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Seasonal Migration and Feminization of Farm Management: Evidence from India

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Abstract

This paper explores the association between short-term migration in the household and feminization of farm management in rural India. The analysis uses a nationally representative data set covering 35,604 rural Indian households in the year 2013. There is gender disaggregated information on who operates land in addition to the presence of a short-term migrant in the household. We model the labor outcomes of women as reflected by their participation as major decision-makers (main operator) or minor decision makers (associated operator) on the household operational holding. Overall, we find that women are less likely than men to be either main or an associated operator. However, in households with a short-term migrant, the probability of a woman being a decision maker as an operator increases. These results are robust to endogeneity and sample selection concerns. Our study highlights the importance of unpacking the feminization process to better understand the role of women as farm managers.

Keywords: Feminization of agriculture; Female farm managers; Seasonal migration; Agricultural households; Operational holdings; India

JEL Codes: Q1, R2, J1

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1. Introduction

In developing countries, including India, the discourse on feminization of workforce has focussed on 'feminization of agricultural labor' rather than on 'feminization of farm management'. However, a more complete understanding of the issue of feminization of agriculture has to recognize that women are involved in a range of decisions related to the farm as managers and not only as laborers (de Brauw et al. 2013; World Bank 2016).

Using gender disaggregated data from rural India on which individual operates land, this paper explores the feminization of farm management by examining the impact of short-term migration on women left behind. It is a stylized fact that male migration contributes to the feminization of agriculture in developing countries[4]. The importance of short-term migration affecting women's decision making cannot be underscored in south-Asia, and is particularly relevant for India, where the number of seasonal migrants is significantly larger than permanent migrants in any year.

We analyse data from India's National Sample Survey Organisation's (NSSO) Survey on Land and Livestock Holdings conducted in rural India during January – December 2013. This is the first time that information on both short-term migration and association of household members with operational holdings was collected as part of the same survey. Hence, this nationally representative data affords a rare glimpse of how the presence of a short-term migrant in the household affects whether other members are associated with the household's operational holding as decision makers. In this paper we attempt to identify the causal impact of seasonal migration

[4]See Mueller et al. (2015) for a detailed review of the effect of migration on agriculture in Asia.

on decision making on matters pertaining to operational agricultural land holding by women left behind.

This paper makes an important contribution to the literature by empirically validating at a national level, the stylized fact that migration is a key driver of feminization of agriculture. Often, studies that consider the impact of migration are not nationally representative; they tend to focus on high migration localities with a consequent biased view of its impacts (Mueller et al. 2015). Further, the data provide information on each household member's association with the operational holding and whether they are major decision makers on the operational holding or not. Thus, for the first time in the context of a large developing country, *viz*. India, we can focus on feminization of farm management and not the feminization of farm labor. This provides a superior estimate of managerial feminization over the current measures in the literature that use female-headed households as a proxy for managerial feminization (de Brauw et al 2013). We build on the insights provided by the literature that has analysed data from a survey conducted in India in 2003 in order to understand characteristics of individuals who like to farm or do not like to farm (Agarwal and Agrawal 2017; Birthal et al. 2015). The analysis presented here also complements the recent literature on trends and patterns in women's labor force participation in India (Lahoti and Swaminathan 2016). Their study results suggest that India does not conform to a U-shaped relationship between level of domestic product and women's labor force participation rate. The authors further note that there is little understanding of the causal mechanisms that affect women's economic activities. We establish one plausible pathway of changes in women's economic responsibilities.

Migration requires labor reallocation in the household due to the temporary loss of a member to migration. Factors such as gender roles and responsibilities, social norms, household structure are also important considerations in this process and likely to have differential impacts on labor supply responses of men and women. Focussing on women left behind there is no consistent pattern that emerges in the literature, which is not totally surprising given the vastly different contexts of the studies (Lokshin and Glinskaya 2009; Binzel and Assaad 2011; Mendola and Carletto 2012). The evidence is also not conclusive on how women's decision-making is affected by migration. In the absence of men, women's role in farming activity is likely to change from being a helper to being an operator with some decision making authority (Paris et al. 2005; Paris et al. 2010). In a study of rice farming households in eastern Uttar Pradesh in India, Paris et al. (2005) find that in migrant households while women's decision making on rice farms had increased considerably, it came at the cost of increased work load. A descriptive study in Philippines, Thailand and Vietnam examined women's decision making on rice farms when men had migrated (Paris et al., 2010). Decisions under different domains (crop and livestock related, children's education, and allocation of remittances) were considered; while there was some variation in women's role in crop and livestock decisions across the countries, there was greater participation in education and remittances decisions by women from migrant households than women from non-migrant households. These findings are also reinforced in two districts in Nepal (Maharjan et al. 2012 as cited in Mueller et al. 2015). In contrast, Mu and van de Walle (2011) find that agricultural work increases (with a reduction in off-farm activities) for Chinese women in migrant households but no concomitant increase in farm, fishing or livestock related decision-making abilities.

In this paper we follow the approach of previous studies that considers the impact of migration on

women's labor force participation (Lokshin and Glinskaya, 2009; Mu and van de Walle 2011; Mendola and Carletto 2012). In these papers the authors have also examined the number of hours worked by men and women. However, information on hours worked is not routinely collected in most national data systems. In its absence, participation rates are what are frequently calculated and monitored (World Bank 2016). We model the labor outcomes of women as reflected by their participation in their household farming operations as major (main operator) or minor (associated operator) decision makers on the operational holding. The uniqueness of the data we use is that we have information on farm management at an individual level for a nationally representative sample. Estimates from our data show that in 2013, 11.8 million women and 85 million men in the age group 15-65 years take major decisions *i.e.* are the main operators.

We estimate an ordered probit model that serves as the baseline result for establishing the correlates of feminization of farm management. Our results suggest that women are less likely than men to be either main operators or an associated operator. But, in households with a short-term migrant, the probability of a woman being an operator (main or associated) increases. However, there are potential endogeneity concerns that must be addressed. The unobservable characteristics that influence the migration decision may also impact the decision of the extent of involvement of an individual with land. This is addressed by the use of appropriate instruments and we find that our results hold even after accounting for endogeneity. Finally, as an additional robustness check, we include a selection equation to rule out selectivity bias due to a household's decision whether or not to operate land. This does not impact our key result. We also find differential impacts of educational attainment and size of land possessed by the household on men and women. Consistent with the literature, we find that men who have completed secondary education or above are less likely to be involved with the operational holding. Unlike women, the

probability of men being involved with plot of land increases with the amount of land possessed by the household.

2. Seasonal Migration in India

A distinctive feature of south Asian countries including India is that there has not been a significant increase in permanent migration from rural to urban areas. Urbanisation in south-Asia is driven by natural rate of increase and reclassification of rural as urban areas rather than permanent rural-urban migration. Ellis and Roberts (2015) point out that "though the tendency often is to think of urban population growth as being driven by rural-urban migration, the majority of such growth in South Asia has actually been due to either natural increase or reclassification" (p. 54). In India, the contribution of rural-urban migration to urban population growth which was estimated at 21.1 per cent for the decadal period 1991-2001 increased marginally to 22.2 per cent in the period 2001-11 (Pradhan 2013).

In India, the most important aspect of worker mobility is short-term migration and not permanent migration. It is estimated that 10 million households in rural India have at least one or more short-term migrant staying away from home for more than 15 days but less than six months of the year. In fact, it would not be incorrect to say that in the last decade short term migration, and not necessarily permanent migration, has emerged as an integral part of a household's livelihood strategy in rural India[5]. A recent study using nationally representative data from India finds that seasonal migrants are more likely to be men rather than women, reside in a district (a

[5] The number of short-term migrants is in fact seven times larger than permanent migrants (Keshri and Bhagat 2013).

sub-national unit) with a larger concentration of workers in the construction sector, less likely to be higher educated and more likely to be from land-scarce households (Agrawal and Chandrasekhar 2016).

The impacts of seasonal migration on women have largely been focussed on their labor allocation across sectors and nature of activity (paid or unpaid). However, the data used in this paper does not lend itself to such analysis as there is no information on labor allocation. We use another data source to shed some light on this issue. The NSSO's Situation Assessment Survey of Agricultural Households also conducted in 2013, while not having time use patterns, provides information on women's work status. The data collected information on the principal and subsidiary work status of women in the household and whether any member of the household is a short-term migrant.[6] Among households without a short-term migrant 41.6 per cent of women report undertaking domestic household duties as their usual primary work status. In contrast, in households with a short-term migrant, the percentage of women reporting domestic duties as their usual primary work status is higher at 46.7 per cent. We also find a stark difference in the distribution of subsidiary status of women across these two types of households. In households without a short-

[6] Principal status and subsidiary status of an individual are assigned as follows. "The activity status on which a person spent relatively longer time (major time criterion) during the 365 days is considered the principal usual activity status. A person whose principal usual status is determined on the basis of the major time criterion may have pursued some economic activity for a relatively shorter time (minor time) during the reference period of 365 days preceding the date of survey. The status in which such economic activity is pursued is the subsidiary economic activity status of the person. In case of multiple subsidiary economic activities, the status of the activity in which relatively longer time has been spent will be considered."

term migrant, among women reporting domestic duties as their usual principal status, 79 per cent report undertaking unpaid work as their subsidiary status. In households with a short-term migrant this number is higher at nearly 86 per cent. The industry of work for over 95 per cent of these women is agriculture. These summary statistics confirm the conjecture that in the absence of men, albeit for short periods of time, women assume larger set of roles. This pattern is consistent with results obtained from other countries. Among other studies, Mendola and Carletto (2012) who model the employment status (wage employed, paid self-employed or unpaid worker) of left behind individuals in Albania, find that there are instances where women increase their unpaid work similar to what we find in India.

3. Data and Descriptive Statistics

We use cross-sectional data from the National Sample Survey Organisation's (NSSO) Survey on Land and Livestock Holdings conducted in rural India during January – December 2013. Each rural household was visited twice, first during January – July 2013 and then during August – December 2013. The survey collected information from 35,604 and 35,337 households in visit 1 and visit 2, respectively. Details of the sampling procedure are available in the report published by Government of India (2014a). The survey has information on the demographic, and activity particulars of all household members.

NSSO makes a distinction between ownership of land and operational holding. Household operational holding refers to all land (owned, leased, or possessed in some other form) where the household has undertaken some agricultural activity during the reference period. Thus, households that have operational holdings are actively engaged in the agricultural sector, which

may not always be true for households that own land. We find that of the estimated 156 million rural households, 68 per cent report operating land for agriculture of which 9.06 million or 9.5 per cent are female headed households. A comparison of households operating *vs.* households not operating land shows they are different along several important parameters (Table 1). Households that are actively engaged in agriculture have more male members; on average the head is marginally older and also more likely to be better educated. Not surprisingly, these households are also less likely to be headed by a female, suggesting a correlation between headship and number of male household members.

(Table 1 about here)

Of particular interest to this paper are the two questions related to short-term migration and the individual's operator status. Information is sought on whether any member of the household stayed away from the village continuously for 15 days or more for employment during last 6 months. This question refers to short-term migration and not permanent out-migrants from the household. We estimate that 10.08 million rural households, i.e. 6.5 per cent of rural households have a short-term migrant. A comparison of characteristics of household with a short-term migrant and with no short-term migrant shows some interesting differences (Table 2). Heads of households with short-term migrants are on average younger and with relatively lower educational qualifications (except that they are more literate) than heads of households without a short-term migrant. While this may seem counter intuitive, it is important to remember, this is the education of the head, not the migrant, who could be better educated. Not surprisingly, for the former set of households, income share from agriculture is lower while income from wage/salary work is higher than the latter households. Not surprisingly, migrants belong to households that

possess significantly less land than other households. The size of landholding is an important determinant of income levels and sources of income in rural households. Small and marginal farmers who constitute the majority of the population engaged in agriculture are unable to meet their consumption expenditure through earnings. The share of income from wages or salary decreases with increase in size of land possessed. As a mirror image, the share of net receipt from cultivation increases (Government of India 2014b). Since the share of income from cultivation is the least among the small land holders, it gives rise to the possibility that members from these households would opt to stay away from home for short periods of time in order to find alternative sources of income for sustenance.

(Table 2 about here)

The second question driving our analysis is whether a household member is associated with the household operational holding. The response could be one of the following: main operator of the household operational holding, other member associated with the household operational holding, not associated with household operational holding. According to the survey guidelines, the main operator is identified as the individual who takes the major decisions regarding the household operational holding. If no single individual takes major decisions, the senior most operator is identified as the main operator. Thus, it is likely that the operators taking minor decisions are recorded as associate operators. In 2013, we estimate that 11.8 million women and 85 million men in the age group 15-65 years are main operators. These men and women can truly be considered as farm managers. We also estimate that 104 million women and 58.7 million men in the above age group are associated operators.

A limitation of the data set we analyze is that we do not know the specific decisions taken by the woman. A different survey conducted in the southern state of Karnataka in India is informative and suggests the following patterns (Deere et al. 2013). First, they find differences by marital status (Figure 1). Among women without a partner and owning land, only 13.4 percent report not being associated with decisions on what to grow. In contrast, among women who own land and have a partner, 37.2 percent report not making decisions on what to grow. What is also striking is the higher proportion of married women who own land report that they are not involved in decisions pertaining to sale of crops. The authors conjecture that the lower probability of a woman making decisions when there is a male household member could be driven by the fact that "product market are seen as men's domains and by the nature of their organization, pose barriers to women's entry" (p.7). In similar vein, Singh et al. (2016) proffer the conjecture that whether women participate in decision making is determined by the extent of their bargaining power which in turn depends on their 'position within the household and larger community'. Their analysis based on survey of farm households from Rajasthan in India found differences in the nature of intra household decision making along the following lines: the head of household solely took decisions, the household head took the decision after consulting all family members, the wife was consulted but the household head decided, and decisions were made collectively.

(Figure 1 about here)

Both the short-term migration question and the association with the household operational holding was administered only in the first visit; hence the analysis presented here is based on visit 1 data with the sample comprising all working age individuals, *i.e.,* those aged 15-65 years.

4. Empirical Methods

The outcome of interest takes one of three values: 0 if the individual is not associated with the operational holding; 1 if otherwise associated; and 2 if the individual is the main operator of the holding. Since these represent a ranking of the individual's participation in agriculture, an ordered probit model is estimated with the operator status as a function of individual, household, operational land, and district level characteristics.

$$\begin{aligned} &Pr(Associated_{ihds} = j) \\ &\quad = F(\beta_0 + \beta_1 STM_{hds} + \beta_2 Female_{ihds} + \beta_3 STM_{hds} * Female_{ihds} \\ &\quad + \beta_4 X_{ihds} + \beta_5 Z_{hds} + \beta_6 V_{ds} + \mu_s) \\ &j = \{0, 1, 2\} \end{aligned} \tag{1}$$

Where *i*, *h*, *d*, and *s* denote individual, household, district and state, respectively. The dependent variable takes on the value of 0, 1, or 2 based on operator status (*j*). The variable STM_{hds} represents whether the household has any short-term migrant ($STM_{hds} = 1$) or not($STM_{hds} = 0$). The gender of the individual is captured by the dummy variable $Female_{ihds}$, which takes the value 1 or 0 indicating whether the individual is female or male. We are mainly interested in the interaction between $STM_{hds}$and $Female_{ihds}$. The coefficient of the interaction term (β_3) reflects the gender-specific difference in the effect of STM_{hds} on an individual's association with the household operational holding. If we hypothesize that the presence of short-term migrant has a positive effect on women's association with the operational holding of the household, then we would expect β_3 to be positive and significant. In addition, we include control variables at the level of individual (X_{ihds}), household (Z_{hds}), and district (V_{ds}).

Individual specific characteristics include age, age square (to allow for possible non-linearity in the effect of age), education, and relationship to head. At the household level, to control for the composition of the household, we include household size, proportion of male members, the average age of the household members, and the ratios of children in 0–5 and 6–14 years age-group to total household size (dependency ratios). Moreover, we control for the characteristics of the household head by including a dummy variable reflecting whether the head is female, age of the household head, and dummies to capture the education level of the household head.

Based on their main income source, households are grouped into four categories: self-employed in agriculture (cultivation, livestock farming, and other agricultural activities), non-agricultural enterprise, wage/salaried employee, and others (pensioners, remittance recipients, etc.).[7] Further, we control for the social group (scheduled caste, scheduled tribe, other backward class, others), and religion (Hinduism, Islam, Christianity, Others) of the household.

The extent and characteristics of the agricultural land operated by the household are important determinants of who manages and controls it. Therefore, we include the amount of land possessed and leased out. Households are categorized based on their land-possession: less than 0.4 hectare, 0.4–1 hectare, 1–2 hectares, 2–4 hectares, and 4 hectares of above. These cut offs are typically used to classify agricultural households into small, marginal, medium and large farmers in India.

[7] Unfortunately, there is no information in the survey on receipt or amount of remittances, which is an important consideration for labor allocation decisions in the household. The income categorization provided by NSSO clubs other sources of non-wage income with remittances making it impossible to identify which households have received remittances.

While the area of land possessed is directly under control of the household, the land which has been leased out is a part of the land owned by the household. We have to control for land possessed and leased out. Among the sample households who operate land, 12.97 per cent have some land leased in. So we include the share of land leased in among the total possession as another explanatory variable. Additional control variables include the duration of possession: share of land that is possessed for less than one agricultural season, at least one agricultural season but less than one agricultural year, at least one agricultural season but less than two agricultural years, and two or more agricultural years. We also control for the location of the possessed land: share of area within village, outside village but within the district, outside the district but within the state, and outside the state.

At the district level, we include controls that could potentially affect cropping patterns and agricultural productivity; the percentage of land that is not irrigated, and the percentage of households having *Kisan Credit Card* (farmer credit card) with a credit limit of Rs. 50,000 or above. Both these variables are sourced from the Socio-Economic and Caste Census 2011. Finally, our model includes state fixed effects (μ_s) to allow for unobserved inter-state differences.

A key concern in the current specification is that short-term migration is endogenous to household members' participation in agricultural activities. Migration and labor supply decisions are likely to be determined simultaneously within the household (Binzel and Assaad, 2011; Mendola and Carletto 2012). We, therefore, adopt an instrumental variable (IV) estimation strategy to address the potential endogeneity of short-term migration to an individual member's association with the operational holding.

We use the following two variables, lagged and measured at the district level, as instruments for STM: (a) share of workers engaged in construction work and (b) rate of short-term migration. Share of construction workers is measured from the NSSO survey of employment and unemployment conducted in 2011-12 while the rate of short-term migration is calculated from the NSSO survey of employment, unemployment and migration conducted in 2007-08. The share of workers engaged in construction considers only those individuals whose usual principal activity (for the last 365 days) involved working on the construction site. This variable captures the extent of permanent work available at the construction sites and excludes short-term migrants who may be engaged in similar kind of work. We argue that the availability of permanent construction work is exogenous to demand from rural households. It is determined by development of the real estate sector influenced by macroeconomic characteristics of a broader region. The logic behind this instrument is similar to the study by Antman (2011) where employment levels in construction industry and accommodation and food industry at the probable destination of the migrant were used as instruments for migration. We posit that districts with greater availability of construction work (as reflected by the share of permanent construction workers) are likely to attract more short-term migrants, and thus, have a positive effect on STM while being independent of household labor outcomes in agriculture.

The idea behind the second instrument is that a stronger migrant network exists in districts that experienced higher share of migration in the past, which could influence the current short-term migratory flows in the district (Mendola 2012). Similar region-level rates of migration (preferably lagged) have been used as an instrument for individual and household level decision to migrate (Lokshin and Glinskaya 2009; Binzel and Assaad 2011; Mendola and Carletto 2012).

The main concern is whether this instrument satisfies the exclusion restriction. Since we use a lagged measure of short-term migration rate in the district, any contemporaneous relationship between this variable and an individual member's participation in agriculture can be ruled out.

In addition to STM, the interaction between STM and Female should also be treated as another endogenous variable in the regression. Since Female is exogenous, therefore, it is plausible to interact the instruments with the female dummy and use these interaction terms as additional instruments for STM*Female (Wooldridge, 2002). Therefore, we interact both share of construction workers and rate of STM with the female dummy and include them in the set of instruments. In this Two Stage Least Square (2SLS) framework, we have two first stage equations, one for each of the two endogenous variables. The first stage equations are specified below.

$$\begin{aligned} STM_{ihds} = {} & \eta_0 + \eta_2 Female_{ihds} + \eta_2 X_{ihds} + \eta_3 Z_{hds} + \eta_4 V_{ds} \\ & + \eta_5 Constructionshare_{ds} + \eta_6 Migrantrate_{ds} \\ & + \eta_7 Constructionshare_{ds} * Female_{ihds} \\ & + \eta_8 Migrantrate_{ds} * Female_{ihds} + \psi_s + u_{ihds} \end{aligned} \tag{2}$$

$$\begin{aligned} STM_{hds} * Female_{ihds} & \\ = {} & \theta_0 + \theta_2 Female_{ihds} + \theta_2 X_{ihds} + \theta_3 Z_{hds} + \theta_4 V_{ds} \\ & + \theta_5 Constructionshare_{ds} + \theta_6 Migrantrate_{ds} \\ & + \theta_7 Constructionshare_{ds} * Female_{ihds} \\ & + \theta_8 Migrantrate_{ds} * Female_{ihds} + \varphi_s + v_{ihds} \end{aligned} \tag{3}$$

These two equations are estimated using Ordinary Least Squares (OLS), and the predicted values of the two endogenous variables are then used in the second stage of the estimation, given by Equation (4). The second stage is a linear probability model where the dependent variable is a binary indicator of whether the individual is main operator/associated with operational holding ($Associated_{ihds} = 1$) or not ($Associated_{ihds} = 0$).

$$\begin{aligned} Associated_{ihds} \\ &= \alpha_0 + \alpha_1 \widehat{STM_{hds}} + \alpha_2 Female_{ihds} + \alpha_3 STM_{hds} * \widehat{Female}_{ihds} \\ &+ \alpha_4 X_{ihds} + \alpha_5 Z_{hds} + \alpha_6 V_{ds} + \xi_s + \epsilon_{ihds} \end{aligned} \quad (4)$$

Unlike the ordered probit model which considers the categorical dependent variable indicating different levels of association of an individual with the operational holding, we consider a binary dependent variable in the instrumental variable framework. There are two reasons why we consider a binary indicator and a linear model while correcting for endogeneity of short-term migration. First, there are econometric issues involved in using instrumental variable to tackle endogeneity in an ordered probit framework especially when the endogenous explanatory variable is binary (in our case, STM). Second, existing literature suggests that it is preferable to estimate a linear model when the main interest is to obtain the marginal effects of the main explanatory variable (Angrist 2001; Angrist and Pischke, 2009).

We first estimate the model separately for the female and male sample where the interaction between STM and Female is dropped. We are interested in the sign and magnitude of the coefficient α_1 which reflects how having a STM in the household affects the probability of a male or a female individual being an operator of the land. Additionally, we estimate the model

taking both male and female individuals together and including an interaction term between STM and Female. In this pooled sample, we are interested in the estimate of the coefficient α_3 which captures the differential effect of STM by gender. The estimated standard errors are robust to heteroskedasticity and clustered at the household level. We present results from both these approaches in the following section.

5. Results

The summary statistics of the analytic sample are reported in Table 3. We estimate an ordered probit model (Equation 1) separately for men and women and the marginal effects are reported in Table 4a. Consistent with our expectations, we see that the presence of a short-term migrant in the household affects women's association with the operational holding, but not for men. For men, a short-term migrant in the household is not a statistically significant determinant of the nature of involvement with operational land holding. However, in case of women, the probability of their being involved with the operational holding either as a main or associated operator increases by 4.1 percentage points.

(Table 3 about here)

(Table 4a about here)

Older men and women are more likely to be associated with the operational holding. Women are less likely to be involved in decision making pertaining to operational land when they are more educated. In contrast, men who have completed at least secondary education are less likely to be involved with the operational holding. This is presumably correlated with age, where older

members of the household are likely to have lower educational attainments. More educated members are presumably looking beyond the farming sector for employment opportunities. Our finding is consistent with studies that find that more educated farmers report a greater dislike for farming than less educated ones (Birthal et al. 2015; Agarwal and Agrawal 2017). Agarwal and Agrawal (2017) report that among farmers who have completed at least secondary schooling barely 15 per cent report that they like farming. In contrast, among those who are illiterate nearly 48 per cent report that they like farming.

Our results suggest that position in the household matters. As heads, men and women are more involved as operators on their land holdings, but not in any other role in the household. In female headed households, both men and women are more likely to be involved with the operational holding either as associated or main operator. Female heads are either *de facto* heads (when the male head, usually the husband, is absent from the household) or *de jure* heads (where the woman is a widow, unmarried or separated). In both these circumstances, female-headed households are missing an adult member and are thus, labor constrained compared to male-headed ones.

We find a differential impact of the size of land possessed on men and women's operator status. Consistent with the literature, our results suggest that as land size increases, men are more likely to be operators, but not women. Evidence suggests that often, the land owned or operated by women may be smaller in size or of inferior quality when compared with those owned or operated by men (Keller et al. 1990 as cited in FAO 2011).

We re-estimate the ordered probit model by pooling data for men and women (Table 4b). The results from the pooled model reinforce the findings presented in Table 4a. We find that women, in comparison with men, are less likely to be either associated or be the main operator of the operational holding when there is no short-term migrant in the household. However, the interaction term (STM*Female) is significant across the three outcomes. We find that in a household with a short-term migrant, the probability of a woman not being involved with the operational holding either as a main or associated operator goes down by 4.4 percentage points. This estimate is similar to that obtained in China where the probability of working on a farm is 6 per cent higher for women left behind in migrant households (Mu and van de Walle 2011). Overall, the results suggest that short-term migration is indeed associated with a greater degree of feminization of farm management. An immediate implication for policy is to ensure that the agricultural extension system becomes gender sensitive and can respond to the needs of women farmers. This is usually not the norm in many developing countries and certainly not of the Indian context as well. A recent study of the southern Indian state of Karnataka finds a gender gap in extension services with female heads less likely to benefit from these services than male heads (World Bank and IFPRI 2010).

(Table 4b about here)

The results from the IV regressions corrected for endogeneity of a short-term migrant, are reported in Table 5. Columns (1) and (2) present the coefficients from the models estimated separately for women and men, respectively. We find that even after accounting for endogeneity, women are more likely to be associated with the operational in the presence of a short-term migrant. The coefficient on the short-term migrant variable is positive and significant for men,

whereas it was not significant in the simple ordered probit regression, indicating the importance of correcting for endogeneity (Table 4a, cols 4-6). Estimating the model with a pooled sample and including the interaction term does not alter our findings (Table 5, col 3). The effects of the individual and household characteristics from the 2SLS model (Appendix Table 3) are qualitatively similar to what we find in the ordered probit model.

(Table 5 about here)

We undertake several diagnostic tests to judge the validity of the 2SLS estimation (Table 5). The Kleibergen-Paap rk Wald F statistics varies from 11.41 to 19.46 across the models, indicating that the models do not suffer from the problem of weak identification. The Hansen J statistics for overidentification is statistically not significant, suggesting that the instrumental variables are valid – that they are unlikely to have any direct relationship with the dependent variable in the model. The first stage results of the 2SLS model also corroborate that the instruments are highly correlated with the endogenous variables (Table 6). The instruments are significant and they show a plausible relationship with the endogenous variables. The share of construction workers as well as rate of short-term migration in the district has a significantly positive effect on the incidence of short-term migration in the household.

(Table 6 about here)

6. Robustness Check

In our sample, nearly 24 per cent of households did not operate any land for agriculture during the last 365 days from the date of survey. For these households, the dependent variable indicating who operates the agricultural land is not relevant, and hence, not defined. Given the systematic differences observed, we have a non-random sample of households for whom an individual member's association with the operational holding is reported. If there are unobservable characteristics, e.g. household's affluence, preferences etc., that determine the probability of operating any land and also which member of the household is associated with the operational holding, then we have a sample selection problem; not accounting for selectivity will result in biased and inconsistent estimates.

We follow Wooldridge (2002) to deal with the problem of endogeneity and sample selection in our empirical model. Both of these problems are considered in a single framework. We first estimate a selection equation using a probit model:

$$\begin{aligned} Pr(Opland_{ihds} = 1) \\ &= \Phi(\gamma_0 + \gamma_2 Female_{ihds} + \gamma_2 X_{ihds} + \gamma_3 Z_{hds} + \gamma_4 V_{ds} \\ &+ \gamma_5 Constructionshare_{ds} + \gamma_6 Migrantrate_{ds} \\ &+ \gamma_7 Constructionshare_{ds} * Female_{ihds} \\ &+ \gamma_8 Migrantrate_{ds} * Female_{ihds} + \gamma_9 Land_{ds} + \delta_s) \end{aligned} \quad (5)$$

The dependent variable is a binary indicator of whether the individual belongs to a household having any operational land. $\Phi(.)$ is the cumulative distribution function of the standard normal distribution. All explanatory variables from the main model (Equation 1) are included except the two endogenous variables, namely short-term migration status and its interaction with the female

dummy. The selection equation should also contain another identifying variable which affects the probability of operating agricultural land, but does not affect individual's association with operational holding. We use district level percentage of households with land ($Land_{ds}$) as the identifying variable for selection. Similar to Heckman (1979), we estimate the Inverse Mills Ratio or IMR (ratio of the estimated standard normal density and cumulative distribution function) from this equation. In the next step, the main model is estimated using the 2SLS method described in section 3. In the 2SLS, the selection correction term is included as an additional independent variable and the full set of instruments are used.[8] If we find the coefficient of IMR to be significant, it would indicate the necessity of accounting for sample selection.

The results from the 2SLS model, corrected for selectivity and for endogeneity are presented in Table 7. The findings corroborate those obtained through the ordered probit models (Table 4a). The pooled model once again suggests that while females are less likely to be associated with the operational holding; this difference reduces significantly in the presence of a short-term migrant in the household. When the model is estimated separately for males and females, we find that having a short-term migrant has a significant positive effect on association with land for both male and female. However, the effect is higher for females. These findings support our hypothesis that women get more involved in agricultural decision making when there is a short-term migrant in the household. The first stage of the 2SLS model correcting for selectivity is presented is Appendix Table 1, while the selection equation is presented in Appendix Table 2.

[8] Each of the last three equations involved in the 2SLS estimation includes Inverse Mills Ratio as an explanatory variable. Therefore, to avoid the problem of generated regressor, the standard errors, which are clustered at the household level, are bootstrapped (Wooldridge, 2002).

The identifying variable, *i.e.,* proportion of landed households in the district, is a significant determinant of whether household operates land or not.

(Table 7 about here)

7. Discussion

Information on who owns *vs*. who operates the farm in developing countries is unavailable from either agricultural censuses or surveys of employment and unemployment. In the absence of this information, a broad swath of the literature on feminization of agriculture has focused almost exclusively on the trends and patterns in the proportion of women working in the agricultural sector as self-employed, unpaid help or wage labor. The skimming over of the difference between 'feminization of agricultural labor' and 'feminization of farm management' masks crucial differences in women's roles and responsibilities in the household farm operation. In case of the former, it refers largely to the proportion of work undertaken by women on a farm, while in case of latter, it includes women's participation in a range of decisions including input use, cropping decisions, sale of crops etc.

The contribution of this paper is that it provides estimates of 'feminization of farm management' in rural India and highlights how short-term migration from the household affects the probability of a woman being associated with decisions pertaining to the operational holding of the household. Despite the fact that women from the 10 million rural households with a short-term migrant are more likely to be involved in decisions pertaining to operation of land, India's national agricultural policies are still not fully aligned to creating a conducive ecosystem for

women engaged in farming (Government of India 2011). Women also tend to be less educated on average than men and face restrictions on their mobility in certain contexts, both of which could affect their ability to engage in market transactions (de Schutter 2013; Singh et al. 2016). A limiting factor is that in patriarchal societies, women are often not recognised as owners of land, which impairs their ability to access non-land agricultural inputs (FAO 2010). Given the evidence that women operate under considerable constraints there needs to be a greater emphasis on policies to support women farmers.

An increase in farm related responsibilities of women has two plausible effects. Evidence suggests that expanding women's employment options is an important contributor to their economic empowerment; indeed it is seen that even working as unpaid family workers on the farm gives women greater bargaining power than being homemakers as it concretises women's contributions to the household. It is well established that when women have a greater say in household decisions and resource allocations, it positively enhances their own welfare as well as those of other household members. The downside is that, additional responsibilities could mean that they have to work extra hours in addition to their domestic duties thereby reducing leisure time and hence affect their welfare levels. We provide some insights into this issue by focussing on the principal and subsidiary work status of women from households with and without short-term migrants.

Due to data constraints, our study results do not directly speak about the association between migration and women's agency, but we are able to comment on her role as an operator, responsible for making farm-related decisions. Thus, the analysis presented here also highlights the need for better sex disaggregated data on women and men's labor supply as well as time use

data to understand and monitor trends in work (paid, unpaid, across sectors). An integration of such data in migration surveys would give us an enhanced understanding of the welfare of women left behind in the home community of the migrant.

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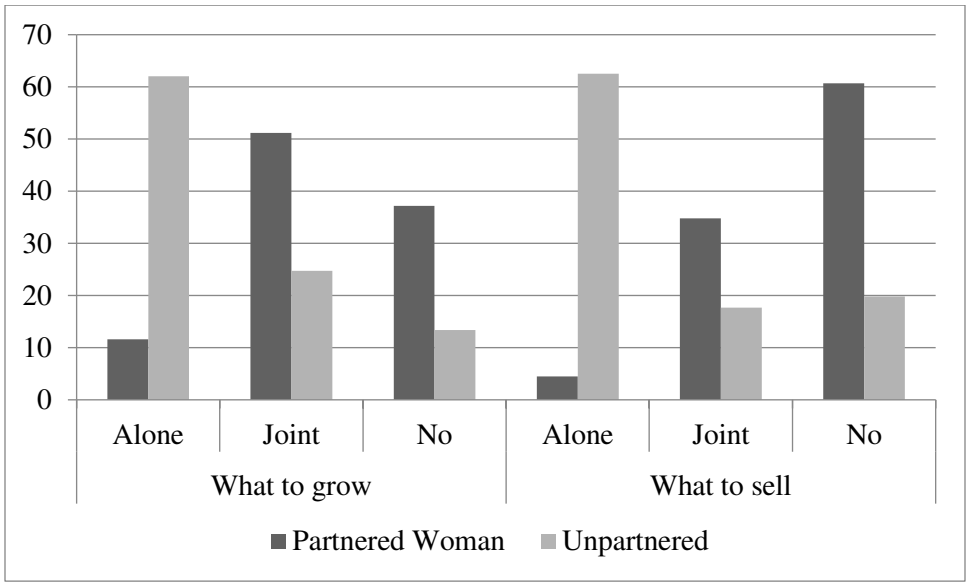
Figure 1: Participation of women landowners in agricultural decisions by marital status in Karnataka, India



Data source: Deere et al. 2013

Table 1: Comparison of characteristics depending on whether household operated any land

Variables	Operated land	Did not operate land	Difference	p-value (two tail)
Proportion of male members in the household	0.381	0.346	0.036	0.000
Average age of the household members	31.191	29.537	1.654	0.000
Whether household head is female	0.087	0.203	-0.116	0.000
Age of household head	50.177	42.881	7.296	0.000
Head's education: Illiterate	0.343	0.435	-0.091	0.000
Head's education: Below primary	0.141	0.139	0.002	0.632
Head's education: Primary	0.127	0.124	0.003	0.479
Head's education: Middle	0.160	0.134	0.026	0.000
Head's education: Secondary	0.114	0.083	0.032	0.000
Head's education: Higher secondary	0.056	0.045	0.011	0.000
Head's education: Graduate or above	0.059	0.041	0.017	0.000
Household size	5.445	3.874	1.572	0.000
Dependency ratio: 0-5 children in total household size	0.249	0.272	-0.024	0.000
Dependency ratio: 6-14 children in total household size	0.068	0.058	0.010	0.000
Income source: agriculture	0.764	0.082	0.683	0.000
Income source: non-agriculture	0.055	0.209	-0.154	0.000
Income source: wage/salary	0.157	0.555	-0.398	0.000
Income source: other	0.024	0.155	-0.131	0.000
Caste: Other	0.274	0.216	0.059	0.000
Caste: SC	0.129	0.267	-0.138	0.000
Caste: ST	0.193	0.142	0.051	0.000
Caste: OBC	0.404	0.375	0.029	0.000
Religion: Hindu	0.809	0.795	0.015	0.004
Religion: Muslim	0.089	0.124	-0.036	0.000
Religion: Christian	0.062	0.041	0.021	0.000
Religion: Other	0.040	0.040	-0.000	0.981
Land possessed	1.547	0.064	1.483	0.000
Total land leased out	0.034	0.045	-0.011	0.015
Share of owned land out of total possessed	0.898	0.849	0.049	0.000
Share of leased in land out of total possessed	0.085	0.110	-0.025	0.000
Share of homestead land	0.073	0.949	-0.875	0.000
Share of area possessed <1 season	0.013	0.023	-0.010	0.000
Share of area possessed >= 1 season but < 1 year	0.025	0.016	0.009	0.000
Share of area possessed >= 1 year but < 2 years	0.021	0.020	0.002	0.358
Share of area possessed >= 2 years	0.941	0.941	-0.001	0.850
Share of plot area within village	0.896	0.987	-0.091	0.000
Share of plot area outside village but within district	0.099	0.009	0.090	0.000
Share of plot area outside district but within state	0.003	0.003	0.000	0.728
Share of plot area outside state	0.002	0.001	0.000	0.535

Table 2: Comparison of characteristics depending on whether household has a short term migrant

Variables	Household with STM	Household without STM	Difference	p-value (two tail)
Proportion of male members in the household	0.368	0.373	-0.006	0.199
Average age of the household members	27.287	31.04	-3.753	0.000
Whether household head is female	0.113	0.114	-0.001	0.891
Age of household head	46.904	48.569	-1.664	0.000
Head's education: Illiterate	0.453	0.359	0.094	0.000
Head's education: Below primary	0.141	0.141	0	0.977
Head's education: Primary	0.112	0.127	-0.015	0.041
Head's education: Middle	0.14	0.155	-0.015	0.065
Head's education: Secondary	0.084	0.108	-0.025	0.000
Head's education: Higher secondary	0.034	0.055	-0.021	0.000
Head's education: Graduate or above	0.037	0.056	-0.019	0.000
Household size	5.767	5.03	0.737	0.000
Dependency ratio: 0-5 children in total household size	0.291	0.252	0.039	0.000
Dependency ratio: 6-14 children in total household size	0.045	0.067	-0.023	0.000
Income source: agriculture	0.519	0.609	-0.09	0.000
Income source: non-agriculture	0.093	0.091	0.002	0.727
Income source: wage/salary	0.332	0.245	0.087	0.000
Income source: other	0.055	0.055	0.001	0.893
Caste: Other	0.204	0.264	-0.06	0.000
Caste: SC	0.178	0.16	0.018	0.027
Caste: ST	0.234	0.178	0.056	0.000
Caste: OBC	0.384	0.398	-0.014	0.210
Religion: Hindu	0.784	0.807	-0.023	0.010
Religion: Muslim	0.136	0.095	0.041	0.000
Religion: Christian	0.047	0.057	-0.011	0.041
Religion: Other	0.033	0.041	-0.008	0.088
Land possessed	0.991	1.213	-0.222	0.000
Total land leased out	0.047	0.036	0.01	0.174
Share of owned land out of total possessed	0.894	0.886	0.007	0.269
Share of leased in land out of total possessed	0.082	0.092	-0.01	0.091
Share of homestead land	0.303	0.277	0.026	0.005
Share of area possessed <1 season	0.011	0.016	-0.005	0.076
Share of area possessed >= 1 season but < 1 year	0.022	0.023	-0.001	0.834
Share of area possessed >= 1 year but < 2 years	0.019	0.021	-0.002	0.589
Share of area possessed >= 2 years	0.947	0.94	0.007	0.162
Share of plot area within village	0.912	0.918	-0.006	0.233
Share of plot area outside village but within district	0.083	0.078	0.005	0.333
Share of plot area outside district but within state	0.003	0.003	0.001	0.534
Share of plot area outside state	0.002	0.002	0.001	0.436

Table 3: Sample characteristics

Variables	Obs.	Mean	SD
Individual characteristics			
Main operator of the holding	92,376	0.253	0.435
Associated operator of the holding	92,376	0.499	0.500
Female	92,376	0.495	0.500
Age	92,376	35.34	14.44
Square of age	92,376	1,458	1,123
General education: Primary or lower	92,376	0.208	0.406
General education: Middle	92,376	0.192	0.394
General education: Secondary	92,376	0.147	0.354
General education: Higher secondary or above	92,376	0.174	0.379
Spouse of head	92,376	0.228	0.419
Married child	92,376	0.107	0.309
Spouse of married child	92,376	0.113	0.317
Unmarried child	92,376	0.216	0.411
Grandchild	92,376	0.0278	0.165
Father/Mother/Father-in-law/Mother-in-law	92,376	0.0188	0.136
Brother/Sister/Brother-in-law/Sister-in-law/Other relatives	92,376	0.0465	0.211
Servants/Employees/Other non-relatives	92,376	0.00168	0.0409
Household characteristics			
Household has a short-term migrant	92,376	0.0698	0.255
Whether household head is female	92,376	0.0701	0.255
Age of household head	92,376	52.10	12.66
Head's education: Primary or lower	92,376	0.270	0.444
Head's education: Middle	92,376	0.158	0.364
Head's education: Secondary	92,376	0.117	0.321
Head's education: Higher secondary or above	92,376	0.114	0.318
Household size	92,376	6.607	3.634
Dependency ratio: 0-5 children in total household size	92,376	0.0873	0.124
Dependency ratio: 6-14 children in total household size	92,376	0.142	0.165
Proportion of males aged 15 years or above	92,376	0.397	0.165
Average age of the household members	92,376	30.43	9.119
Main income source: non-agriculture	92,376	0.0525	0.223
Main income source: wage/salary	92,376	0.144	0.352
Main income source: other	92,376	0.0172	0.130
Caste: SC	92,376	0.122	0.327
Caste: ST	92,376	0.190	0.392
Caste: OBC	92,376	0.408	0.492
Religion: Muslim	92,376	0.0939	0.292
Religion: Christian	92,376	0.0626	0.242
Religion: Other	92,376	0.0414	0.199
Land possessed [0.4, 1)	92,376	0.175	0.380
Land possessed [1, 2)	92,376	0.336	0.472
Land possessed [2, 4)	92,376	0.233	0.423
Land possessed [4, .)	92,376	0.0789	0.270
Total land leased out	92,376	0.0349	0.342
Share of leased in land out of total possessed	92,376	0.0815	0.237
Share of area possessed >= 1 season but < 1 year	92,376	0.0236	0.136
Share of area possessed >= 1 year but < 2 years	92,376	0.0205	0.126

Share of area possessed >= 2 years	92,376	0.943	0.210
Share of plot area outside village but within district	92,376	0.106	0.259
Share of plot area outside district but within state	92,376	0.00277	0.0448
Share of plot area outside state	92,376	0.00151	0.0366
Livestock units equivalent[a]	92,376	1.475	1.924
Region characteristics			
Percentage of land unirrigated in district	92,376	44.67	19.61
Percentage of households with KCC	92,376	3.664	3.986
Average rainfall deviation	92,376	-21.41	41.12
Share of construction workers	92,376	0.175	0.122
Rate of short term migration	92,376	0.0579	0.166
Proportion of households with land in the district	92,376	0.461	0.175

Source: National Sample Survey 2013 data on Land and Livestock Holding for all variables except: percentage of un-irrigated land in the district, percentage of households having *Kisan* credit card, and proportion of households with land in the district (Socio-Economic and Caste Census 2011), rainfall deviation (Indian Meteorological Department), share of construction workers (National Sample Survey 2011-12) and rate of short term migration (National Sample Survey 2007-08).

[a] The animal unit equivalent is constructed following the method given in the Manual on Cost of Cultivation Surveys by Central Statistical Organization of India: http://mospi.nic.in/Mospi_New/upload/manual_cost_cultivation_surveys_23july08.pdf.

Table 4a: Marginal effects from ordered probit model for different types of association with the operational holding

Variables	Female			Male		
	Not associated	Associated with other members	Main operator	Not associated	Associated with other members	Main operator
	(1)	(2)	(3)	(4)	(5)	(6)
STM	-0.041***	0.032***	0.009***	-0.005	0.0005	0.005
	(0.009)	(0.007)	(0.002)	(0.004)	(0.0004)	(0.004)
Individual characteristics						
Age	-0.030***	0.024***	0.007***	-0.024***	0.002***	0.022***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Square of age	0.0004***	-0.0003***	-0.0001***	0.0003***	-0.00003***	-0.0003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
General education: Primary or lower	0.018***	-0.014***	-0.004***	-0.015***	0.001***	0.013***
	(0.006)	(0.004)	(0.001)	(0.005)	(0.000)	(0.004)
General education: Middle	0.037***	-0.029***	-0.008***	-0.001	0.0001	0.001
	(0.007)	(0.005)	(0.001)	(0.005)	(0.0004)	(0.004)
General education: Secondary	0.075***	-0.058***	-0.016***	0.014***	-0.001***	-0.013***
	(0.007)	(0.006)	(0.002)	(0.005)	(0.000)	(0.004)
General education: Higher secondary or above	0.128***	-0.100***	-0.028***	0.039***	-0.004***	-0.036***
	(0.008)	(0.006)	(0.002)	(0.005)	(0.001)	(0.004)
Spouse of head	0.564***	-0.440***	-0.124***	0.332***	-0.030***	-0.302***
	(0.017)	(0.015)	(0.003)	(0.056)	(0.007)	(0.051)
Married child	0.666***	-0.520***	-0.146***	0.399***	-0.036***	-0.363***
	(0.026)	(0.022)	(0.005)	(0.007)	(0.005)	(0.005)
Spouse of married child	0.707***	-0.552***	-0.155***	0.441***	-0.040***	-0.401***
	(0.020)	(0.017)	(0.004)	(0.014)	(0.006)	(0.013)
Unmarried child	0.748***	-0.584***	-0.164***	0.438***	-0.039***	-0.399***
	(0.020)	(0.017)	(0.004)	(0.008)	(0.006)	(0.006)
Grandchild	0.826***	-0.645***	-0.181***	0.512***	-0.046***	-0.466***
	(0.027)	(0.022)	(0.006)	(0.011)	(0.007)	(0.010)
Father/Mother/Father-in-law/Mother-in-law	0.723***	-0.564***	-0.158***	0.442***	-0.040***	-0.402***
	(0.022)	(0.019)	(0.004)	(0.013)	(0.006)	(0.012)
Brother/Sister/Brother-in-law/Sister-in-law/Other relatives	0.695***	-0.542***	-0.152***	0.423***	-0.038***	-0.385***
	(0.020)	(0.017)	(0.004)	(0.007)	(0.006)	(0.006)
Servants/Employees/Other non-relatives	0.764***	-0.597***	-0.168***	0.441***	-0.039***	-0.401***
	(0.071)	(0.056)	(0.015)	(0.024)	(0.006)	(0.022)
Household characteristics						
Whether household head is female	-0.044***	0.035***	0.010***	-0.078***	0.007***	0.071***
	(0.011)	(0.009)	(0.002)	(0.005)	(0.001)	(0.005)
Age of household head	0.0001	-0.0001	-0.00001	-0.001***	0.0001***	0.001***

	(0.0002)	(0.0002)	(0.00007)	(0.000)	(0.000)	(0.000)
Head's education: Primary or lower	0.013**	-0.010**	-0.003**	0.009***	-0.001***	-0.008***
	(0.006)	(0.005)	(0.001)	(0.003)	(0.000)	(0.003)
Head's education: Middle	0.031***	-0.024***	-0.007***	0.015***	-0.001***	-0.014***
	(0.007)	(0.006)	(0.002)	(0.004)	(0.000)	(0.003)
Head's education: Secondary	0.030***	-0.024***	-0.007***	0.015***	-0.001***	-0.014***
	(0.008)	(0.006)	(0.002)	(0.004)	(0.000)	(0.004)
Head's education: Higher secondary or above	0.046***	-0.036***	-0.010***	0.018***	-0.002***	-0.016***
	(0.009)	(0.007)	(0.002)	(0.005)	(0.000)	(0.004)
Household size	0.007***	-0.006***	-0.002***	0.008***	-0.001***	-0.008***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Dependency ratio: 0-5 children in total household size	-0.105***	0.082***	0.023***	-0.057***	0.005***	0.052***
	(0.026)	(0.021)	(0.006)	(0.016)	(0.002)	(0.014)
Dependency ratio: 6-14 children in total household size	-0.072***	0.056***	0.016***	-0.035***	0.003***	0.032***
	(0.021)	(0.016)	(0.005)	(0.012)	(0.001)	(0.011)
Proportion of males aged 15 years or above	0.141***	-0.110***	-0.031***	0.052***	-0.005***	-0.047***
	(0.021)	(0.017)	(0.005)	(0.012)	(0.001)	(0.011)
Average age of the household members	-0.002***	0.002***	0.0004***	-0.001**	0.0001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.00002)	(0.000)
Main income source: non-agriculture	0.016	-0.012	-0.003	0.072***	-0.006***	-0.065***
	(0.011)	(0.009)	(0.002)	(0.006)	(0.001)	(0.006)
Main income source: wage/salary	-0.049***	0.039***	0.011***	0.073***	-0.007***	-0.066***
	(0.007)	(0.005)	(0.002)	(0.004)	(0.001)	(0.004)
Main income source: other	-0.025	0.020	0.006	0.035***	-0.003***	-0.032***
	(0.017)	(0.013)	(0.004)	(0.011)	(0.001)	(0.010)
Caste: SC	-0.053***	0.041***	0.012***	0.001	-0.0001	-0.001
	(0.008)	(0.006)	(0.002)	(0.004)	(0.0002)	(0.004)
Caste: ST	-0.093***	0.073***	0.020***	-0.018***	0.002***	0.017***
	(0.008)	(0.006)	(0.002)	(0.004)	(0.000)	(0.004)
Caste: OBC	-0.039***	0.031***	0.009***	-0.001	0.0001	0.001
	(0.006)	(0.005)	(0.001)	(0.003)	(0.0002)	(0.003)
Religion: Muslim	0.039***	-0.030***	-0.009***	0.007	-0.001	-0.006
	(0.009)	(0.007)	(0.002)	(0.004)	(0.000)	(0.004)
Religion: Christian	0.006	-0.005	-0.001	-0.005	0.0005	0.005
	(0.014)	(0.011)	(0.003)	(0.007)	(0.001)	(0.006)
Religion: Other	0.045***	-0.035***	-0.010***	0.017**	-0.002**	-0.016**
	(0.015)	(0.012)	(0.003)	(0.008)	(0.001)	(0.007)
Land possessed [0.4, 1)	0.028***	-0.022***	-0.006***	-0.037***	0.003***	0.034***
	(0.007)	(0.006)	(0.002)	(0.004)	(0.001)	(0.004)
Land possessed [1, 2)	0.031***	-0.024***	-0.007***	-0.042***	0.004***	0.038***

	(0.007)	(0.006)	(0.002)	(0.004)	(0.001)	(0.004)
Land possessed [2, 4)	0.034***	-0.027***	-0.008***	-0.043***	0.004***	0.039***
	(0.008)	(0.006)	(0.002)	(0.004)	(0.001)	(0.004)
Land possessed [4, .)	0.049***	-0.038***	-0.011***	-0.045***	0.004***	0.041***
	(0.011)	(0.009)	(0.002)	(0.006)	(0.001)	(0.005)
Total land leased out	-0.001	0.001	0.0001	0.005	-0.0005	-0.005
	(0.007)	(0.005)	(0.002)	(0.003)	(0.0003)	(0.003)
Share of leased in land out of total possessed	0.006	-0.004	-0.001	0.004	-0.0004	-0.004
	(0.010)	(0.008)	(0.002)	(0.006)	(0.001)	(0.005)
Share of area possessed >= 1 season but < 1 year	-0.052*	0.040*	0.011*	-0.008	0.001	0.007
	(0.027)	(0.021)	(0.006)	(0.013)	(0.001)	(0.012)
Share of area possessed >= 1 year but < 2 years	-0.054**	0.042**	0.012**	-0.011	0.001	0.010
	(0.027)	(0.021)	(0.006)	(0.014)	(0.001)	(0.013)
Share of area possessed >= 2 years	-0.034	0.027	0.008	0.012	-0.001	-0.011
	(0.022)	(0.017)	(0.005)	(0.010)	(0.001)	(0.009)
Share of plot area outside village but within district	0.021**	-0.016**	-0.005**	-0.012***	0.001***	0.011***
	(0.009)	(0.007)	(0.002)	(0.004)	(0.000)	(0.004)
Share of plot area outside district but within state	0.038	-0.030	-0.008	-0.023	0.002	0.021
	(0.050)	(0.039)	(0.011)	(0.024)	(0.002)	(0.022)
Share of plot area outside state	0.115*	-0.090*	-0.025*	-0.020	0.002	0.018
	(0.063)	(0.049)	(0.014)	(0.032)	(0.003)	(0.029)
Livestock units equivalent	-0.009***	0.007***	0.002***	-0.004***	0.0003***	0.003***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Region characteristics						
Percentage of land unirrigated in district	-0.001***	0.001***	0.0002***	-0.0002***	0.00002**	0.0002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Percentage of households with KCC	-0.0001	0.0001	0.00003	0.001	-0.0001	-0.0005
	(0.001)	(0.001)	(0.0002)	(0.000)	(0.0001)	(0.0003)
Average rainfall deviation	0.0001	-0.0001	-0.00002	-0.0001***	0.00001***	0.0001***
	(0.0001)	(0.0001)	(0.00002)	(0.000)	(0.000)	(0.000)
Observations	45,729	45,729	45,729	46,647	46,647	46,647
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4b: Marginal effects from ordered probit model for different types of association with the operational holding – all individuals (15-65 years)

Variables	(1) Not associated	(2) Associated with other members	(3) Main operator
STM	0.004	-0.0004	-0.003
	(0.005)	(0.0007)	(0.004)
Female	0.157***	-0.057***	-0.100***
	(0.004)	(0.001)	(0.003)
Female*STM	-0.045***	0.020***	0.025***
	(0.009)	(0.003)	(0.006)
Observations	92,376	92,376	92,376
Other control variables	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes

Standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: 2SLS estimates of the effect of STM on individual's association with operational holding (binary dependent variable of whether associated or main operator of the operational holding)

Variables	(1) Female	(2) Male	(3) All
STM	0.925***	0.502***	0.607***
	(0.272)	(0.134)	(0.143)
Female			-0.197***
			(0.010)
STM * Female			0.219*
			(0.122)
Other control variables	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
Observations	45,729	46,647	92,376
R-squared	0.028	0.149	0.084
Weak identification test Kleibergen-Paap rk Wald F	11.41	19.46	13.88
Overidentification test Hansen J	1.458	0.305	2.039
Overidentification test p value	0.227	0.581	0.361

Standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: First stage of 2SLS estimate

	(1)	(2)	(3)	(4)
	Female	Male	All	
Variables	STM	STM	STM	Female * STM
Share of construction workers	0.105***	0.098***	0.104***	-0.017***
	(0.022)	(0.023)	(0.023)	(0.006)
Rate of short term migration	0.093***	0.074***	0.074***	-0.004
	(0.017)	(0.017)	(0.016)	(0.004)
Female * Share of construction workers			-0.006	0.139***
			(0.009)	(0.018)
Female * Rate of short term migration			0.019**	0.102***
			(0.008)	(0.015)
Other control variables	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
Observations	45,729	46,647	92,376	92,376
R-squared	0.045	0.044	0.044	0.062

Standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Second stage estimates from 2SLS with selection correction (binary dependent variable of whether individual is associated with/main operator of operational holding)

Variables	(2) Female	(3) Male	(1) All
STM	0.971***	0.555***	0.672***
	(0.173)	(0.118)	(0.133)
Female			-0.196***
			(0.010)
Female * STM			0.208*
			(0.119)
Inverse Mills Ratio	0.013	0.004	0.011
	(0.019)	(0.017)	(0.015)
	(0.029)	(0.022)	(0.022)
Constant	0.380***	0.320***	0.460***
	(0.055)	(0.039)	(0.041)
Observations	45,729	46,647	92,376
R-squared	0.006	0.124	0.055
Other control variables	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
Weak identification test (Kleibergen-Paap rk Wald F)	22.825	19.385	15.231
Overidentification test (Hansen J)	2.921	0.692	2.544
Overidentification test p value	0.2321	0.7074	0.4674

Bootstrapped standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix

Appendix Table 1: First stage results of 2SLS with selection correction (all individuals)

	(1)	(2)
		Female *
Variables	STM	STM
Share of construction workers	0.093***	-0.022***
	(0.022)	(0.006)
Rate of short term migration	0.070***	-0.006
	(0.016)	(0.004)
Female * Share of construction workers	-0.006	0.139***
	(0.009)	(0.019)
Female * Rate of short term migration	0.019**	0.102***
	(0.008)	(0.015)
Inverse Mills Ratio	0.021*	0.013**
	(0.012)	(0.006)
Observations	92,376	92,376
R-squared	0.045	0.062
Other control variables	Yes	Yes
State fixed effects	Yes	Yes

Bootstrapped standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 2: Coefficient estimates from the selection equation (probit) for whether household operated any land for agriculture (all individuals)

Variables	(1) Opland
Proportion of households with land	0.603*** (0.063)
Other control variables	Yes
Observations	112,437
State fixed effects	Yes

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 3: Full model estimates for the 2SLS second stage

Variables	(1) Female	(2) Male	(3) All
STM	0.925***	0.502***	0.607***
	(0.272)	(0.134)	(0.143)
Individual Characteristics			
Female			-0.197***
			(0.010)
STM * Female			0.219*
			(0.122)
Age	0.034***	0.036***	0.035***
	(0.001)	(0.001)	(0.001)
Square of age	-0.0004***	-0.0004***	-0.0004***
	(0.000)	(0.000)	(0.000)
General education: Primary or lower	-0.020**	0.037***	-0.003
	(0.008)	(0.007)	(0.005)
General education: Middle	-0.043***	0.022***	-0.015**
	(0.010)	(0.008)	(0.006)
General education: Secondary	-0.086***	-0.007	-0.047***
	(0.011)	(0.009)	(0.007)
General education: Higher secondary or above	-0.145***	-0.039***	-0.080***
	(0.013)	(0.010)	(0.008)
Spouse of head	-0.009	-0.082	0.012**
	(0.016)	(0.078)	(0.006)
Married child	-0.135***	-0.042***	-0.046***
	(0.027)	(0.013)	(0.010)
Spouse of married child	-0.157***	-0.110***	-0.132***
	(0.020)	(0.029)	(0.012)
Unmarried child	-0.197***	-0.123***	-0.151***
	(0.021)	(0.015)	(0.011)
Grandchild	-0.298***	-0.291***	-0.289***
	(0.032)	(0.026)	(0.021)
Father/Mother/Father-in-law/Mother-in-law	-0.235***	-0.246***	-0.250***
	(0.024)	(0.029)	(0.016)
Brother/Sister/Brother-in-law/Sister-in-law/Other relatives	-0.144***	-0.082***	-0.104***
	(0.021)	(0.012)	(0.011)
Servants/Employees/Other non-relatives	-0.196**	-0.067	-0.086*
	(0.094)	(0.055)	(0.049)
Household Characteristics			
Whether household head is female	0.049***	0.043***	0.055***
	(0.016)	(0.012)	(0.010)
Age of household head	-0.0004	0.0001	-0.0003
	(0.0003)	(0.0004)	(0.0003)
Head's education: Primary or lower	-0.006	-0.022***	-0.007
	(0.009)	(0.008)	(0.006)
Head's education: Middle	-0.034***	-0.035***	-0.029***
	(0.011)	(0.009)	(0.008)
Head's education: Secondary	-0.031**	-0.021**	-0.022**
	(0.012)	(0.010)	(0.009)
Head's education: Higher secondary or above	-0.041***	-0.018	-0.030***
	(0.014)	(0.012)	(0.010)
Household size	-0.012***	-0.012***	-0.012***
	(0.002)	(0.002)	(0.002)
Dependency ratio: 0-5 children in total household size	0.171***	0.166***	0.165***
	(0.037)	(0.023)	(0.025)
Dependency ratio: 6-14 children in total household size	0.146***	0.021	0.085***
	(0.032)	(0.019)	(0.020)
Proportion of males aged 15 years or above	-0.129***	-0.075***	-0.110***
	(0.032)	(0.021)	(0.021)
Average age of the household members	0.003***	0.001***	0.002***
	(0.001)	(0.000)	(0.000)
Main income source: non-agriculture	-0.068***	-0.108***	-0.091***
	(0.016)	(0.011)	(0.011)

Main income source: wage/salary	-0.032**	-0.094***	-0.066***
	(0.014)	(0.009)	(0.009)
Main income source: other	-0.063**	-0.071***	-0.068***
	(0.027)	(0.022)	(0.019)
Caste: SC	0.052***	0.001	0.029***
	(0.013)	(0.008)	(0.008)
Caste: ST	0.088***	0.017**	0.053***
	(0.017)	(0.008)	(0.009)
Caste: OBC	0.046***	0.002	0.026***
	(0.011)	(0.006)	(0.006)
Religion: Muslim	-0.079***	-0.020**	-0.047***
	(0.018)	(0.009)	(0.010)
Religion: Christian	-0.003	0.009	-0.001
	(0.024)	(0.012)	(0.012)
Religion: Other	-0.069***	-0.026*	-0.049***
	(0.025)	(0.015)	(0.015)
Land possessed [0.4, 1)	-0.010	0.026***	0.007
	(0.012)	(0.008)	(0.008)
Land possessed [1, 2)	-0.003	0.047***	0.021***
	(0.011)	(0.007)	(0.007)
Land possessed [2, 4)	-0.003	0.055***	0.024***
	(0.012)	(0.008)	(0.008)
Land possessed [4, .)	-0.005	0.070***	0.031***
	(0.018)	(0.011)	(0.011)
Total land leased out	-0.015	-0.012*	-0.014
	(0.013)	(0.007)	(0.009)
Share of leased in land out of total possessed	-0.032*	-0.015	-0.023**
	(0.017)	(0.010)	(0.011)
Share of area possessed >= 1 season but < 1 year	0.037	0.014	0.026
	(0.043)	(0.025)	(0.027)
Share of area possessed >= 1 year but < 2 years	0.069	0.038	0.055**
	(0.042)	(0.024)	(0.026)
Share of area possessed >= 2 years	0.010	-0.004	0.003
	(0.035)	(0.019)	(0.021)
Share of plot area outside village but within district	-0.020	0.013	-0.005
	(0.015)	(0.008)	(0.009)
Share of plot area outside district but within state	-0.061	0.062*	0.0002
	(0.066)	(0.037)	(0.044)
Share of plot area outside state	-0.143	0.035	-0.056
	(0.115)	(0.053)	(0.066)
Livestock units equivalent	0.014***	0.009***	0.011***
	(0.003)	(0.001)	(0.001)
Regional Characteristics			
Percentage of land unirrigated in district	0.001**	0.0002*	0.001***
	(0.000)	(0.0001)	(0.000)
Percentage of households with KCC	0.004*	0.001	0.002**
	(0.002)	(0.001)	(0.001)
Average rainfall deviation	0.0001	0.0003***	0.0002***
	(0.0001)	(0.000)	(0.000)
Other control variables	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
Observations	45,729	46,647	92,376
R-squared	0.028	0.149	0.084
Weak identification test Kleibergen-Paap rk Wald F	11.41	19.46	13.88
Overidentification test Hansen J	1.458	0.305	2.039
Overidentification test p value	0.227	0.581	0.361

Standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1