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Raising Farm Income in India: What Does a Simultaneous Quantile Regression Approach Tell?§

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Abstract

This paper focuses on the contribution of farm income component of farmers' income and traces its determinants by Situation Assessment Survey of Agricultural Households 2012-13. This study analyses the determinants of farm income by Simultaneous Quantile Regression Model (SQRM) and highlights that contribution of farm income to double farmers' income would not be attainable without considering the variability of impact of different factors across farm income groups. The distribution of farm income is highly skewed; explanatory variables do not influence farm income in a similar manner across all quantiles, and the failure of identification of the specificity of the predictor variables is prone to be affected by generalization. Results indicate that coefficients estimated by SQRM mostly retain signs but their magnitude and significance differ across quantiles of farm income. The results further indicate that loan outstanding per hectare and machinery hiring inversely impact farm income at lower quantiles of agricultural households contrary to, insignificant or positive impacts on higher quantiles of farm income households. From the policy point of view, it may be argued that it is more important to focus on the low farm income households rather than considering the entire farm income distribution aggregately. Alternative sources of income have an immense role in the upgradation of the economic situation of the agricultural households, a frontal strategy to raise farm income will naturally have to take into account the determinants of this income of different groups of farmers, and in particular, strategies must target specific issues faced by low farm income groups.

Key words: Farm income, simultaneous quantile regression, agricultural households

JEL Classification: Q12 Q18 Q28

Introduction

The Union Budget 2016 directly focused on doubling the income of farmers[1]. But, the relevant strategies to raise farm income remain ambiguous. Further, it is not clear whether the proposition is expected only to a particular section of farmers across the country, on average, or whether it would be equally applied to all segments of farmers? Will it, for example, be applicable for the lower most income quantile group of agricultural households who earn an ₹ 1,812 per annum[2] or bottom 40 per cent of households with average income of ₹ 19,754 per annum which is

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[1] We need to think beyond 'food security' and give back to our farmers a sense of 'income security,' and Government will, therefore, reorient its interventions in the farm and non-farm sectors to double the income of the farmers by 2022" (Budget Speech 2016, GOI).

[2] Annual income includes nonfarm business, livestock income and wages. These are measured by deducting the expenses from the value of output.

equivalent to ₹ 1,646 per month as much as to farmers in the top decile, earning ₹ 31,715 per month on an average. Secondly, what is the contribution of farm income to doubling the farmers' income? Coming to the components of farm income including increasing productivity, crop intensity, shift towards high-value crops (hereafter HVC), comprises 53.2 per cent of contribution to doubling the farmers' income, is important to focus to attain the milestone. Considering the share of contribution as base, 31.4 per cent of increment is supposed to be attained by raising the crop productivity level by 4.1 per cent per annum (NITI Ayog, 2017)[3]. But, there is also a recognition that a 'single-minded focus on increasing productivity growth' in agriculture as a source of welfare enhancement in rural areas is likely to be counterproductive in the context of a global economy[4]. Thirdly, does the purpose here to make the sector more remunerative and prosperous for the farm households, or does it indirectly indicate the need to shift from farm to nonfarm sector to increase the level of farmers' income? "Decent growth in farm income requires high growth in output, favourable farm produce prices, and some cultivators moving out of agriculture" (NABARD, 2016).

Nonetheless, it is important to focus on the components of farm income which are the core parts of farmers' income at the household level and trace the pattern of revenue generation by agricultural households. Farm income is not only a measure of income generation from farming, it further indicates the sustainability of the sector and the engagement of agricultural households with the production system. Indirectly, it also reveals the feasibility of pursuing the present pattern of agricultural production, as well as farmer's repayment capacity and capability to reinvest in the production system (Reddy and Galeb, 2009; Dev and Rao, 2010). Due to rising cost, volatility in price, and declining support of government, a large section of Indian farmers is deeply distressed; the extreme form of which gets manifested into the phenomenon of farmers' suicides. It is important to recognize that institutional failure is not only a single reason of farmer's distress; it works as a catalyst in a precarious situation of low farm income from current production process which appears to be a dead-end for the farmer. Literature and content analysis on the incidents of farmers' suicides reveals that farmers with poor resource base but high aspirations to produce more, are more prone to suicide due to investment failure or return (farm income) below the expectation level compared to the farmers who cultivate at subsistence level (Mishra, 2009). Hence, this paper is devoted to tracing how the resource endowments, input usage, socio-economic characteristics of agricultural household influence the different levels of farm income households. This paper argues that variables which significantly impact the lower farm income households may not be relevant for the rest of the farm income quantiles and vice versa.

Database

The present study is based on the dataset of 'Agricultural Situation Assessment Survey'[5] of the 70th round of NSSO unit level data for the year 2012-13 (July-June). Farm income is defined as the surplus of the gross value of output over the total actual or paid-out cost (A_2)[6] excluding imputed cost of owned

[3] According to the report, government's intention is to double the real income from farm by augmenting productivity level, resource-use efficiency, intensifying cropping pattern and production towards high-value crops. But, the study shows that Bihar, Chhattisgarh and Maharashtra experienced a decline in farm income component of farmers' income between 2002-03 and 2012-13 considering real income from cultivation as well as total income of the household (Chandrasekhar and Mehrotra, 2016). The study also indicated the doubling of farm income is specific to a particular section of farm household during the same time period and the inclusivity of all sections of farmers under a single policy frame is prone to be affected by the error of generalization.

[4] According to a study conducted by NCAER in 2008 shows that the benefits of higher productivity are 'concentrated among the better-off households' as well as it increases input expenses of production.

[5] The survey used the interview method of data collection from a sample of randomly selected households and members of the household by stratified multi-stage design method. The survey used for the present analysis has covered the rural areas only. The information has been collected by NSSO in two visits to the same set of sample households. Datasets were merged to get the annual estimation of any continuous variable, wherever were needed. Otherwise, datasets were individually used for the analysis, mentioned in the specific section. For the binary variables, either visit one has been used or two visits have been dealt separately.

[6] Net return from cultivation

Table 1. Farm size distribution and share of farm income in total income of households across farm size groups and states

(Values are in percentages)

State	Marginal farms	Small farms	Semi-medium farms	Medium farms	Large farms
Punjab	62.2 (29.0)	11.7 (56.9)	13.2 (56.9)	11.6 (72.4)	1.4 (77.3)
Haryana	56.4 (24.7)	16.4 (51.1)	18.3 (54.3)	8.4 (69.6)	0.5 (80.4)
Rajasthan	55.8 (30.5)	17.9 (41.1)	15.3 (42.9)	9.6 (48.9)	1.7 (58.1)
Uttar Pradesh	82.4 (51.4)	11.6 (66.0)	4.6 (74.2)	1.3 (82.0)	0.1 (85.8)
Bihar	85.5 (50.8)	10.5 (66.1)	3.3 (79.2)	0.7 (82.1)	—
West Bengal	91.5 (31.0)	6.7 (53.6)	1.6 (53.2)	0.2 (39.9)	—
Jharkhand	86.1 (37.7)	9.8 (55.2)	3.8 (65.2)	0.4 (57.4)	—
Odisha	81.7 (38.8)	13.4 (56.6)	3.7 (59.5)	1.2 (67.2)	—
Chhattisgarh	53.4 (48.6)	29.9 (69.4)	13.6 (73.6)	3.2 (99.9)	—
Madhya Pradesh	51.8 (46.7)	26.3 (76.2)	16.4 (73.8)	5.3 (82.7)	0.7 (84.3)
Gujarat	61.1 (28.0)	19.2 (44.4)	12.9 (41.2)	6.6 (53.9)	0.2 (75.0)
Maharashtra	45.2 (29.3)	29.5 (45.7)	17.3 (58.6)	7.8 (77.8)	0.4 (57.4)
Andhra Pradesh	52.9 (23.8)	23.9 (30.1)	15.8 (70.4)	6.5 (40.0)	0.9 (69.6)
Karnataka	54.2 (30.6)	24.2 (40.9)	13.7 (62.0)	6.7 (76.4)	1.3 (74.5)
Kerala	84.9 (31.9)	10.7 (52.2)	4.2 (68.7)	0.3 (59.5)	0.1 (37.7)
Tamil Nadu	73.2 (18.5)	15.6 (48.2)	8.5 (53.3)	2.5 (51.8)	0.2 (84.8)
Telangana	73.2 (86.6)	16.3 (63.2)	8.6 (49.7)	1.9 (72.4)	0.4 (36.8)
All India	67.7 (37.5)	17.3 (53.9)	10.2 (60.9)	4.4 (68.2)	0.4 (69.9)

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13
Notes: figures within the parentheses are share of farm income to total income.

resources (family labour, interest on owned capital and rental value of owned land (Khusro, 1964; Saini, 1971; Sen and Bhatia, 2004). In this survey, detailed information has been covered on the receipts and expenses of households' farm and the current data set provides the scope to study the affordability and income generation capacity from the cost structure of farming for the household as an operational unit.

Results and Discussion

Farm Income as a Component of Farmers' Income

The dependence of agricultural households[7] on farm income reveals the ability of farming to sustain the engagement of the agricultural households to the production system. The share of farm income to total income across farm-size groups reveals that marginal agricultural households[8] have lower dependence on farm income in most of the states whereas it is around 50 per cent for small farmers at the national level. At all India level, the percentage share of farm income component to total income drastically rises from marginal farm-size group to small farmers and as obvious, continues to increase in share for large farms.[9] But, the pattern varies across states; it is noticeable that percentage share of farm income for marginal farm households is below the national average (below 30%) in southern states (other than Telangana) and even in the agriculturally-advanced states of Punjab and Haryana. Another interesting fact is the lower share of

[7] NSS 70th SAS round covers the agricultural households which do not cultivate land but earn a minimum amount of ₹ 3000 per year from agriculture and allied activities.

[8] According to SAS survey estimation, 70 per cent of the farmers belong to marginal farm- size group (62.85 million).

[9] Percentages share of farm income pattern may distort at the higher farm-size groups in states with few percentages of medium and large farms in particular states.

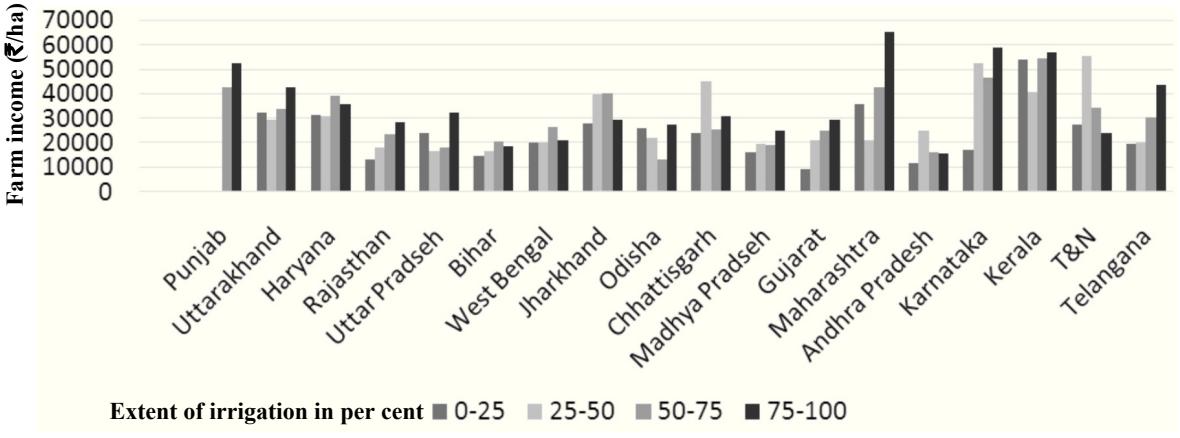

Figure 1. Level of irrigation and farm income

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13

farm income in West Bengal and Andhra Pradesh across all farm-size groups which indicates lower dependence on farming as a source of livelihood, irrespective of farm size which substantiates moving away from agriculture due to low returns from farming.

Determinants of Farm Income

Descriptive analysis of determinants of farm income across states and farm-size groups[10] has been carried out as a prelude to empirical analysis.

Input Usage

The advent of Green Revolution has been with intense use of fertilizers to augment the productivity level. Due to continuous marginalization of landholdings, intense use of fertilizer has been taken as a key way to use per unit of land more intensely to increase the output level. At the national level, fertiliser expense covers 26 per cent share of the total paid out cost with an expenditure of ₹ 5,010/ ha for marginal farms and it reduces to ₹ 3,150/ ha for the large farms comprising 19 per cent of total paid-out cost. The states with fertiliser cost per hectare for small farms, above the national average are Kerala, Andhra Pradesh, West Bengal, Tamil Nadu, Maharashtra, Telangana, Karnataka, Uttar Pradesh and Punjab in descending order. The fertilizer expense per hectare is the maximum among the marginal farm-size group of West Bengal and Andhra Pradesh with average expenses of ₹ 8,083/ha and ₹ 7,879/ha, respectively. However, fertiliser expense per hectare is the least for the small farms in low productivity states of Rajasthan, Jharkhand, and Chhattisgarh with an average of ₹ 2,000/ ha only.

Level of Irrigation

An important determinant of farm income is the intensity of irrigation. Literature has broadly compared farm income of irrigated and unirrigated regions as irrigation facilities augment the level of productivity (Bardhan, 1973; Vaidyanathan *et al*., 1994). Irrigation contributes to the increasing efficiency of biochemical inputs, followed by higher crop yields per unit area and value of output per hectare (productivity). The expansion of irrigated area widely varies across states. The level of irrigation has been classified by the stretch of irrigated land and farm income has been plotted against those classes (Figure 1). The farm income per hectare naturally upgrades by the increase in the levels of irrigation, but the impact is not that distinct in Bihar, West Bengal, Odisha and Andhra Pradesh. That means in spite of higher irrigation intensity (total irrigated land to gross cropped area), income from farm remains low due to higher cost of cultivation in these states

[10] 63 per cent of marginal farm-size groups comprise bottom 50 per cent of farm income households whereas, top 10 per cent of farm income households is comprised with 59 per cent large farm households. Regarding landownership, the distribution follows the same.

compared to other major states, while, the relationship between farm income and the stretch of irrigation is distinct in Maharashtra, Karnataka, Telangana and Rajasthan.

Social Identity and Farm Income

The social identity of the household mostly determines the resource base of the agricultural households as well as the bargaining position in both input and output market. Discrimination in the accessibility of public institutions further creates hindrances to their production processes. Regarding land ownership, the mean owned area per household varies between 1.2 ha for the general household to only 0.55 ha for SC households. With 15.4 per cent share of SC farm households , possesses only 7 per cent share of total farm income; contrary to that 46.3 per cent share of OBC households has command on 46.8 per cent share of farm income and 26.7 per cent of general agricultural households possess 36 per cent share of farm income. The share of leased-in to total operated land is the maximum among SC households comprising 21 per cent of operated land along with 52 per cent of households with the extent of tenancy above 75 per cent. 41 per cent of farm households who are earning a negative net return from cultivation belong to SC category in West Bengal, the share is around 27 per cent for both Andhra Pradesh and Tamil Nadu. The poor resource base of SC households leads to a higher expenditure on lease rent, hiring of machinery with acute indebtedness trapping in a vicious cycle of distress. In comparison to SC households, the ST agricultural households are well off considering farm income due to better command over land resources.

Access to Agricultural Extension Service Providers and Krishi Vigyan Kendra

The lack of transparency, lack of articulation of information between policies of government and operation of agricultural extension service providers, vacancies in the post, caste and identity-based inclination in approach (Birner and Anderson, 2007) hinder the efficiency and the purpose of institution. According to the 59th round of NSS survey (2002-03), the percentage of farm households who availed

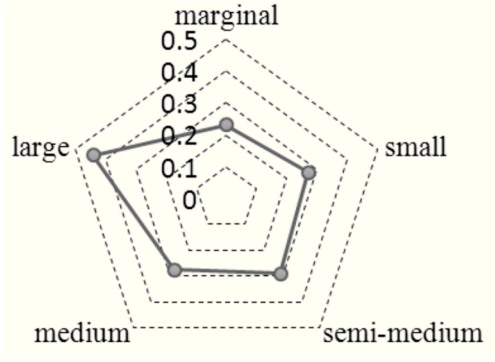

Figure 2. Accessibility to institutional facilities across farm size groups

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13.

information from extension service providers was only 5.7 per cent which declined to 4.8 per cent during 2012-13. The accessibility increases across farm-size groups and it is highest for large farms. The poor access to extension agents, in particular by the marginal farmers disentangles the inefficiency of the institutional facilities to reach the most vulnerable group of rural economy. The principal purpose of these service providers is to disseminate information on the judicious use of inputs, efficient cost saving technologies, market signals of the crop among farmers and failure of that would lead to uncertain remuneration from production.

Knowledge of Farmers

Low literacy rate, less years of schooling, poor understanding capacity create negative impacts on skill and awareness generation among the farmers. The Study of Special Program for Marginal and Small Farmers (2008) revealed that level of formal education is positively related to land size and lack of education increases the deprivation point of small and marginal farmers. Low educational level from farmers' side and lack of dissemination of information by extension service providers and other institutions lead to creating a worse situation for the small and marginal farms and create hurdles to upgrade their production system and to establish a proper linkage with the market. Institution access index[11] was constructed using variables

[11] Constructed by scoring the dummies of access to a particular institution. A score of 1 is given if the farmer has access to the respective institution and 0 depicts inaccessibility. If the farm household has access to all the mentioned institutional facilities, it gets a score of 4.

Table 2. Farm productivity, farm expenditure across quantiles of farm income

Farm income deciles	Farm productivity (gross value of output in ₹ /ha)	Expenditure (₹ /ha)	Farm income (₹ /ha)
1	30299	37092	-6793
2	36480	19900	16579
3	38637	18247	20389
4	39757	15493	24264
5	42488	16785	25702
6	43823	16496	27326
7	49018	17867	31151
8	53929	18357	35572
9	74269	20113	54156
10	107570	26083	81487

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13.

regarding access to mediums of connectivity (television, radio, and internet), knowledge of farmer, access to extension service, and KVK (Krishi Vigyan Kendra). The relative position of farm households indicates the highest score for the large farms (0.45) and declines to 0.21 for marginal farms. Overall participation is anyway meagre among the agricultural households concerning institutional accessibility, but it is further low for all farm-size groups, except large farms.

Socio-Economic Characteristics of Farm Income Quantiles

The input usage in farm, household expenditure, cropping pattern, and socioeconomic composition of households differ across farm income quantiles. The average ownership increases from 0.36 ha/household to 2.47 ha/household from bottom quartile to top quartile of farm income households. At all India level, the extent of tenancy declines across income quartiles, whereas, the share of area under HVC (high-value crops) is the maximum for the top quartile of farm income group. At the regional level, 56 per cent of farm households of North-West region belong to the top quartile of farm income, whereas the share is only 4 per cent in the Southern region. Social identity-wise 46 per cent SC households belong to the lowest farm income quartile, whereas the share is 24 per cent for general households. The accessibility to institutions increases across income quartiles, it shows that 35 per cent of agricultural households have access to extension services at upper quartile of farm income households, whereas, the share is only 15 per cent at the bottom quartile of farm income.

Farm productivity, expenditure of cultivation per hectare and farm income are tabulated against farm income deciles to show that there is a positive association between farm productivity and farm income, but expenditure per hectare does not show any distinct pattern with farm income. Higher expenditure per hectare and lower productivity are attributes of low farm income households.

Figure 3 shows the distribution pattern of farm income by a histogram, normal distribution and kernel density estimation. It is observed that farm income data do not follow Gaussian distribution; hence kernel distribution has been fitted by default epanechnikov function[12] (optimal mean square error sense) to get a smoothened probability density estimation curve of farm income[13]. The difference in farm income values of the median and mean demonstrates that average value overestimates the farm income towards the upper end of the distribution. When calculated according to the quartiles of the agricultural households, the result shows that farm income of upper quartile is 12.58-times higher than the lower median quartile, whereas the mean farm income of bottom most quartile runs in negative. In this context, a single regression model cannot explain the impact of the predictor variables.

Thereby, the coefficients of determinants of farm income were estimated by the Simultaneous Quantile Regression Model (hereafter SQRM). Due to the presence of outliers in the dataset, ordinary linear regression is less efficient to capture the relation of

[12] Minimizes asymptotic mean integrated squared error.

[13] Histogram displays the density of respondents within the class or range of income (y axis). It presents the general shape of the farm income distribution, which appears to be normal, unimodal, and skewed to the right. The kernel density estimation, on the other hand, smoothens the contribution of each observed data point over a local neighbourhood of that data point.

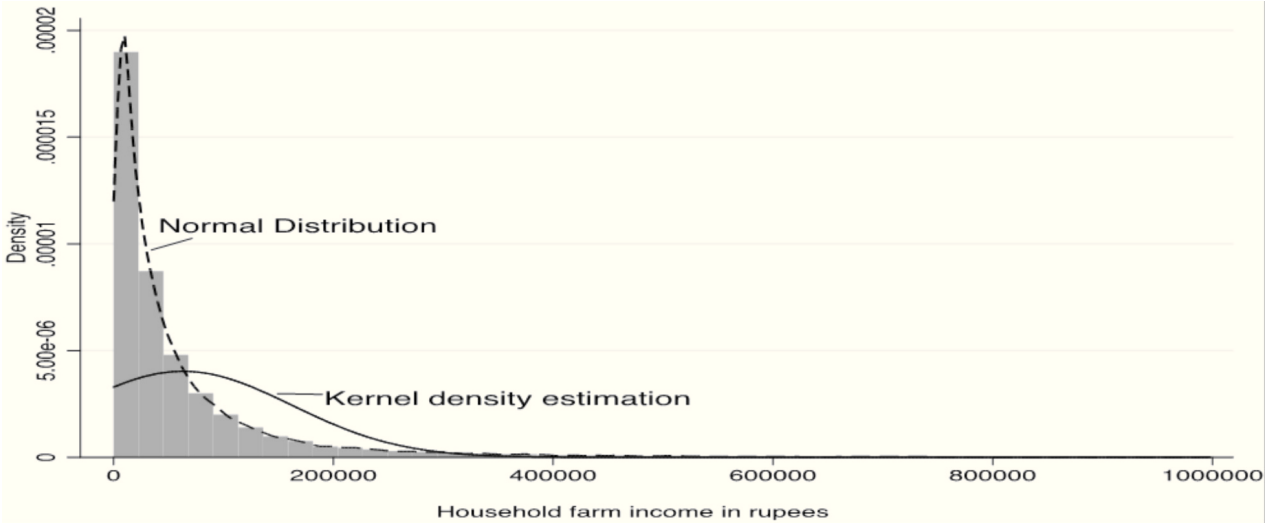

Figure 3. Distribution curve of farm income at the national level

Skewness =10.73 Mean= 69893.57 Median= 2936 Kurtosis*= 192.88

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13.

*Describes the shape of a random variable's probability distribution. Positive kurtosis indicates a relatively peaked distribution. That means a higher percentage of agricultural households are in the lower income quantiles of income distribution.

input-output variables at different levels of output. SQRM is an econometric tool to compare the coefficients of different quantiles and captures the relative effect of the predictor variables on the output. In the linear regression, the error values are assumed to be normally distributed which might not be applicable always in all datasets (Buchinsky, 1998). Koenkar and Bassett (1978) had thereby, proposed Quantile Regression Model (QRM) which is constructed on the basis of conditional quantiles rather than conditional means to model both locational shift and shape shifts of the impact of predictor variables. The equation of SQRM is:

$$Q_q(y) = a_q + b_{q,1}x_1 + b_{q,2}x_2 + \ldots + b_{q,n}x_n$$
$$Q_{0.75}(y) = a_{0.75} + b_{0.75,1}x_1 + b_{0.75,2}x_2 + \ldots + b_{0.75,n}x_n$$
$$Q_{0.25}(y) = a_{0.25} + b_{0.25,1}x_1 + b_{0.25,2}x_2 + \ldots + b_{0.25,n}x_n$$

where, $x_1,\ldots,x^n$ are predictor variables and in the present analysis SQRM is fitted at 25th, 50th (median), and 75th quantiles of farm income. The model further estimates the coefficients of predictor variables for upper 10 per cent and bottom 10 per cent of farm income households and measures how the above tabulated predictor variables influence different quantiles (levels) of farm income and furthermore, determines that relationship between input and output variables varies across quantiles at statistically significant level or not.

The graph of farm income depicts that distribution is skewed towards the right and considerably higher mean value than median persists due to the effect of high-end income values. As the farm income demonstrates heavily tailed skewed distribution conditional mean is not sufficient to capture the effects of predictor variables on the response variable (Hao and Naiman, 2007). Few studies have applied this method to determine farm income across quantiles[14] in the Indian context. Thereby, the present study has estimated piecewise linear curves for different quantiles rather than fitting one single linear equation by OLS to capture variation in the relation between input and output variables. SQRM is similar to QRM regarding

[14] The tool is mostly used to measure determinants of different quantiles of wage incorporating dummies of the quality of training, educational attainment, regional and racial background, etc. (Chay and Honore 1998, Machado and Mata 2000). Pede and Luis *et al*. (2012) studied income of the household of four rice producing area of Philippines following quantile regression approach and estimated variation of the parameter across income quantiles. It is found from the analysis that socioeconomic characteristics of farm households as well as magnitude of input efficiency drastically vary across quantiles of income.

Table 3. Socio-economic and institutional characteristics for farm income quartiles of agricultural households

Variable	Bottom 25 per cent	Lower median	Upper median	Top 25 per cent
Owned land (ha)	0.36	0.64	1.15	2.47
Fertiliser and manure (per ha)	6022.6	5582.6	6266.5	8247.7
Extent of tenancy (%)	14	13	9	7
Percentage of area under HVC (%)	12	14	19	30
Loan outstanding (₹/ ha)	320355	50901	34868	34810
Farm Investment (₹/ha)	2509	4607	4134	9245
Extent of Irrigation (%)	69	69	69	74
Machinery hiring (₹/ha)	2895	2347	2329	1971
North West region (%)	10	12	21	56
Northern region (%)	48	25	17	9
Eastern region (%)	24	25	24	27
North East region (%)	18	26	36	20
Western region (%)	23	27	26	24
Southern region (%)	45	36	15	4
General (%)	30	26	21	23
Scheduled caste (%)	46	31	16	7
Other Backward class (%)	30	29	24	17
Scheduled tribe (%)	26	37	25	12
Access to extension service providers (%)	15	21	29	35
Access to KVK (%)	23	21	25	31

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13.

coefficient results, but the estimation method is different as it measures equations simultaneously and it supports to test the significance of variation of coefficients across quantiles. This model estimates variance-covariance matrix of standard error (VCE) by bootstrapping in the dataset across quantile classes (Hao and Naiman, 2007).

Table 4 presents the results of OLS regression and SQRM at 10th, 25th, 50th, 75th and 90th level of quantiles. Comparing the coefficients of OLS and SQRM, it is observed that signs of coefficients are mostly the same, but the magnitude of the relationship varies widely across different levels of farm income. Hypothesis test was run for all the variables to get the confidence intervals of the difference in relationship at 25th and 75th quantiles and the result showed that all the variables other than institutional variables had an impact on the farm income distinctively at a statistically significant level[15]. Change in coefficient values depict the relative variation in the strength of the variable to explain the dependent variable, whereas switching of the sign, indicates the variation with different levels of farm income.

In both OLS and SQRM regressions, the extent of owned land positively influenced farm income, but the magnitude of the coefficients of land owned was much

[15] On the basis of the results of hypothesis test [q25] x_i = [q75] x_i across all the predictor variables to test the effects of predictor variables on output variable are same or not at 25th and 75th quantiles of farm income. Lincom [q75] x_i -[q25] x_i has been used to obtain the values of the confidence interval of the previous test. Institutional variables include amount of loan outstanding in rupees, access to extension agents, progressiveness of farmer, caste identity. Regarding caste identity, other than OBC, the influence of the identity is same across farm income quantiles.

Table 4. Regression results of simultaneous quantile regression

Variables	OLS	10th	25th	50th	75th	90th
Land owned (ha)*	0.441*	0.054*	0.129*	0.272*	0.488*	0.766*
	(0.005)	(0.003)	(0.004)	(0.006)	(0.011)	(0.028)
Leased in to operated*	0.168*	0.015*	0.051*	0.106*	0.209*	0.322*
	(0.005)	(0.004)	(0.005)	(0.007)	(0.012)	(0.027)
Fertiliser and pesticide (₹/ha)*	2.983*	0.003	0.220**	1.382*	3.188*	6.220*
	(0.212)	(0.025)	(0.125)	(0.208)	(0.398)	(0.629)
Farm power exp. per ha*	0.045*	-0.004**	0.018*	0.050*	0.099*	0.110*
	(0.005)	(0.002)	(0.004)	(0.006)	(0.011)	(0.017)
Extent of irrigation*	0.111*	0.009*	0.019*	0.033*	0.048*	0.043*
	(0.006)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
Share of area under HVC*	0.125*	0.005*	0.013*	0.029*	0.076*	0.196
	(0.005)	(0.001)	(0.001)	(0.002)	(0.005)	(0.012)
Machinery hiring (₹/ha)*	-1.965*	-0.290*	-0.427*	-0.782*	1.373	1.643
	(0.363)	(0.059)	(0.106)	(0.132)	(0.159)	(0.250)
Eastern region*	-0.257*	-0.028*	-0.054*	-0.104*	-0.161*	-0.214*
	(0.016)	(0.002)	(0.003)	(0.004)	(0.009)	(0.019)
Western region*	-0.268*	-0.040*	-0.066*	-0.105*	-0.155*	-0.216*
	(0.018)	(0.002)	(0.003)	(0.004)	(0.011)	(0.018)
Northern region*	-0.060**	-0.027*	-0.042*	-0.063*	-0.075*	-0.096*
	(0.027)	(0.003)	(0.004)	(0.005)	(0.011)	(0.031)
Central region*	-0.171*	-0.015*	-0.031*	-0.065*	-0.120*	-0.185*
	(0.017)	(0.002)	(0.003)	(0.004)	(0.010)	(0.018)
Southern region*	-0.208*	-0.035*	-0.058*	-0.090*	-0.122*	-0.175*
	(0.018)	(0.002)	(0.003)	(0.005)	(0.011)	(0.022)
Educational status	0.141*	0.064*	0.048*	0.047*	0.044*	0.034*
	(0.020)	(0.002)	(0.004)	(0.006)	(0.009)	(0.019)
Scheduled tribe	-0.097*	0.002	-0.006**	-0.021*	-0.042*	-0.034*
	(0.016)	(0.002)	(0.003)	(0.004)	(0.006)	(0.011)
Scheduled caste	-0.076*	-0.007*	-0.015*	-0.019*	-0.036*	-0.035*
	(0.018)	(0.002)	(0.002)	(0.003)	(0.005)	(0.010)
Other backward class*	-0.031*	0.001	-0.002	-0.004	-0.024*	-0.023*
	(0.013)	(0.001)	(0.002)	(0.003)	(0.005)	(0.009)
Loan outstanding ((₹/ha)*	-0.002	-0.005**	-0.002**	0.001	0.001	0.004
	(0.005)	(0.005)	(0.006)	(0.003)	(0.002)	(0.005)
Access to extension service providers	0.193*	0.008**	0.023*	0.038*	0.067*	0.219*
	(0.025)	(0.004)	(0.005)	(0.009)	(0.013)	(0.083)
Constant	0.042	-0.387	-0.297	-0.132	0.159	0.575
	(0.029)	(0.003)	(0.005)	(0.008)	(0.016)	(0.024)
R^2 values	.337	.054	.115	.209	0.312	0.399

Source: Calculated by unit level data from NSS quinquennial survey on SAS of Agricultural Households in India 2012-13.
Note: Standard errors of parameters estimate are in parenthesis. SQRM has been generated 100 replicates to estimate bootstrap standard error[§].'*', '**', '***' refer to significance at the 0.1 per cent, 1 per cent and 5 per cent levels, respectively. OLS estimates R^2 and SQRM estimates pseudo R^2. Asterisk mark on variable denotes the significance level of difference in relationship.

[§]bootstrap permits to compute maximum likelihood estimates of standard errors and multiple changes in dataset can be detected by this method.

higher in the upper quantile of farm income than in OLS estimate. The relative strength was 12 per cent for the bottom 25 per cent of farm income households, whereas it went up to 48 per cent at the 75th quantile. The OLS regression showed that percentage of leased-in to operated land had a positive relationship with farm income, on the contrary to that, different magnitudes of the relationship between tenancy and farm income was noticed across the income quantiles by the estimates of SQRM. For the bottom 10 per cent of farm income households the extent of tenancy influenced farm income by only 1 per cent which increased to 10 per cent and 21 per cent at the 25th and 50th quantiles, respectively. It reveals that at the lower end of farm income lease rent drags down the net return from cultivation, whereas the extent of tenancy positively influences the farm income at the higher levels of farm income households. The per hectare expenditure on fertiliser and pesticides augments the upper level of farm income at a higher level; whereas, for the bottom 10th quantile of farm income, intensifying input explains the increase in farm income only by 0.3 per cent.

The OLS regression shows overall relation that a one-unit increase in expenditure of fertiliser and pesticides enhanced the farm income by 2.9 units controlling other variables fixed. But, further detailing of farm income revealed that at 90th quantile intensifying this input usage per hectare by 1 unit could lead to 6.2 units increase in farm income, while, the value was only 0.22 units at 25th quantile. Concerning the usage of farm power per unit of land the significance was negligible at the bottom 10th quantile, but the relative strength got doubled at the 50th quantile of farm income.

At the lower quantile of farmers, farm income is only 2 per cent lesser in Eastern states compared to the poorest section of farmers in Punjab and Haryana. Whereas, the difference between the farm income level of North-western states and Eastern states is 21 per cent for the 90th quantile of agricultural households. The OLS regression captures the gap at the aggregate level across regions, but it is noticed that there is a drastic difference in the gap considering income levels from cultivation between North-West regions and other parts of the country across different levels of farm income households. The relative position of the lower 10th quantile lies almost to the same degree across regions whereas the gap widens across quantiles with the maximum deviation of 22 per cent for the 90th quantile of farm income in Western region with reference to North-western states.

In OLS regression, the influence of share of high-value crops augments farm income by 12 per cent level at 0.1 per cent significance level, but among the low farm income households, the impact is only 1.3 per cent (25th quantile), whereas it is 7.6 per cent at the 75th quantile of farm income households, followed by insignificant relation for top 10 per cent of farm income households. This association reveals that the impact of the share of area under HVC on farm income does not explain the income of top 10 quantiles of farm households at significant level. Machinery hiring inversely impacts the level of farm income, and it creates a constraint to generate returns from cultivation. About 29 per cent of farm income reduces by one-unit increase in machinery hiring expenses of bottom 10th quantile at 1 per cent significance level whereas at the higher end of farm income, it augments farm income level keeping other variables constant but not at a statistically significant level.

In OLS regression, farm income is lower among SC, ST and OBC agricultural households in comparison to general social group by 9 per cent, 7 per cent and 3 per cent respectively at 0.1 per cent significance level. Regarding the caste identity, the hypothesis test indicates that the two coefficients of 25th and 75th quantiles have a statistically significant difference among OBC households. Access to extension service providers positively influences the farm income across all quantiles at a significant level compared to those households which do not have access to extension services and the hypothesis of no difference holds true for the institutional access across all quantiles. It may be due to overall low accessibility of farm households to extension service providers.

Conclusions

This study has investigated the determinants of farm income component of farmers' income. The distribution of farm income is highly skewed; explanatory variables do not impact the farm income in a similar manner across all quantiles. Thus, strategies and policies to increase income should take into account the variability of impact of different factors

across farm income groups. The analysis shows that the extent of tenancy augments farm income across all quantiles. But, this result does not hold for the lowest quantile, probably because the terms of lease are more onerous for this group. Determinants of farm income need to be focused with more clarity for the realization of increase in farmers' income of poor agricultural households. Our result indicates that the impact of intensity of input use on farm income is significantly lower for the bottom 50 per cent of farm income households. However, the study also reveals that the outreach of extension service providers and the access to KVK is meagre, especially for marginal and small farmers. In the absence of dissemination of information and knowledge, it is difficult to increase the resource-use efficiency of the low farm income households which has been taken as a key strategy to increase farm income. In the current precarious situation, it is necessary to evaluate the efficacy of the policies regarding doubling of farm income from the vantage point of their ability to reduce agrarian distress in the countryside. The extent of tenancy, area under high-value crops, and expense on fertilizer per unit of land has significant different influence on farm income as shown by the magnitude of relationship across farm income quantiles. Whereas, loan outstanding per hectare and machinery hiring inversely impact farm income at lower quantiles of agricultural households, contrary to insignificant or positive impacts on higher quantiles of farm income households.

From the policy point of view, it may be argued that it is more important to focus on the low farm income households rather than considering the entire farm income distribution aggregately. This should lead to a consideration of the responses of different levels of farm income households. While alternative sources of income have an immense role in the betterment of the economic situation of the agricultural households, a frontal strategy to raise farm income will naturally have to take into account the determinants of this income of different groups of farmers, and in particular, strategies must target specific issues faced by the low farm income groups.

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