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A. Ganesh-Kumar and Varun Kumar Das

Indira Gandhi Institute of Development Research, Mumbai
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Email(corresponding author): agk@igidr.ac.in

Abstract

This paper analyses the role of storage facility and structural factors in determining agricultural commercialization in India. Commercialization of agriculture represents an important aspect of farm market behaviour. Farmers' commercialization decision may be represented by farmers' decision to participate in market sale, degree of market participation, number of market transactions and diversity of market agency sale. Access to storage could significantly regulate post-harvest management and marketing decisions by farmers. It could prevent distress sale and enhance better commercialization practices by farm households. Apart from access to storage facilities, this study considers various other farm, household, and structural variables in affecting farmers' crop sale outcomes. Results show that farm households with likely access to storage facility have higher probability to participate in market transaction, sell more number of crops, and are more likely to have higher number of market transactions. This shows that having access to storage facility is likely to raise agricultural commercialization of farmers in India. The findings also show that structural or location specific variables which are beyond the control of the farm and household could significantly affect farmers' marketing decisions.

Keywords: Commercialization; storage; sale ratio; agency sale; sale diversity; market participation; market transaction; structural factors

JEL Code: O13; Q12; Q13; Q18

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This paper analyses the role of storage facility and structural factors in determining agricultural commercialization in India. Commercialization of agriculture represents an important aspect of farm market behaviour. Farmers' commercialization decision may be represented by farmers' decision to participate in market sale, degree of market participation, number of market transactions and diversity of market agency sale. Access to storage could significantly regulate post-harvest management and marketing decisions by farmers. It could prevent distress sale and enhance better commercialization practices by farm households. Apart from access to storage facilities, this study considers various other farm, household, and structural variables in affecting farmers' crop sale outcomes. Results show that farm households with likely access to storage facility have higher probability to participate in market transaction, sell more number of crops, and are more likely to have higher number of market transactions. This shows that having access to storage facility is likely to raise agricultural commercialization of farmers in India. The findings also show that structural or location specific variables which are beyond the control of the farm and household could significantly affect farmers' marketing decisions.

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†Indira Gandhi Institute of Development Research, Mumbai. Email: varun@igidr.ac.in

1 Introduction

Commercialization of agriculture, wherein farmers produce for and sell their output in market, is expected to improve farmers' income and welfare. Commercialization of agriculture acquires importance in the context of the Government of India's policy of "Doubling of Farmers' Income by the year 2022". The "Committee on Doubling Farmers' Income" (Dalwai committee report - DCR (2018)) lays emphasis on commercialization of agriculture for higher returns. It is argued that commercialization provides signals on the emerging trends in demand for different agricultural products, helps in value addition for farm produce, and thus ensures both producer and consumer's interests are satisfied. The Report notes that market linked farming and market expansion would help in raising farmer's income. Polices such as recent APMC Act amendments, e-NAM, public procurement through the minimum support price (MSP), market infrastructure development, direct purchase of agricultural produce from farmers, participatory market management, encouraging contract farming, etc., are steps towards providing better marketing avenues for farmers (Singh, 2019).

Yet the fact is a significant proportion of farmers in India does not participate in output markets and essentially operate as subsistence farmers, i.e., they produce for their self-consumption needs. Even when farmers engage in markets (i.e., decide to participate in market), there is substantial variation in the degree to which they participate in commercial transactions. There are at least three aspects based on which one can assess the extent to which farm households are commercialized: First, many farmers in India may grow one or more primary crop(s) for sale in the market, at the same time cultivating another subsidiary crop(s) exclusively for household consumption which is not sold in the market. The ratio of number of crops sold to the number of crops cultivated essentially captures the extent or degree of market participation of a farmer. Second, farm households may not sell their produce in a single transaction. Depending on various factors, farm households may engage in staggered market transactions, selling the harvested crop several times. For example, a farmer may sell half the crop and save the rest to sell at a later date. Such a selling behavior (or, number of market transactions) may reflect the prevailing market conditions, farmer's

ability to hold on to stocks and not be forced to go for distress sale, and hence affect the farmer's income. Third, relates to the diversity of agency or marketing channels through which farmers sell their produce. Farmers in India are known to sell their produce through several agencies such as local private traders, *mandis*, input dealers, co-operative / government agency, and processors. A farmer can engage in transactions with one or more agencies. Often farmers make use of only one or few of these agencies for their sale transactions. It is argued that farmers in India are often at a disadvantage due to interlinked input and output markets (Bardhan, 1980; Basu, 1986; Bell and Srinivasan, 1989). That is, the farmers' choice of output market channels / agencies is contractually pre-determined in their transactions in other markets such as input / credit markets. Having diversified option of sale to different agency would then imply a higher bargaining power in the market and is likely to reap a higher return on produce as opposed to concentrated sales indicating higher probability of tied contracts.

What determines the farmers' decision to participate in output markets and to what extent? This paper examines farmer's decision to participate in market, degree of market participation, number of market transactions, and diversity of agency through which they market their produce. The commercial decision of farmers is likely to be influenced by several factors. One may expect that farm and household level factors are likely to determine these decisions. Such factors could be farm size, access to credit, irrigation, household demography, etc. However, farm households do not operate in isolation. There is larger structural environment under which farm operate. A number of studies have highlighted the importance of providing better rural infrastructure such as roads, transport services, storage and marketing facilities, etc., in order to facilitate farmers' physical access to output markets as a prerequisite for commercialization (Umali-Deininger and Deininger, 2001; Acharya, 2004; Banerji and Meenakshi, 2004; Fafchamps and Hill, 2005; Fafchamps et al., 2006, 2008; Shilpi and Umali-Deininger, 2008; Vaidyanathan, 2010; Chamberlin and Jayne, 2013; Takeshima and Nagarajan, 2012; Asher and Novosad, 2016; Aggarwal, 2018). Some recent studies have demonstrated that structural factors that are beyond the farm and household do play a critical role in determining farmers' income and decisions relating to on-farm and off-farm

diversification choices (Das, 2018; Das and Ganesh-Kumar, 2019, forthcoming) suggesting that they are likely to affect farmers' commercialization decisions as well. Hence, using a nationally representative data from the 70^{th} round National Sample Survey (NSS) of agricultural households for the year 2012-2013, and combining it with information on various structural variables from Census and other sources (described later), this paper provides an integrated study on farmers' commercialization decision by combining structural conditions with farm and household level factors.

Among all the various factors that could influence farmer's sale decisions and their marketing practice, access to storage facility is perhaps one of the most important. Availability of storage is a precursor for improved post-harvest management and marketing practices. Lack of access to storage facility often leads to distress sale or selling at lower the market clearing rate, resulting in sub-optimal outcomes. Access to storage facility on the other hand offers the farmer the flexibility to postpone the sale to a later date when the market conditions are more favorable and also to choose the agency with which to enter into a sale transaction. Indeed, farmers' undertaking more than one sale transaction points towards the benefits of access to storage facilities as mentioned earlier. While these are theoretical ex-ante explanations of the possible channels through which storage can help farmers, there is dearth of empirical understanding on the influence of storage facility on marketing decision of farmers.

A possible reason for this dearth of studies on storage is the lack of comprehensive data on the availability and access to storage facilities covering the country as a whole. A few studies have relied on primary surveys whose scope was limited to select commodities / regions to explore this issue. For example, Minten et al. (2010) analyse the benefits of cold storage on potato marketing in the state of Bihar in India. They find that access to cold storage mostly benefits large farmers, with small farmers benefiting indirectly through higher prices of potato prevailing in the market.

To overcome this data limitation, this study proposes a novel approach to indirectly identify farm households that possibly have access to storage facilities. Specifically, information

contained in the 70^{th} round National Sample Survey (NSS) are used for this purpose. This Survey provides information on both the quantity of crop sales and quantity of crop output at the household level. Using this, ratio of sales quantity to output quantity can be generated. By observing the cases where this ratio exceeds one or cases where this ratio is undefined due to positive sales with zero output, one can develop an indicator of households that are likely to have access to storage facility, either self-owned or procured from market. The analysis here demonstrates that this indeed is a significant determinant of farmers' decision to participate in output markets and their extent of commercialization.

The rest of the paper is arranged as follows: the next section 2 discusses the data used in this study. The indicators of commercialization, storage, as well as various explanatory variables considered in the analysis here are defined and some summary statistics on them are provided here. Then the methodology of the study is discussed in section 3. It is then followed by a discussion of the results in section 4. Finally, section 5 concludes the paper along with policy implications from this study.

2 Data description

2.1 Measuring extent of commercialization

As mentioned earlier, this paper is primarily based on agricultural household level data from the 70^{th} NSS Situation Assessment Survey (Schedule 33). The 70^{th} round NSS defines an 'agricultural household' as one (i) receiving value of produce equal to or greater than Rs.3000/- from agricultural activities (cultivation of crops, animal husbandry, poultry, fishing, etc.) during the last 365 days, and (ii) with at least one member of the household self-employed in agriculture either in principal status or in subsidiary status. The NSS survey is canvassed for the agricultural year July 2012 to June 2013 in two visits. The first Visit 1 is for *kharif* season from July-December 2012, and the second one is Visit 2 canvassed for the *rabi* season January-June 2013. It surveyed 34,907 agricultural households in both the two visits. Among the 34,907 agricultural households, a further careful scrutiny leaves only 28,917 households with complete information of all the explanatory variables. However,

out of these, there are only 19,976 households which report growing of crops. Hence, the analysis is restricted to only those 19,976 households which at least grow crops. NSS provides information on various farm and household level characteristics. However, to bring in information on structural variables, the NSS data is combined with Census 2011 and other statistical sources (discussed later in this section).

The NSS records up to 5 different types of crops grown for each household during each visit (Table 1). A total of 4,790 farm households report growing of only one crop in each visit. 2,903 households grow only one crop during Visit 1, but grow 2 types of crops in Visit 2. Similarly, 2,292 households grow 2 crops during Visit 1, and then growing only 1 crop during Visit 2. Only 69 households report growing 5 different types of crops in each season.

Table 1: Number of crop types grown in Visit 1 and Visit 2

	Number of crop types grown in Visit 2					
Number of crop types grown in Visit 1	1	2	3	4	5	Total
1	4,790	2,903	1,300	641	911	10,545
2	2,292	1,474	680	259	415	5,120
3	1,057	659	317	119	192	2,344
4	496	261	128	37	69	991
5	474	266	124	43	69	976
Total	9,109	5,563	2,549	1,099	1,656	19,976

Source: Authors' calculation based on NSS 70^{th} round.

For each crop growing household, NSS describes sale of at most 4 types of crops. If a household is growing crop for subsistence purpose then even though it reports growing of crop, it does not record its sale of crop. For the rest of households making a sale transaction, it reports up to 4 number of sale for each crop, viz., 3 major and 1 'other' sale. Thus, a household can report maximum of 16 transactions across 4 different crops. NSS also records the agency of sale for each sale transaction. In all 6 different agencies are recorded: local

private, *mandi*, input dealers, cooperative / government agency, processors, and others.

Table 2: Sale transition matrix for number of crop sale in Visit 1 and Visit 2

	Number of sales in Visit 2												
Number of sales in Visit 1	0	1	2	3	4	5	6	7	8	11	13	14	Total
0	3,834	353	124	35	9	1	3	1	1	0	0	0	4,361
1	1,630	4,527	2,117	642	356	47	27	11	6	1	1	0	9,365
2	646	1,914	890	321	137	17	14	5	0	0	1	1	3,946
3	249	709	329	125	55	12	9	3	0	0	0	0	1,491
4	94	282	140	40	27	1	2	2	0	0	0	0	588
5	12	45	21	8	3	1	0	0	0	0	0	0	90
6	8	41	14	11	7	0	0	0	0	0	0	0	81
7	2	15	4	4	3	0	1	0	0	0	0	0	29
8	1	10	4	0	4	1	0	0	0	0	0	0	20
9	1	0	0	1	0	0	0	0	0	0	0	0	2
10	0	1	0	0	0	0	0	0	0	0	0	0	1
11	0	1	0	0	0	0	0	0	0	0	0	0	1
12	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	6,477	7,899	3,643	1,187	601	80	56	22	7	1	2	1	19,976

Source: Authors' calculation based on NSS 70^{th} round.

Crop cultivation and sale transactions vary drastically across the two visits. The highest recorded number of sale transactions is 12 during Visit 1 (Table 2), whereas it is 14 during Visit 2. There are 3,834 farmer producer households which only report about growing of crops, but do not make a sale (i.e., 0 sale records) during both the seasons. These are households are treated as subsistence households in the study. 4,527 households report about making at least one market transaction in both the seasons. Over 2,117 households make only one sale in Visit 1 but makes two sales during Visit 2. Similarly, 1,914 households engage in two market transactions in Visit 1 and only one sale during Visit 2. The number of farm households for higher ordered market transactions declines in both the two seasons. Also, the agencies with which these sale transactions are made also vary significantly across agencies in the two visits. The maximum number of market transactions is made with the local private trader, followed by transaction at *mandis* in both the two visits (Table 3). Sale transactions with co-operative / government agencies and processors are quite few in both

the visits.

Based on the above information contained in the NSS survey, one can measure four different aspects of commercialization of agriculture as follows:

(i) *Decision to participate in market*: This is captured through a binary variable taking the value 1 if the farmer has transacted at least once in the market, 0 otherwise.

(ii) *Degree of market participation*: The ratio of number of crops sold to number of crops cultivated can be considered as an indicator of the degree of market participation. This ratio can range between 0 (indicating subsistence farming) and 1 (full commercialization).

(iii) *Number of market transactions*: A count of the number of market transactions indicates how frequently the farmer transacts in the market. A farmer transacting more than once is likely to be better integrated with the market. Since the number of farmers reporting more than two transactions is far fewer in number (Table 2) this aspect is measured as a categorical variable taking values 0 if no transaction, 1 if transacted once, and 2 for two or more transactions

(iv) *Diversity of agency of sale*: This indicates the ability of the farmer to transact with multiple agencies thereby suggesting that the farmer may not be subject to inter-linked or tied-markets problem. This aspects is measured using the Simpson's index of agency diversification, which ranges between 0 (complete concentration) and 1 (complete diversification).

2.2 Measuring storage

As discussed in the previous section, there is no comprehensive nation-wide data on availability and access to storage facilities, either privately owned or publicly provided. Therefore, using data on quantity of crop sold and produced contained in the 70^{th} round NSS, an indirect approach is applied to capture farm households that are likely to have access to storage facility (either self-owned or market accessed). The ratio of crop sales quantity to produced

Table 3: Number of sales by agency

No. of transactions	Local private	*Mandi*	Input dealer	Co-op & govt	Processors	Others
Visit 1						
0	10,547	15,454	18,639	18,639	19,568	19,143
1	6,438	3,086	1,020	1,231	393	644
2	2,032	1,003	247	90	14	128
3	732	349	58	15	1	46
4	227	84	12	1	0	15
Visit 2						
0	11,736	16,165	18,783	19,139	19,675	19,552
1	5,220	2,488	880	796	294	341
2	2,057	920	246	39	5	59
3	691	296	53	2	1	16
4	272	107	14	0	1	8

Source: Authors' calculation based on NSS 70^{th} round.

quantity (SR) can give an indication of availing storage facility. The SR thus generated revealed some patterns (Table 4). Three scenarios are possible: (a) $SR > 1$; (b) SR undefined which occurs when a farmer reports a sale transaction of a crop during a particular season (NSS Visit) but has not produced that crop during that season; (c) $0 \leq SR \leq 1$. Situation (a) can arise only when the amount by which sale in a season exceeds output in that season was produced and stored in the previous cropping season. Similarly, in situation (b) the entire quantity sold in that season must have been produced and stored in the previous cropping season. Thus, both cases (a) and (b) indirectly indicates that farmer is likely to have access to storage – either self-owned or hired. However, (c) is uninformative about whether the farmer has access to storage or not[1]. The analysis of data show that over 48% and 43% of households belong to cases (a) and (b) in Visit 1 and Visit 2, respectively. Thus using SR a dummy variable is constructed to indicate whether the farm household is likely to have access to storage facility. This dummy variable takes the value 1 for farm

[1]There are at least three possibilities in such cases. (i) The farmer does not have access to storage facility and has only kept aside a part of the output for self-consumption; (ii) the farmer has access to storage facilities and has sold only a part of the output while keeping the rest in storage; and (iii) the farmer has access to storage facilities and has kept one part of the output in storage and another part for self-consumption and has sold only the remaining part.

households belonging to cases (a) and (b) above, 0 otherwise. This indicator variable of farm household's likely access to storage facility in this study.

2.3 Other factors likely to affect extent of commercialization

Various farm and household level variables affect farmer's marketing decisions. These are available from the NSS data. At the farm level, the average number of crops cultivated during both visits is 2 (Appendix Table 6). Total average farm size is 1.6 hectares. On an average, 60% of farm land is under irrigation during Visit 1 and around 50% of land is irrigated during Visit 2. Around 10% of households have crop insurance in Visit 1, and this falls to only 4% during Visit 2. 73% of households have an outstanding institutional outstanding credit. At the household level, with an average household size of around 6, 90% households are male headed. Average household age is 31. The average male female ratio is 0.52. The average monthly *per capita* consumption expenditure is Rs 1397.4 during Visit 1, and Rs 1705.6 during Visit 2. At the village neighborhood level, off-farm labor market may impact household marketing decisions. Using NSS data, the proportion of households in a village engaged in any form of non-farm activity is calculated for each farm household (except that particular household). About 44% of households in a village are engaged in off-farm work in Visit 1, and 48% during Visit 2.

Information regarding structural feature of the economy is available at the district level. As the village codes are not the same for NSS, Census and other sources, most of the district level variables are measured in terms of proportion. Proportion of SC and ST households in a district denotes the social composition of the district. On an average 20% of district's population are SC and 8% are ST population. To control for access to infrastructure, on an average proportion of villages with public transport is 98%., with average proportion of villages with towns within 5 kms being 23%. On an average, 23% of a district's credit is agricultural credit. 66% of districts have villages with self-help groups (SHGs), and 32% of villages in districts have access to financial services. Average net sown area weighted power available for agricultural use in a district is 7 hours/day during summer and for 6.3 hours/day during winter. Farm household's marketing decision is significantly influenced by

Table 4: Sales ratio frequency

Types	Frequency	Percent
Visit 1		
SR less than or equal to 1	18077	51.65
SR greater than 1	15936	45.53
SR undefined	989	2.83
Total	35002	100
Visit 2		
SR less than or equal to 1	22498	57.76
SR greater than 1	15814	40.6
SR undefined	640	1.64
Total	38952	100

Source: Authors' calculation based on NSS 70^{th} round.
Note: SR refers to sales ratio defined as quantity of crop sold to quantity of crop output.

urbanization. Urban centres classified by population sizes are considered in this study. On an average, there are one class 1 and class 2 cities in a district. To account for state level policy variables which could influence marketing practice of a farm household, this study controls for the amount of capital and total expenditure in agriculture, and it per capita state GSDP. On an average, Rs. 590.3 million/hectare is spent under capital expenditure in agriculture and a total average amount of Rs. 3108.1 million/hectare is spent in agriculture. The average *per capita* state GSDP for 2012-2013 is Rs. 81832.9.

3 Methodology

As described above, the variable of interest in this study, viz., commercialization has been defined in four ways: (i) Decision to participate in market, defined as a binary variable taking the value 1 if the farmer has transacted at least once in the market, 0 otherwise; (ii) Degree of market participation defined as the ratio of number of crops sold to number of crops cultivated, which can range between 0 and 1; (iii) Number of market transactions, measured as a categorical variable taking values 0 if no transaction, 1 if transacted once,

and 2 for two or more transactions; and (iv) Simpson's index of diversity of agency of sale, which ranges between 0 (complete concentration) and 1 (complete diversification). As is evident, the four variables capturing different aspects of commercialization vary in nature. Accordingly, different econometric models are specified for each of them and appropriate estimation methods are applied. These are described below in this Section.

3.1 Decision to participate in market

To understand the various factors which affect farmer's decision regarding selling of crop cultivated or just producing for household consumption only (subsistence), the following binary probit model is considered for two main agricultural seasons in India, $t = 1, 2$, where 1 represents *kharif* and 2 represents *rabi* season:

$$P^*_{ivdst} = \alpha_{0t} + \alpha_{1t} FARMCH_{ivdst} + \alpha_{2t} HHLDCH_{ivdst} + \alpha_{3t} VILLCH_{vdst} + \alpha_{4t} DISTCH_{ds} + \alpha_{5t} STATE_s + \epsilon_{ivdst} \quad (1)$$

In equation (1), P^*_{ivdst} is a latent variable representing farmer's decision of selling in the market or only for household consumption for i$^t hhousehold, in$vth village, in d^{th} district , in s^{th} state , in seasons $t = 1, 2$. Since, the latent variable P^*_{ivdst} is not observed, the response variable which is observed is P_{ivdst}, for both $t = 1, 2$, where:

$$P_{ivdst} = \begin{cases} 1 \text{ if there is at least one market sale} \\ 0 \text{ if there is no market sale at all} \end{cases} \quad (2)$$

$FARMCH_{ivdst}$ are the individual farm level characteristics such as farm size, number of crops cultivated, land under irrigation, credit, crop insurance, etc. $HHLD_{ivdst}$ are household socio-economic and demographic characteristics such as social group, household size, average age, education, gender composition, etc. $VILLCH_{vdst}$ could be village characteristic such as labour market conditions. $DISTCH_{ds}$ are district level structural features such as storage facility, social composition, physical and financial infrastructure, urbanization, etc. $STATEPOL_s$ are state level policy variables such as agricultural expenditure and *per capita* state GDP. And, the error term $\epsilon_{ivdst} \sim N(0, \sigma^2)$.

The binary variable on market participation, P_{ivdst}, and farm, household and village level explanatory variables are available for the two agricultural seasons, $t = 1, 2$. However, variables at the district and state levels are available only on an annual basis. Hence, the above binary probit models in equation (1) for the two seasons are estimated under a seemingly unrelated regression (SUR) system as in Das (2018).

3.2 Degree of market participation

To understand the determinants of degree of market participation the following linear model is specified for the two seasons, $t = 1, 2$.

$$SR_{ivdst} = \beta_{0t} + \beta_{1t} FARMCH_{ivdst} + \beta_{2t} HHLDCH_{ivdst} + \beta_{3t} VILLCH_{vdst} + \beta_{4t} DISTCH_{ds} + \beta_{5t} STATE_s + u_{ivdst} \quad (3)$$

SR_{ivdst} is sale ratio of number of crops sold to number of crops produced for a particular farmer producer, $0 \leq SR_{ivdst} < 1$. As in the former estimation equation (2), the explanatory variables $FARMCH_{ivdst}$, $HHLDCH_{ivdst}$, $VILLCH_{vdst}$, $DISTCH_{ds}$, and $SATEPOL_s$, have the same interpretations. The error term $u_{ivdst} \sim N(\mu, \sigma^2)$. Similarly, since most of the district and state level explanatory variables are on an annual basis, equation (3) is estimated as ordinary least squares (OLS) under a SUR set-up.

3.3 Number of market transactions

Farm households could engage in several market transactions. To identify the factors affecting farmer's decision on the number of times farmers engage in selling their produce, the following ordered probit model is estimated for the two seasons, $t = 1, 2$, as follows:

$$y^*_{ivdst} = \gamma_{0t} + \gamma_{1t} FARMCH_{ivdst} + \gamma_{2t} HHLDCH_{ivdst} + \gamma_{3t} VILLCH_{vdst} + \gamma_{4t} DISTCH_{ds} + \gamma_{5t} STATE_s + \nu_{ivdst} \quad (4)$$

y^*_{ivdst} is a latent variable denoting the total number of market transactions a farmer producer makes to sell all the types of crops produced. The observed variable y^*_{ivdst} represents the

following:

$$P_{ivdst} = \begin{cases} 0 \text{ if no sale transaction} \\ 1 \text{ if only 1 sale transaction} \\ 2 \text{ if 2 or } > 2 \text{ sale transactions} \end{cases} \quad (5)$$

The explanatory variables $FARMCH_{ivdst}$, $HHLDCH_{ivdst}$, $VILLCH_{vdst}$, $DISTCH_{ds}$, and $SATEPOL_s$, have the same interpretations as above, and the error term $\nu_{ivdst} \sim N(0, \sigma^2)$. In equation (5) too since most of the district and state level explanatory variables are on an annual basis, equation (3) is estimated as ordinary least squares (OLS) under a SUR set-up.

3.4 Diversity of agency

Finally, to understand the factors affecting diversity of agency of sales, the following linear model is specified for the two seasons, $t = 1, 2$, as follows:

$$SDIV_{ivdst} = \delta_{0t} + \delta_{1t} FARMCH_{ivdst} + \delta_{2t} HHLDCH_{ivdst} + \delta_{3t} VILLCH_{vdst} + \delta_{4t} DISTCH_{ds} + \delta_{5t} STATE_s + \omega_{ivdst} \quad (6)$$

$SDIV_{ivdst}$ is a Simpson's measure of sale agency diversity as calculated as:

$$SDIV_{ivdst} = 1 - \sum_a AP_a$$

AP_a is agency proportion sale to an agency a=1,2,. . . ,6, where:

$$AP_a = 1 - \frac{\text{Number of sale to agency a}}{\text{Total sales}}$$

As Simpson's index is related to diversity of agency sale, the above equation (6) is estimated for only those farm households which have made at least two transactions in both seasons[2]. Therefore, the agency diversity index, $0 \leq SDIV_{ivdst} \leq 1$. 0 denotes least diversified (i.e. most concentrated) and 1 is most diversified (i.e. least concentrated).

[2]The number of farm households is restricted to only 2218, unlike 19976 households in the previous three commercialization specifications.

It is conceivable that the number of sale transactions could affect $SDIV_{ivdst}$. But, number of sale transactions ($Sale_{ivdst}$) could itself be affected by many of the explanatory variables as follows:

$$Sale_{ivdst} = \theta_{0t} + \theta_{1t}FARMCH_{ivdst} + \theta_{2t}HHLDCH_{ivdst} + \theta_{3t}VILLCH_{vdst} + \theta_{4t}DISTCH_{ds} + \theta_{5t}STATE_s + \tau_{ivdst} \quad (7)$$

Hence, equations (6) and (7) are estimated as jointly as a recursive system of simultaneous equation model (SEM).

4 Results

The factors affecting farm households to sell their produce are estimated using four different models. The results are presented in Table 5. First, model (1) is a binary probit estimation for any sale in Visit 1 and Visit 2 under a SUR system. Model (2) is a linear OLS estimation of sale ratio of number of crops sold to total crops grown under a SUR system. Then, model (3) is an ordered probit estimation for understanding the frequency of market sale for both the visits in SUR set-up. Finally, using an OLS estimate under SUR, model (4) identifies the factors determining the diversity of agency sale.

4.1 Decision to participate in market: Binary probit

Estimation results under model (1) shows that the possibility of having storage facility (Dummy LTHS) has a positive and significant effect on the farm household's decision to participate in market transaction during Visit 2. Under other farm variables, the number of crops cultivated does not determine a farmer producer's decision regarding market participation. However, the squared term of number of crops cultivated has a negative and significant effect on market participation only in Visit 2. Access to irrigated land has a positive and significant influence on probability of market sale only during Visit 2. The dummy variable on outstanding credit has a positive significant effect on market sale decision during both the seasons. The interaction term between Dummy LTHS and Dummy outstanding credit has a negative impact on sale decision only during Visit 2. Under village neighbourhood impact,

the analysis shows that proportion of households with non-farm work have a negative effect on market participation only during Visit 2.

Having a higher proportion of SC population in a district increases the probability of market crop sale decision. The results show that access to public transport and proportion of villages with towns within 5 kms does not impact sale decision. Agricultural credit and agricultural market density have a negative significant impact on sale decision only during Visit 2. However, the interaction term between agricultural credit and market density has a positive effect on sale decision. Similarly, only the interaction term between proportion of villages in a district with self-help groups (SHG) and proportion of villages with access to financial services, has a significant positive effect on sale decision during Visit 2. Average power availability for agricultural use has a U-shaped relationship with sale decision in both the two visits. This implies that at lower level, agricultural power availability has a negative impact on sale decision. But, at a higher level (squared term) agricultural power availability has a positive impact on sale decision. Presence of Class 1 cities has a positive influence on the probability of sale decision during Visit 2, whereas, Class 3, 4, 5 6 cities have a significant positive effect on sale decision during both the visits. However, the squared term of Class 3, 4, 5 6 cities has a negative and significant effect on sale decision. This implies that though presence of small urban centres help in market participation, however at a higher level it may have a negative effect on sale decision; showing an inverted U-shaped relationship with probability of sale decision.

State capital expenditure in agriculture has a U-shaped relationship with sale decision during both the visits, and total agricultural expenditure has an inverted U-shaped relationship with sale decision. The size of the state economy – measured by *per capita* state GDP has a positive and significant effect on market participation only at a higher level (squared term).

4.2 Degree of market participation: Number of commodities sold to number of commodities produced - OLS

Model (2) shows Dummy LTHS has a positive and significant effect on sale ratio of number of sold in the market to number of crops cultivated. This implies that the possibility of usage of storage facility significantly improves sales ratio of a farm household, signifying the farmer is more commercialized. The number of crops cultivated increases the sales ratio of crop in a U-shaped fashion, implying that only at a higher level (squared term) the number of crops cultivated raises sales ratio. Outstanding credit is positively associated with SR, implying that having an outstanding loan leads a farmer to sell a greater number of crops and hence more commercialized. However, the interaction between Dummy LTHS and having outstanding loan has a negative significant effect on sales ratio. Average age of the household has a positive and significant effect on sale ratio during both the visits. Village neighborhood proportion of households having non-farm work negatively affects sales ratio during Visit 2.

At the district level, higher proportion of SC population in the district is positively associated with sales ratio in both the visits. Having higher proportion of ST population in the district has a negative and significant effect on sales ratio in both the visits. Interaction between agricultural credit and agricultural market has a significant positive effect on sales ratio in both the seasons. Similarly, interaction of proportion of villages with SHGs and proportion of village with access to financial services has a positive significant impact on sales ratio in both the visits. Availability of power for agricultural use has a U-shaped relation with sales ratio. That is the squared term of power availability for agricultural use has a positive and significant effect on sales ratio. Presence of Class 3, 4, 5 6 cities have an inverted U-shaped relationship with sales ratio. Ratio of number of Class 1 2 cities has a positive effect on sales ratio.

State capital expenditure in agriculture has a significant negative impact on sales ratio, however its squared term has a positive effect, signifying a U-shaped relationship. This

implies that capital expenditure has a significant positive role in raising sales ratio but only at a higher level. Total agricultural spending has an inverted U-shaped relationship with sales ration only during Visit 2. Per capita state GDP has a U-shaped relationship with sales ratio.

4.3 Number of market transactions: Ordered probit - 0, 1, 2

The determinants of farmer's decision on the frequency of market transactions by farmers are identified in Model (3). The results show that the possibility of having access to storage facility has a positive and significant effect on the number of market transactions. Having outstanding institutional credit has a positive and significant effect on the number of market transactions. However, the interaction between possibility of having access to storage and having an outstanding loan has a negative significant effect on number of market transactions. Among household variables, average age of the household has a positive and significant effect on number of market transactions. Village neighborhood proportion of households having non-farm work negatively affects market transactions during Visit 2.

At the district level, higher proportion of SC population in the district is positively associated with number of market transactions in Visit 2. Having higher proportion of ST population in the district has a negative and significant effect on market transactions in both the visits. Interaction between agricultural credit and agricultural markets has a positive significant impact only during Visit 2. Whereas, the interaction term between SHGs and access to financial services has a positive significant effect on the number of market transactions in both the visits. Agricultural power availability has a U-shaped relationship with number of market transactions. Among urban centers, Class 3, 4, 5 6 cities has an inverted U-shaped relationship with number of sale frequency. Higher the proportion of Class 1 2 cities, higher would be market transactions during Visit 2. State capital expenditure in agriculture has a U-shaped relationship with number of sale in both the visits. Whereas total expenditure on agricultural has an inverted U-shaped association with the number of sale. *Per capita* state GDP has a U-shaped relationship with number of sale.

4.4 Diversity of agency: Simpson's index - SEM

The NSS records six different types of agency sale. A higher diversity of agency sale signifies more options for crop sale and a higher bargaining power. In model (4), Simpson's index of diversity in agency sale is estimated. Since, there is an endogeneity issue with total number of market transactions, a simultaneous recursive system is estimated with total number of market transactions as a dependent variable. The results show that, possibility of having access to storage facility does not significantly affect diversity of agency sale. Number of crops cultivated has a positive relationship only during Visit 2. But, the squared term of number of crops cultivated has a negative relationship with diversity of sale. Proportion of irrigated land shows a positive and significant impact on diversity only during Visit 1. Insurance cover increases diversity of sale only in Visit 1. Having outstanding credit positively affects diversity of sale only during Visit 1. Dummy of SC/ST household raises diversity of agency sale only during Visit 1. Village neighborhood proportion of households having non-farm work positively affects market transactions during Visit 1. Access to power for agricultural use has an inverted U-shaped relationship with diversity in sale in Visit 1, whereas it has a U-shaped relationship during Visit 2. Presence of Class 1 and Class 2 cities has varied impact on diversity of agency sale in Visit 1 and Visit 2. State capital expenditure and total agricultural expenditure have an inverted U-shaped association with diversity of agency sale only in Visit 2. Whereas, per capita state GDP has an inverted U-shaped relationship with diversity of sale in both the two visits.

The analysis also reveals that state policy variables such as state level capital and total agricultural expenditure can significantly affect selling decision, sale ratio of crops, and number or frequency of crop sales. This may imply that policy makers can significantly affect farmer's marketing behavior through fiscal policy changes. Also, access to power for agricultural use can also significantly affect farmer's marketing decision. Smaller urban centers (Class 3, 4, 5, and 6) have a significant role in affecting selling decisions than bigger urban centers. Providing higher agricultural credit and market access leads to a higher sale ratio. Having greater number of SHGs and access to financial services in a district significantly affect farmer's sale

ratio and number of market transactions.

In all the four models, the crop types of each crop is controlled for using exact crop codes recorded in the NSS. In general, the crop codes are arranged in an increasing manner with regard to its value i.e. a higher valued crop has a higher value. There are 4 crops in each visits for which sale information is reported. Thus, there are 8 crop codes in total in the regressions. In all the four types of regressions, the crop codes have a significant impact on the dependent variables under consideration. This implies that higher the value of the crop, higher is probability of market sale of crops in model (1), higher would be sale ratio in model (2), higher would be the number of sale in model (3), and higher would be sale diversity in model (4).

Table 5: Results for market participation

	Model 1		Model 2		Model 3		Model 4	
	Binary probit		Sale ratio		Ordered probit		Simpons index	
	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2
(I) Farm & Household levels								
Dummy LTHS	0.245	0.278***	0.0933***	0.108***	0.497***	0.284***	-0.0398	0.0360
	(0.97)	(2.71)	(10.18)	(5.99)	(4.07)	(3.28)	(-0.47)	(0.42)
No. of sale transactions							0.00848	-0.0144
							(0.56)	(-0.84)
No. of crops cultivated	0.158	0.0523	-0.342***	-0.322***	0.0728*	0.0205	0.00473	0.0509**
	(0.94)	(1.27)	(-66.33)	(-39.27)	(1.70)	(0.63)	(0.23)	(2.52)
Sq no. of crops cultivated	-0.00401	-0.0197***	0.0366***	0.0363***	-0.00222	-0.0113*	-0.000544	-0.00783**
	(-0.13)	(-2.68)	(38.22)	(24.86)	(-0.28)	(-1.95)	(-0.14)	(-2.16)
Total land	0.0169	0.000919	-0.00164	-0.000117	-0.0163*	-0.00542	0.00798	0.00583
	(0.53)	(0.10)	(-1.63)	(-0.07)	(-1.69)	(-0.77)	(1.15)	(0.88)
Sq total land	-0.000477	-0.00000578	0.0000425	-0.0000145	-0.0000205	0.000205	-0.000517	-0.00122*
	(-0.35)	(-0.01)	(1.12)	(-0.23)	(-0.05)	(0.68)	(-0.78)	(-1.88)
Prop of irrigation	0.163	0.187***	0.000846	0.0156	-0.0561	0.148***	0.0691**	0.0309
	(0.66)	(2.62)	(0.11)	(1.12)	(-0.87)	(2.71)	(2.41)	(1.01)
Dummy insurance	-0.662	0.0525	-0.0105	0.00380	-0.382**	0.0197	0.117*	0.0989
	(-1.62)	(0.35)	(-0.69)	(0.13)	(-2.53)	(0.17)	(1.77)	(1.02)
Dummy credit	5.430***	1.678***	0.628***	0.377***	3.173***	1.470***	-0.204**	0.0780
	(15.95)	(18.98)	(66.99)	(23.83)	(25.31)	(19.05)	(-2.28)	(0.89)
Dummy LTHS*Dummy credit	-0.252	-0.201**	-0.112***	-0.106***	-0.562***	-0.221***	0.0625	-0.0483
	(-0.94)	(-2.34)	(-12.46)	(-7.00)	(-4.59)	(-2.94)	(0.74)	(-0.58)
Dummy LTHS*Prop of irrigation	0.114	-0.0388	0.0135*	-0.00727	0.0507	-0.0528	-0.0503	-0.00895
	(0.43)	(-0.51)	(1.71)	(-0.49)	(0.74)	(-0.92)	(-1.62)	(-0.28)
Dummy LTHS*Dummy insurance	0.461	-0.0155	0.00199	-0.000945	0.380**	0.0480	-0.0684	-0.0273
	(1.01)	(-0.10)	(0.12)	(-0.03)	(2.37)	(0.38)	(-0.95)	(-0.26)
Dummy head male	-0.408*	-0.0286	-0.00906	-0.0103	-0.0541	-0.0665**	0.0132	-0.0145
	(-1.87)	(-0.68)	(-1.63)	(-1.25)	(-1.15)	(-2.04)	(0.60)	(-0.75)
Dummy head illiterate	-0.0542	-0.0454*	0.0000829	-0.00509	0.0173	-0.0227	-0.0110	-0.0275**
	(-0.57)	(-1.86)	(0.03)	(-1.05)	(0.70)	(-1.19)	(-0.89)	(-2.27)
Household size	-0.0295*	-0.00107	-0.00134**	-0.000252	0.00163	-0.000664	0.00181	-0.000658
	(-1.87)	(-0.24)	(-2.45)	(-0.28)	(0.37)	(-0.19)	(0.72)	(-0.26)
Dummy SC/ST household	0.0418	-0.0355	-0.00648**	-0.00179	0.0507*	-0.0286	0.0242*	0.00178
	(0.37)	(-1.30)	(-1.97)	(-0.33)	(1.85)	(-1.33)	(1.81)	(0.14)
Avg household age	0.00517	0.00141	0.000512***	0.000693***	0.00369***	0.00175**	0.000388	0.000572
	(1.07)	(1.29)	(3.69)	(3.19)	(3.18)	(2.08)	(0.67)	(1.06)
Prop of dependents	0.172	-0.0255	0.0297***	-0.0152	0.110*	-0.00506	0.0326	0.0283
	(0.75)	(-0.53)	(4.38)	(-1.59)	(1.95)	(-0.14)	(1.15)	(1.23)
Male female ratio	-0.394	-0.0698	-0.00403	-0.0259*	-0.0365	-0.0851	-0.0887**	-0.0268
	(-1.35)	(-0.98)	(-0.46)	(-1.84)	(-0.50)	(-1.55)	(-2.51)	(-0.82)
Graduates and above	-0.290	0.0228	-0.0264***	0.0177	-0.0983	0.0803	-0.00589	-0.0302
	(-1.09)	(0.31)	(-2.91)	(1.17)	(-1.30)	(1.37)	(-0.15)	(-0.87)
Monthly per capita consumption	-0.0000107	0.00000731*	0.000000326	0.00000100	-0.000000765	0.00000427	0.00000816	-0.00000276
	(-0.44)	(1.75)	(0.34)	(1.00)	(-0.09)	(1.07)	(1.26)	(-0.65)

Table 5 (*contd.*): Results for market participation

	Model 1		Model 2		Model 3		Model 4	
	Binary probit		Sale ratio		Ordered probit		Simpons index	
	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2
(II) Village level								
Village prop of non-farm workers	-0.0507	-0.241***	0.00402	-0.0311***	-0.00841	-0.143***	0.0338*	0.0130
	(-0.35)	(-6.63)	(0.96)	(-4.33)	(-0.24)	(-5.07)	(1.93)	(0.75)
(III) District level								
Prop of SC	2.698***	0.759***	0.154***	0.185***	0.122	1.158***	-0.0547	-0.138
	(3.51)	(4.48)	(7.52)	(5.30)	(0.70)	(8.55)	(-0.57)	(-1.45)
Prop of ST	0.524	-0.814***	-0.0728***	-0.0598**	-0.551***	-0.483***	-0.184***	0.0750
	(0.93)	(-6.01)	(-5.32)	(-2.53)	(-4.45)	(-4.75)	(-2.88)	(1.19)
Prop with public transport	1.217	-0.585	0.0352	-0.0808	0.538	-0.649*	-0.174	0.201
	(0.40)	(-1.25)	(0.68)	(-0.92)	(1.30)	(-1.95)	(-0.88)	(1.03)
Prop with towns within 5 kms	3.255	0.873	0.0643	0.279	1.158	0.649	0.0621	0.530
	(0.49)	(0.97)	(0.64)	(1.64)	(1.47)	(1.02)	(0.16)	(1.41)
Public transport * towns 5 kms	-4.025	-0.0691	-0.128	-0.137	-1.793**	0.202	0.0394	-0.497
	(-0.60)	(-0.08)	(-1.27)	(-0.80)	(-2.26)	(0.31)	(0.10)	(-1.31)
Prop of agri credit to total credit	-0.493	-0.364***	-0.0795***	-0.0372	-0.0504	-0.408***	-0.0728	-0.114*
	(-1.18)	(-2.68)	(-5.35)	(-1.48)	(-0.38)	(-3.85)	(-1.10)	(-1.74)
Prop of agri markets	-0.00654	-0.231**	0.0232**	-0.0307	0.266***	-0.302***	0.00899	0.107**
	(-0.01)	(-2.32)	(2.01)	(-1.58)	(2.77)	(-3.92)	(0.19)	(2.26)
Agri credit * agri markets	0.466	1.070***	0.141***	0.175***	0.357	1.163***	-0.0551	-0.129
	(0.46)	(4.74)	(5.38)	(3.96)	(1.63)	(6.58)	(-0.49)	(-1.16)
Proportion of SHG	-1.115*	0.0520	0.00637	0.000112	0.230**	0.00833	0.120*	0.0993
	(-1.81)	(0.46)	(0.53)	(0.01)	(2.00)	(0.09)	(1.78)	(1.49)
Proportion of finservices	0.811	-0.892***	-0.0767***	-0.161***	-0.306	-0.792***	0.120	0.339**
	(0.92)	(-4.91)	(-4.48)	(-5.56)	(-1.51)	(-5.15)	(0.78)	(2.21)
SHG * finservacs	-0.572	1.008***	0.145***	0.250***	0.416*	1.082***	-0.173	-0.322*
	(-0.57)	(4.35)	(6.20)	(6.35)	(1.68)	(5.69)	(-0.99)	(-1.88)
Avg power for agri use	-0.344***	-0.105***	-0.0210***	-0.0170***	-0.121***	-0.0803***	0.0117**	-0.0168***
	(-6.45)	(-11.08)	(-20.24)	(-9.51)	(-11.70)	(-10.90)	(2.25)	(-3.25)
Sq avg power for agri use	0.0193***	0.00539***	0.000808***	0.000950***	0.00636***	0.00424***	-0.000650**	0.00131***
	(5.99)	(9.20)	(13.63)	(9.34)	(8.69)	(9.01)	(-2.04)	(3.91)
Class 1 cities	0.128	0.0852***	-0.000214	0.0151**	-0.0191	0.0636**	-0.0378**	0.0229
	(0.85)	(2.58)	(-0.06)	(2.33)	(-0.59)	(2.49)	(-2.37)	(1.46)
Sq class 1 cities	-0.0285	-0.00292	0.000362	-0.00107	0.00905	-0.00476	0.00379	-0.00261
	(-1.28)	(-0.49)	(0.52)	(-0.90)	(1.55)	(-1.04)	(1.28)	(-0.89)
Class 2 cities	-0.172	0.0284	0.00172	0.00650	0.0534**	0.0213	-0.0304**	0.0211*
	(-1.05)	(1.15)	(0.58)	(1.31)	(2.15)	(1.10)	(-2.39)	(1.68)
Sq class 2 cities	0.0685	-0.0114***	-0.000480	-0.00221***	-0.0116***	-0.00968***	0.00666***	-0.00198
	(1.53)	(-2.77)	(-0.94)	(-2.58)	(-2.80)	(-2.96)	(3.05)	(-0.92)
Class 3, 4, 5, 6 cities	0.0457**	0.0103***	0.00361***	0.00256***	0.0186***	0.0127***	0.00141	-0.00915***
	(2.14)	(2.68)	(7.81)	(3.26)	(4.91)	(4.25)	(0.74)	(-4.86)
Sq class 3, 4, 5, 6 cities	-0.000406**	-0.000109***	-0.0000302***	-0.0000267***	-0.000163***	-0.000117***	-0.0000229	0.0000780***
	(-1.98)	(-2.95)	(-6.68)	(-3.48)	(-4.40)	(-3.99)	(-1.27)	(4.37)
Ratio of class 1 and 2 cities	0.796	0.193	0.0554***	0.0448*	0.000719	0.238**	-0.00154	-0.125**
	(1.03)	(1.52)	(3.75)	(1.80)	(0.01)	(2.50)	(-0.03)	(-2.18)
District rainfall deviation	0.00148	0.0000777***	0.000273***	0.0000136***	0.000470	0.0000745***	0.0000500	0.000000791
	(1.20)	(3.06)	(6.29)	(2.79)	(1.33)	(4.05)	(0.25)	(0.07)

Table 5 (*contd.*): Results for market participation

	Model 1		Model 2		Model 3		Model 4	
	Binary probit		Sale ratio		Ordered probit		Simpons index	
	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2	Visit 1	Visit 2
(IV) STATE								
Capital exp in agri	-0.00148***	-0.00131***	-0.000138***	-0.000241***	-0.000553***	-0.000887***	-0.0000963**	0.000176***
	(-4.63)	(-17.95)	(-16.45)	(-17.16)	(-6.91)	(-15.34)	(-2.09)	(3.87)
Sq capital exp in agri	0.000000481***	0.000000187***	2.60e-08***	3.43e-08***	0.000000161***	0.000000131***	8.01e-09	-1.68e-08**
	(6.37)	(18.88)	(25.06)	(19.15)	(13.98)	(17.06)	(1.19)	(-2.46)
Total agri exp	0.00166***	0.000197***	0.00000653	0.0000375***	0.000301***	0.000237***	-0.0000263	0.0000583**
	(4.28)	(4.50)	(1.31)	(4.57)	(5.88)	(6.96)	(-0.90)	(2.08)
Sq total agri exp	-0.000000228***	-1.46e-08***	-6.95e-10	-3.14e-09***	-4.57e-08***	-1.89e-08***	3.13e-09	-6.61e-09*
	(-4.29)	(-2.78)	(-1.24)	(-3.36)	(-6.76)	(-4.56)	(0.79)	(-1.72)
Per capita state GDP	-0.000129***	-0.0000367***	-0.00000790***	-0.00000670***	-0.0000351***	-0.0000212***	0.00000513**	0.00000901***
	(-8.22)	(-10.33)	(-19.49)	(-10.24)	(-9.92)	(-7.82)	(2.57)	(4.73)
Sq per capita state GDP	5.72e-10***	2.30e-10***	4.05e-11***	4.03e-11***	1.65e-10***	1.39e-10***	-2.36e-11**	-5.14e-11***
	(6.78)	(11.61)	(18.02)	(11.07)	(8.20)	(9.16)	(-2.10)	(-4.81)
Cropcodes(jt)	+++	+++	+++	+++	+++	+++	+++	+++
Log likelihood	-8519.7773				-24341.161			
LR test of rho=0	61.9081				149.17			
Prob ¿ chi2	0.000		0.000	0.000	0.000		0.000	0.000
RMSE			0.18573	0.31421			0.25250	0.24989
R-sq			0.796	0.472			0.1084	0.1032
Chi2			76142.37	17640.28			234.5	250.85
N	19976	19976	19976	19976	19976	19976	2218	2218

Notes: (i) Authors' calculation based on NSS 70^{th} round.
(ii) Cropcodes(jt) are controls for each crop $j = 1, 2, 3, 4$ in visit $t = 1, 2$.
(iii) +++ denote that all the four Cropcodes(jt) are positive and significant at 1% level.
(iv) t and Z statistics reported in parentheses for models 1 and 3, and models 2 and 4, respectively.
(v) $***p < 0.001$, $**p < 0.05$, $*p < 0.1$

5 Conclusion

This paper analyses the factors affecting a farmer producer's market participation or commercialization decision. Various farm and household level factors affect sale decisions. In particular, access or availability of storage facility could significantly influence farmer's marketing decisions. Specially, in developing countries where farmers do not have proper marketing facilities, having access to storage facility would allow farmers to store their produce to delay their sale and sell their produce at a better price. In this regard, the objective of this study is to consider various forms of farmers commercialization decisions to understand the farm, household, and structural variables affecting farmer's selling decisions. 70^{th} round NSS farm household level data from India is analysed to understand this phenomenon. This data is combined with various structural level variables from Census and other government statistical sources. Four different models of farm commercial behaviour are analysed. The first model is a binary probit model of farmer's selling decision. The second is linear model of sale ratio of number of crops sold to the number of crops cultivated. In the third model the number or frequency of market transactions is analysed using an ordered probit set-up. In the last model, the diversity of agency sale is analysed by considering agency diversity index in a linear model.

The analysis shows that access to storage facility could significantly influence farmers' commercialization decisions. Results from the first three models show that farm households which are likely to have access to storage facility are more likely to take part in market transaction, sell more number of crops, and are more likely to have higher number of market transactions. This indicates that having access to storage facility is likely to augur well for raising agricultural commercialization. These findings substantiate DCR (2018)'s policy emphasis on improving farmers' access to storage facilities in order to raise agricultural commercialization in India.

The results also show that apart from farm and household level factors, there are many structural or location specific variables which are beyond the control of the farm household which

affects farmer's marketing decision. Having outstanding credit affects farmer's decision to participate in in the market and sale ratio. Higher agricultural credit together with market access influences sale ratio in both the two visits. Agricultural power availability shows a U-shaped relationship with farmer's selling decision, sale ratio, and number of sales. Presence of smaller urban centers (Class 3, 4, 5, and 6) has an inverted U-shaped relationship with selling decision, sale ratio, and number of sales. Capital and total expenditure in agriculture significantly affects farmer's market participation. This may imply that policy makers can influence farmer's marketing behavior through making effective structural changes.

Due to lack of information on storage facility at the household level, this study uses an indirect method of measuring access to storage facility. It would have been better if some direct measures were available. Since such information is not available, the findings are limited to farm household's likelihood / possibility of access to storage but not direct or actual record of access to storage facility.

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Appendices

Table 6: Variable description and summary statistics

Variable	Description	Mean	Std. Dev.
(I) FARM & HOUSEHOLD (Source: NSS 70^{th} round)			
(i) Commercialization			
Dummy participate in market transaction (Visit 1)	Dummy =1 if sold any crop in Visit 1	0.78	0.41
Dummy participate in market transaction (Visit 1)	Dummy =1 if sold any crop in Visit 2	0.68	0.47
Sale ratio of no. of crops sold to crops cultivated (Visit 1)	Ratio of no. of crops sold to no. of crops cultivated in Visit 1	0.62	0.41
Sale ratio of no. of crops sold to crops cultivated (Visit 2)	Ratio of no. of crops sold to no. of crops cultivated in Visit 2	0.52	0.43
Number of market transactions (0, 1, or) (Visit 1)	Categorical variable of no. of market transactions 0, 1 or = 2 in Visit 1	1.09	0.72
Number of market transactions (0, 1, or = 2) (Visit 2)	Categorical variable of no. of market transactions 0, 1 or = 2 in Visit 2	0.96	0.78
Simpsons index (Visit 1)	Simpsons index for diversity of agency sale in Visit 1	0.2	0.27
Simpsons index (Visit 2)	Simpsons index for diversity of agency sale in Visit 2	0.16	0.26
(ii) Storage			
Dummy LTHS (likely to have storage)	Dummy=1 if sale quantity ¿ produced quantity	0.85	0.36
(iii) Other farm & household level variables			
Number of crops cultivated (Visit 1)	Total no. of crop types cultivated in Visit 1	1.8	1.1
Number of crops cultivated (Visit 2)	Total no. of crop types cultivated in Visit 2	2	1.2
Total land	Total land possessed (in hectares)	1.6	2
Proportion of irrigation (Visit 1)	Share of irrigated land in Visit 1	0.6	0.5
Proportion of irrigation (Visit 2)	Share of irrigated land in Visit 2	0.5	0.5
Dummy insurance (Visit 1)	Dummy=1 if any crop insured in Visit 1	0.1	0.2
Dummy insurance (Visit 2)	Dummy=1 if any crop insured in Visit 2	0.04	0.2
Dummy credit	Dummy=1 if any outstanding credit	0.73	0.45
Dummy head male (Visit 1)	Dummy=1 if head is male, 0 otherwise in Visit 1	0.93	0.25
Dummy head male (Visit 2)	Dummy=1 if head is male, 0 otherwise in Visit 2	0.92	0.27
Dummy head illiterate (Visit 1)	Dummy=1 if head is illiterate, 0 otherwise in Visit 1	0.37	0.48
Dummy head illiterate (Visit 2)	Dummy=1 if head is illiterate, 0 otherwise in Visit2	0.37	0.48
Household size	Household size	5.6	2.9
Dummy SC/ST household	Dummy=1 if household ST/SC	0.3	0.4
Average household age	Average age of the household members	31.2	11.5
Proportion of dependents	Proportion of dependents in the household	0.49	0.24
Male female ratio	Ratio of male to female members in the household	0.52	0.16
Graduates and above	Proportion of household members graduate & above	0.05	0.05
Monthly per capita consumption (Visit 1)	Monthly per capita consumption in Visit 1	1397.4	1441.5
Monthly per capita consumption (Visit 2)	Monthly per capita consumption in Visit 2	1705.6	2387.3

Table 6 (*contd.*): Variable description and summary statistics

Variable	Description	Mean	Std. Dev.
(II) VILLAGE (Source: NSS 70^{th} round)			
Village prop of non-farm workers (Visit 1)	Proportion of households engaged in non-farm activities in the village (except itself) in Visit 1	0.44	0.35
Village prop of non-farm workers (Visit 2)	Proportion of households engaged in non-farm activities in the village (except itself) in Visit 2	0.48	0.34
(III) DISTRICT (Source: Census, RBI, GOI, IMD)			
Proportion of SC	Proportion of SC population in the district	0.2	0.09
Proportion of ST	Proportion of ST population in the district	0.08	0.13
Proportion with public transport	Proportion of villages in the district with access to public transport	0.98	0.1
Proportion with towns within 5 kms	Proportion of villages in the district with town ¡ 5 kms	0.23	0.22
Proportion of agri credit to total credit	Proportion of agricultural credit to total credit	0.39	0.19
Proportion of agri markets	Proportion of villages in the district with agricultural markets	0.5	0.31
Proportion of SHG	Proportion of villages in the district with self-help groups	0.66	0.28
Proportion of finservices	Proportion of villages with access to financial services	0.32	0.25
Avg power for agri use (hrs./day) Summer	Average power available for agricultural use during summer	7	4.91
Avg power for agri use (hrs./day) Winter	Average power available for agricultural use during winters	6.3	4.65
District rainfall deviation (Visit 1)	Rainfall deviation from normal (Visit 1)	-22.7	43.2
District rainfall deviation (Visit 2)	Rainfall deviation from normal (Visit 2)	69.7	491.7
Class 1 cities	Number of urban centers with population 100000 or above	1.2	1
Class 2 cities	Number of urban centers with population 50000-99999	1.1	1.3
Class 3, 4, 5, 6 cities	Number of urban centers with population 20000-49999, 10000-19999, 5000-9999, below 500	320.9	1161.8
Ratio of class 1 and 2 cities	Ratio of class 1 & 2 urban centers	0.2	0.2
(IV) STATE (Source: RBI, EPWRF)			
Capital expenditure in agriculture (Rs. million/hect)	Capital expenditure in agriculture in the state	590.3	1116.7
Total agri expenditure (Rs. million/hect)	Total capital & revenue expenditure in agriculture	3108.1	2178.9
Size of the state economy	Per capita State GDP	81832.9	43434.6

Source: Authors' calculation based on sources as stated in the table.