fibers, and spices, though small, was rising, suggesting a movement away from cereals and pulses to alternative crops. However, the transition has been slow.

Figure 1. Composition of the Agricultural Sector in India (in %)



Source : Authors' compilation from *Agricultural Statistics at a Glance 2018.*

Figure 2. Crops Cultivation in India in 2002–03 and 2012–13



Source : Authors' computation from NSSO (2005) and NSSO (2013).

To analyze the shift in the cropping pattern, four crop diversification indices have been calculated for the 59th (2002 – 03) and 70th (2012 – 13) Rounds. Table 1 shows the comparison of crop diversification indices across both the Rounds. At the aggregate level, the crop sector in India does not seem to be much diversified. As per GM and SI, higher the index, greater is the crop diversification. However, for HI and BI, it is the reverse, wherein higher index value implies lower crop diversification. All the four indices of crop diversification constructed indicate an improvement in diversification, though it is highest for GM and SI and least for BI and HI. To substantiate, the GM for the 70th Round is 0.323, which is greater than the index value of 0.190 for the 59th Round.

To further analyze the progress towards diversification from the 59th to the 70th Rounds (2002– 03 to 2012– 13), the crop diversification index has been calculated at the sub-national level. The same are presented in Table 2. Pertinent observations that emerge from Table 2 are as follows :

Table 1. Crop Diversification Index : National Level

Index	***GM***		***SI***		***BI***		***HI***	
Round	59th	70th	59th	70th	59th	70th	59th	70th
Value	0.190	0.323	0.244	0.409	61.17	60.876	0.694	0.677

Source : Authors' calculation based on data from NSSO (2005) and NSSO (2013).

Table 2. Crop Diversification at the Sub - National Level for Major Producing States [2]

		Higher Index, Represents Higher Diversification				**Higher Index, Represents Lower Diversification**			
Sr. No.	**States**	***GM***		***SI***		***BI***		***HI***	
	Rounds	**59th**	**70th**	**59th**	**70th**	**59th**	**70th**	**59th**	**70th**
1	Andhra Pradesh	0.13	0.40	0.25	0.53	67.13	55.83	0.70	0.60
2	Assam	0.15	0.25	0.28	0.37	63.19	63.45	0.83	0.75

[2] Correlations between all four indices have also been estimated. Correlation between GM and SI remains positive and significant, while that between GM and HI (and also BI) remains negative and significant.

3	Bihar	0.14	0.21	0.27	0.33	70.87	75.84	0.78	0.79
4	Chhattisgarh	0.09	0.09	0.22	0.22	84.27	87.17	0.90	0.91
5	Gujarat	0.21	0.45	0.33	0.57	53.09	51.54	0.57	0.55
6	Haryana	0.20	0.44	0.32	0.57	38.21	47.01	0.46	0.56
7	Jharkhand	0.14	0.19	0.27	0.32	72.59	70.30	0.84	0.81
8	Karnataka	0.21	0.36	0.33	0.49	70.16	58.14	0.74	0.64
9	Madhya Pradesh	0.31	0.34	0.43	0.47	56.39	60.66	0.65	0.66
10	Maharashtra	0.27	0.37	0.39	0.50	57.98	57.30	0.64	0.63
11	Odisha	0.06	0.15	0.18	0.27	86.18	79.89	0.92	0.85
12	Punjab	0.14	0.44	0.27	0.57	25.05	41.48	0.35	0.56
13	Rajasthan	0.24	0.39	0.36	0.52	60.26	54.37	0.64	0.61
14	Tamil Nadu	0.09	0.56	0.22	0.68	51.65	39.59	0.54	0.44
15	Telangana	NA	0.31	0.13	0.43	NA	63.53	NA	0.69
16	Uttar Pradesh	0.24	0.35	0.36	0.47	55.55	60.12	0.64	0.65
17	Uttarakhand	0.36	0.45	0.49	0.57	47.67	48.94	0.59	0.55
18	West Bengal	0.13	0.18	0.25	0.31	72.95	77	0.78	0.82

Source : Authors' calculation based on data from NSSO (2005) and NSSO (2013).

↳ For the 70th Round, amongst all the major crop-producing states, our calculated indices show that Tamil Nadu has the highest crop diversification GM index (0.56) followed by Gujarat (0.45), Uttarakhand (0.45), and Haryana and Punjab (both at 0.44). Chhattisgarh, on the other hand, has the lowest GM index at 0.09. West Bengal, Odisha, and Bihar too have low GM index.

↳ With respect to an increase in crop diversification between the two Rounds, according to both the GM and SI index, Tamil Nadu illustrates the maximum change from 59th – 70th Rounds from 0.09 and 0.22, respectively to 0.56 and 0.68, respectively. However, with respect to the BI and HI index, it is Punjab.

↳ While most of the states witness an increase in crop diversification from 59th – 70th Rounds, Chhattisgarh continues at stagnant low crop diversification level GM index of 0.09 (for both time periods). A major reason for lower diversification is due to rice cultivation, which accounts for over 80% of the cropped area. Mono-culture, as witnessed in Chhattisgarh, has led to decreasing productivity, lower fertiliser response ratio, degradation of soil health, and declining returns on cultivation (Ministry of Finance, Government of India, 2017).

Based on the Ministry of Finance, Government of India (2017) data, states and UTs have been categorized into the following three categories of high, medium, and low crop diversification :

(i) High Crop Diversification : GM index 'greater than 0.65.'

(ii) Moderate Crop Diversification : GM index between '0.45 – 0.55.'

(iii) Low Crop Diversification : GM index 'less than 0.45.'

Based on the index value, we too classify states and UTs as having high, moderate, or low crop diversification index (Table 3). In Table 3, crop diversification has been reported for all the states as well as union territories, and not just for the major crop-producing states. Analysis of Table 3 reveals that while 24 states and 5 UTs have low crop diversification (less than 0.45), four states and two UTs have a moderate level of crop diversification.

Amongst all the states and UTs, Puducherry is the only UT which has high crop diversification (greater than 0.65). Thus, based on our findings, 75% of the states and and union territories in India are poorly diversified. It is further observed that there is a moderate level of diversification for only Sikkim, Tamil Nadu, Chandigarh, Delhi, Uttarakhand, and Gujarat.

To analyze the intertemporal behaviour in crop diversification, we also analyze the change in crop diversification in the Indian states and UTs over the period from 2002 – 03 to 2012 – 13. States and UTs for which change in crop diversification index 'increased by 65% or more' have been classified as 'leaders' in adopting crop diversification strategies. States and UTs for which change in crop diversification index lies 'between 45 – 65%' are considered to be 'emerging leaders,' while states and UTs for which the change in crop diversification index is 'less than 45%' over the period or where the index has fallen are classified as 'laggards.'

Five leaders for which the index increased by over 65% are Punjab, Chandigarh, Delhi, Tamil Nadu, and Puducherry. Additionally, crop diversification increased in 23 states and four UTs. This illustrates that the majority of states and UTs are putting in efforts to move away from crop specialization and embrace crop varieties. Lakshadweep and Telangana, as laggards, have shown slow progress towards crop diversification as the change is less than 45%. For Nagaland and Chhattisgarh, the situation is grim, as no change in the index value is observed.

Table 3. Classification of States and Union Territories According to the Diversification in Cropping Pattern

Level of Crop Diversification		Inter – Temporal Change in Crop Diversification		
Index Range	**States and Union Territories**	**Classification**	**Range**	**States and Union Territories**
High : Greater than 0.65	Puducherry	Leaders	Increase in crop diversification greater than 65%.	Punjab, Chandigarh, Delhi, Tamil Nadu, Puducherry
Moderate : Between 0.45 – 0.55	Sikkim, Tamil Nadu, Chandigarh, Delhi, Gujarat, Uttarakhand	Emerging Leaders	Increase in crop diversification between 45 – 55 %.	Haryana, J&K, Himachal Pradesh, Uttarakhand, Rajasthan, Uttar Pradesh, Bihar, Sikkim, Arunachal Pradesh, Manipur, Mizoram, Tripura, Meghalaya, Assam, West Bengal, Jharkhand, Odisha, Madhya Pradesh, Gujarat, Daman & Diu, D&N Haveli, Maharashtra, Andhra Pradesh, Karnataka, Goa, Kerala, A&N Islands
Low : Less than 0.45	Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Rajasthan, Bihar, Uttar Pradesh, Tripura, Meghalaya, Assam, West Bengal, Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, Daman & Diu, D&N Haveli, Maharashtra,Andhra Pradesh, Karnataka, Goa, Lakshadweep, Kerala, A&N Islands, Telangana	Laggards	Increase in crop diversification less than 45% / Decline in crop diversification index.	Lakshadweep, Telangana Nagaland, Chhattisgarh

Source : Authors' computation from NSSO (2005) and NSSO (2013).

Needless to say, both states need to reorient their agricultural policies, not just to meet changing consumer requirements, but improve their earning capacity as well.

(2) Crop Disposition : According to the 70th Round of NSSO survey, out of the total crop disposed through six agencies, that is, local private agents, mandis, input dealers, co-operatives and government agencies, processors, and others, disposition through local private agents was maximum at 57.2%. This is followed by mandis, where 25% of the total crop was disposed. Disposition through input dealers was at 6.7%. Disposition through

Table 4. Crop Diversification and Crop Disposition Across States and Union Territories of India (%)

Sr. No.	States and Union Territories	Crop Diversification	Local Private Agents (1)	Mandis (2)	Input Dealers (3)	Co-operative & Govt. Agencies (4)	Processors (5)	Others (6)
		Gibbs and Martin Index[3]	Disposition of Crops Through Agency at State Level					
1	Puducherry	69	78.57	3.57	0.00	17.86	0.00	0.00
2	Sikkim	58	46.96	29.28	2.09	17.49	0.00	4.18
3	Tamil Nadu	56	69.06	17.33	2.54	8.71	1.35	1.01
4	Chandigarh	54	5.00	85.00	0.00	0.00	0.00	10.00
5	Delhi	48	9.09	90.91	0.00	0.00	0.00	0.00
6	Uttarakhand	45	22.15	25.5	13.42	16.11	20.13	2.68
7	Gujarat	45	67.58	8.44	6.54	16.4	0.76	0.28
8	Punjab	44	18.13	56.98	0.86	18.99	3.31	1.73
9	Haryana	44	23.83	58.01	3.32	8.4	5.08	1.37
10	Meghalaya	42	34.38	50.73	12.44	1.86	0.29	0.29
11	Kerala	41	86.24	3.07	1.11	5.87	0.53	3.17
12	Andhra Pradesh	40	75.18	10.61	9.51	1.30	1.30	2.10
13	Himachal Pradesh	39	44.71	48.00	3.29	0.24	1.18	2.59
14	Rajasthan	39	48.55	43.37	5.3	0.6	1.57	0.6
15	Maharashtra	37	50.96	36.37	3.22	6.94	1.54	0.97
16	Karnataka	36	49.54	33.24	4.59	7.62	2.96	2.05
17	A & N Islands	36	72.68	4.12	0.00	11.34	0.52	11.34
18	Uttar Pradesh	35	44.27	27.67	11.11	7.98	6.79	2.17
19	Mizoram	35	67.47	5.95	5.02	0.19	0.93	20.45
20	Madhya Pradesh	34	45.77	37.66	11.57	3.41	0.59	1.00
21	Arunachal Pradesh	33	66.42	12.77	0.73	0.00	0.00	20.07
22	Jammu & Kashmir	31	74.51	15.38	6.15	0.00	0.88	3.08
23	Telangana	31	46.86	15.65	27.09	7.78	1.78	0.84
24	Goa	26	32.14	0.00	0.00	64.29	0.00	3.57
25	Assam	25	69.03	18.84	4.69	0.09	3.77	3.58
26	D & N Haveli	25	77.78	22.22	0.00	0.00	0.00	0.0
27	Bihar	21	57.79	10.13	11.73	8.12	0.67	11.56
28	Manipur	20	75.58	10.74	4.09	0.00	2.81	6.78

[3]For easy comparison with crop disposition, the index has been multiplied by 100.

29	Jharkhand	19	50.6	39.29	5.95	2.08	0.60	1.49
30	Daman & Diu	19	80.00	20.00	0.00	0.00	0.00	0.00
31	West Bengal	18	74.87	18.78	2.61	0.64	1.07	2.03
32	Tripura	16	67.76	21.58	6.06	1.09	0.48	3.03
33	Odisha	15	74.45	12.83	3.32	5.86	1.00	2.54
34	Nagaland	9	65.88	17.65	8.82	0.00	0.00	7.65
35	Chhattisgarh	9	69.65	20.74	2.62	4.59	0.00	2.62
36	Lakshadweep	2	52.00	0.00	0.00	3.00	0.00	28.00
	Total		**57.2**	**25.00**	**6.70**	**5.80**	**2.20**	**3.00**

Source : Authors' computations based on NSSO (2013).

co-operatives and government agencies was a mere 5.8%. A negligible share of the crop was disposed through others (3%) and processors (2.2%). Table 4 represents diversification and disposition through various agencies at the sub-national level.

Few observations that emerge from Table 4 are as follows :

↳ **Private Agents :** Crop disposition through private agents was highest for Kerala (80%), with crop diversification of 40%. Twenty - five states out of the 28 states and five UTs out of eight UTs had more than 40% of the crops disposed of through private agents. Chandigarh had the lowest disposition through private agents, which was at 5% and with a crop diversity of 54%.

↳ **Mandis :** Delhi recorded the highest sale of produce through mandis at over 90% (with crop diversification of 48%) followed by Chandigarh, with 85% of crop disposed of through mandis (with crop diversification of 54%).

↳ **Input Dealers :** Crop disposition through input dealers was highest for Telangana at 27%, with crop diversification of 31%. It has been observed that eight states had no disposition through this market channel.

↳ **Co-operatives and Government Agencies :** Disposition through cooperative and government agencies was highest for Goa (64.29%) with crop diversification of 26%. Similarly, 19% of Punjab's farmers accessed government agencies to dispose of their produce. Their crop diversification is at 44%.

↳ **Processors and 'Others' :** Uttarakhand is the only state where more than 20% of the crop was disposed through processors. All other states recorded less than 5% of disposition through this channel. Similarly, Mizoram is the only state to record 20% of the crop disposition through 'others.' All other states and UTs observed less than 12% of disposition through this channel.

Majority of the states and union territories with a moderate and high level of crop diversification accessed government agencies. However, the share of local private agents for disposition of produce remains, in general, highest at the sub-national level. For estimating the relationship between crop diversification and crop disposition through various agencies, a correlation matrix, along with the significance level, has been computed. The same is reported in Table 5. Based on Table 5, our findings reveal the following :

(i) The correlation coefficient between crop diversification and sale to mandis is positive and significant, implying that farmers disposing a greater share of their crops to mandis diversify more. Since farmers have to carry

Table 5. Correlation Matrix Between Crop Diversification and Crop Disposition

	Crop Diversification	Local Private Agents	Mandis	Input Dealers	Coop & Govt. Agency	Processors	Others
Crop Diversification	1						
Local Private Agents	–0.3398**	1					
Mandis	0.3548**	–0.7764**	1				
Input Dealers	–0.0665	–0.1115	–0.0712	1			
Coop & Govt.	0.1948	–0.2487	–0.2318	–0.1014	1		
Processors	0.1606	–0.3234*	0.062	0.3334**	0.1106	1	
Others	–0.3065*	0.0657	–0.306*	–0.1822	–0.1231	–0.1358	1

Source : Authors' computation from NSSO (2013).

Note. ***, **, * refer to significance at the 1%, 5%, and 10% levels, respectively.

their produce to mandis, which may be far-away from the village, *a priori*, knowing the price at which their produce will command in the mandi is not possible, especially for small holders who are not connected with e-marketing channels. As a risk-mitigation strategy, such information price asymmetries probably make farmers diversify crops.

(ii) The correlation coefficient between crop diversification and sale to local private agents is negative and significant, implying that farmers disposing a greater share of their crops to private dealers diversify less. Selling more of few crops is expected to increase the bargaining power of farmers to get the right price for their produce. Similarly, the correlation between crop diversification and sale to input dealers is negative and significant. This too seems logical as it motivates the private dealers to enter into an agreement with the farmers when the expected produce is concentrated and not diversified.

(iii) The relationship between crop diversification and crop disposition through co-operatives and government agencies is positive, though non-significant.

(iv) Further, the correlation between co-operatives and government agencies with all other variants of crop disposition remains negative, viz., local private agents, mandis, input dealers, others, and processors.

The literature on crop disposition suggests that government procurement provides a sense of security against price volatility to the farmers. However, in no state government, procurement exceeded 20% of the overall produce (except Goa, a union territory). Further, our estimates from NSSO data indicate that the sale of crops was highest to local private agents. In fact, for several states and UTs, over 70% of the produce was disposed of through private agents. These states and UTs are Kerala, Tamil Nadu, Andhra Pradesh, Assam, Jammu and Kashmir, Manipur, West Bengal, Odisha, Puducherry, and Chhattisgarh.

Conclusion and Policy Implications

Given the low productivity and earnings of Indian farmers, especially small and marginal landholders, it is pertinent to understand the constraints under which they operate and correspondingly address the same. Amongst several factors, farmers' earnings can also improve through crop diversification and conducive crop disposition channels, which involve fewer middlemen. This way, farmers are able to capture a greater share of value addition in the supply chain from farm-gate to consumer.

With this backdrop, the following has been analyzed in the present study. First, the extent of crop diversification in states and union territories of India and changes in the same from 2003 – 2013. Second, the study analyzes the ways in which crop disposition takes place across states and UTs of India ; and, finally, the study examines the relationship between crop diversification and variants of crop disposition. For the micro-trends, farm-level household data from the 59th and 70thRounds of NSSO has been analyzed. For the macro-trends, data were collated from the Directorate of Economics and Statistics, Ministry of Agriculture. Four crop diversification indices have been calculated, namely Gibbs and Martin, Herfindal – Hirschman Index, Simpson Diversity Index, and Bhatia's Index. However, for further analysis, only the GM Index has been used.

Important findings of the study are : Crop diversification remains 'low' to 'moderate' for most of the Indian states and UTs. Though diversification increased for several states and UTs during the two Rounds, the pace of improvement has been slow. With respect to crop disposition, our findings reveal that it is generally undertaken through private agents. Government as an agency for disposition in none of the states and UTs exceeded 20% of the overall produce. Also, in the context of the relationship between crop diversification and crop disposition, our two main findings are that the relationship between crop diversification and sale to 'mandis' is positive and significant, while that between crop diversification and 'sale to local private agents' is negative and significant. Based on our findings, important implications for policy are hereby provided.

To hasten the pace of crop diversification towards high-value crops, the road map should focus on investment in physical infrastructure such as improved irrigation facilities, access to institutional credit, investment in technology development and dissemination, better logistics and storage facilities, and marketing of produce through concerted public sector support (Asia and the Pacific Division, International Fund for Agricultural Development, 2011 ; Gulati et al., 2020). The Government of India has taken several measures to bridge the existing gaps by introducing policies such as crop diversification programme for promoting diversification in major paddy growing states, soil health management for improving crop productivity, Pradhan Mantri Krishi Sinchayee Yojana for enhancing water use efficiency and availability for the crops, Kisan credit cards (KCC) for institutional credit availability for small farmers, and Fasal Bima Yojana for insuring the farmers for crop yields.

With respect to crop disposition strategies to effectively increase farmers' earnings, there is a need to strengthen marketing channels and improve marketing infrastructure. In this context, option of strengthening the government procurement channel needs to be explored as it provides a sense of security against price volatility to the farmers. It also enables the government to procure grains for subsidised food distribution. Several measures have been taken by the government to extend marketing support to farmers by introducing policies such as investment in Agri-Market Infrastructure Fund for upgrading marketing infrastructure, and rural infrastructure development through concerted policies such as Pradhan Mantri Gram Sadak Yojana for rural roads, Gramin Bhandaran Yojana for storage and e-markets (Bandaru, 2019), and information kiosks for technology and information dissemination. These measures, though in the right direction, need to be strengthened.

Limitations of the Study and Scope for Further Research

This research could be extended by empirically analyzing the micro-economic determinants which increase the probability of crop diversification by households in the states and union territories of India, wherein market disposition mechanisms are also considered as an explicit variable. Further, the impact of crop diversification and crop disposition on the earnings of the farm households can be analyzed using appropriate econometric tools.

Authors' Contribution

Prof. Simrit Kaur and Cheshta Kapuria designed and implemented the research, analyzed the results, and prepared

the manuscript. Additionally, Prof. Simrit Kaur conceived the idea and supervised the research paper and Cheshta Kapuria extracted the data from NSSO.

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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