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## Characteristics and Performance of Agricultural Households Diversifying to High Value Crops: Evidence from Rural India

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### ABSTRACT

A plethora of empirical studies from Africa, Asia and Southeast Asia have shown that diversification to high value crops (HVC) is a win-win strategy in terms of its significant positive effects, *inter alia*, on income, employment, food and nutritional security and gender equality. Crop diversification also helps in environmental protection and adaptation to climate change; checks degradation of natural resources including soils and contributes towards attaining eight out of the seventeen sustainable development goals. It is, therefore, important to understand salient characteristics and performance of agricultural households diversifying to such crops to devise suitable strategies to promote crop diversification. This study, using data from situation assessment surveys of 2012-13 and 2018-19, brings out distinguishing characteristics of households diversifying to HVCs and compares their performance in terms of net returns, household income, and consumption expenditure, extent of income inequality and incidence of poverty with non-diversifiers.

**Key Words:** Agricultural Households; Diversification; High Value Crops; Income; Poverty

**JEL:** J43, Q10, Q12

### I

### INTRODUCTION

In theoretical literature, crop diversification by an agricultural household is adopted as a strategy either to minimise risk arising out of uncertain weather and concomitant risks or to increase income and earn profits (Kumar *et al.*, 2002; Quiroz and Valdés, 1995). With augmentation of irrigation facilities, increased availability of high yielding disease resistant short duration crop varieties and other means of risk minimisation like crop insurance, crop diversification is being increasingly adopted as a strategy to enhance income and maximise returns. Crop diversification has been variously defined as an addition of more crops to the existing cropping pattern, replacement of low value crops with high value crops usually fruits and vegetables, growing mixed varieties of a spices in a monoculture, temporal diversity through crop rotations, and so on (Feliciano, 2018). Studies on the sources of growth in Indian agriculture have shown that technology and crop diversification are the two important sources of India's agricultural growth since 1980s (Joshi *et al.*, 2006; Birthal *et al.*, 2014; Kumar *et al.*, 2020; Sharma, 2023). Crop diversification towards high value disease resistant and climate resilient cash crops is, therefore, advocated as one of the strategies to enhance farmers income (Chand, 2017a, b; Saxena *et al.*, 2015).

A plethora of empirical studies, both from India and abroad particularly from Africa and Southeast Asia, are available on the extent and effect of crop diversification on income, employment, poverty, food availability, nutritional security and diversity of food basket, commercialisation, environment and resource use, and so on. For example, it has been shown that crop diversification enhances income and yields

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higher returns (Ali, 2002; Joshi *et al.*, 2004; Benziger, 1996; McCulloch and Ota, 2002; Sharma, 2005 and 2011; Makate *et al.*, 2016; Bravo-Ureta *et al.*, 2006; Perz, 2004; Huang *et al.*, 2009; Basantaray and Nancharaiiah, 2017); helps in environmental protection and checks degradation of natural resources including soils (Lin, 2011; Perz, 2004; Joshi *et al.*, 2004; Chand, 1996); enhances employment opportunities (McCulloch and Ota, 2002; Weinberger and Genova, 2005; Dolan *et al.*, 1999; Dolan and Sorby, 2003; von Braun, 1995; Ali and Abedullah, 2002; Abedullah and Farooq, 2002; Weinberger and Lumpkin, 2007; Joshi *et al.*, 2003); promotes diversity of food and nutritional security (Nugendi, 2013; Jones *et al.*, 2014; Kabunga *et al.*, 2014; Anwer *et al.*, 2019; Ali and Abedullah, 2002; von Braun, 1995; Makate *et al.*, 2016; Douxchamps *et al.*, 2015; Bennet, 1941); reduces poverty (McCulloch and Ota, 2002; Malik, 2003; Weinberger and Lumpkin, 2007; Goletti, 1999; BIRTHAL *et al.*, 2005; 2015; Waha *et al.*, 2018; Zeba and Shazia, 2016; Perz, 2004; Thapa *et al.*, 2018; Barghouti *et al.*, 2005; Zezza and Tasciotti, 2010); contributes towards commercialisation and development of rural economy (Pingali and Rosegrant, 1995; von Braun, 1995; Minot, 2002; Minot and Naggi, 2004; Minot and Roy, 2006; Weinberger and Genova, 2005; Deshingkar *et al.*, 2003); helps adaptation to climate change to minimise its adverse effects (Lin, 2011; Antwi-Agyei, 2013; Joshi *et al.*, 2004; Mijatovic *et al.*, 2013; BIRTHAL and Hazrana, 2019); promotes protection against pests and diseases and reduces market fluctuations leading to sustainable production and increased crop productivity (Makate *et al.*, 2016; Nugendi, 2013; Lin, 2011); leads to gender equality (Joshi *et al.*, 2004; Snapp and Fisher, 2015) and is ecologically cost effective and easier way of reducing uncertainties among small holders (Nugendi, 2013; Mishra and El-Osta, 2002). In brief, diversification towards high value crops (HVCs) including fruits and vegetables is a win-win situation and, as pointed out by Feliciano (2018), contributes towards attaining eight out of the seventeen sustainable development goals, namely, no poverty (SDG1); zero hunger (SDG 2); gender equality (SDG5); decent work and economic growth (SDG 8); reduced inequality (SDG10); sustainable production (SDG 12); climate action (SDG 13); and life on land (SDG 15).

The above cited empirical studies from Africa, Asia and Southeast Asia have brought out multiple positive effects of crop diversification. The studies have also shown that the extent of crop diversification is higher among marginal and small farmers as compared to their medium and large counterparts because of, *inter alia*, their comparative advantage in terms of the availability of cheap labour resulting in low cost of production. Furthermore, more recent developments such as demand driven crop diversification due to rising incomes, favourable effect of crop diversification on income, employment and poverty, huge export potential of high value crops like fruits and vegetable, stricter quality and safety standards like enforcement of traceability, sanitary and phytosanitary (SPS) measures, emergence of retail cold supply chain facilities, increasing mechanisation of different crop operations and the emergence of agro-processing industries adding value to these crops have incentivised the medium and large households to adopt crop diversification as an income enhancing strategy. The data, however, shows that around one-fifth of the total households have only diversified their cropping patterns towards HVCs. Again, available studies while bringing out positive effects of crop diversification to

HVCs on income, employment and poverty have not adequately discussed the distinguishing characteristics of households who have adopted crop diversification as a strategy to enhance their income vis-a-vis those who have not diversified to such crops.

Against this background, the present study discusses the (i) Selected socio-economic characteristics of households who have diversified their cropping patterns to HVCs as compared to those who have not diversified to such crops; (ii) The effect of crop diversification on net returns, income, consumption, poverty and income inequality; (iii) Factors including crop diversification affecting household income and the probability of a household to opt for diversification to HVCs and escape poverty. The study is divided into six sections. Section II presents source, type and comparability of data and the methods used in the study. Section III discusses the selected socio-economic characteristics, accessing of technical knowhow from different sources and disposal of marketed surplus by these two categories of households. The cost of cultivation and gross and net returns per hectare at constant prices, expenditure on different inputs including borrowing from institutional and non-institutional sources for these two categories of households have been presented in Section IV. Section V discusses household income, consumption expenditure, incidence of poverty and the extent of income inequality among those who have diversified to HVCs and those who have not diversified to high value cash crops. The results of the linear regression and logit regression models are discussed in Section VI. Summary and broad policy insights emanating from the study are given in Section VII.

## II

### DATA AND METHODS

As mentioned above, the study uses unit level data from two rounds of national sample surveys (NSSO) pertaining to the years 2012-13 and 2018-19. The NSSO in its 70th round survey conducted during January-December, 2013 collected data from 70,170 households from a total of 4529 sample villages. Similarly, the 77<sup>th</sup> round survey (July-December 2018) collected data from 58035 sample agricultural households in the first visit and from 44770 sample agricultural households in the second visit (January-June 2019) from the same set of sample households. A comparison of the definitions and concepts used in these two surveys reveals that data from these rounds is broadly comparable. In the 70th round, an agricultural household is defined as 'agricultural production unit' which produces field crops, horticultural crops, livestock and the products of any of other specified agricultural activities with or without possessing and operating any land receiving value of produce more than Rupees 3000/- from agricultural activities and having at least one member self-employed in agriculture either in the principal status or in the subsidiary status during the last 365 days. There is no change in the definition of an agricultural household in the 77th round survey except that the value of the produce received from agricultural activities by an agricultural household has been increased to Rupees 4000/- to account for inflation during the period. It may, however, be mentioned here that like previous rounds households receiving income entirely from coastal fishing, activity of rural

artisans, and agricultural services were not considered and kept outside the scope of 77th round NSS round.

For the present study, we have divided all agricultural households into two categories, namely, diversified households and non-diversified households. While the diversified households are those who are growing HVCs like vegetables, fruits, condiments and spices, flowers, aromatic and medicinal plants, and plantation crops, all other households are considered non diversifiers. Using unit level data from 70<sup>th</sup> and 77th round situations assessment surveys and removing outliers, we have calculated Gini ratio and coefficient of variation to measure the extent of income inequality among both the categories of households. The method to identify outliers has been given in Appendix 1. Further, using the unit level data from the latest NSSO 77<sup>th</sup> round and removing outliers from the cross sectional data, we have estimated OLS regression model to quantify the effect of different factors on household income. Using the same data set, two separate logit regression models have also been estimated by maximum likelihood method to identify factors affecting the probability of a household falling below the poverty line and diversifying to high value crops. Equation 1, gives the forms of OLS regression equation. We have checked for the presence of heteroskedasticity and multicollinearity in the OLS model by applying white's heteroskedasticity test and variance inflation factor (VIF) test, respectively. The model was found to be free from the problem of multicollinearity, but it had the problem of heteroskedasticity. Therefore, robust standard errors are calculated for determining the significance of individual regression coefficients and hence R-Square and not Adjusted R-Square is reported in the table containing regression results. Further, augmented regression model was used, where we regressed predicted residuals on all the independent variables, to check for the presence of endogeneity. And the result did not suggest presence of endogeneity in the model. Equation 2 and 3 give logit regression model with poverty as a binary dependent variable, and logit regression model with diversification as a binary dependent variable, respectively.

$$\begin{aligned} \text{Income} = & \alpha + \beta_1(\text{diversification}) + \beta_2(\text{age}) + \beta_3(\text{literacy}) + \\ & \beta_4(\text{socialgroup}) + \beta_5(\text{irrigatedland}) + \beta_6(\text{access to technical advice}) + \\ & \beta_7(\text{Income from wages \& salary}) + \beta_8(\text{Income from non -} \\ & \text{farm business}) + \beta_9(\text{Income from livestock farming}) + \\ & \beta_{10}(\text{Aware about MSP}) + \beta_{11}(\text{Membership of farmers' organisation})....(1) \end{aligned}$$

$$\begin{aligned} \text{Poverty} = & \alpha + \beta_1(\text{diversification}) + \beta_2(\text{age}) + \beta_3(\text{caste}) + \beta_4(\text{literacy}) + \\ & \beta_5(\text{irrigation}) + \beta_6(\text{institutionalcredit}) + \beta_7(\text{technicaladvice}) + \\ & \beta_8(\text{MSPawareness}) \dots (2) \end{aligned}$$

$$\begin{aligned} \text{Diversification} = & \alpha + \beta_1(\text{age}) + \beta_2(\text{literacy}) + \beta_3(\text{caste}) + \\ & \beta_4(\text{agriculturaltraining}) + \beta_5(\text{irrigation}) + \beta_6(\text{accesstomarket}) + \\ & \beta_7(\text{FarmerProducerOrganisationmembership}) + \beta_8(\text{MSPawareness}) + \\ & \beta_9(\text{technicaladvice}) \dots (3) \end{aligned}$$

Marginal effects have been calculated after estimation of equation 2 and 3 to quantify the effect of change in independent variables on the probability of respective dependent variables.

## III

## SELECTED CHARACTERISTICS OF DIVERSIFIERS AND NON-DIVERSIFIERS

Table 1 presents the selected characteristics of the agricultural households diversifying to high value crops and those who are not diversifying to such crops. Table shows that the proportion of marginal households is higher among those who are diversifying to high value crops as compared to those who are not diversifying to such crops. Further, between 2012-13 and 2018-19, while proportion of marginal households diversifying to high value crops increased significantly from around 67 per cent to 71 per cent, there was a decrease in the proportions of small and large households diversifying to these crops. The higher proportion of marginal households diversifying to high value crops has also been brought out by the earlier studies in the literature (Birthal, *et al.*, 2013; 2015). Regarding different socio-economic characteristics, the age of the head of the households among diversifying households is higher as compared to non-diversifying households. Similarly, the proportions of households belonging to scheduled tribe, other categories, the heads of households who have primary, middle, secondary and above graduation education and those who have received training in agriculture are significantly higher among households growing high value crops as compared to those who are not growing these crops. There is, however, no significant difference in household size and proportion of male headed and female headed households in the two categories of households. In the literature on crop diversification, Ali and Hau (2001) have shown that the adopters of vegetable cultivation in Bangladesh are better educated and technically informed/trained and have low amount of land and higher family labour. Similarly, Ali and Abedullah (2002), using data from some Asian countries, namely, South Vietnam, Cambodia, Laos, and Bangladesh have also shown that vegetable growers have smaller land size and that the heads of such households are better educated.

TABLE 1. SOME SELECTED CHARACTERISTICS OF DIVERSIFIERS AND NON DIVERSIFIER AGRICULTURAL HOUSEHOLDS IN RURAL INDIA; 2012-13 TO 2018-19

Characteristics (1)	(per cent)			
	Diversifiers		Non- Diversifiers	
	2012-13 (2)	2018-19 (3)	2012-13 (4)	2018-19 (5)
Land size category				
Marginal (0.001-1 hectare)	67.39	71.26	67.31	68.30
Small (1-2 hectare)	19.08	17.54	18.06	18.87
Large (More than 2 hectares)	13.53	11.19	14.63	12.82
Total households	100 (19.40)	100 (18.70)	100 (63.70)	100 (69.50)
Household size (Number)	5.13	4.80	5.12	4.90
Age of the household head (Years)	49.37	51.20	47.94	49.60
ST households (per cent)	16.14	17.21	13.43	14.02
SC households (per cent)	12.77	12.81	16.28	15.84
OBC households (per cent)	40.63	39.94	46.35	47.22
Others households (per cent)	30.47	30.04	23.94	22.92
Male headed families (per cent)	91.95	91.82	91.87	90.96
Female headed families (per cent)	8.05	8.17	8.13	9.02
Households possessing job cards (per cent)	47.03	47.37	43.71	41.36
No Education (per cent)	29.51	29.00	44.39	37.83
Upper primary/middle education (per cent)	49.47	43.00	37.73	38.85
Secondary education (per cent)	16.42	21.65	14.36	18.16
Graduate and above (per cent)	4.60	6.35	3.52	5.17
Received training in agriculture (per cent)	2.55	3.07	2.73	1.19

Source: Computed by the authors using unit level data from 70th (2012-13) and 77th (2018-19) round of NSSO surveys. Note: Values in parentheses are number of households in millions

The information on different sources of technical knowhow accessed by households diversifying to high value crops and those not diversifying to such crops has been given in Table 2. As may be seen from the table, the proportion of households accessing technical knowhow from sources such as extension agents, krishi vigyan kendras, agricultural university/colleges, private commercial agents, radio/TV/newspaper/internet is higher among households of the former category as compared to households of the latter category. For example, the proportion of diversified households who access technical know how from any of the various

TABLE 2 SOURCES OF TECHNICAL KNOWHOW ACCESSED BY DIVERSIFIERS AND NON DIVERSIFIER AGRICULTURAL HOUSEHOLDS IN RURAL INDIA; 2012-13 TO 2018-19

Variables (1)	Diversified		Non- Diversified	
	2012-13 (2)	2018-19 (3)	2012-13 (4)	2018-19 (5)
Access to Technical Advice from				
Extension Agent	8.80	5.21	6.67	3.68
Krishi Vigyan Kendra	6.03	2.77	2.80	1.31
Agricultural University /College	2.00	0.85	1.21	0.42
Private Commercial Agents (Including Drilling Contractor)	11.72	2.18	9.32	1.77
Progressive Farmer	26.30	28.82	28.30	33.03
Radio/TV/Newspaper/Internet	35.78	25.85	21.10	17.46
Veterinary Department	15.00	10.34	8.59	8.00
NGO	2.59	1.32	1.26	0.59
Any One of the Above	57.33	51.90	47.54	48.06
Households Having Crop Insurance	6.80	10.91	7.34	13.56
Households who Experienced Crop Loss	49.98	55.05	47.98	53.84

Source: Same as Table 1

sources is around 60 per cent as compared to around 48 per cent among non-diversifying households. The data on the disposal of the marketed surplus to different agencies by these two categories of households has been presented in Table 3. Table shows that around 70 per cent of the households who have diversified to HVCs sell their marketed surplus to local private dealers as compared to around 68 per cent of those who have not diversified to such crops. Other important agencies to which a

TABLE 3. MARKETED SURPLUS SOLD TO DIFFERENT AGENCIES BY DIVERSIFIER AND NON DIVERSIFIER AGRICULTURAL HOUSEHOLDS IN RURAL INDIA; 2012-13 TO 2018-19

Variables (1)	Diversified		Non-Diversified	
	2012-13 (2)	2018-19 (3)	2012-13 (4)	2018-19 (5)
Percentage of marketed surplus	87.18	76.26	76.65	69.24
Percentage of marketed surplus procured/bought by				
Local Private	48.91	69.00	35.43	58.39
Mandi	31.64	7.17	31.57	10.04
Input Dealers	6.41	5.98	7.52	2.34
Cooperative and Government Agency	7.93	6.84	18.63	16.93
Farmer producer organisations (FPO)	NA	1.44	NA	0.03
Processors	3.64	6.61	5.54	7.79
Contract farming sponsors/ companies	NA	0.53	NA	1.79
Others	1.46	2.44	1.31	2.68

Source: Same as Table 1.

Notes: 1. the share has been calculated on the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> disposal for 2012-13, whereas for 2018-19 it has been calculated on the data available on major disposal. 2. The above percentage shares have been calculated on value (Rs) terms.

higher proportion of such households sell their marketed surplus are input dealers and farmers producers' organisation. One of the possible reasons for high proportion of marketed surplus sold to input dealers by households diversifying to high value crops is that input dealers supply inputs to these households on the promise of selling their crops to them which in economic parlance is commonly referred to interlinkage of input and output markets. Similarly, high proportion of marketed surplus through farmer producers' organisations could also be explained in terms of high price which they receive by selling through these organisations. Another important feature is that a significantly higher proportion of households not diversifying to HVCs sell their marketed surplus to cooperative and government agencies in comparison to those who have diversified to such crops which may be attributed to their growing traditional crops like cereals and pulses.

## IV

## INPUTS USE, COSTS AND RETURNS

Table 4 presents data on economic performance of both the categories of households in terms of inputs use and costs and returns at constant prices. The table shows that cost A1 and cost A2 per hectare at constant prices are significantly higher

TABLE 4 COSTS, INPUTS USE AND RETURNS OF DIVERSIFIER AND NON DIVERSIFIER  
AGRICULTURAL HOUSEHOLDS IN RURAL INDIA: 2012-13 TO 2018-19

Variables (1)	Diversified		Non- Diversified	
	2012-13 (2)	2018-19 (3)	2012-13 (4)	2018-19 (5)
Cost A1 (Rs/Ha)*	23753	25982	18371	17151
Cost A2 (Rs/Ha)*	25029	26750	19315	17777
Percentage Distribution of A2 cost				
Fertilisers	21.47	19.88	22.82	20.06
Chemicals and pesticides	7.16	8.62	5.77	7.03
Human Labour	24.17	25.57	18.66	21.02
Irrigation	4.19	4.02	6.05	7.00
Hiring Of Machinery	8.75	8.65	13.74	16.84
Rent For Leased Land	5.10	2.87	4.88	3.52
Manure	3.51	4.23	2.79	2.22
Diesel	3.07	1.83	3.21	2.66
Animal Labour	1.59	1.26	2.39	1.44
Maintenance of Machinery	1.60	0.95	1.76	1.19
Interest Costs	1.18	1.56	0.91	1.15
Seed	11.42	12.74	11.49	11.18
Electricity	1.03	1.13	1.62	1.81
Other Costs	5.77	6.69	3.88	2.87
Gross Returns (Rs/Ha)*	74040	70976	44862	39149
Net Returns (over A2)*	49010	44226	22547	21372
Net Returns (over A1)*	50287	44994	26490	21999
Households borrowing from Institutional Sources** (%)	67.44	77.08	58.74	69.29
Households Borrowing from Non-Institutional Sources*** (%)	32.06	22.62	41.07	30.74
Indebtedness (Rupees)*	7561	9290	6212	7513

Source: Same as Table 1.

Note: (\*) These are at constant prices that have been calculated by using consumer price index (Rural) with 2012=100. The value of CPI (Rural) for 2018 has been collected from Ministry of Statistics and Programme Implementation, Central Statistical Office, Press release dated 13<sup>th</sup> August, 2018 which is 140.5 for June 2018. (\*\*) Institutional sources include scheduled commercial bank, regional rural bank, co-operative society, co-operative bank, insurance companies, provident fund, Employer, financial corporation/institution, NBFCs including micro-financing institution, bank linked SHG/JLG, non-bank linked SHG/JLG and other institutional agencies; 2.

(\*\*\*) Non-Institutional Sources include landlord, agricultural moneylender, professional moneylender, input supplier, relatives and friends, chit-fund, market commission agent/traders and others.



in case of households diversifying to HVCs as compared to those not diversifying to such crops. The per cent share of expenditure on different inputs in total A2 cost further shows that households diversifying to HVCs incur higher expenditure on inputs like chemicals and pesticides, human labour, manure, seeds and other costs as compared to non-diversifiers. High expenditure incurred by diversifying households on these inputs is because high value crops are more prone to insect and pest diseases. However, the proportion of expenditure on hiring of machinery, maintenance of machinery, irrigation, fertilisers and electricity is lower in case of households diversifying to HVCs as compared to their non-diversifying counterparts which may be attributed to the use of more labour and less use of fertilisers in the production of these crops. Similarly, a significantly higher proportion of households diversifying to HVCs borrow from institutional sources as compared to households not diversifying and that the average amount of outstanding debt is significantly higher in case of the former category of households as compared to the households of the latter category.

The net returns at constant prices both over cost A1 and cost A2, though decreased in 2018-19 as compared to 2012-13, are significantly higher in case of households diversifying to high value crops as compared to those who are not diversifying to these crops.

#### V

##### LEVELS OF INCOME, CONSUMPTION, INEQUALITY AND POVERTY

The impact of diversification to high value crops has been studied by comparing the income from cultivation, income from all sources, per capita monthly consumption expenditure, the coefficient of variation, extent of income inequality measured by Gini ratio and the incidence of poverty among households growing HVCs and those not growing such crops. In this regard, Table 5 shows that the income from cultivation, income from all sources and per capita monthly expenditure at constant prices are significantly higher in case of households of the former category as compared to those of the latter category. Further, among households growing high value crops, the coefficient of variation in income from cultivation and income from all sources is lower as compared to those not growing these crops. The extent of income inequality, measured by Gini ratio, and the incidence of poverty are also significantly lower among households growing HVCs as compared to those not growing such crops. The significant positive effect of diversification to high value crops on income, consumption and poverty has also been documented by a number of survey based empirical studies. For example, Thapa et al. (2018) have shown positive impact of crop diversification on the standard of living in terms of its effect on monthly per capita consumption and poverty in Nepal. The authors show that small farmers need to derive at least 35 per cent of their share of revenue from the cultivation of HVCs to escape poverty. Birthal *et al.* (2015), using data from situation assessment survey (2003) have shown that the extent of poverty is lower among households growing high value cash crops. Using dose response function, they find that small and marginal farmers need to increase area under HVCs cultivation from 39 per cent to about 50 per cent to enable them to escape poverty. Benziger (1996) shows as to how two successful programmes, one in Thailand and one in Taiwan, helped small and dispersed rice

TABLE 5 INCOME, CONSUMPTION, INCOME INEQUALITY AND THE INCIDENCE OF POVERTY AMONG DIVERSIFIER AND NON DIVERSIFIER AGRICULTURAL HOUSEHOLDS IN INDIA RURAL INDIA; 2012-13 TO 2018-19

Variables (1)	Diversified		Non- Diversified	
	2012-13 (2)	2018-19 (3)	2012-13 (4)	2018-19 (5)
Income and Expenditure at Current prices				
Income from cultivation (Rs. /annum)	34555	39537	26390	31647
Household income (Rs. /annum)	73893	126410	62351	101598
Monthly per capita expenditure (Rs. /month)	1357	1994	1236	1826
Income and Expenditure at Constant prices (2012=100)				
Income from cultivation (Rs. /annum)	34555	28140	26390	22525
Household income (Rs. /annum)	77893	89972	62351	72312
Per capita expenditure (Rs. /month)	1357	1419	1236	1300
Coefficient of Variation (%)				
Income from cultivation (Rs. /annum)	125	118	142	125
Household income (Rs. /annum)	103	91	109	96
Monthly per capita expenditure (Rs. /month)	49	44	49	43
Gini Coefficient				
Income from cultivation	0.61	0.58	0.65	0.60
Total income	0.51	0.46	0.52	0.47
Percentage of Poor Households <sup>1</sup>	46.06	36.12	53.54	42.71
Percentage of Poor Households <sup>2</sup>	57.17	51.66	64.55	60.26

Source: Authors' computation

Notes: (i) Income and expenditure (constant prices) are calculated using CPI (Rural) 2012=100.

(ii) <sup>1</sup> is based on Tendulkar state specific poverty line for 2011-12 (mixed reference period).

Poverty line for 2012-13 is same as state specific poverty line for 2011-12. And for 2018-19 poverty line is adjusted for inflation by using CPI (rural) index;

(iii) <sup>2</sup> Based on monthly per capita expenditure which is calculated from Household Consumer Expenditure in India 2011-12, NSS 68th Round, and NSSO

growing farmers to switch over to HVCs causing a significant increase in their net income pulling them out of poverty. Similarly, in yet another study of small farm colonists in Amazon, Perz (2004) finds that farms with greater farm diversity have significantly higher income and that production and conservation are fully compatible. The author reports that perennials and market oriented annual crops like tomatoes, pineapple and watermelons grown by a majority of the households do not require much land and absorb more labour and generate higher amount of income.

## VI

### FACTORS AFFECTING HOUSEHOLD INCOME, POVERTY AND CROP DIVERSIFICATION

A number of factors such as size of the household, farm size, education of the head of the family, social category of a household, technical training of the head of the household, availability of irrigation facilities, availability of different sources of income, awareness of MSP, membership of farmers' producers organisations and diversification to high value crops are expected to affect the level of household income and the probability of a household escaping poverty. While all the above mentioned factors are expected to have positive effect on the household income and increase the probability of a household escaping poverty, social category of a household like scheduled caste and tribe is expected to have negative effect on household income and increase the probability of household falling below poverty line. The effect of these factors on household income has been quantified by estimating a linear regression

model considering the above mentioned variables as independent variables and household income from all sources as dependent variables using unit level data excluding outliers for the year 2018-19. The summary statistics of the variables included in the OLS regression model are given in Appendix 2A while the results of the regression model are presented in Table 6. Table 6 shows that the diversification to HVCs has a positive and significant effect on the level of household income. Other variables, namely, literacy, age of the head of the household, amount of irrigated land, access to technical advice, awareness of minimum support price (MSP), membership of farmers' organisations, sources of income, namely, income from wages & salary, income nonfarm business and income from livestock farming have positive and statistically significant effect on household income. Social category of a household like scheduled caste, scheduled tribe and other backward castes have negative and statistically significant effect on the household income. The value of R square shows that the variables included in the regression model explain around 68 per cent of the variations in household income.

TABLE 6 FACTORS AFFECTING HOUSEHOLD INCOME: RESULTS OF OLS REGRESSION

Dependent variable: Total Annual Income (Rs.)	
Independent variables	Coefficient
Diversification (Reference category: Non-Diversification)	16445.47* (1057.64)
Age of the household head (yrs)	627.33* (35.81)
Literacy (Reference category: Illiterate)	11377.58* (836.59)
Social Group (Reference category: General)	
ST	-7281.42* (1291.00)
SC	-15533.01* (1214.90)
OBC	-8783.59* (1091.30)
Irrigated land (ha)	24938.65* (754.28)
Access to technical advice (Yes=1, No=0)	945.21 (805.76)
Source of income	
Income from Wages & salary income (Rs. /annum)	0.95* (0.01)
Income from non-farm business (Rs. /annum)	0.96* (0.01)
Income from livestock farming (Rs. /annum)	1.11* (0.01)
Aware about MSP (Yes=1, No=0)	7566.06* (916.58)
Membership of farmers' organisation (Yes=1, No=0)	14315.58* (2633.05)
Constant	-13611.88* (2127.21)
Number of observations	26,489
R <sup>2</sup>	0.68
F(13, 26475)	4116.22

Note: (i) Values in parentheses are robust standard errors;

(ii) \*, \*\*, \*\*\* imply significant at 1 per cent, 5 per cent, and 10 per cent level, respectively

(iii) Outliers have been removed using method given in appendix 1.

Source: Authors' computation

As mentioned above, a logit model has been estimated to quantify the effect of different variables including diversification on the probability of a household falling below poverty line. In addition to the factors mentioned above, some other factors are also considered while estimating the logit model. The summary statistics of the variables included in the logit model are given in Appendix 2B and the results of the estimated model are given in Table 7. Table 7 shows that the variables like diversification to HVCs, age of the head of the household, literacy, high proportion of

TABLE 7 FACTORS AFFECTING PROBABILITY OF AN AGRICULTURAL HOUSEHOLD FALLING BELOW POVERTY LINE: RESULTS OF LOGIT REGRESSION

Dependent variable: Above poverty line=1; Below poverty line=0				
Independent variables (1)	Coefficients (2)	Z value (3)	Marginal effect (4)	Z value (5)
Diversification (Reference category: Non-diversification=0)	0.11*	2.56	0.02*	2.61
Age of the household head(yrs)	0.01*	7.10	0.002*	7.15
Caste (Reference category: General)				
ST	-0.18*	-2.56	-0.03*	-2.53
SC	-0.47*	-7.95	-0.10*	-7.87
OBC	-0.18*	-3.95	-0.04*	-3.99
Literacy (Reference category: Illiteracy)	0.20*	5.03	0.04*	4.99
Higher extent of irrigation: Proportion of irrigated land $\geq 0.5$ ha =1, Proportion of irrigated land $< 0.5$ ha=0 (reference category)	0.17*	3.49	0.04*	3.45
Access to institutional credit (Yes=1, No=0)	0.55*	13.18	0.12*	12.79
Receiving technical advice (Yes=1, No=0)	0.17*	4.23	0.03*	4.19
Aware about MSP (Yes=1, No=0)	0.32*	8.41	0.07*	8.43
Constant	-0.63*	-5.78	-	-
Number of observations	21,995			
Log likelihood	-8760.21			
LR chi2(11)	563.19			
P value	0.00			
Pseudo R2	0.03			

Source: Authors' computation

Note: (i) \* significant at 1 per cent level;

irrigated area, access to institutional credit, receiving technical advice, and awareness about minimum support price have positive and statistically significant effect on the probability of a household staying above the poverty line. However, a household belonging to social categories like scheduled tribe, scheduled caste and other backward castes has higher probability of falling below poverty line. Further, since diversification to high value crops has a significant positive effect on the household escaping poverty, we have estimated a logit model to quantify factors affecting the probability of a household diversifying to HVCs. The summary statistics of the variables included in the model are given in Appendix 2C while the results of model are presented in Table 8. As may be seen from the table, variables like age of the household, literacy, agricultural training, access to market, membership of farmer producers' organisations and receiving technical advice have positive and significant effect on the probability of a household diversifying to HVCs. The effect of minimum support price and higher proportion of irrigated area (more than 0.5ha) have negative and statistically significant effect on the probability of a household switching over to such crops.

## VII

### CONCLUSIONS AND POLICY OPTIONS

A plethora of studies from different countries including India have pointed out multiple positive effects of crop diversification to HVCs to the rural communities, in general and small and marginal agricultural households, in particular. These studies have also shown how diversification to these crops helps in the attainment of different sustainable development goals (SDGs). It is, therefore, imperative to take policy

TABLE 8. FACTORS AFFECTING THE PROBABILITY OF AN AGRICULTURAL HOUSEHOLD DIVERSIFYING TO HIGH VALUE CROPS: RESULTS OF LOGIT REGRESSION

Dependent variable: Diversification=1; Non-diversification=0				
Independent variables	Coefficients	Z value	Marginal effect	Z value
Age of the head of the household	0.02*	13.88	0.003*	14.05
Literacy (Reference category: Illiteracy)	0.44*	12.35	0.07*	12.89
Caste (Reference category: General)				
ST	0.54*	10.45	0.11*	10.16
SC	-0.21*	-4.03	-0.04*	-4.11
OBC	-0.09*	-2.62	-0.02*	-2.61
Agricultural training (Yes=1; No=0)	0.97*	10.57	0.20*	9.74
Higher extent of irrigation: Proportion of irrigated land >=0.5 ha=1, Proportion of irrigated land <0.5 ha=0 (Reference category)	-0.98*	-25.28	-0.20*	-23.59
Access to Market (Yes=1, No=0)	1.22*	15.26	0.17*	21.55
Membership in farmer organisation (Yes=1, No=0)	0.35*	5.41	0.07*	5.13
Aware about MSP (Yes=1, No=0)	-0.09*	-2.96	-0.02*	-2.96
Receiving technical advice (Yes=1, No=0)	0.12*	3.72	0.02*	3.75
Constant	-2.60	-21.87	-	-
Number of observations	28905			
Log likelihood	-12682.23			
LR chi2(11)	1777.67			
P value	0.00			
Pseudo R2	0.07			

Note: \* significant at 1 per cent level; Source: Authors' computation

measures to accelerate the process of crop diversification. In the Indian context, crop diversification is the need of the hour not only to meet growing demand for fruits and vegetables to provide nutritious food to the growing population but also to conserve and protect natural resources including soil and water, particularly in the North-Western states. Analysis of selected socio-economic and other characteristics of households diversifying to HVCs as compared to those not diversifying to such crops shows that policy makers, among other things, need to provide technical training, facilitate access to technical knowhow, credit, inputs, and markets to accelerate the process of crop diversification. Some of the important lessons which emerge from the perusal of the extensive literature documenting the process of crop diversification across countries and regions are as under. First, the farmers switching over to HVCs should be protected from the losses they are likely to incur in the beginning which can be withdrawn later as the farmers are trained and become familiar with the technology and markets. This will be particularly helpful in case of farmers of Punjab and Haryana to persuade them to diversify to high value crops including fruits and vegetables. Second, government needs to supply public goods like market infrastructure, rural roads/transport and irrigation. Third, facilitation of supply of much needed services like inputs, credit, extension and marketing through a single package is important to save transaction costs. Four, farmers' associations play an important role in facilitating the process of crop diversification by persuading them to switch over to the cultivation of HVCs. It in this context that the Farmers Producers Organizations (FPOs) which are being currently promoted in the country by many agencies including NABARD, are expected to play an important role in easing the constraints of the availability of

modern inputs including technical advice and link fragmented smallholders with small marketable surplus with emerging modern retail supply chains. Five, the government in partnership with the private sector should increase the expenditure on basic and applied research to develop suitable technologies and short duration high yielding and climate resilient crop varieties.

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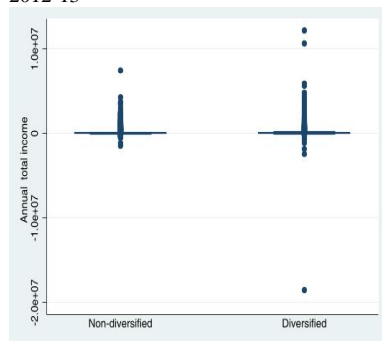
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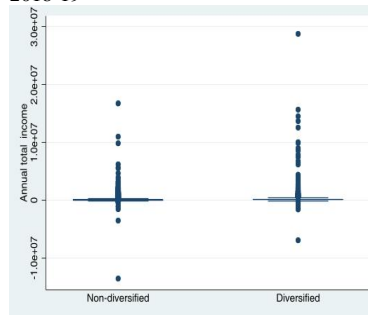
## APPENDIX 1: BOX PLOTS OF SELECTED VARIABLES WITHOUT REMOVING THE OUTLIERS

## PART A: ANNUAL TOTAL INCOME (INCLUDING OUTLIERS)

2012-13

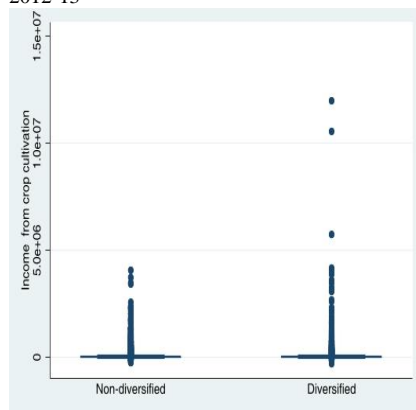


2018-19

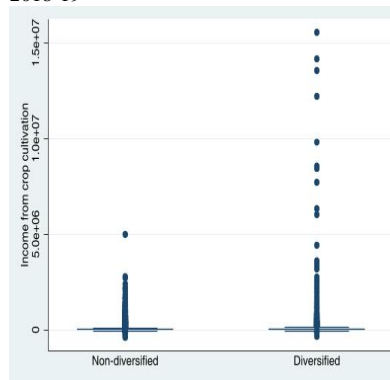


## PART-B: INCOME FROM CULTIVATION (INCLUDING OUTLIERS)

2012-13

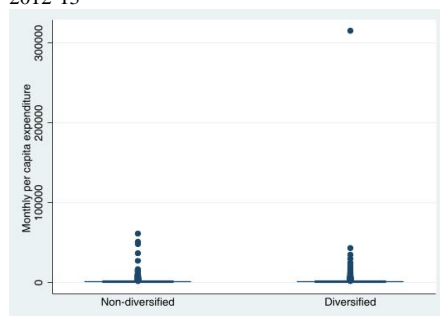


2018-19

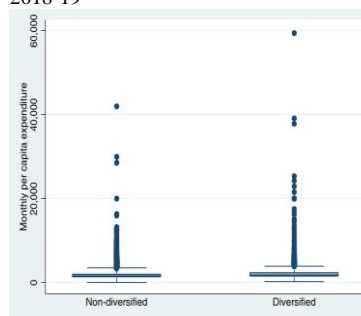


## PART-C: MONTHLY PER CAPITA EXPENDITURE (INCLUDING OUTLIERS)

2012-13



2018-19



## IDENTIFICATION OF OUTLIERS:

Inter Quartile Range (IQR) was first calculated and observations greater than  $[Quartile\ 3 + (3 \times IQR)]$  or less than  $[Quartile\ 1 - (3 \times IQR)]$  were declared outliers and hence they were removed from calculations. Therefore, variables such as total income, income from cultivation, per capita consumption expenditure, and Gini coefficients are free from outliers. Further, estimation of OLS and logit models are done after removing the outliers.

## APPENDIX 2A: SUMMARY STATISTICS OF THE VARIABLES USED IN THE ESTIMATION OF THE OLS MODEL

Variable	Mean	Standard Deviation
Total annual income (Rs.)	126429	113986.1
Diversification to high value crops (Yes=1; otherwise 0)	0.249462	0.4327098
Age of the household head (yrs)	51.24814	13.3014
Literacy (Literate =1; otherwise 0)	0.6677489	0.4710294
Social Group (Reference category: General)	4.252331	2.989887
Irrigated land (ha)	1.455719	1.634071
Receiving technical advice (Yes=1; otherwise =0)	0.6369059	0.4809007
Wages & Salary (Rs./annum)	35589.58	67754.19
Non-farm (Rs./annum)	6948.355	32511.08
Livestock (Rs./annum)	19931.74	39357.78
Aware about MSP (Yes=1; otherwise =0)	0.0473027	0.2122895
Membership in farmer organisation (Yes=1; otherwise=0)	0.4218355	0.4938618

## APPENDIX 2 B: SUMMARY STATISTICS OF VARIABLES USED IN LOGIT MODEL ESTIMATED TO QUANTIFY THE FACTORS AFFECTING PROBABILITY OF AN AGRICULTURAL HOUSEHOLD FALLING BELOW POVERTY LINE

Variable	Mean	Standard Deviation
Poverty line (Above poverty line=1; otherwise =0)	0.63	0.48
Diversification (Yes=1; otherwise =0)	0.29	0.45
Age of the household head (yrs)	50.80	13.36
Social group (Reference category: General)	3.97	3.00
Literacy (Literate =1; otherwise 0)	0.66	0.47
Higher extent of irrigation: Proportion of irrigated land>0.5 ha =1		
Proportion of irrigated land <0.5 ha = 0 (reference category)	0.84	0.37
Access to institutional credit (Yes=1; otherwise = 0)	0.76	0.43
Receiving technical advice (Yes=1; otherwise = 0)	0.59	0.49
Aware about MSP (Yes=1; otherwise = 0)	0.36	0.48

## APPENDIX 2 C: SUMMARY STATISTICS OF VARIABLES USED IN LOGIT MODEL ESTIMATED TO QUANTIFY THE FACTORS AFFECTING PROBABILITY OF A HOUSEHOLD DIVERSIFYING TO HIGH VALUE CROPS

Variable	Mean	Standard Deviation
Diversification (Yes=1; otherwise =0)	0.29	0.46
Age of the household head (yrs)	51.14	13.40
Literacy (Yes=1; otherwise =0)	0.67	0.47
Social group (Reference category: General)	4.04	3.05
Agricultural training (Received =1; otherwise =0)	0.02	0.15
Higher extent of irrigation: Proportion of irrigated land>0.5 ha =1		
Proportion of irrigated land <0.5 ha = 0 (reference category)	0.84	0.37
Access to market (Yes=1; otherwise =0)	0.93	0.25
Membership in farmer organisation (Yes=1; otherwise =0)	0.05	0.22
Aware about MSP (Yes=1; otherwise =0)	0.37	0.48
Receiving technical advice(Yes=1; otherwise =0)	0.60	0.49