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Drivers of farmers' income: The role of farm size and diversification

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The basic objective of this study is to analyse the role of farm size and diversification in determining farmers' income. Using data from NSS 70th round Situation Assessment Survey, the study considers two measures of income, viz., farm income per hectare (from crop and animal husbandry) and farmer's income per capita (from both farm and non-farm sources). Linear, log linear and panel data models are estimated to understand the nature of relationship between income, farm size and the two forms of diversification (on-farm and off-farm diversification). The study finds that a U-shaped relationship exists between farm size and farm / farmer's income. The results also show that both on-farm and off-farm diversification have an inverted U-shape relationship with farm / farmer's income. That is, diversification up to some level helps improve income but excessive diversification might lead to misallocation of resources and hence a fall in income. The results also show that engagement in public works programme such as MGNREGA has an adverse impact on farm / farmer's income, possibly due to the opportunity cost of time spent in such programmes. Finally, positive effect of education on income is seen only at somewhat high education levels.

Keywords: Farm size, farm income, farmer's income, on-farm / off-farm diversification

JEL Code: L25, Q12, Q15, Q18

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Contents

1. Introduction

The agricultural landscape of India presents a criss-crossed view of tiny plots of land. Most of these small pieces of land are owned by small and marginal farmers, who are usually endowed with limited agricultural resources. Small farm size and fragmented land holdings are pervasive in India. Around 67 per cent of total operational land holdings in India are owned by marginal farmers, with an average size of 0.39 hectare[1] (GoI a). A farm size of less than a hectare, irrespective of its efficiency, may hold only a limited livelihood potential. Yet, majority of land holdings in India are less than a hectare. The average farm size of land holding for a marginal farmer has remained unchanged between 2000-01 and 2010-11 at around 0.4 hectare. The average farm size of large farmers has increased marginally from 17.12 hectares in 2000-01 to around 17.38 hectares in 2010-11. Small farms have become even smaller with 85 per cent of farmers lacking access to farm inputs and credit (Krishnamurthi and Khandelwal 2011). Even the average "large farm" in India is not large enough when compared to average farm size of countries like USA, Canada, Brazil, Australia, etc.

1.1 Farm income and farmer's income

On February 28, 2016, the Prime Minister of India set forth the target of doubling farmer's income by 2022. However, given the various constraints and problems facing Indian agriculture, the feasibility of achieving such a goal has been largely debated (Chand 2017; Birthal et al. 2017; Gulati and Saini 2016). The smallness of average farm size in India is one such major constraint (MoA 2017; NABARD 2016). There is also a dichotomy between doubling of "farm income" and doubling of "farmers' income" by the year 2022. In this

[1] According to Agricultural Census definition, marginal farms are those with less than 1 hectare of land. Small and semi-medium farms are those with size of 1-2 and 2-4 hectares respectively. Medium farms have a size of 4-10 hectares. Those with more than 10 hectares are termed as large farms.

context, it is imperative to first understand what constitutes a farmer's income, and the factors influencing farmer's income.

According to Chand et al. (2015), farm income grew at a rate of 3.5% during 2004-2011, compared to 2.1% during 1993-2004. However, the notion of "farm" income falls short of reflecting "farmer's total" income. Income from both farm and from off-farm sources constitutes a farmer's total income. A complete knowledge on farmer's income from both the two sources would inform us about the true nature of economic condition of farmers.

On an average, 80 per cent of agricultural households are dependent on both non-farm income and, wages and salaries (NSSO 2014 a). Thus, to understand the determinants of farmer's income one needs to understand the drivers of both on-farm and off-farm diversification. On-farm diversification refers to diversification between crop and animal husbandry (livestock, dairy, poultry, fishery, etc.), and within the crop basket as well. On-farm diversification is a farmer's strategy to hedge against both production and market risks endemic to individual agricultural commodities. Significant non-agricultural activities are also reported in rural areas. Farmers often work at off-farm non-agricultural enterprises as entrepreneurs or as wage employees, including in public works. Off-farm diversification acts as an additional source of livelihood. It could also be a coping mechanism against adverse shock to farming such as due to droughts, pest attack, etc.

1.2 Farm size and farmer's income

There is a perennial debate on the relationship between farm size and productivity. There is vast amount of literature linking farm size and productivity. One view is that there exists an inverse relationship between farm size and productivity (Sen 1962; Chand et al. 2011; Gaurav and Mishra 2015). This side of the debate argue that large farms suffer from

'diseconomies of scale'. Smaller farms tend to use inputs more intensively and hence are able to reap higher yields. In response to this, there is a counter view that smaller farms are constrained by access to modern technologies and agricultural services. This could hamper investments in farm infrastructure and restrict their productive capacity. Hence, according to this view a direct relation between farm size and productivity seems to be more convincing (Monchuk et al. 2010; Deininger et al. 2016).

There is yet another view which emphasises that the relationship between farm size and productivity could be contextual (Deolalikar 1981; Chattopadhyay and Sengupta 1997). The theory of inverse relationship may be applicable in underdeveloped economies with surplus labour. However, such a relationship may cease to exist in developed economies where farm labour is generally scarce.

Some recent studies on farm size and productivity have thrown new light into this enduring debate. Assunçãoa and Ghatak (2003) showed that diminishing returns may not be the cause for inverse relationship. It may be due to unobserved heterogeneity with respect to farmer's skill. Monchuk et al. (2010) find that land fragmentation may even adversely affect agricultural production. In fact, Ghatak and Roy (2007) find heterogeneous impact of land reforms on productivity in India. In contrast, in a recent study Gaurav and Mishra (2015) find an inverse relationship between returns to land from farm production and its size. Thus, the nature of the relationship between farm size and productivity continues to remain an open empirical question. In this entire milieu, we understand that there always emerges the question of land reforms and its impact on agriculture. However, the current discussion is not placed in that direction.

Even as this debate on farm size-productivity relationship remains inconclusive, an agrarian crisis has hit Indian agriculture, which has invariably culminated with an erosion of farmers' income (Krishna 2017), rise in rural indebtedness and in extreme form even resulted in farmers committing suicide (Mishra 2008; Mishra 2014). Most of the misery is among the marginal and small farm holders. Small farmers are usually scarcely endowed. Implication of farm size on farmer's income is not well understood in the literature. The relationship between farmer's income and farm size may be increasing / decreasing / (inverted) U-shaped. This study makes an attempt to empirically establish such a relationship.

1.3 Diversification and farmer's income

Studies have found that farm diversification has a major role in alleviating rural poverty (Michler and Josephson 2017; Birthal et al. 2015). Various institutional as well as market factors influence a farmer's decision to diversify (Joshi et al. 2007; Birthal et al. 2007). All these empirical studies on farm diversification have considered only crop cultivation for the definition of a 'farm'. However, farming engagement has become a diversified vocation in the recent past. Livestock and poultry have a significant role to play in a farmer's income. Kishore et al. (2016), mention that dairying has become an important vocation for small holder farmers. Also, most of these studies have considered diversification as growing HYV crops only (Birthal et al. 2015; Birthal et al. 2007). But, in reality, a farmer's diversification basket may involve both on-farm and off-farm diversification strategies. Such studies look only at farmers' welfare from the perspective of "farm" diversification, rather than "livelihood" diversification.

On-farm diversification involves growing more than one type of crop and may also involve investing in allied activities. Apart from influencing a farmer's decision to intensify or

diversify production, farm size, could also compel a farmer to look for off-farm livelihood opportunity elsewhere. A farmer could also look out for non-farm employment opportunity to supplement his or her farm income or simply to escape from rainfall and other production uncertainties. Non-farm employment may involve working as a wage labour, maintaining petty shops, etc.

This makes it clear that both on-farm and off-farm diversification has an important role to play in contributing towards a farmer's total income. Focusing on income only from farming may not be comprehensive to understand the factors effecting a farmer's livelihood (Chandrasekhar and Mehrotra 2016; Mehta 2009). To the best of our knowledge, there is hardly any study on the relationship between farmer's income and the two forms of diversification (on-farm and off-farm). This study makes a modest attempt to fill that gap in the literature.

Income of a farm household may be defined in two ways. One way is to consider farm income per hectare (from crop and animal husbandry). And the other is to consider farmer's income per capita (from both farm and non-farm sources). Using data from NSS 70th round Situation Assessment Survey, this study estimates linear, log linear and panel data models to understand the nature of relationship between both the forms of income, farm size and the two forms of diversification. The study finds that a U-shaped relationship exists between farm size and farm / farmer's income. The results also show that both on-farm and off-farm diversification have an inverted U-shape relationship with farm / farmer's income. That is, diversification up to some level helps improve income but excessive diversification might lead to misallocation of resources and hence a fall in income. The results also show that engagement in public works programme such as MGNREGA has an adverse impact on farm /

farmer's income possibly due to the opportunity cost of time spent in such programmes. Finally, a positive effect of education on income is seen only at somewhat high education levels.

The structure of this paper is as follows: Section 2 discusses the model specification. Particulars regarding data are discussed in section 3. Section 4 presents the results and discussions. And, section 5 concludes the paper.

2. Model specification

2.1 Basic model

This study is an attempt to understand the impact of farm size and farmer's diversification strategy (both on-farm and off-farm) on farmer's income. We estimate the following empirical relationship:

$$y_i = \beta_0 + \beta_1.FS_i + \beta_2.OFD_i + \beta_3.NFD_i + \beta_4.FARMCH_i + \beta_5.HHLDCH_i + \beta_6.LOCCH_i + \varepsilon_i \quad (1)$$

The dependent variable y_i i.e. i^{th} farmer's income is defined in two ways. One is in per hectare terms, and the other is in terms of per capita. When it is considered in terms of per hectare, income is defined as from farm sources only (y_i: *on-farm income per hectare*). Farm income consists of income from on-farm sources i.e. crop cultivation and livestock[2]. When it is defined in terms of per capita, income incorporates farmer's income from both on-farm and non-farm sources (y_i: *total income per capita*). Non-farm income source includes wages and salaries, off-farm entrepreneurial income, wages from public works, etc.

[2] Here livestock combines all types of livestock, dairy, poultry, fishery etc.

FS_i is the i^{th} household's farm size. OFD_i, represents on-farm diversification, whereas, NFD_i, represents non-farm diversification. Farm characteristics are captured by the term $FARMCH_i$. Household characteristics of the i^{th} household are captured by the term $HHLDCH_i$. $LOCCH_i$ are the location specific characteristic of the i^{th} household.

We also specify a log linear model as follows:

$$\ln y_i = \beta_0 + \beta_1 . \ln FS_i + \beta_2 . OFD_i + \beta_3 . NFD_i + \beta_4 . FARMCH_i + \beta_5 . HHLDCH_i + \beta_6 . LOCCH_i + \varepsilon_i \quad (2)$$

The above log linear model however, takes into account only those households whose incomes are positive. This leads to dropping of those households experiencing negative income shocks.

$$y_{it} = \beta_0 + \beta_1 . FS_{it} + \beta_2 . OFD_{it} + \beta_3 . NFD_{it} + \beta_4 . FARMCH_{it} + \beta_5 . HHLDCH_{it} + \varepsilon_i \quad (3)$$

$$\ln y_{it} = \beta_0 + \beta_1 . \ln FS_{it} + \beta_2 . OFD_{it} + \beta_3 . NFD_{it} + \beta_4 . FARMCH_{it} + \beta_5 . HHLDCH_{it} + \varepsilon_i \quad (4)$$

In order to account for seasonality between *kharif* (visit 1) and *rabi* (visit 2) seasons, panel models are also considered in this study (equations (3) and (4)). Depending on the results of Hausman test, we construct a random effect or fixed effect model. The panel model should capture any seasonality effects on the variables.

2.2 Hypothesis on variables

The main variables of interest here are FS_i, OFD_i and NFD_i (Table 1). The hypothesis is that farm size, FS_i, may have a positive or negative relationship with the dependent variable y_i.

On-farm diversification, OFD_i, and non-farm diversification, NFD_i, are hypothesized to have a positive impact on farm/farmer's income. Depending on the components of farm and household characteristics, the variables $FARMCH_i$ and $HHLDCH_i$ may have positive or negative influence on farm/farmer's income.

In doing so, we also posit the question of an optimal farm size i.e. whether there exists an optimal relationship between farm size and income. In order to account for this, we consider the quadratic term FS_i^2 and hypothesize that there exists an optimal farm size i.e. $\frac{\partial FS_i^2}{\partial y_i} < 0$. Similarly, we also ask the question whether an optimal point of diversification exists for both on-farm diversification and non-farm diversification. We hypothesize that there exists an optimal diversification for both $OFD_i^2$and NFD_i^2 i.e. $\frac{\partial OFD_i^2}{\partial y_i} < 0$ and $\frac{\partial NFD_i^2}{\partial y_i} < 0$.

2.3 Measuring diversification

Usual literature on calculating diversification uses concentration / diversity index methods like Simpsons index method, Herfindhal index method, etc. Such studies generally take share of land allocated for different crops for measuring diversity indices. However, it becomes difficult to construct diversity indices with components of income from various sources as a definition of livelihood diversification. An agricultural household may experience production or market shocks in both farm and non-farm activities. This leads to some component of the household's income to be negative. And if the magnitude of such a negative component of the income is large enough, it may even render the diversity index to be greater than 1.

Hence, in this study diversification is measured using count method. That is, diversity in a particular income source is measured by counting the number of components in that activity. For example, number of crops grown by particular household, number of non-farm activities, etc. In doing so, we are aware of the fact that there is an equal weight assigned to each component within an activity.

3. Data

There is a dearth of recent reliable information on agricultural household income in India (Bhatnagar 2017). The only available data is provided by National Sample Survey Organisation (NSSO) in its two recent surveys. The two rounds of surveys were conducted by NSSO to assess farmers' livelihood situation during 2002-2003 (59th round) and 2012-2013 (70th round). This study is based on the data from National Sample Survey (NSS), Situation Assessment Survey (SAS), 70th round (Schedule 33) (GoI b). The 70th round of the NSS SAS reports on farm production and household level characteristics of agricultural households for the agricultural year from July 2012 to June 2013. Information on employment and income from non-farm employment sources is also reported for the agricultural household.

Data is collected during two visits. Visit 1 is canvassed for *kharif* season from July–December 2012. And, visit 2 is canvassed for the *rabi* season January–June 2013. Combination of the two visits gives information on agricultural households for the entire duration of the agricultural year 2012-13. To account for local weather characteristics, departure in actual from normal rainfall is taken from Rainfall Statistics of India (GoI c) for the agricultural year 2012-13.

The NSS 70th round defines an 'agricultural household' as one 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, at least one member of the household should be self-employed in agriculture either in principal status or in subsidiary status. A total of 35,200 households were interviewed during visit 1. Out of this, 35,200 households, only 34,907 could be interviewed again during visit 2 of the survey. This implies that 293 households were 'casualty' or missing households during visit 2 of the survey.

The survey categorises farmers by principal source of income. The income sources are crop cultivation, livestock, wages and salary, non-farm sources, remittances, pensions and others. However, the survey provides information regarding receipt and expenses only from four sources viz. crop income, livestock income, non-farm income, and wages and salary. It does not report on receipts from remittances, pensions and others. Hence, this study drops such households which report their principal source of income as remittances, pensions and others[3].

According to the survey, around 67% of households are marginal farmers with an average farm size of 0.38 hectare (Figure 1). While 18% are small farmers, 10% are semi-medium and 4% are medium farmers with an average farm size of 1.37, 2.53 and 5.41 hectares, respectively[4]. Only around 1% farms are large farms with an average farm size of about 15.13 hectares.

Around 64% of agricultural households report income from crop cultivation as their main source of income (Figure 2). After which about 22% report income from wages and salaries as their principal source of income. This is then followed by non-agricultural enterprises and livestock. Though around 3% of household bank on remittances as their main source of

[3] Due to similar data limitations, Chandra and Mehrotra (2016), and Chakravorty et al. (2016) also drop such households whose primary sources of income are remittances, pensions and others.

[4] We use the same definition as Agricultural Census to categorize the farm households into marginal, small, semi-medium, medium and large farm categories.

income, however, the amount of this receipt is not reported in the survey. As farm size increases, prominence of crop cultivation as the main source of livelihood increases (Figure 3). Whereas, the reporting of wages and salaries as the principal source of income decreases as farm size increases.

3.1 Summary of data

There are 34,907 agricultural households for which information is available for both the two visits. However, there are also households with income from any source being missing / not reported. This study drops such households from the study. Also, households for which data on farm size is missing / not reported are dropped from the study. Thus, this study is conducted with 29,830 households (Appendix 1).

Average annual income of agricultural households is about Rs. 82,456, with average per capita income being Rs. 18,744[5]. However, many agricultural households have experienced negative income shock during that agricultural year. Average farm size is around 1.5 hectares, with the maximum farm size being about 52 hectares. On an average, about half of a household's land is irrigated. Average household expenditure on diesel, electricity and fertilizers is around Rs. 1,021, Rs. 247 and Rs. 4,169, respectively.

Households grow on an average cultivate 2 different types of crops and engaged in at least 1 livestock activity. Some households do not engage in non-farm activity, while some households engage in 6 different non-farm activities. Average household size is about 5 members. Average age of household members is around 31, while age of those engaged in

[5] Income across four different components of income source (crop, livestock, non-farm, and wages & salary) is presented in Appendix 2.

agriculture is about 40. On an average, 30% of household members report to have worked in MGNREGA[6] program.

Only 5% of crops cultivated by households are reported to be insured. About 40% of households report to have received technical advice for any crops cultivated[7]. More than 55% of households report to have outstanding loans from institutional sources. Most of the households have a dwelling unit of their own, possess a ration card and have access to safe drinking water.

3.2 Issue on crop inputs

The 70th round Schedule 33, asks households on expenditure made by the household across various farm inputs. It however, reports on expenditure amount only if expenditure is incurred from 'out of pocket'. The instruction manual supplied to its field staff by the NSSO, notes that "only actual expenses out of pocket (both in cash and in kind) will be recorded (here)" (p. E-25, NSSO 2014 b). Use of such inputs sourced from home stock, or borrowed, or through exchange are to be recorded as zero. This limits the information on actual usage of farm inputs by households. Though majority of households report purchasing of farm inputs (Appendix 3), yet there are households which use inputs that are farm saved or exchanged. Also if the agency source of a farm input, especially electricity, is reported to be from government or co-operative source (Appendix 4), then the expenditure on that input is recorded as zero.

This is a serious problem since we know that majority of farms in some States receive free electricity. Such households are then recorded with no 'expenditure' on electricity even they

[6] Mahatma Gandhi National Rural Employment Guarantee Act

[7] The survey however does not report on technical advice received for rearing of livestock component, although livestock constitute a major component of a farmer's livelihood.

are using electricity. Similarly, the problem persists with other farm inputs as well. Recording of a farm input expenditure as zero may not imply that the household is not using that input. It may be due to the procurement source / agency of that input. Given this limitation in data, this study records expenditure on any farm input only if the households are making an actual expenditure on such inputs.

Another issue is that even if expenditure on electricity and diesel are reported in the data, there is no way to confirm the actual use of these inputs in farm production. Such inputs could be diverted for home consumption or other non-farm consumption purposes. Also, for some households, even the expenditure on 'purchase' of input items is reported to be zero. This then makes it difficult to understand whether this is an anomaly or the input has been purchased on credit. Even some inputs like electricity, human and animal labour are reported to have been used from 'farm saved'. This is difficult to comprehend. There is no clarity in this regard.

3.3 Reference period

As discussed earlier, agricultural household income could be categorized into four different heads. These are crop income, livestock income, wages / salaries and non-farm income. However, in the NSS 70th round, information on income from these four sources is collected with a varied reference period. In each visit, information on income from crop cultivation and wages are surveyed with a reference period of 6 months. But, income from non-farm sources and livestock are surveyed with a recall period of 30 days. In order to have a common uniform reference period, the non-farm income and livestock income components are multiplied by 6. The combination of incomes from Visit 1 and Visit 2 gives the total annual income of a particular household.

4. Results and discussion

The general findings of this study are presented in Table 2. The study finds that, there exists a U-shaped relationship between farm size and on-farm income per hectare, and farmer's income per capita. The results also show that both on-farm and off-farm diversification have an inverted U-shape relationship with farm / farmer's income. The results also suggest that a higher proportion of household members in public works programme like MGNREGA have an adverse impact on farm / farmer's income. Finally, positive effect of education on income is seen only at somewhat high education levels. The results are discussed in detail below.

4.1 Combining both Visit 1 and Visit 2

We first estimate equation (1) for the entire agricultural year combining visit 1 and visit 2. The results are reported in Table 3. As discussed above, income is considered in two ways. Models 1 and 2 have the dependent variable as on-farm income per hectare (income from crops & livestock), whereas models 3 and 4 have the dependent variable as farmer's income per capita (income from crop, livestock, non-farm sources, and wages & salary). Locational characteristics are controlled in models 2 and 3 with rainfall deviation, state dummies and state region dummies. Expenditure on diesel, seed, electricity, fertilizer, human labour and animal labour are controlled for in the estimation equations. Variables on crop insurance, credit, technical advice, SC/ST, housing, safe drinking water, ration card are controlled as dummy variables in the models.

Farm size has a significant negative impact on on-farm income per hectare. It however, does not influence much over income per capita. Square of farm size (*Sq. farm size*) show a positive and significant impact over on-farm income per hectare. There seems to exist, an inflection point after which farm size has a positive relationship with on-farm income per

hectare. In other words, the relationship between farm size and on-farm income may be U-shaped. Higher the diversification in crop cultivation during both the seasons (*Crop count visit 1* and *Crop count visit 2*) has a direct and significant effect on income per capita. However, at higher levels of diversification (*Sq. crop count visit 1* and *Sq. crop count visit 2*), the relationship between income and diversification becomes negative. This implies that there may exist, an optimal level of crop diversification during both the two seasons. Whereas, the number of livestock activity (*Livestock visit 1*) positively impacts income per capita only during visit 1, livestock activity during visit 2 (*Livestock count visit 2*) has a positive and significant effect on both on-farm income and total income. This may be due to the fact that during *rabi* season there is lack of rainfall and irrigation. Farmers have to depend on rearing of livestock during this season. But, at a higher level of livestock diversification (*Sq. livestock count visit 1* and *Sq. livestock count visit 2*), the relationship with income turns negative. Similar to crop diversification, there may exist, an optimal level of livestock diversification as well.

Non-farm activity during visit 1 (*Non-farm count visit 1*) has a positive and significant impact on on-farm income. But here too, there may exist, an optimal relationship between non-farm activity and income. Non-farm activity during visit 2 (*Non-farm count 2*) has a positive and significant relationship with income per capita. At a higher level of non-farm diversification during visit 2 (*Sq. non-farm count visit 2*), the relationship turns negative and significant.

As household size increases, it significantly pulls down per capita income. Having a higher proportion of household members engaged in agriculture (*Share agriculture*) may lead to significant decrease in per capita income. This informs us that, in order to raise farmer's

income, it is better to have less number of household members in agriculture. As mentioned in Chand et al. (2011), in order to raise income of smallholders, it is important to raise land-man ratio.

Higher the proportion of household members engaged in MGNREGA works (*Share MNREGA*), lower will be both on-farm income per hectare and total income per capita. MGNREGA is a public works program focusing towards raising rural employment and enhancing agricultural productivity. However, there may not be a significant impact on raising farm income (Varshney et al. 2017). This may be due to higher opportunity cost of time involved in MNREGA works. The household may do well in raising income by investing their labour time in other non-farm activity.

Education helps in raising income of the household (*Sq. avg. household edu.*), but only at a higher level. Similarly, only at a higher level of education of adult household members engaged in agriculture (*Sq. avg. adult edu. in agri*) has a positive and significant impact on farm income. Higher household age raises both farm and total income (*Avg. age of household*), but higher age of members engaged in agriculture may lead to a fall in on-farm income (*Avg. age of agri workers*). Also, higher the standard deviation in ages of household members, lower will be their on-farm and total income (*SD of age of household* and *SD of age of agri workers*). Deviation in rainfall during that year (2012-13) from the normal (*Rainfall deviation*) has a negative and a significant impact on on-farm and total income.

If we look at the results for the log linear equation (2) in Table 4, we find similar results. There is a significant negative relationship between farm size (*Ln(farm size)*) and income. Crop diversification (*Crop count visit 1* and *Crop count visit 2*) during both the visits raises on-farm income. But, at a higher level of diversification this relationship turns to be negative

(*Sq. crop count visit 1* and *Sq. crop count visit 2*), implying that there may exist, an optimal level of diversification. Similarly, livestock diversification significantly improves on-farm income and total income (*Livestock visit 1 and Livestock visit 2*). Non-farm diversification significantly helps in raising on-farm and total income during both the seasons (*Non-farm count visit 1* and *Non-farm count visit 2*). But, it is important to realise that there is an optimal level of non-farm activity for the household.

If the household size increases, it may lead to a significant fall in per capita income. Engagement of household members in MGNREGA activity may not have a positive impact in raising income. (*Share MNREGA*) Higher the proportion of household members involved in agriculture, lower will be the per capita income (*Share agriculture*). Average education level of household seems to help in raising income but only at a higher level (*Sq. avg. household edu.*). Similarly, average education level of adults engaged in agriculture has positive impact on income only after some higher end (*Sq. avg. adult edu. in agri*). A higher average age of the household raises per capita income but a difference in age of household members may not have a positive impact on income.

4.2 Visit 1 (*kharif*)

The results for linear equation (1) during visit 1 are presented in Table 5. There seems to exist, an inverse relationship between farm size and on-farm income per hectare. But, an optimal level of farm size may exist implying that at a higher level of farm size there may a positive relationship between farm size and income. Hence, there might be an U-shaped relationship between farm size and income. Both crop and livestock diversification during *kharif* season (*Crop count visit 1* and *Livestock count visit 1*), have a positive and significant impact in raising income per capita. Non-farm activity raises on-farm income per hectare

(*Non-farm count visit 1*). The squared terms of all these three types of diversification show a negative and significant effect on income. This may imply that there exists, an optimal level for these diversifications. In other words, the relationship between diversification and income may be a U-shaped curve.

Higher the household share of members working in MGNREGA during the *kharif* season (*Share MNREGA visit 1*), lower would be both on-farm and total income. However, the interaction term of MGNREGA and farm size shows positive influence on on-farm income. Only at a higher level of education of household members (*Avg. household edu.*) and agricultural workers (*Sq. avg. adult edu. in agri*), a positive and significant effect is visible on income. A higher average age of household members (*Avg. age of household*), helps in raising both on-farm and total income.

Results for the log linear equation (2) for visit 1 are presented in Table 6. *Ln(farm size)* has a negative and significant impact on on-farm income and income per capita. This implies that there may exist, an inverse relationship between farm size and income. *Crop count visit 1* and *Livestock count visit 1* show a significant and positive impact on on-farm income nad income per capita. However, a higher degree of crop diversification during visit 1 may not yield positive results. Similarly, non-farm diversification (*Non-farm count visit 1*) may have significant positive effect in raising per capita income. Higher share of household members working in MGNREGA program may lead to a significant decline in per capita income. Education of household members helps in raising income but only at a higher level.

4.3 Visit 2 (*rabi*)

Results for the linear model in equation (2) during visit 2 (*rabi*), are presented in Table 7. In visit 2 too, farm size and on-farm income seems to have a negative relationship. But, at a

higher level of farm size, the relationship turns to be positive. Livestock diversification (*Livestock count visit* 2) helps in increasing on-farm income. But, a higher amount of diversification may not be helpful. Non-farm diversification (*Non-farm count visit* 2) has a significant positive impact on total income per capita. Working in MGNREGA works during the *rabi* season (*Share MNREGA visit* 2) may not lead to a rise in per capita income. Having higher male members in the household (*Adult male-female* ratio) during the lean season raises total per capita income but not on-farm income.

For the log linear model in equation (2) for the visit 2, the results are presented in Table 8. Farm size and on-farm income, and income per capita are negatively related. Livestock and non-farm diversification (*Livestock count visit 2 and Non-farm count visit 2*) have a positive and significant impact on total income per capita. Engagement of household members in MGNREGA works (*Share MNREGA visit 2*) may have significant negative effect on both on-farm and total income. This reiterates the fact that there be high opportunity cost of time involved with such public works program.

4.4 Panel models for Visit 1 and Visit 2

We estimate a two period panel models over both equations (1) and (2). The results are presented in Table 9. Hausman test results suggest a random effects model with dependent variable being on-farm income per hectare. And, a fixed effect is suggested for the model with the dependent variable as total income per capita.

Both *Farm size* and *Sq. farm size* has a negative and significant relationship with on-farm income per hectare. *Ln(farm size*) on the other hand shows a positive effect on on-farm income. Crop diversification (*Crop count*) has a positive and significant impact on on-farm income. Diversification in terms of non-farm activity raises total income per capita. A higher

share of household members engaged in MGNERGA works leads to a fall in both on-farm and total income. Education helps in raising income only at a higher level.

5. Conclusion

Land is a scarce economic resource, and agricultural land is even dearer. The recent public discourse on doubling of farmers' income by the year 2022, has rekindled the debate on farm size and agricultural income. Although there are a lot of studies looking into the relationship between farm size and productivity, the relationship between farmer's income and farm size has not been properly understood. Farmer's income is the result of both on-farm and off-farm diversification. There must be some relationship between these two forms of diversification and farmer's income. This study makes an attempt to empirically establish the relationship between farm size and farmer's income, and diversification (both on-farm and off-farm) and farmer's income.

To study the above this study relies on agricultural household data from the 70th round of the NSS situation assessment survey. The results shows that there might exist, a negative but optimal relationship between farm size and on-farm income / total income. This then suggest that the relationship between farm size and farmer's income is U-shaped-declining first, but at a higher level farm size has a positive relationship with income.

Crop diversification may have a positive and significant effect in raising farmer's income. Similarly, diversifying in livestock activity significantly improves farmer's income. Non-farm diversification may even sometimes supplement on-farm income. However, excessive diversification may lead to misallocation of resources, which may lead to negative effect on both on-farm and farmer's income. This suggests there exist, an optimal level of diversification. Hence, the relationship between diversification (both on-farm and non-farm)

and income might be a U-shaped curve. The study also finds that higher the number of household members engaged in MGNREGA works, lower might be its on-farm / total income. Higher opportunity costs involved with seeking such public works lead to fall in income earnings.

In drawing the above conclusions, one also needs to understand the limitations of this study. Most of the variables on expenditure on farm inputs turn out to have an insignificant impact on farm income. This might be due to endogeneity issue among expenditure on different farm inputs. In order to account for that these inputs could have been instrumented with irrigation share of land use. But, as discussed in Section 3.2 above, there arises problem with taking irrigation share as an instrumental variable for expenditure on farm inputs. However, keeping these limitations in mind, it is expected that the above findings gives a flavour of the possible relationship between farm size, diversification and farmer's income.

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Tables

Table 1: Hypothesis on variables of interest

Variables of interest	Hypothesis
FS_i	+/-
OFD_i	+
NFD_i	+
$FARMCH_i$	+/-
$HHLDCH_i$	+/-

Table 2: General findings

Variables	Combined		Visit 1		Visit 2		Panel	
	On-farm	Total	On-farm	Total	On-farm	Total	On-farm	Total
Farm size	-	-	-	-	-	-	-	
Sq. farm size	+		+	+	+		+	
Crop count visit 1	+	+	+	+				
Sq. crop count visit 1	-	-	-	-				
Crop count visit 2	+	+				+		
Sq. crop count visit 2	-	-				-		
Crop count (panel)							+	
Sq. crop count (panel)							-	
Livestock count visit 1	+	+		+				
Sq. livestock count visit 1	-	-		-				
Livestock count visit 2	+	+			+			
Sq. livestock count visit 2	-	-			-			
Livestock count (panel)							+	-
Sq. livestock count (panel)								
Non-farm count visit 1	+	+	+	+				
Sq. non-farm count visit 1	-	-	-	-				
Non-farm count visit 2		+				+		
Sq. non-farm count visit 2		-				-		
Non-farm count (panel)							+	+
Sq. non-farm count (panel)							+	-
Share MNREGA	-	-	-	-		-	-	-
Avg. household edu.		-		-			-	
Sq. avg. household edu.		+		+			+	
Avg. adult edu. in agri	-		-		-		-	
Sq. avg. adult edu. in agri.	+		+		+		+	

Table 3: Linear model for the entire agricultural year (combining Visit 1 & Visit 2)

VARIABLES	(1)		(2)		(3)		(4)	
	On-farm income per hectare		On-farm income per hectare		Income per capita		Income per capita	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Farm size (hec)	-373,756***	(58768)	-375,941***	(66070)	-273.8	(292)	-364.2	(311.6)
Sq. farm size (hec2)	11,508***	(3003)	12,030***	(3384)	4.681	(11.36)	11.45	(13.02)
Crop count visit 1	245851	(398227)	361340	(416632)	4,258***	(1297)	5,233***	(1653)
Sq. crop count visit 1	-53176	(63724)	-81695	(68259)	-780.5***	(249.4)	-958.7***	(306.3)
Crop count visit 2	-86337	(318473)	-258846	(327680)	4,868***	(971.3)	1953	(1687)
Sq. crop count visit 2	7216	(59893)	39276	(61859)	-912.3***	(192.9)	-406.4	(306)
Livestock count visit 1	-198809	(391067)	203726	(448089)	10,286***	(2126)	10,954***	(2210)
Sq. livestock count visit 1	3455	(121289)	-87730	(140970)	-3,255***	(833.4)	-3,322***	(829.4)
Livestock count visit 2	932,303***	(263521)	914,930***	(302160)	16,635***	(1894)	15,234***	(2051)
Sq. livestock count visit 2	-394,392***	(106472)	-375,756***	(110228)	-4,948***	(911.8)	-4,234***	(947.2)
Non-farm count visit 1	1.080e+06***	(345984)	1.342e+06***	(439106)	-345.4	(1764)	745	(1747)
Sq. non-farm count visit 1	-377,621**	(156403)	-407,164**	(167667)	5,942***	(1315)	4,375***	(1426)
Non-farm count visit 2	-85833	(246433)	195353	(292708)	4,337***	(1642)	5,251***	(1408)
Sq. non-farm count visit 2	1631	(87854)	-64242	(85280)	2,248**	(1115)	839.1	(1013)
Irrigation share	504566	(920371)	1042000	(957789)	-959	(5228)	-2176	(5557)
Sq. irrigation share	-255963	(906159)	-863042	(945441)	1153	(4980)	2547	(5340)
Household size (nos.)	19017	(31006)	2928	(34560)	-1,546***	(166)	-1,514***	(159.3)
Share MNREGA	-179,972**	(91719)	-164,646*	(95593)	-807.4	(678.4)	-474.9	(693.6)
Share MNREGA * farm size	-51343	(37313)	-61798	(41014)	-279.2**	(139.2)	-297.8*	(163.7)
Share agriculture	-1097	(8510)	845.2	(9654)	-33.26	(23.03)	-29.45	(23.58)
Avg. household edu.					-3,222***	(967.2)	-3,631***	(962.6)
Sq. avg. household edu.					345.7***	(89.69)	360.9***	(88.32)
Avg. adult edu. in agri	-46,458**	(18709)	-49,911***	(18191)				
Sq. avg. adult edu. in agri	594.7**	(245.4)	630.3***	(235)				
Adult male-female ratio	-1.064e+06*	(607346)	-1.021e+06*	(583214)	-6537	(4231)	-5134	(4126)
Avg. age of household	46,718**	(22934)	52,818**	(23672)	478.6***	(103.3)	488.5***	(102.8)
SD of age of household	16290	(28652)	21008	(31221)	-594.0***	(141.6)	-598.7***	(139.1)
Avg. age of agri workers	-69,410***	(18164)	-67,639***	(18410)	-22.87	(42.6)	-26.74	(43.36)
SD of age of agri workers	-36,896**	(17243)	-38,612**	(18483)	-97.76*	(58.82)	-88.96	(59.13)
Adult percentage	1876	(6399)	2183	(6486)	67.88**	(28.24)	55.85**	(28.06)
Rainfall deviation			-115.5**	(55.46)			-1.816	(2.253)
Constant	4.930e+06**	(2326000)	3062000	(2390000)	11,412**	(4624)	15,095***	(5439)
Observations	19791		19791		29852		29852	
R-squared	0.006		0.008		0.135		0.155	
Adj. R-squared	0.004		0.004		0.134		0.151	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 4: Log linear model for the entire agricultural year (combining Visit 1 & Visit 2)

VARIABLES	(1)		(2)		(3)		(4)	
	ln(on-farm income per hectare)		ln(on-farm income per hectare)		ln(income per capita)		ln(income per capita)	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Ln(farm size)	-1.013***	(0.021)	-1.029***	(0.022)	-0.0516***	(0.012)	-0.0283**	(0.014)
Crop count visit 1	0.397***	(0.111)	0.364***	(0.102)	0.0425	(0.054)	0.142*	(0.075)
Sq. crop count visit 1	-0.0674***	(0.019)	-0.0620***	(0.018)	-0.00836	(0.010)	-0.0245	(0.015)
Crop count visit 2	0.232**	(0.107)	0.276***	(0.103)	0.404***	(0.069)	0.0843	(0.089)
Sq. crop count visit 2	-0.0456**	(0.018)	-0.0508***	(0.018)	-0.0796***	(0.012)	-0.0257	(0.015)
Livestock count visit 1	0.117	(0.106)	0.237**	(0.117)	0.695***	(0.098)	0.758***	(0.095)
Sq. livestock count visit 1	-0.0409	(0.045)	-0.0726	(0.045)	-0.211***	(0.034)	-0.229***	(0.034)
Livestock count visit 2	0.309**	(0.120)	0.306***	(0.117)	1.113***	(0.110)	0.949***	(0.127)
Sq. livestock count visit 2	-0.107**	(0.048)	-0.0953**	(0.048)	-0.307***	(0.043)	-0.251***	(0.045)
Non-farm count visit 1	-0.146	(0.101)	-0.125	(0.102)	0.376***	(0.073)	0.465***	(0.073)
Sq. non-farm count visit 1	0.0959**	(0.044)	0.0480	(0.042)	0.00608	(0.030)	-0.0593**	(0.028)
Non-farm count visit 2	-0.0579	(0.098)	-0.0324	(0.093)	0.387***	(0.064)	0.488***	(0.061)
Sq. non-farm count visit 2	0.0869**	(0.043)	0.0236	(0.038)	-0.0219	(0.026)	-0.0834***	(0.022)
Irrigation share	-0.218	(0.286)	-0.151	(0.286)	-0.167	(0.220)	-0.332	(0.218)
Sq. irrigation share	0.427	(0.273)	0.389	(0.273)	0.238	(0.226)	0.400*	(0.225)
Household size (nos.)	0.00742	(0.011)	0.00793	(0.011)	-0.115***	(0.012)	-0.115***	(0.011)
Share MNREGA	-0.00871	(0.039)	0.00731	(0.039)	-0.0544**	(0.027)	-0.0557**	(0.027)
Share MNREGA * farm size	-0.0221***	(0.005)	-0.0178***	(0.004)	-0.0130**	(0.005)	-0.00989**	(0.005)
Share agriculture	-0.000937	(0.001)	-0.00165	(0.001)	-0.00271***	(0.001)	-0.00277***	(0.001)
Avg. household edu.					-0.175***	(0.037)	-0.179***	(0.033)
Sq. avg. household edu.					0.0214***	(0.003)	0.0200***	(0.003)
Avg. adult edu. in agri	-0.00961*	(0.005)	-0.00952*	(0.005)				
Sq. avg. adult edu. in agri	0.000133**	(5.33e-05)	0.000131**	(5.48e-05)				
Adult male-female ratio	-0.457**	(0.207)	-0.401**	(0.199)	0.0941	(0.172)	0.160	(0.163)
Avg. age of household	-8.86e-05	(0.004)	0.00127	(0.004)	0.0113***	(0.003)	0.0106***	(0.003)
SD of age of household	-0.0123**	(0.006)	-0.0107*	(0.006)	-0.00905**	(0.004)	-0.00825*	(0.004)
Avg. age of agri workers	0.000694	(0.003)	0.00153	(0.002)	0.000851	(0.001)	-0.000738	(0.001)
SD of age of agri workers	0.00255	(0.005)	0.00108	(0.004)	-0.000705	(0.002)	-0.00130	(0.002)
Adult percentage	0.00314	(0.002)	0.00283	(0.002)	0.000942	(0.002)	0.000553	(0.001)
Rainfall deviation			-9.25e-05	(6.45e-05)			-0.000124**	(4.93e-05)
Constant	10.08***	(0.310)	10.07***	(0.382)	8.463***	(0.255)	9.352***	(0.320)
Observations	14,379		14,379		26,951		26,951	
R-squared	0.553		0.575		0.361		0.412	
Adj. R-squared	0.551		0.572		0.360		0.408	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 5: Linear model for Visit 1 (*kharif*)

VARIABLES	(1)		(2)		(3)		(4)	
	On-farm income per hectare		On-farm income per hectare		Income per capita		Income per capita	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Farm size (hec)	-272,342***	(51,184)	-281,176***	(59,968)	-116.6	(223.9)	-104.4	(266.6)
Sq. farm size (hec2)	6,590***	(1,882)	6,727***	(1,985)	-5.118	(5.339)	-1.868	(6.187)
Crop count visit 1	422,537	(434,618)	475,629	(426,271)	5,372***	(1,235)	4,023***	(1,493)
Sq. crop count visit 1	-73,833	(67,401)	-86,392	(68,706)	-960.8***	(219.1)	-728.9***	(263.6)
Livestock count visit 1	-983.9	(448,712)	165,606	(419,765)	11,769***	(1,366)	12,094***	(1,450)
Sq. livestock count visit 1	-35,639	(130,353)	-72,172	(135,453)	-3,076***	(638.7)	-3,018***	(630.0)
Non-farm count visit 1	1.181e+06***	(339,381)	1.364e+06***	(415,684)	-745.3	(2,729)	996.1	(2,567)
Sq. non-farm count visit 1	-490,245***	(147,747)	-521,609***	(160,456)	5,708***	(1,940)	4,095**	(2,007)
Irrigation share visit 1	-811,130	(815,807)	-1.031e+06	(837,755)	-9,544**	(4,856)	-5,771	(4,981)
Sq. irrigation share visit 1	1.011e+06	(862,474)	1.146e+06	(848,359)	10,475**	(4,667)	6,827	(4,852)
Household size (nos.)	-11,920	(24,916)	-8,864	(27,340)	-881.3***	(128.7)	-809.1***	(127.8)
Share MNREGA visit 1	-848,968***	(220,737)	-894,902***	(273,392)	-2,664***	(968.4)	-2,529**	(1,113)
Share MNREGA * farm size	114,472***	(38,054)	109,683***	(36,374)	-154.9	(191.3)	-266.0	(260.6)
Avg. household edu.					-2,418***	(895.3)	-2,692***	(874.6)
Sq. avg. household edu.					274.8***	(77.91)	286.8***	(76.97)
Avg. adult edu. in agri	-24,522*	(13,678)	-29,906**	(12,492)				
Sq. avg. adult edu. in agri	295.5*	(173.4)	341.3**	(159.5)				
Adult male-female ratio	-802,996	(525,227)	-985,786*	(515,124)	-178.7	(3,409)	663.8	(3,313)
Avg. age of household	27,731*	(16,534)	34,487**	(16,839)	267.8***	(92.13)	264.9***	(90.03)
SD of age of household	37,025*	(20,638)	38,804*	(22,158)	-302.1**	(130.1)	-296.3**	(125.3)
Avg. age of agri workers	-46,672***	(14,191)	-44,919***	(14,093)	9.948	(31.84)	3.194	(31.58)
SD of age of agri workers	-27,460**	(13,055)	-30,090**	(14,070)	-112.0***	(41.78)	-106.5**	(42.52)
Rainfall deviation			-4,107	(3,960)			4.575	(11.12)
Constant	4.467e+06*	(2.710e+06)	3.606e+06	(2.733e+06)	16,852*	(10,141)	17,608*	(9,670)
Observations	19,213		19,213		26,077		26,077	
R-squared	0.004		0.007		0.104		0.124	
Adj. R-squared	0.001		0.002		0.103		0.119	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 6: Log linear model for Visit 1 (*kharif*)

VARIABLES	(1)		(2)		(3)		(4)	
	ln(on-farm income per hectare)		ln(on-farm income per hectare)		ln(income per capita)		ln(income per capita)	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Ln(farm size)	-0.975***	(0.026)	-0.996***	(0.026)	-0.0519***	(0.015)	-0.0172	(0.016)
Crop count visit 1	0.215*	(0.129)	0.236**	(0.119)	0.243***	(0.071)	0.156*	(0.081)
Sq. crop count visit 1	-0.0424*	(0.023)	-0.0445**	(0.021)	-0.0474***	(0.013)	-0.0326**	(0.015)
Livestock count visit 1	0.722***	(0.141)	0.675***	(0.137)	0.582***	(0.111)	0.582***	(0.115)
Sq. livestock count visit	-0.161***	(0.055)	-0.136**	(0.056)	-0.117***	(0.044)	-0.120***	(0.044)
Non-farm count visit 1	0.193*	(0.108)	0.178	(0.111)	0.251**	(0.102)	0.448***	(0.099)
Sq. non-farm count visit	-0.0250	(0.049)	-0.0764	(0.047)	0.109***	(0.039)	-0.0131	(0.037)
Irrigation share visit 1	0.000157	(0.450)	-0.0625	(0.465)	-0.605	(0.383)	-0.339	(0.382)
Sq. irrigation share visit	0.0769	(0.449)	0.166	(0.458)	0.578	(0.380)	0.344	(0.380)
Household size (nos.)	0.00711	(0.011)	0.00659	(0.011)	-0.0740***	(0.008)	-0.0753***	(0.008)
Share MNREGA visit 1	0.0301	(0.127)	0.0910	(0.144)	-0.207**	(0.085)	-0.236***	(0.085)
Share MNREGA * farm si	-0.0299	(0.032)	-0.0319	(0.036)	-0.0651***	(0.021)	-0.0670***	(0.022)
Avg. household edu.					-0.149***	(0.045)	-0.166***	(0.043)
Sq. avg. household edu.					0.0188***	(0.003)	0.0184***	(0.003)
Avg. adult edu. in agri	-0.00614	(0.006)	-0.00602	(0.0062)				
Sq. avg. adult edu. in agr	4.18e-05	(8.72e-05)	4.20e-05	(8.61e-05)				
Adult male-female ratio	-0.113	(0.213)	-0.0156	(0.206)	0.196	(0.166)	0.215	(0.160)
Avg. age of household	0.00199	(0.005)	0.00211	(0.005)	0.0162***	(0.004)	0.0150***	(0.004)
SD of age of household	-0.0104	(0.006)	-0.00796	(0.006)	-0.0105*	(0.006)	-0.0106**	(0.005)
Avg. age of agri workers	0.000175	(0.002)	0.000929	(0.002)	-0.00152	(0.001)	-0.00317*	(0.001)
SD of age of agri workers	0.00261	(0.004)	0.00208	(0.003)	-0.00719**	(0.002)	-0.00650**	(0.002)
Rainfall deviation			0.00100	(0.001)			-0.000514	(0.001)
Constant	10.58***	(0.330)	11.12***	(0.661)	8.081***	(0.232)	9.088***	(0.468)
Observations	14,211		14,211		22,322		22,322	
R-squared	0.502		0.524		0.234		0.303	
Adj. R-squared	0.500		0.521		0.233		0.299	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 7: Linear model for Visit 2 (*rabi*)

VARIABLES	(1)		(2)		(3)		(4)	
	On-farm income per hectare		On-farm income per hectare		Income per capita		Income per capita	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Farm size (hec)	-246,145***	(45,801)	-273,032***	(54,576)	51.03	(210.7)	15.03	(204.6)
Sq. farm size (hec2)	8,305***	(2,574)	9,029***	(2,801)	-1.337	(7.446)	-0.100	(7.495)
Crop count visit 2	38,796	(216,911)	-51,295	(233,105)	4,611***	(778.4)	549.6	(1,167)
Sq. crop count visit 2	-2,855	(45,982)	17,329	(49,205)	-850.0***	(145.0)	-129.5	(200.9)
Livestock count visit 2	382,985***	(141,917)	466,543***	(147,862)	3,190**	(1,321)	3,181**	(1,377)
Sq. livestock count visit 2	-173,603***	(53,992)	-188,872***	(54,971)	-721.5	(582.7)	-756.5	(608.1)
Non-farm count visit 2	-92,882	(126,263)	-72,743	(131,778)	5,652***	(1,233)	6,315***	(1,103)
Sq. non-farm count visit 2	93,817	(59,125)	57,118	(51,657)	1,207*	(658.5)	145.9	(652.3)
Irrigation share visit 2	654,001	(982,863)	525,814	(1.022e+06)	9,174	(7,406)	7,044	(7,385)
Sq. irrigation share visit 2	-718,294	(932,859)	-533,369	(964,071)	-8,512	(7,279)	-6,609	(7,234)
Household size (nos.)	9,347	(20,165)	-516.8	(20,125)	-500.3***	(115.1)	-527.0***	(105.9)
Share MNREGA visit 2	22,716	(51,491)	46,128	(49,537)	-943.9**	(386.0)	-830.7**	(375.3)
Share MNREGA * farm size	-57,392*	(31,716)	-61,441*	(33,169)	-133.1	(81.48)	-123.1	(87.40)
Avg. household edu.					-560.4	(712.6)	-662.2	(741.8)
Sq. avg. household edu.					73.30	(64.78)	70.35	(64.37)
Avg. adult edu. in agri	-48,405***	(18,059)	-47,815***	(18,471)				
Sq. avg. adult edu. in agri	758.6**	(362.4)	763.1**	(365.1)				
Adult male-female ratio	-87,222	(197,831)	-76,958	(195,177)	14,357***	(1,987)	14,087***	(1,975)
Avg. age of household	764.8	(3,872)	1,871	(3,643)	41.56	(35.39)	30.33	(36.02)
SD of age of household	16,564**	(7,734)	17,285**	(7,694)	75.70*	(45.97)	77.12*	(45.60)
Avg. age of agri workers	-1,486	(3,448)	-2,064	(3,358)	47.63**	(19.99)	24.67	(19.41)
SD of age of agri workers	-2,993	(5,380)	-5,085	(5,666)	-111.6***	(37.49)	-119.4***	(37.59)
Rainfall deviation			-9.227	(18.74)			-0.438	(0.787)
Constant	810,411*	(445,515)	130,357	(521,610)	-8,456**	(3,720)	-3,482	(4,624)
Observations	19,653		19,577		26,776		26,700	
R-squared	0.005		0.007		0.117		0.134	
Adj. R-squared	0.002		0.003		0.115		0.130	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 8: Log linear model for Visit 2 (*rabi*)

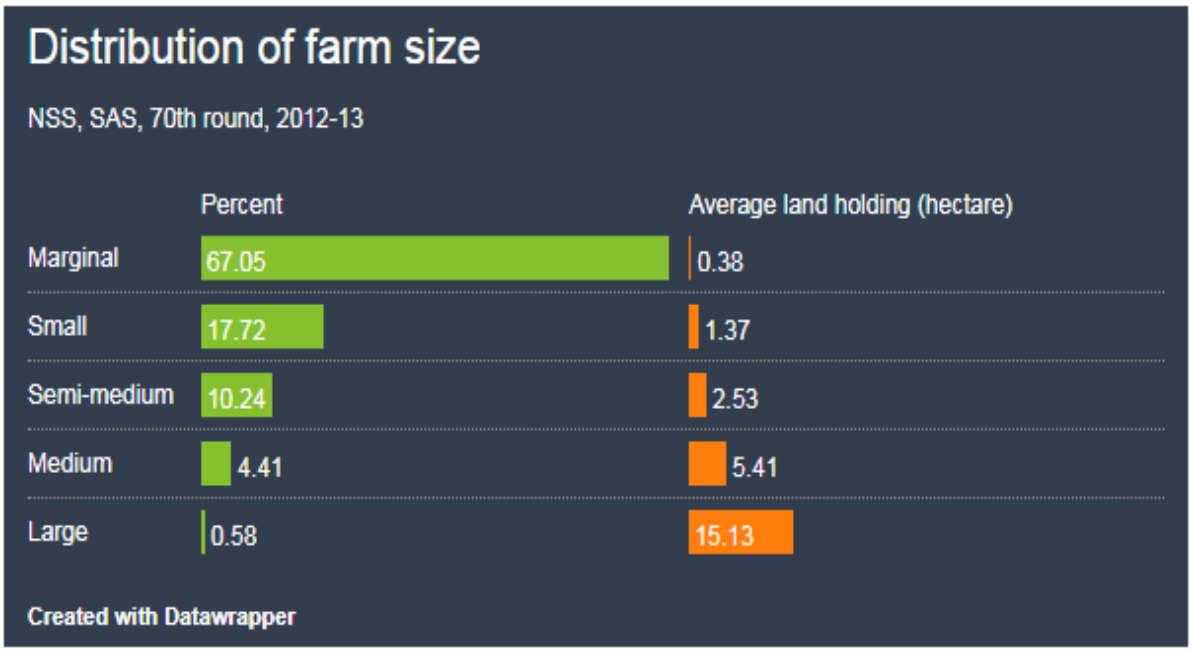
VARIABLES	(1)		(2)		(3)		(4)	
	ln(on-farm income per hectare)		ln(on-farm income per hectare)		ln(income per capita)		ln(income per capita)	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Ln(farm size)	-1.048***	(0.026)	-1.047***	(0.025)	-0.0468***	(0.015)	-0.0387**	(0.016)
Crop count visit 2	0.0837	(0.156)	0.0845	(0.146)	0.194*	(0.099)	-0.0288	(0.113)
Sq. crop count visit 2	-0.0197	(0.027)	-0.0172	(0.025)	-0.0487***	(0.017)	-0.0104	(0.019)
Livestock count visit 2	0.0942	(0.162)	0.225	(0.156)	0.343***	(0.129)	0.444***	(0.139)
Sq. livestock count visit 2	0.00342	(0.061)	-0.00842	(0.058)	-0.0769	(0.047)	-0.0897*	(0.049)
Non-farm count visit 2	-0.00994	(0.130)	0.0314	(0.119)	0.518***	(0.088)	0.585***	(0.087)
Sq. non-farm count visit 2	0.0382	(0.063)	-0.0204	(0.056)	0.0305	(0.030)	-0.0308	(0.026)
Irrigation share visit 2	0.895	(0.667)	0.736	(0.652)	0.848	(0.522)	0.677	(0.481)
Sq. irrigation share visit 2	-0.899	(0.658)	-0.712	(0.640)	-0.834	(0.526)	-0.689	(0.473)
Household size (nos.)	0.00878	(0.016)	0.00275	(0.016)	-0.116***	(0.017)	-0.118***	(0.014)
Share MNREGA visit 2	-0.0922*	(0.050)	-0.0970*	(0.057)	-0.0883***	(0.031)	-0.0870***	(0.030)
Share MNREGA * farm size	0.00150	(0.002)	0.00354	(0.002)	-0.00487*	(0.002)	-0.00447	(0.002)
Avg. household edu.					-0.0530	(0.052)	-0.0410	(0.048)
Sq. avg. household edu.					0.00877*	(0.004)	0.00696	(0.004)
Avg. adult edu. in agri	-0.00346	(0.006)	-0.00596	(0.006)				
Sq. avg. adult edu. in agri	7.41e-05	(6.54e-05)	0.00010	(6.59e-05)				
Adult male-female ratio	0.432***	(0.157)	0.374**	(0.148)	0.896***	(0.130)	0.865***	(0.110)
Avg. age of household	0.00309	(0.004)	0.00345	(0.003)	0.00141	(0.002)	0.00161	(0.002)
SD of age of household	-0.00579	(0.005)	-0.00185	(0.005)	0.00384	(0.004)	0.00504	(0.004)
Avg. age of agri workers	-0.00465*	(0.002)	-0.00483*	(0.002)	0.00433	(0.002)	0.00211	(0.002)
SD of age of agri workers	-0.00134	(0.005)	-0.00290	(0.005)	-0.00909***	(0.003)	-0.0107***	(0.003)
Rainfall deviation			-7.31e-05*	(4.29e-05)			-5.38e-05*	(2.96e-05)
Constant	9.440***	(0.381)	8.581***	(0.539)	7.361***	(0.249)	7.851***	(0.308)
Observations	12,180		12,128		21,857		21,804	
R-squared	0.484		0.517		0.233		0.292	
Adj. R-squared	0.482		0.513		0.231		0.288	
State dummy			YES				YES	
State region dummy			YES				YES	

Table 9: Panel model estimation for Visit 1 and Visit 2

VARIABLES	(1)		(2)		(3)		(4)	
	On-farm income per hectare		ln(on-farm income per hectare)		Income per capita		ln(income per capita)	
	Random effect		*Random effect*		*Fixed effect*		*Fixed effect*	
	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev	Coefficient	Std. dev
Farm size (hec)	-643,901***	(86,269)						
Sq. farm size (hec2)	18,655***	(3,925)						
Ln(farm size)			-1.000***	(0.005)				
Crop count	834,694**	(376,880)	0.0323	(0.034)	-393.4	(1,442)	-0.0829*	(0.047)
Sq. crop count	-132,352*	(68,263)	-0.0118*	(0.006)	-34.37	(261.6)	0.000459	(0.008)
Livestock count	-384,429	(394,778)	0.328***	(0.036)	-1,427	(1,504)	0.0986**	(0.049)
Sq. livestock count	107,006	(184,855)	-0.0868***	(0.016)	1,101	(711.9)	-0.00687	(0.023)
Non-farm count	364,414	(330,097)	-0.0521*	(0.030)	6,336***	(1,322)	0.567***	(0.041)
Sq. non-farm count	229,686	(158,451)	0.0827***	(0.015)	1,379**	(629.8)	-0.0468***	(0.018)
Irrigation share	-531,642	(1.909e+06)	0.420**	(0.173)	8,661	(7,301)	0.707***	(0.231)
Sq. irrigation share	814,498	(1.889e+06)	-0.363**	(0.171)	-11,119	(7,249)	-0.831***	(0.230)
Household size (nos.)	-60,724	(53,596)	0.000103	(0.004)				
Share agriculture	34,461	(49,310)	0.00962**	(0.004)	134.8	(172.0)	0.0260***	(0.005)
Share MNREGA	-228,528	(218,027)	-0.0681***	(0.019)	-1,654*	(888.0)	-0.0795***	(0.026)
Avg. household edu.	-477,323**	(190,750)	-0.0214	(0.017)				
Sq. avg. household edu.	34,858**	(16,989)	0.00273*	(0.001)				
Avg. adult edu. in agri	-33,173	(22,238)	-0.00379*	(0.002)				
Sq. avg. adult edu. in agri	419.3	(336.8)	4.95e-05	(3.08e-05)				
Adult male-female ratio	-846,345**	(424,349)	-0.0479	(0.038)	-3,593**	(1,665)	-0.0394	(0.054)
Rainfall deviation	-57.04	(106.4)	-2.77e-05***	(8.26e-06)	-0.386	(0.404)	-2.40e-07	(1.34e-05)
Constant	4.254e+06***	(1.120e+06)	10.13***	(0.102)	18,143***	(2,053)	8.718***	(0.067)
Observations	38,790		26,339		38,790		30,184	
R-squared					0.069		0.048	
Number of HHID	19,791		17,675		19,791		18,651	
R-squared within	0.002		0.012		0.068		0.048	
R-squared between	0.006		0.623		0.064		0.056	
R-squared overall	0.005		0.554		0.066		0.057	
Hausman test	*Do not reject null*		*Do not reject null*		*Reject null*		*Reject null*	

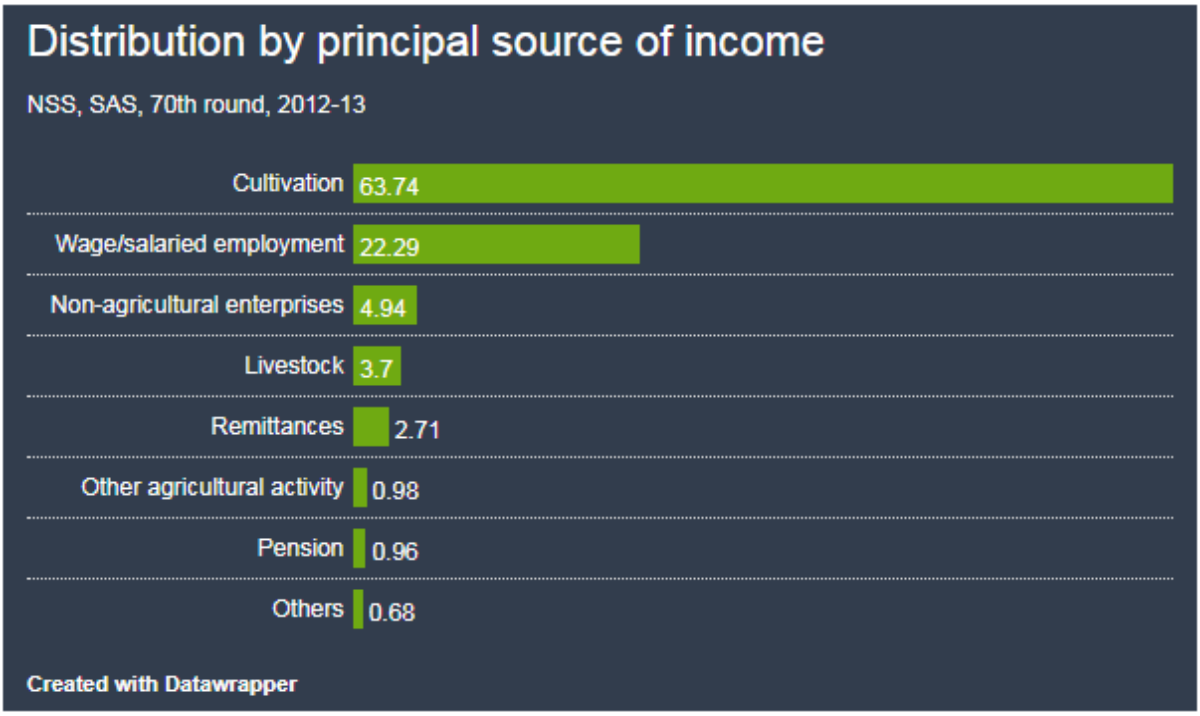
Figures

Figure 1: Land distribution and average holding



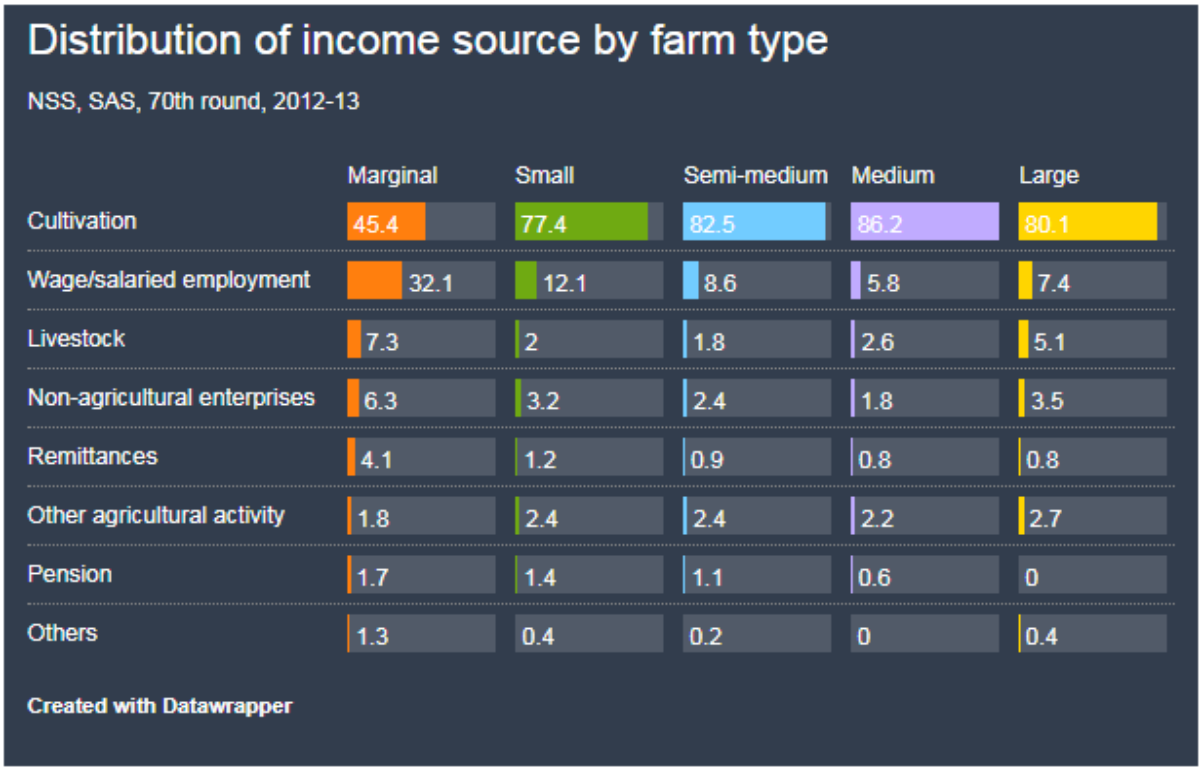
Authors' calculation based on NSS 70th round

Figure 2: Distribution of households by principal source of income



Authors' calculation based on NSS 70th round

Figure 3: Distribution of income source by farm size categories



Authors' calculation based on NSS 70th round

Appendix

Appendix 1: Summary statistics on some household and farming characteristics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Total income (Rs.)	29,830	82456.42	203844.6	0.001	1.11E+07
Per capita income(Rs.)	29,830	18744.3	56005.43	0	3709683
Land (hec)	29,830	1.47	1.79	0	51.8
Share of irrigated land	29,830	0.51	0.42	0	1
Diesel expenditure (Rs.)	29,830	1021.14	5183.50	0	275000
Electricity expenditure (Rs.)	29,830	246.98	1635.98	0	85000
Fertilizer expenditure (Rs.)	29,830	4169.28	10617.35	0	325000
Seed expenditure (Rs.)	29,830	26.18	547.70	0	75000
Human labour expenditure (Rs.)	29,830	8956.94	20878.23	0	814100
Animal labour expenditure (Rs.)	29,830	479.89	2095.16	0	150000
Number of crops grown	29,830	2.23	1.44	0	5
Number of livestock activity	29,830	0.71	0.64	1	4
Number of non-farm activity (including wages & salary)	29,830	0.88	0.56	0	6
Household size	29,830	5.42	2.67	8.8	41
Ratio of adult male to female	29,830	0.35	0.17	0	1
Average age of household	29,830	31.29	11.39	0	95
Average age of household members engaged in agriculture	29,830	40.69	12.42	0	97
Proportion of household members engaged in MGNREGA	29,830	0.30	0.89	0	1
Share of household members engaged in agriculture	29,830	0.59	0.24	0	1
Other characteristics					Percent
Crop insured by loan or additionally insured					5.07
Technical advice obtained					39.47
Institutional loan outstanding					58.75
SC/ST household					33.99
Own house					98.08
Pucca house					60.65
Safe drinking water source					86.38
Ration card					88.33

Authors' calculation based on NSS 70th round

Appendix 2: Annual income of households by source and farm size class (in Rs.)

Farm type	Income source	Mean	Std. Dev.	Min	Max
Marginal	Crop	64660.83	219880.9	-4590220	5764450
	Livestock	4471.663	27241.9	-400115	1986251
	Wage & salary	44375.96	60549.87	1	1224000
	Non-farm	15986.31	55806.14	-1490000	455000
Small	Crop	67087.15	250080.7	-1797345	1.09E+07
	Livestock	4474.078	19498.63	-220423	657140
	Wage & salary	46145.43	71786.96	1	1500000
	Non-farm	15789.59	62893.24	-1597000	359300
Semi-medium	Crop	65063.72	256701.2	-1343667	1.11E+07
	Livestock	3847.387	16399.89	-397310	323200
	Wage & salary	46036.81	75610.71	1	1800000
	Non-farm	17457.91	36441.8	-209000	515060
Medium	Crop	58505.54	192721.4	-1248150	2856700
	Livestock	4584.313	16849.67	-205200	324089
	Wage & salary	49488.35	75230.68	3	1036000
	Non-farm	17209.32	25089.06	-13700	258000
Large	Crop	60244.67	188742	-650130	2876240
	Livestock	3874.798	25492.18	-288860	637190
	Wage & salary	45060.15	62121.64	126	748000
	Non-farm	15735.6	20092.42	-20035	154500
All	Crop	64907.61	234105.1	-4590220	1.11E+07
	Livestock	4323.49	22708.13	-400115	1986251
	Wage & salary	45430.79	67463.39	1	1800000
	Non-farm	16441.24	50594.48	-1597000	515060

Authors' calculation based on NSS 70th round

Appendix 3: Procurement source of some farm inputs

Procured through	Farm inputs				
	Diesel	Electricity	Fertilizer	Human labour	Animal labour
Farm saved	0.05	1.02	0.18	7.13	33.22
Exchange	0.08	1.98	0.13	0.85	0.68
Purchase	98.08	89.89	98.31	70.84	47.46
Borrowed	0.12	0.51	63	0.41	0.86
Others	1.65	6.58	1.14	20.77	17.78

Authors' calculation based on NSS 70th round

Appendix 4: Source of agency of some farm inputs

Agency procured	Farm inputs				
	Diesel	Electricity	Fertilizer	Human labour	Animal labour
Own farm	0	0.92	0.19	7.4	33.63
Local trader	72.48	1.43	75.01	21.39	19.59
Input dealers	10	0.29	10	1.74	1.81
Cooperative & govt. agency	10.36	93.56	13	0.43	0.21
Others	7.18	3.8	1.96	69.04	44.75

Authors' calculation based on NSS 70th round