Rural non-farm diversification, gender and labour allocation to farm: Evidence from India

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ABSTRACT

The present study contributes to the limited literature on the interlinkage between household non-farm diversification, agricultural feminization and female autonomy in farming. The study uses unit level data from the India Human Development Survey for the years 2004-05 and 2011-12. The paper employs Instrumental Variable regression methods to study such interlinkages. The results show household non-farm diversification to be a significant factor contributing to the feminization of agriculture. Further, greater participation of women in agriculture significantly contributes to female autonomy in farm decision-making. The results are robust to the use of alternative indicators of agricultural feminization. Further robustness checks support the overall conclusions of the paper. The study concludes with some policy suggestions.

***Keywords*:** Rural; Non-farm; Agriculture; Female; Empowerment; Instrumental Variable.

JEL Codes: C26; J16; J43; O13; Q15.

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1. Introduction

Non-farm employment has become a ubiquitous element of the rural economy. Rural livelihoods are increasingly diversifying into non-farm activities. Such diversification transpires because of returns to assets which vary across time or individuals; because of a need to exploit economies of scope; and/or as a response to market failures etc. (Barrett, Reardon, & Webb, 2001). Although the literature exploring the drivers of rising livelihood diversification is large, relatively lesser attention has been devoted to the other side of the picture i.e. the influence of livelihood diversification on the structure of the rural economy (Davis, Winters, Reardon, & Stamoulis, 2009). One such aspect which is the subject of the current study is the influence of household livelihood diversification on labour allocation and decision-making on the farm.

Despite the rising prevalence of non-farm activities among rural households, agriculture still has an important role to play in the development of the rural economy. Recent literature in this regard envisages a synergistic relationship between the farm and the non-farm sector for overall rural development (Davis et al., 2010). Non-farm incomes, by acting as a source of additional incomes, credit and insurance can enable rural households to enhance the efficiency of farming and undertake risky intensification activities in their farms (Davis et al., 2009; Haggblade, Hazell, & Reardon, 2007).

A concomitant issue that deserves attention is the gendered implications of the relation between the farm and the non-farm economy. The extant literature finds that the impact of household non-farm income on labour force participation of its members differ by gender (Mendola & Carletto, 2012; Mu & van de Walle, 2011). Such gender-specific heterogeneities in the impact of non-farm participation on labour allocation of household members are especially interesting given its implications for 'equity and efficiency' (Quisumbing et al., 2014). Changes in female participation in farming consequent to household non-farm diversification can increase the burden of unpaid work for women besides having consequences for female empowerment in agriculture. Besides, such a trend can have implications for farm productivity given women's unequal access to vital agricultural inputs (Food and Agriculture Organization, 2011; Quisumbing et al., 2014).

The issue of increasing non-farm participation and its impact on female labour allocation and autonomy within farming is especially pertinent given the discourse on the 'feminization of

agriculture'[3] (Food and Agriculture Organization, 2011; Srivastava, 2011). There is also an ongoing debate on the implications of such a process of feminization, driven by rising non-farm participation and other structural changes in the rural economy, on the autonomy, empowerment and well-being of women left behind in agriculture (Paris, Singh, Luis, & Hossain, 2005; Pattnaik, Lahiri-Dutt, Lockie, & Pritchard, 2018). Although there have been a few studies which explore the impact of non-farm participation on labour use and decision-making in farming, they are primarily concerned with the impact of migration and remittances. However, given the pervasiveness of local non-farm activities among rural households, its impact on labour allocation in farming deserves equal attention. Further, household decisions to diversify into both local non-farm diversification and migration form an integrated strategy. Hence, studying the impact of migration and remittances without considering the effect of local non-farm diversification, or vice versa, may not provide us with a comprehensive picture.

The present study attempts to contribute to the limited but pertinent literature on the impact of rising non-farm participation on labour allocation in farming and its gendered implications. Specifically, the study attempts to answer the following research questions:

i. Does household diversification into non-farm activities lead to the feminization of agriculture?
ii. Does increasing participation in non-farm work and the feminization in agriculture have any impact on female autonomy and decision-making in farm activities?

The paper is divided into four sections. Section 2 provides a conceptual framework for the study. Section 3 presents the data and the methodology, and Section 4 discusses the results. Section 5 provides some robustness checks. Section 6 concludes the paper and presents some policy suggestions.

2. Conceptual framework

[3] Although the discourse on feminization of agriculture has been used to highlight the rising participation of women in own farm as well as the agricultural wage labour market, in the present study we restrict ourselves to the later i.e. female participation in own farm work. The phenomenon of feminization of agricultural wage work has been taken up in Garikipati, (2008); Garikipati & Pfaffenzeller, (2012); da Corta & Venkateshwarlu, (1999); Abdelali-Martini & de Pryck, (2015).

Household diversification into non-farm activities can influence labour allocation and decision-making in farming through the following channels:

Firstly, non-farm participation can be a source of additional income to the household thereby potentially raising the reservation wages of its members and lowering labour force participation as well as engagement in farm work. Such a decline would be especially pronounced for females given social norms against their labour market participation in many regions in India. On the other hand, non-farm diversification is due to a desire to cope with uncertain farm incomes, additional non-farm income may not increase total household income and will not have any effect on farm and overall work participation of its members.

Secondly, participation in non-farm activities also entails household labour re-allocation to non-farm activities which can have implications for farm labour. Such household engagement in non-farm work can lead to specialization of its members with males spending relatively more time in non-farm activities and females increasing their involvement in farming. Such gender-specific response to non-farm participation is especially convenient for households given social norms against the participation of females in work outside the farm (Entwisle, Henderson, Short, Bouma, & Fengying, 1995; Fan, 2003; Zuo, 2004). The effect on overall labour force participation is however ambiguous and depends on the extent of reallocation between farm and non-farm activities.

The above discussion shows that theory, as well as logical reasoning, fails to provide us with unambiguous answers on the impact on non-farm diversification on household's labour allocation in farming. As such, we rely on empirical evidence to ascertain the effect of non-farm participation on household's labour allocation in farming.

Does the increasing participation of women in farming increase their say in farm-related decisions-making? In this regard, studies by Twyman, Useche, & Deere, (2015) and Anderson, Reynolds, & Gugerty, (2017)**,** find that greater participation of women in farm positively influences their say in decisions related to farming operations. Twyman et al., (2015) argues that the involvement of women in farm work signals their commitment and provides them with an 'earned right' and greater voice to engage in agricultural decision-making. In line with the arguments by Twyman et al., (2015), we hypothesize that increasing participation of women in farming should increase their autonomy in farm-related decision-making. This conjecture is all

the more plausible as increased female participation in the farm would enable her to acquire the necessary skills and know-how to manage farm operations independently.

Our arguments are also in line with the predictions of the intra-household bargaining theory that women's participation in the labour market (as well as women's access to assets such as land) would increase their empowerment by improving their threat points or utility from the non-cooperative solution (Agarwal, 1997). However, Anderson & Eswaran, (2009), making a distinction between women's farm work and market work, argue that the women's work in the farm does not influence her 'threat points' and hence should have no effect on their say on overall household related decisions[4]. Similar results have been obtained by Kantor, (2003).

3. Data and Methods

3.1. Data and variable description

The study uses panel data from the Indian Human Development Survey (IHDS) conducted for the years 2004-05 (IHDS-I) and 2011-12 (IHDS-II) (Desai & Reeve, 2015a, 2015b). Both IHDS-I and IHDS-II are representative at the national level. While the rural sample for IHDS is based on stratified random sampling, the urban sample was drawn using a stratified sample of towns and cities within states selected by probability proportional to population sampling. We restrict our analysis to rural households who have at least one household member working in the farm. Further, because we use certain household-level variables from the IHDS-I (2004-05) survey, we lose some observations due to sample attrition.

IHDS contains detailed individual, household and community-level information which we use for our analysis. Specifically, we use information on participation and hours worked in the farm over the previous year by the household members as well as information on the gender of the primary decision maker in the farm as our outcome variables. Additionally, IHDS contains information on income earned from a variety of sources. We aggregate income earned from non-farm business, remittances as well as agricultural and non-agricultural wage employment to

[4] It is noteworthy that Anderson & Eswaran, (2009) and Kantor, (2003) consider women's autonomy in decision-making with regard to general household decisions such as those related to purchase of food, clothing etc. On the other hand, Twyman et al., (2015) and Anderson et al., (2017) consider decisions related to farming operations in particular. It can be argued that although women's participation in the farm does not influence their autonomy with regard to general household-related decisions, it has a positive influence on their say in farm-related decisions through the greater voice, skills and know-how they obtain from such participation.

arrive at the total non-farm income of the household. IHDS also contains detailed data on the demographic and socio-economic characteristics of the households. Finally, the data contains village-level information on occurrence on floods and droughts, local agricultural wage rates and village infrastructure.

Measures of agricultural feminization and female autonomy in farming: Following de Brauw, Li, Liu, Rozelle, & Zhang, (2008) and de Brauw, Huang, Zhang, & Rozelle, (2013), we use four measures of agricultural feminization: firstly, we measure participation (for males and females separately) as a binary variable equaling one if the person works in the farm and zero otherwise; secondly, we use hours worked on the farm by males and females separately; thirdly, we consider the share of female household members out of all household members engaged in farming as a measure of feminization; fourthly, we consider a dummy variable equaling one if all household members engaged in farming are males and zero otherwise.

Recent literature has explored women's empowerment in agriculture using various indicators within a multidimensional framework (Alkire et al., 2013; Twyman et al., 2015). However, given the limitations of data, we use the gender of the primary decision-maker on the farm as a proxy for female autonomy in farming. Despite its limitations, we believe that such a measure should still provide us with an informative picture on women's empowerment and decision-making ability in Indian agriculture.

3.2. Descriptive Statistics

Table 1 provides the definitions and descriptive statistics for the outcome variables of interest. Our summary statistics show household engagement in non-farm activities to be associated with rising feminization of agriculture. Non-farm participation also has contrasting gender implications with males withdrawing from farming and female increasing their labour contribution to farming as households diversify into non-farm activities. Finally, household diversification into non-farm activities is associated with an increase in female autonomy in farm-related decision-making (Table 1).

Table 2 (as well as Additional Table A1) summarizes and defines the independent variables to be used in the study. The primary independent variable of interest is the non-farm income of the household. Given the skewed nature of the variable, we log-transform the variable in further

econometric specifications (*log_nonfarm_inc*). Important individual-level covariates affecting participation in the farm include age, gender and education. Given the influence of the status of the family member in the household in labour force participation, we include separate dummies depicting relationship with the household head (Fafchamps & Quisumbing, 2003). Further, we include standard household-level covariates affecting agricultural feminization and female autonomy such as religion, caste, household agricultural and non-agricultural assets etc.

The study controls for household composition through the inclusion of variables measuring household head's age, the number of adult males and females as well as the proportion of minors and elderly in the household. An important correlate of female autonomy in the household is women's access to assets such as land (Agarwal, 1997; Allendorf, 2007; Wiig, 2013). We accordingly proxy for women's land rights through a variable measuring female inheritance of land (*dmy_land_female*). Such a measure is also less likely to be contaminated by endogeneity concerns compared to direct indicators of women's land rights (Maluccio & Quisumbing, 2003).

Given the important role of exposure to media in furthering women's empowerment, we include separate variable capturing women's (and men's) exposure to news media, radio and TV media. The role of media in creating awareness among women about their rights is widely documented in the literature (Jensen & Oster, 2009). However, exposure to media can also provide women with information on agricultural practices thus improving their decision-making capacity in farming. Finally, the study controls for village-level factors such as the occurrence of floods, droughts etc., village-level agricultural wages as well as conditions of labour shortage in the village.

3.3. Methods

The study uses regression methods to examine the relationship between agricultural feminization and non-farm participation. However, an important econometric issue in estimating such a relationship is that decisions related to farm and non-farm participation are likely to be made simultaneously. Further, unobserved individual and household-level characteristics may be correlated with both non-farm incomes and the outcome variable leading to omitted variable bias. Similar problems arise in estimating the model of female autonomy in farming. Following the existing literature, we make use of the Instrumental Variable (IV) approach to estimate our model (Mendola & Carletto, 2012; Mu & van de Walle, 2011).

As discussed in Section 3.1, the study attempts to measures agricultural feminization using both binary and continuous variables. Accordingly, in case the outcome variable is binary, we model the impact of non-farm incomes on agricultural feminization using an IV-probit specification, as follows:

$$\Pr(y_1 = 1 \mid X) = \Phi(X\gamma) \ldots\ldots (1)$$

Here, y_1 is a dummy variable denoting participation in the farm, Φ is the cumulative standard normal distribution and X is the vector of independent variables including non-farm incomes which is the variable of interest (*ln_nonfarm_inc*). Other independent variables in the model include individual-level variables such as gender, age, education, marital status and dummies for relationship with the household head. Additionally, we control for household-level factors such as religious and caste affiliation, household composition and access to agricultural and non-agricultural assets. We also control for labour market conditions in the village. Finally, we control for the macro-level socio-economic environment through the inclusion of state/province dummies. The two-step estimator proposed by Newey, (1987) is used to estimate the model.

Similarly, in case the outcome variable is continuous such as hours worked in the farm[5] or the share of farm work undertaken by women in the household, the model is estimated using a 2-Stage Least Squares (2SLS) specification as follows:

$$y_2 = X\beta + u \ldots\ldots (2)$$

Here, y_2 is a continuous variable denoting either logarithm of hours worked in the farm or the share of farm work undertaken by women and X is defined as in Eq. (1). The model is estimated using the two-step GMM estimator which offers efficiency gains over traditional 2SLS estimators under possible violation of the homoscedasticity assumption (Cameron & Trivedi, 2005).

[5] A critical problem is modelling participation using hours worked in the farm is that male and female work hours in farm activities are censored at zero. A common approach to overcome such issues in the econometrics literature is the use of the tobit model. However, the tobit model has been extensively criticized for its sensitivity to departures from the assumption of homoscedastic normality of the error terms (Moffit, 2004). A useful alternative to the tobit model in such cases is the two-part model widely used in the health economics literature (Dow & Norton, 2003; Hertz, 2009). Following the approach used in the two-part model, we estimate the hours worked equations conditional on participation in the farm i.e. only for persons with positive hours of work.

Finally, female autonomy in farming is modelled using an IV-probit specification as in Eq. (1), as follows,

$$\Pr(y_3 = 1 \mid X) = \Phi(X\gamma) \ldots\ldots (3)$$

Here, y_3 is a dummy variable equaling 1 if the primary decision-maker in the farm is a female and zero otherwise. Φ is defined as in Eq. (1) and X is a vector of independent variables. Given our interest in studying the impact of agricultural feminization on female autonomy, our independent variable of interest is the share of female household members out of all household members engaged in farming (*hhld_sh_fem_farm*). Other important covariates of interest include household non-farm income (*ln_nonfarm_inc*) and women's access to inherited land (*dmy_land_female*). Additionally, the model includes standard controls such as religious and caste affiliation of the household, household composition, access to agricultural and non-agricultural assets as well as state/province dummies.

Given endogeneity concerns with covariates such as non-farm income and female farm work in the above models, we rely on Instrumental Variable (IV) framework to estimate the effect of the potentially endogenous covariates on our outcome variables related to agricultural feminization and female autonomy. Instrumental variables used in the study are summarized in Table 2 and discussed below.

Instrumental variables: We use the following variables to instrument for household non-farm income:

The first instrument that we consider is the occupation of the father/husband's father of the household head[6] (*occ_head_fathr_prof* and *occ_head_fathr_clrck*). The existing literature finds that father's occupation significantly influences both participation and income from non-farm activities (Emran & Shilpi, 2011; Lentz & Laband, 1990). However, conditional on the household engaging in farming and controlling for various individual, household and community-level characteristics, the occupation of the household head's father is unlikely to influence outcomes related to agricultural feminization and female autonomy in farm-based activities.

[6] Specifically, we use the dummies *occ_head_fathr_prof* and *occ_head_fathr_clrck* to capture the occupation of the father/husband's father of the household head, with *occ_head_fathr_cultv* acting as the reference category.

Secondly, we use migrant networks defined as the number of seasonal migrants from the village in the year before the survey year (*vill_migr*) as an instrument of household non-farm income. Migrant networks are supposed to be highly correlated with remittances, an important component of non-farm income. Similar instruments have been widely used in the migration literature (Binzel & Assaad, 2011; de Brauw, 2010; Lokshin & Glinskayai, 2009; Mendola & Carletto, 2012; Taylor, Rozelle, & Brauw, 2003). Migrant networks are postulated to lower the costs and hazards of migration for households through the formation of extensive social and information networks that link the migrants in the destination with family and friends at home (de Brauw, 2010; Lokshin & Glinskayai, 2009; Mendola & Carletto, 2012; Taylor et al., 2003). However, controlling for individual, household and community-level characteristics, migrant networks should not directly affect our outcome variables.

Thirdly, we use the number of years ago the family moved to the current location as an instrument for household non-farm income (*yrs_place*). Households residing in the location for a longer period are supposed to earn higher incomes from non-farm sources through the accumulation of greater social capital and other channels. However, controlling for individual, household and community-level covariates, the number of years of residence in a place should not affect outcomes related to agricultural feminization and female autonomy in farming.

Similarly, the study instruments for *hhld_sh_fem_farm* in Eq. (3) using the number of adult males and females in the household (*hhld_n_adult_male* and *hhld_n_adult_female*). The number of adult males and females in the household is supposed to be highly correlated with *hhld_sh_fem_farm* but is not likely to affect female autonomy in farm-related decision-making except indirectly through *hhld_sh_fem_farm*.

4. Results and Discussion

4.1. Instrument Validity and Relevance

Given the importance of the Instrumental Variables (IVs) for our identification strategy, we first report the results for the validity and the relevance of the IVs. The results for the Weak-Identification tests show the instruments to be highly relevant and strong. The Kleibergen-Paap rk F-statistic in all cases exceeds the rule-of-thumb value of 10 as proposed by Stock & Yogo, (2005) (Table 3 and 4). Further, the over-identification tests strongly support the validity of our

instruments. Based on the results for the Hansen's J test or the Amemiya-Lee-Newey test, we cannot reject the null hypothesis that the instruments are valid (Table 3 and 4).

However, the reliability of the over-identification test hinges on there being at least enough instruments to identify the 2SLS model exactly (Wooldrige, 2010). In this regard, Murray, (2006) argues that the credibility of the over-identification tests is enhanced if the instruments are different from each other in terms of their underlying logical reasoning and theoretical rationales. As such, the favorable results from our over-identification tests assumes greater credibility in the light of the variety of instruments used in our study. We can also take further comfort from the fact that some of the instruments used in our study (such as *yrs_place* and *vill_migr*) have relatively much stronger grounds to be considered as exogenous providing further credence to the over-identification test results[7].

4.2. Econometric Results

Table 3 reports the results for the impact of household non-farm diversification (HND) on labour participation in the farm. The study does not find any significant impact of household participation in non-farm activities on overall participation of the household member in the farm. However, looking at the impact of such non-farm diversification separately by gender provides interesting results. Whereas HND leads to more females participating in farming, the effect is the opposite for males (Table 3). The results concur with related literature on migration which finds migration of a household member to lead to greater participation of women in farm and unpaid work (Binzel & Assaad, 2011; Mendola & Carletto, 2012; Mu & van de Walle, 2011).

Further, HND significantly reduces hours worked on the farm for household members participating in farming. However, in line with our earlier results, we find that the reduction in hours worked farming is larger for male household members relative to females (Table 3). Such results are consistent with the hypothesis of HND leading to a feminization of agricultural operations. Similar results were reported by de Brauw, (2010) who find a larger negative effect of the migration of a household member on days worked on the farm for women relative to men.

The above results are supported by those in Table 4 which find a positive impact of HND on the share of household farm labour performed by women. Similarly, HND is found to

[7] See the arguments provided by Murray, (2006, pp. 116) in regard to this contention.

significantly reduce the probability that no female members engage in farming in the household. The results unambiguously show HND to be a significant factor driving the feminization of agriculture. Our results are robust to the use of alternative specification to measure the phenomenon of agricultural feminization.

Finally, the study looks at the effect of agricultural feminization and other factors on female autonomy in farming. Table 4 show that increasing the share of household farm labour performed by women (*hhld_sh_fem_farm*) significantly improves the probability of a woman being the primary decision-maker in farm-related activities of the household. Our results tally with Twyman et al., (2015) and Anderson et al., (2017) who find a positive influence of women's participation in farm work on their say in farm-related decision making. However, controlling for *hhld_sh_fem_farm*, we do not find any significant impact of HND on female autonomy in farming. In line with the large literature on women's land rights and their empowerment, the study finds a significantly positive impact of women's land rights on their autonomy in farming (Table 4). Further results show women's exposure to media to be an important factor in promoting women's autonomy in farming (Additional Table A10: Column 2).

The results highlight the role of household non-farm diversification on changing gender roles as women take up increasing responsibilities of the farm and men shift to non-farm work. Such a transformation in the division of labour within the household conforms with existing social norms which disapprove of women's market work outside the farm. Further, the increase in women's autonomy in farming in response to agricultural feminization is encouraging given its potentially favorable effects on farm technical efficiency as well as nutrition and schooling of the household members (Malapit, Sraboni, Quisumbing, & Ahmed, 2019; Rao, Gazdar, Chanchani, & Ibrahim, 2019; Seymour, 2017; Wouterse, 2019). However, greater participation of women in agriculture may have its pitfalls in terms of their greater workload and may not be as emancipatory for women as argued in Anderson & Eswaran, (2009).

5. Robustness Checks

The present section assesses the robustness of the results presented earlier through some sensitivity checks.

5.1. Corrections for selection bias

The results presented in the previous section discuss the relation between household non-farm diversification, agricultural feminization and female autonomy in farming *conditional on the household being engaged in farming*. However, farm households may not be randomly selected from the overall population thus leading to a bias in our results. We attempt to correct for such bias using a method proposed by Heckman, (1979). Specifically, we model household participation in farming for rural areas using a probit specification as follows:

$$\Pr(y_4 = 1 \mid X) = \Phi(Z\gamma) \dots\dots (4)$$

Here, y_4 is a dummy variable equaling one if the household engages in farming and zero otherwise. Φ is the cumulative standard normal distribution and Z is the vector of independent variables. The vector Z contains the same household and village-level variables used to study agricultural feminization or female autonomy in farming except the endogenous variables (*ln_nonfarm_inc* and *hhld_sh_fem_farm*). Further, the vector Z contains the instruments used to identify the models for agricultural feminization and female autonomy viz. *occ_head_fathr_prof*, *occ_head_fathr_clrck*, *vill_migr* and *yrs_place*.

Additionally, the vector Z includes a variable (which we call the selection instrument) which affects household engagement in farming but does not impact agricultural feminization or female autonomy in farming. We consider the accessibility of the village by a paved road (*pucca_road*) as our selection instrument. Accessibility of the village by a paved road is supposed to impact farm engagement and exits by influencing the opportunities available for farmers for non-farm work, expectations about family life etc. (Bhandari, 2013). However, the accessibility of the village by a paved road should have no effect on agricultural feminization or female autonomy.

Estimates from Eq. (4) is used to generate the Inverse Mills ratio given by,

$$\lambda(Z\hat{\gamma}) = \phi(Z\hat{\gamma})/\Phi(Z\hat{\gamma})$$

Here, $\phi(.)$ and $\Phi(.)$ are the standard normal distributions and the cumulative standard normal distributions respectively and $\hat{\gamma}$ are the co-efficient estimates from Eq. (4). Finally, we re-estimate Eq. 1, 2 and 3 adding $\lambda(Z\hat{\gamma})$ as an additional regressor.

Consistent with our hypothesis, results from the first stage probit model show *pucca_road* to be a significant predictor of household engagement in farming[8]. Results for the bias-corrected model are available in Additional Tables A2 to A10 (Column 3). We also present the simple OLS/probit model estimates as the benchmark set of results (Additional Table A2 to A10: Column 1). The results are similar to those in Table 2 and 3 and show that the overall conclusions of the study to be robust to any correction for selection bias in our models.

5.2. Alternative measures of non-farm diversification and agricultural feminization

In our second robustness check, we consider alternative measures of household non-farm diversification and agricultural feminization. Specifically, we consider the dummy variable *work_nonfarm* as an alternative indicator of household non-farm diversification (See Additional Table A1). Such an indicator is based on household member's participation in non-farm activities and hence is less likely to be affected by underreporting errors inherent in our measure of non-farm income. Similarly, we consider *hhld_male_farm* as an alternative indicator of agricultural feminization.

Given the fact that *work_nonfarm* and *hhld_male_farm* are binary variables, IV-Probit models are not suitable to estimate Eq. 1 and 3. Following Angrist, (2001), we use 2SLS specifications to estimate our models in case our outcome variable is binary. The results for our estimations based on these alternative indicators are presented in Additional Table A2-A10 (Column 4). The results are similar to those discussed earlier in Section 4.2 and support the overall conclusions of the study.

5.3. Controlling for gender relations in the household

The results of the study quite convincingly show household non-farm diversification to be a significant factor in influencing the agricultural feminization process. Given the importance of the instrumental variables (IVs) in our overall identification strategy, Section 4.1 provide extensive arguments in favour of the validity of the IVs. These arguments are more likely to be justified when we specify our outcome variable as female's share of household farm work (such as *hhld_sh_fem_farm* and *hhld_male_farm*). In such cases, even if the IVs affect participation in farm, they remain valid as long as such an effect does not differ by gender. However, it might

[8] Results for the first stage probit model are not shown in the paper but are available upon request.

still be argued that some of our IVs such as the occupation of the father/husband's father of the household head are likely correlated with gender relations in the household which might also influence agricultural feminization and female autonomy in farming. Similarly, the IVs *hhld_n_adult_male* and *hhld_n_adult_female* might affect gender relations within the household which can have an influence on female autonomy in farming.

The study attempts to preclude such links between the IVs and the outcome variables by including controls for household gender relations in our models. Specifically, the study makes use of information on gender relations within the household from IHDS-I (2004-05). For each household, IHDS-I asked an ever-married women between ages 15 and 49 a number of questions related to their say on household decisions and other aspects of gender relations within the household. The study uses such information as a proxy for gender relations within the household. Additional Table A1 provides the operationalization and summary statistics for such variables.

The results for the specifications controlling for gender relations within the household are presented in Additional Tables A2-A10 (Column 5). The results are similar to those presented in Table 3 and 4 and our overall conclusions remain robust to the inclusion of the controls for gender relations in the household.

6. Conclusion

The paper attempts to contribute to the limited literature on household non-farm diversification, agricultural feminization and female autonomy in farming. The study unambiguously shows household non-farm diversification to be an important factor contributing to agricultural feminization. We also find such a phenomenon of agricultural feminization to lead to greater female autonomy in farming. Another important factor influencing women's autonomy in farming is women's access to land rights. Our results are robust to the use of alternative measures of agricultural feminization. Further robustness checks uphold the findings of the study bestowing greater credibility to our results.

The paper provides interesting insights into the role of household non-farm diversification on the farm economy. The results highlighting the importance of household non-farm diversification as an important driver of agricultural feminization assumes significance given the size and the growth of the sector in rural areas. Such rising prominence of the non-farm economy in rural

areas should lead to greater engagement of women in farming as men shift to non-farm activities. Such changes in gender relations in agriculture can have potential consequences for the farm sector given women's limited access to agricultural assets (Food and Agriculture Organization, 2011; Quisumbing et al., 2014). Such problems are compounded by difficulties related to shortage of male labour, investment and hiring labour for female managed farms (Djurfeldt, Hillbom, Mulwafu, Mvula, & Djurfeldt, 2018; Goldstein & Udry, 2008; Paris et al., 2005; Radel, Schmook, McEvoy, Méndez, & Petrzelka, 2012). Finally, although the favorable impact of agricultural feminization on women's autonomy in farming is desirable, such a process can be a double-edged sword leading to a rising burden of work for women and restricting their scope for more empowering market work outside the farm.

The paper concludes with the following suggestions. Firstly, women's greater involvement in farm activities and decision-making calls for urgent measures to improve their access to agricultural assets such as land. Secondly, there is a need to collect sex-disaggregated data as well as combine both qualitative and quantitative data sources to get a better understanding of gender relations in agriculture (Quisumbing et al., 2014). Thirdly, greater efforts need to be made to lessen women's rising burden of work in agriculture through, for example, mechanization in agriculture. Finally, further studies investigating the causes and consequences of agricultural feminization are warranted.

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TABLES

Table 1: Participation in farming and autonomy by non-farm activity			
Variable	Description	Mean	
		Household does not participate in non-farm	Household participates in non-farm
Individual-level variables			
work_farm	=1 if the individual works in the farm, else 0.	0.54	0.55
work_farm (Male)[a]	=1 if the individual works in the farm, else 0.	0.65	0.62
work_farm (Female)[b]	=1 if the individual works in the farm, else 0.	0.42	0.48
ln_farm_hrs[c]	Logarithm of hours of work in the farm.	6.28	5.67
ln_farm_hrs (Male)[a c]	Logarithm of hours of work in the farm.	6.02	5.55
ln_farm_hrs (Female)[b c]	Logarithm of hours of work in the farm.	6.45	5.77
Household-level variables			
hhld_sh_fem_farm	Ratio of the female household members engaged in farming to total household members engaged in farming.	0.36	0.42
hhld_male_farm	=1 if no female members engage in farming in the household, else 0.	0.27	0.17
hhld_fem_autonmy	=1 if the primary decision-maker in farm-related activities in the household is a female, else 0.	0.07	0.11
No. of Individuals		15250	66677
No. of Households		3019	12425

Note: Statistics reported for individual-level variables are at the individual level i.e. the unit of analysis is the individual. For household-level variables, statistics are reported at the household level.

[a] Estimations are conducted for male individuals only.

[b] Estimations are conducted for female individuals only.

[c] Statistics reported are based on individuals with positive hours of work in the farm.

Source: Authors' calculations based on IHDS-II (2011-12) data.

Table 2: Variable definitions and descriptive statistics		
Variable	Description	Mean

Individual-level variables		
dmy_male	=1 if the individual is male, 0 otherwise	0.50
Age	Age of the individual in years	29.75
yrs_school	Years of schooling of the individual	4.66
dmy_head	=1 if the person is the head of the household, else 0	0.19
Household-level variables		
ln_nonfarm_inc[a]	Logarithm of total non-farm income of the household.	8.57
Hindu	=1 if the household practices Hinduism, else 0.	0.86
caste_gen	=1 if the household is from general caste, else 0.	0.29
caste_obc	=1 if the household is from Other Backward Caste (OBC), else 0.	0.43
caste_sc	=1 if the household is from Scheduled Caste (SC), else 0.	0.17
caste_st	=1 if the household is from Scheduled Tribe (ST), else 0.	0.12
head_male	=1 if the head of the household is male, else 0.	0.91
hhld_n_adult_male	Number of males in the 20 to 60 age group.	1.58
hhld_n_adult_female	Number of females in the 20 to 60 age group.	1.65
hhld_assets05[b]	Number of consumer durables owned by the household	10.00
ln_land_own05[b c]	Logarithm of acres of land owned by the household in 2004-05.	1.17
dmy_land_female	=1 if the household acquired most of its land through inheritance to female members, else 0.	0.02
occ_head_fathr_prof[d]	=1 if the father/husband's father of the household head belonged to a professional or sales related occupation, else 0.	0.03
occ_head_fathr_clrcd[e]	=1 if the father/husband's father of the household head belonged clerical work related occupation or was an agricultural worker, else 0.	0.25
occ_head_fathr_cultv[f]	=1 if the father/husband's father of the household head was a cultivator, else 0.	0.72
vill_migr	Number of persons who left the village to find seasonal work during 2010-11.	97.23
yrs_place	=1 if the family moved to the place less than 50 years ago, else 0.	0.04

Note: Statistics reported are at the individual level i.e. the unit of analysis is the individual.
Statistics reported are based on data from IHDS-II (2011-12) unless otherwise mentioned.
[a] Specifically, *ln_nonfarm_inc*=sign(*nonfarm_inc*)×ln{abs(*nonfarm_inc*)+1}, where *nonfarm_inc* is the non-farm income of the household. sign(*nonfarm_inc*) is +1 if *nonfarm_inc*≥0 and -1 if *nonfarm_inc*<0; abs(*nonfarm_inc*) is the absolute value of *nonfarm_inc* and ln(.) gives us the natural logarithm of the argument.

[b] Statistics reported are based on data from IHDS-I (2004-05).

[c] Specifically, *ln_land_own05=ln(land_own05)* where *land_own05* denotes land owned in acres by the household in 2004-05 and ln(.) gives us the natural logarithm of the argument.

[d] This corresponds to 2-digit NCO-1968 codes 0-29 and 40-49.

[e] This corresponds to 2-digit NCO-1968 codes 30-39, 50-59, 60, 62-68 and 70-99.

[f] This corresponds to 2-digit NCO-1968 codes 61.

Source: Authors' calculations based on IHDS-II (2011-12) data.

Table 3: Impact of non-farm income on farm labour participation

	Dependent Variables					
	work_farm			*ln_farm_hrs* [a]		
	Total	Male	Female	Total	Male	Female
	1	2	3	4	5	6
ln_nonfarm_inc	0.002	-0.083***	0.076***	-0.248***	-0.263***	-0.222***
Weak Identification test [F-statistic] [b]	189.40	96.18	94.78	106.83	61.27	45.67
Over-identification test [p-value] [c]	0.74	0.30	0.95	0.51	0.67	0.39
No. of observations	76448	38202	38246	41001	23102	17899

Note: Additional control variables used in the model include individual, household and village-level covariates. See Additional Tables A2-A7 for further results and details.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] Estimates are based on data for individuals who have worked at least one hour in the farm.

[b] Statistic reported is the Kleibergen-Paap rk Wald F-statistic.

[c] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic in case the outcome variable is binary (Column 1, 2, and 3) and the p-value corresponding to the Hansen's J statistic in case the outcome variable is continuous (Column 4, 5, and 6).

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Table 4: Non-farm income, agricultural feminization and female autonomy in farming

	Dependent Variables		
	hhld_sh_fem_farm	*hhld_male_farm*	*hhld_fem_autonmy*
	1	2	3

ln_nonfarm_inc	0.023***	-0.146***	0.020
hhld_sh_fem_farm			1.095**
dmy_land_female			0.610***
Weak Identification test [F-statistic] [a]	39.46	39.46	39.65
Over-identification test [p-value] [b]	0.65	0.69	0.33
No. of observations	14338	14338	13315

Note: Additional control variables used in the model include household and village-level covariates. See Additional Tables A8-A10 for further details.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[b] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic in case the outcome variable is binary (Column 1 and 3) and the p-value corresponding to the Hansen's J statistic in case the outcome variable is continuous (Column 2).

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

ADDITIONAL TABLES

Additional Table A1: Variable definitions and descriptive statistics		
Variable	Description	Mean
Individual-level variables		
dmy_married	=1 if the person is married/widowed/divorced, else 0	0.55
dmy_head_spouse	=1 if the person is the spouse of the household head, else 0.	0.16
dmy_head_child	=1 if the person is the child of the household head, else 0.	0.37
dmy_head_childinlaw	=1 if the person is the child-in-law of the household head, else 0.	0.08
Household-level variables		
work_nonfarm	=1 if the household operates a non-farm business, receives remittances or any household member is involved in wage employment, else 0.	0.81
educ_head_father	Years of schooling of the father/husband's father of the household head.	1.61
head_age	Age of the head of the household.	51.54
head_educ	Education of the head of the household.	4.71
hhld_prop_minor	Ratio of the number of persons below 6 to the size of the household.	0.11
hhld_prop_elder	Ratio of the number of persons above 60 to the size of the household.	0.09
dmy_tube_pump05[a]	=1 if the household owns tube-wells, electric pumps or diesel pumps in 2004-05, else 0.	0.29
dmy_bullock_cart05[a]	=1 if the household owns bullock carts in 2004-05, else 0.	0.17
dmy_tractr05[a]	=1 if the household owns tractors or threshers in 2004-05, else 0.	0.09
dmy_draft	=1 if the household owns draft animals, else 0.	0.33
dmy_milch	=1 if the household owns milch animals, else 0.	0.65
dmy_goat	=1 if the household owns goats or sheep, else 0.	0.22
dmy_poultry	=1 if the household owns poultry, else 0.	0.12
dmy_othranml	=1 if the household owns pigs, camel, donkey etc., else 0.	0.51
hhld_extended_family	=0 if the household is composed of the head, his/her spouse and their children, else 1.	0.64
hhld_educ_female	Average education of the female adult household members.	1.13
female_radio	=1 if the female members in the household listens to the radio sometimes/regularly, else 0.	0.20
female_news	=1 if the female members in the household watches TV sometimes/regularly, else 0.	0.22

female_tv	=1 if the female members in the household reads newspapers sometimes/regularly, else 0.	0.72
male_radio	=1 if the male members in the household listens to the radio sometimes/regularly, else 0.	0.29
male_news	=1 if the male members in the household watches TV sometimes/regularly, else 0.	0.49
male_tv	=1 if the male members in the household reads newspapers sometimes/regularly, else 0.	0.76
Indicators of gender relations		
dmy_empwr_cook05[a]	=1 if the eligible women has the most say on what to cook in the household on a daily basis, else 0.	0.65
dmy_empwr_buy05[a]	=1 if the eligible women has the most say on whether to by an expensive item in the household, else 0.	0.07
dmy_empwr_nchild05[a]	=1 if the eligible women has the most say on how many children to have, else 0.	0.15
dmy_visit_clinic05[a]	=1 if the eligible women has to seek permission from husband/senior family member to the visit local health center, else 0.	0.83
dmy_visit_relative05[a]	=1 if the eligible women has to seek permission from husband/senior family member to the visit relatives/friends in the village neighborhood, else 0.	0.81
dmy_purdah05[a]	=1 if the eligible practices purdah, else 0.	0.65
dmy_empwr_meal05[a]	=1 if the eligible women takes the main meal with or before men, else 0.	0.40
dmy_girl_educ05[a]	=1 if the eligible women thinks that equally or more educated than boys, else 0.	0.86
Village-level variables		
dmy_drought	=1 if there was a drought in the village in the year 2011, else 0.	0.18
dmy_flood	=1 if there was a flood in the village in the year 2011, else 0.	0.11
cas_agri_wage	Average male wage rate in rupees for casual agricultural labourers (sowing/transplanting)	158.30
dmy_agri_coop	=1 if there is an Agricultural Cooperative Society in the village, else 0.	0.31
shrtge_labrs_peak	=1 if there is a shortage of labourers in the village for agricultural work during peak season, else 0.	0.33
shrtge_labrs_alwys	=1 if there is always a shortage of labourers in the village for agricultural work, else 0.	0.20

shrtge_labrs_never	=1 if there is never a shortage of labourers in the village for agricultural work, else 0.	0.47
pucca_road	=1 if the village is accessible by a pucca (or paved) road, else 0.	0.84

Note: Statistics reported are at the individual level i.e. the unit of analysis is the individual.
Statistics reported are based on IHDS-II (2011-12) data unless otherwise mentioned.
[a] Statistics reported are based on data from IHDS-I (2004-05).
Source: Authors' calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A2: Impact of household non-farm diversification on farm labour participation

Dependent Variable: *work_farm*	1 Probit	2 IV-Probit	3 (2) + Heckman Correction	4 (3) + Non-Farm Dummy	5 (3) + Gender-relations Controls
ln_nonfarm_inc	-0.01	0.01	0.01		0.01
work_nonfarm				0.02	
dmy_male	0.44***	0.44***	0.44***	0.12***	0.44***
Age	0.01***	0.01***	0.01***	0.00**	0.01***
dmy_married	1.03***	1.03***	1.03***	0.32***	1.05***
yrs_school	0.07***	0.07***	0.07***	0.02***	0.07***
dmy_head	1.79***	1.80***	1.80***	0.44***	1.80***
Hindu	0.06***	0.06***	0.06***	0.02***	0.06**
caste_obc[a]	0.14***	0.14***	0.13***	0.03***	0.14***
caste_sc[a]	0.16***	0.16***	0.15***	0.04***	0.14***
caste_st[a]	0.24***	0.24***	0.23***	0.06***	0.22***
head_male	-0.18***	-0.18***	-0.17***	-0.07***	-0.16***
head_educ	-0.02***	-0.02***	-0.02***	-0.01***	-0.02***
hhld_n_adult_male	-0.02**	-0.02**	-0.02**	-0.01	-0.03**
hhld_n_adult_female	-0.04***	-0.04***	-0.04***	-0.01***	-0.04***
hhld_prop_minor	-1.01***	-1.02***	-1.02***	-0.23***	-1.01***
hhld_prop_elder	-0.50***	-0.50***	-0.49***	-0.11***	-0.56***
hhld_assets05	-0.03***	-0.03***	-0.03***	-0.01***	-0.03***
ln_land_own05	0.01	0.02	0.02	0.01	0.02
shrtge_labrs_peak[b]	-0.02	-0.02	-0.02	-0.01*	-0.02
shrtge_labrs_alwys[b]	-0.04**	-0.04**	-0.04**	-0.01**	-0.04*

dmy_drought	-0.02	-0.02	-0.02	-0.01	-0.02
dmy_flood	-0.02	-0.02	-0.02	-0.01	0.01
cas_agri_wage	-0.01	-0.01	-0.01	-0.01	0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		189.40	144.78	102.61	113.72
Over-identification test [p-value] [d]		0.74	0.77	0.83	0.89
No. of observations	76,789	76,448	76,448	76,448	62,317

Note: Column 1 reports the results of the probit model. Column 2 reports the results of the IV-Probit model. Column 3 reports the results of the IV-Probit model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the IV-Probit model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A3: Impact of household non-farm diversification on farm labour participation

	1	2	3	4	5
Dependent Variable: *work_farm* (Male)	Probit	IV-Probit	(2) + Heckman Correction	(3) + Non-Farm Dummy	(3) +

					Gender-relations controls
ln_nonfarm_inc	-0.01***	-0.08***	-0.06**		-0.08***
work_nonfarm				-0.13*	
Age	0.01***	0.01***	0.01***	0.01***	0.01***
dmy_married	1.01***	1.01***	1.01***	0.30***	1.02***
yrs_school	0.10***	0.10***	0.10***	0.02***	0.10***
dmy_head	1.81***	1.79***	1.79***	0.39***	1.80***
Hindu	-0.06*	-0.05*	-0.06*	-0.01	-0.09**
caste_obc[a]	0.03	0.08***	0.07**	0.01**	0.08**
caste_sc[a]	0.06*	0.14***	0.12***	0.02**	0.14***
caste_st[a]	0.09**	0.16***	0.14***	0.03***	0.18***
head_male	-0.34***	-0.39***	-0.38***	-0.09***	-0.35***
head_educ	-0.02***	-0.02***	-0.02***	-0.01***	-0.02***
hhld_n_adult_male	0.10***	0.12***	0.12***	0.03***	0.10***
hhld_n_adult_female	-0.13***	-0.10***	-0.11***	-0.02***	-0.09***
hhld_prop_minor	-0.90***	-0.86***	-0.86***	-0.16***	-0.87***
hhld_prop_elder	-0.33***	-0.44***	-0.40***	-0.08***	-0.55***
hhld_assets05	-0.02***	-0.02***	-0.02***	-0.01***	-0.02***
ln_land_own05	0.02	-0.06**	-0.05*	-0.01	-0.08**
shrtge_labrs_peak[b]	0.01	0.01	0.01	0.01	0.01
shrtge_labrs_alwys[b]	-0.02	-0.03	-0.02	-0.01	-0.04
dmy_drought	-0.01	0.01	0.01	0.01	0.01
dmy_flood	-0.01	0.01	0.01	0.01	0.01
cas_agri_wage	-0.01	-0.01	-0.01	-0.01	-0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		96.17	74.16	53.91	59.59
Over-identification test [p-value] [d]		0.30	0.38	0.51	0.66
No. of observations	38,363	38,202	38,202	38,202	31,138
Note: Column 1 reports the results of the probit model. Column 2 reports the results of the IV-Probit model. Column 3 reports the results of the IV-Probit model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the					

non-farm dummy instead of non-farm income. Column 5 reports the results of the IV-Probit model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Estimates are based on data for male individuals only.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A4: Impact of household non-farm diversification on farm labour participation

Dependent Variable: *work_farm* (Female)	1 Probit	2 IV-Probit	3 (2) + Heckman Correction	4 (3) + Non-Farm Dummy	5 (3) + Gender-relations controls
ln_nonfarm_inc	0.01***	0.08***	0.06**		0.08***
work_nonfarm				0.17**	
Age	-0.01	-0.01	-0.01	-0.01***	-0.01
dmy_married	0.91***	0.93***	0.93***	0.27***	0.95***
yrs_school	0.03***	0.03***	0.03***	0.01***	0.03***
dmy_head	1.59***	1.61***	1.61***	0.47***	1.57***
Hindu	0.17***	0.17***	0.17***	0.05***	0.19***
caste_obc[a]	0.23***	0.18***	0.19***	0.05***	0.18***
caste_sc[a]	0.25***	0.18***	0.19***	0.05***	0.16***
caste_st[a]	0.36***	0.29***	0.31***	0.08***	0.25***
head_male	-0.15***	-0.11***	-0.11***	-0.04***	-0.09**
head_educ	-0.02***	-0.02***	-0.02***	-0.01***	-0.02***
hhld_n_adult_male	-0.16***	-0.18***	-0.17***	-0.04***	-0.18***

hhld_n_adult_female	0.05***	0.03*	0.03**	0.01***	0.03*
hhld_prop_minor	-1.24***	-1.28***	-1.28***	-0.34***	-1.29***
hhld_prop_elder	-0.61***	-0.50***	-0.54***	-0.14***	-0.58***
hhld_assets05	-0.03***	-0.03***	-0.03***	-0.01***	-0.03***
ln_land_own05	0.01	0.08***	0.07***	0.02**	0.09***
shrtge_labrs_peak[b]	-0.04**	-0.05***	-0.05***	-0.01**	-0.06***
shrtge_labrs_alwys[b]	-0.05**	-0.03	-0.04*	-0.01*	-0.02
dmy_drought	-0.03	-0.04	-0.03	-0.01**	-0.04*
dmy_flood	-0.03	-0.04	-0.04	-0.01*	-0.01
cas_agri_wage	0.01	0.01	0.01	0.01	0.01**
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		94.78	71.59	49.61	55.10
Over-identification test [p-value] [d]		0.95	0.80	0.72	0.65
No. of observations	38,426	38,246	38,246	38,246	31,179

Note: Column 1 reports the results of the probit model. Column 2 reports the results of the IV-Probit model. Column 3 reports the results of the IV-Probit model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the IV-Probit model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Estimates are based on data for female individuals only.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A5: Impact of household non-farm diversification on farm labour participation					
	1	2	3	4	5
Dependent Variable: *ln_farm_hrs*	OLS	2SLS	(2) + Heckman Correction	(3) + Non-Farm Dummy	(3) + Gender-relations Controls
ln_nonfarm_inc	-0.03***	-0.25***	-0.20***		-0.23***
work_nonfarm				-2.66***	
dmy_male	0.32***	0.32***	0.32***	0.32***	0.31***
Age	0.01**	0.01**	0.01**	0.01**	0.01***
dmy_married	0.69***	0.61***	0.63***	0.63***	0.62***
yrs_school	0.01	-0.01	-0.01	-0.01	0.01
dmy_head	0.31***	0.28***	0.29***	0.29***	0.32***
Hindu	0.03	0.02	0.01	0.02	0.03
caste_obc[a]	-0.07***	0.09***	0.06***	0.09***	0.08***
caste_sc[a]	-0.06***	0.17***	0.13***	0.16***	0.17***
caste_st[a]	-0.07***	0.13***	0.09***	0.13***	0.16***
head_male	-0.17***	-0.28***	-0.28***	-0.29***	-0.33***
head_educ	-0.01	0.01	0.01	0.01	0.01
hhld_n_adult_male	0.05***	0.12***	0.11***	0.08***	0.13***
hhld_n_adult_female	-0.01	0.06***	0.05***	0.03***	0.04***
hhld_prop_minor	-0.04	0.17***	0.15***	0.18***	0.26***
hhld_prop_elder	-0.09**	-0.47***	-0.35***	-0.44***	-0.30***
hhld_assets05	-0.02***	-0.01***	-0.01***	-0.02***	-0.01***
ln_land_own05	0.13***	-0.10***	-0.07***	-0.10***	-0.12***
shrtge_labrs_peak[b]	-0.03***	-0.01	-0.02	-0.02	-0.01
shrtge_labrs_alwys[b]	-0.06***	-0.10***	-0.09***	-0.08***	-0.10***
dmy_drought	-0.04***	-0.01	-0.02	0.01	0.01
dmy_flood	-0.06***	-0.05**	-0.05**	-0.01	-0.05**
cas_agri_wage	0.01***	0.01	0.01	-0.01	0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		106.83	80.15	55.64	59.28
Over-identification test [p-value] [d]		0.52	0.42	0.55	0.15

No. of observations	41,167	41,001	41,001	41,001	33,271

Note: Column 1 reports the results of the OLS model. Column 2 reports the results of the 2SLS model. Column 3 reports the results of the 2SLS model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the 2SLS model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Estimates are based on data for individuals with positive hours worked in the farm.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Hansen's J statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A6: Impact of household non-farm diversification on farm labour participation

Dependent Variable: *ln_farm_hrs* (Male)	1 OLS	2 2SLS	3 (2) + Heckman Correction	4 (3) + Non-Farm Dummy	5 (3) + Gender-relations Controls
ln_nonfarm_inc	-0.04***	-0.26***	-0.22***		-0.24***
work_nonfarm				-2.87***	
Age	0.01***	0.01***	0.01***	0.01***	0.01***
dmy_married	0.69***	0.60***	0.62***	0.62***	0.61***
yrs_school	0.01***	-0.01	0.01	-0.01	0.01
dmy_head	0.25***	0.23***	0.23***	0.23***	0.26***
Hindu	0.01	-0.02	-0.02	-0.01	0.01
caste_obc[a]	-0.09***	0.07**	0.04	0.07**	0.04
caste_sc[a]	-0.08***	0.16***	0.13***	0.16***	0.15***
caste_st[a]	-0.15***	0.05	0.01	0.05	0.06

head_male	-0.19***	-0.35***	-0.34***	-0.35***	-0.36***
head_educ	-0.01***	0.01	0.01	-0.01	0.01
hhld_n_adult_male	0.08***	0.17***	0.15***	0.12***	0.17***
hhld_n_adult_female	-0.03***	0.03**	0.02	0.01	0.02
hhld_prop_minor	0.11**	0.31***	0.30***	0.33***	0.43***
hhld_prop_elder	-0.01	-0.38***	-0.29***	-0.36***	-0.25**
hhld_assets05	-0.02***	-0.01***	-0.01***	-0.02***	-0.01***
ln_land_own05	0.14***	-0.11***	-0.09***	-0.11***	-0.12***
shrtge_labrs_peak[b]	-0.03**	-0.02	-0.02	-0.02	-0.03
shrtge_labrs_alwys[b]	-0.05***	-0.09***	-0.08***	-0.07***	-0.11***
dmy_drought	-0.04**	-0.02	-0.02	0.01	0.01
dmy_flood	-0.03	-0.01	-0.01	0.02	-0.02
cas_agri_wage	0.01**	0.01	0.01	-0.01	0.01*
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		61.27	43.18	32.16	31.11
Over-identification test [p-value] [d]		0.67	0.59	0.66	0.19
No. of observations	23,185	23,102	23,102	23,102	18,708

Note: Column 1 reports the results of the OLS model. Column 2 reports the results of the 2SLS model. Column 3 reports the results of the 2SLS model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the 2SLS model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Estimates are based on data for male individuals with positive hours worked in the farm.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Hansen's J statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A7: Impact of household non-farm diversification on farm labour participation

Dependent Variable: *ln_farm_hrs* (Female)	1 OLS	2 2SLS	3 (2) + Heckman Correction	4 (3) + Non-Farm Dummy	5 (3) + Gender-relations Controls
ln_nonfarm_inc	-0.02***	-0.22***	-0.18***		-0.22***
work_nonfarm				-2.45***	
Age	-0.01	-0.01	-0.01	-0.01	0.01
dmy_married	0.65***	0.59***	0.61***	0.61***	0.58***
yrs_school	-0.01**	-0.01**	-0.01**	-0.01*	-0.01
dmy_head	0.27***	0.24***	0.25***	0.26***	0.32***
Hindu	0.06**	0.07**	0.06*	0.07**	0.08**
caste_obc[a]	-0.02	0.14***	0.11***	0.14***	0.16***
caste_sc[a]	-0.02	0.19***	0.15***	0.19***	0.21***
caste_st[a]	0.04	0.24***	0.20***	0.24***	0.30***
head_male	-0.19***	-0.26***	-0.26***	-0.26***	-0.29***
head_educ	0.01	0.01	0.01	0.01	0.01
hhld_n_adult_male	-0.01	0.05***	0.03**	0.01	0.06***
hhld_n_adult_female	0.03***	0.10***	0.08***	0.07***	0.09***
hhld_prop_minor	-0.26***	-0.07	-0.09	-0.04	-0.02
hhld_prop_elder	-0.18***	-0.55***	-0.44***	-0.55***	-0.38***
hhld_assets05	-0.02***	-0.02***	-0.02***	-0.03***	-0.01***
ln_land_own05	0.11***	-0.08***	-0.06**	-0.08**	-0.12***
shrtge_labrs_peak[b]	-0.05***	-0.02	-0.02	-0.03	0.00
shrtge_labrs_alwys[b]	-0.07***	-0.12***	-0.11***	-0.10***	-0.11***
dmy_drought	-0.05**	-0.01	-0.02	0.01	-0.00
dmy_flood	-0.10***	-0.10***	-0.10***	-0.07**	-0.10***
cas_agri_wage	0.01	-0.01	0.01	-0.00*	0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES

Weak Identification test [F-statistic] [c]		45.67	37.13	23.42	28.37
Over-identification test [p-value] [d]		0.39	0.39	0.54	0.28
No. of observations	17,982	17,899	17,899	17,899	14,563

Note: Column 1 reports the results of the OLS model. Column 2 reports the results of the 2SLS model. Column 3 reports the results of the 2SLS model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the 2SLS model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include dummies for relationship with household head (viz. *dmy_head_spouse*, *dmy_head_child* and *dmy_head_childinlaw*); age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Estimates are based on data for female individuals with positive hours worked in the farm.

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Hansen's J statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A8: Impact of household non-farm diversification on agricultural feminization

	1	2	3	4	5
Dependent Variable: *hhld_sh_fem_farm*	OLS	2SLS	(2) + Heckman Correction	(3) + Non-Farm Dummy	(3) + Gender-relations Controls
ln_nonfarm_inc	0.01***	0.02***	0.02***		0.03***
work_nonfarm				0.23***	
Hindu	0.04***	0.04***	0.04***	0.04***	0.05***
caste_obc[a]	0.04***	0.03***	0.03***	0.03***	0.03***
caste_sc[a]	0.05***	0.02***	0.03***	0.03***	0.02*

caste_st[a]	0.06***	0.04***	0.04***	0.04***	0.02**
head_male	-0.22***	-0.20***	-0.20***	-0.20***	-0.18***
head_educ	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
hhld_n_adult_male	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***
hhld_n_adult_female	0.06***	0.05***	0.05***	0.05***	0.05***
hhld_prop_minor	-0.03**	-0.04***	-0.04***	-0.05***	-0.04**
hhld_prop_elder	-0.03**	0.01	-0.01	0.01	-0.02
hhld_assets05	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
ln_land_own05	-0.01***	0.01**	0.01**	0.01**	0.02***
shrtge_labrs_peak[b]	-0.01	-0.01*	-0.01*	-0.01*	-0.01**
shrtge_labrs_alwys[b]	-0.01	-0.01	-0.01	-0.01	0.01
dmy_drought	-0.01	-0.01	-0.01	-0.01	-0.01
dmy_flood	-0.01**	-0.02**	-0.02**	-0.02***	-0.01
cas_agri_wage	0.01	0.01	0.01	0.01*	0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		39.46	29.09	20.26	21.12
Over-identification test [p-value] [d]		0.65	0.62	0.52	0.22
No. of observations	14,409	14,338	14,338	14,338	11,391

Note: Column 1 reports the results of the OLS model. Column 2 reports the results of the 2SLS model. Column 3 reports the results of the 2SLS model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the 2SLS model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Hansen's J statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A9: Impact of household non-farm diversification on agricultural feminization					
	1	2	3	4	5
Dependent Variable: *hhld_male_farm*	Probit	IV-Probit	(2) + Heckman Correction	(3) + Non-Farm Dummy	(3) + Gender-relations Controls
ln_nonfarm_inc	-0.02***	-0.15***	-0.24***		-0.26***
work_nonfarm				-0.61***	
Hindu	-0.28***	-0.28***	-0.26***	-0.07***	-0.28***
caste_obc[a]	-0.32***	-0.24***	-0.18***	-0.05***	-0.17***
caste_sc[a]	-0.46***	-0.32***	-0.25***	-0.05***	-0.26***
caste_st[a]	-0.58***	-0.45***	-0.36***	-0.06***	-0.28***
head_male	0.69***	0.62***	0.62***	0.07***	0.52***
head_educ	0.03***	0.03***	0.03***	0.01***	0.03***
hhld_n_adult_male	0.21***	0.27***	0.31***	0.06***	0.31***
hhld_n_adult_female	-0.16***	-0.11***	-0.07**	-0.02***	-0.05
hhld_prop_minor	0.55***	0.66***	0.68***	0.14***	0.78***
hhld_prop_elder	0.60***	0.34***	0.12	0.02	0.16
hhld_assets05	0.03***	0.03***	0.03***	0.01***	0.04***
ln_land_own05	0.07***	-0.07	-0.12**	-0.03**	-0.16**
shrtge_labrs_peak[b]	0.06*	0.07**	0.07*	0.02**	0.11***
shrtge_labrs_alwys[b]	0.06	0.03	0.01	0.01	0.00
dmy_drought	0.04	0.05	0.06	0.02**	0.10*
dmy_flood	0.13***	0.15***	0.15***	0.05***	0.13**
cas_agri_wage	0.01	0.01	-0.01	-0.01	-0.01
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		39.43	29.07	20.21	21.12
Over-identification test [p-value] [d]		0.69	0.88	0.73	0.27
No. of observations	14,409	14,338	14,338	14,338	11,391
Note: Column 1 reports the results of the probit model. Column 2 reports the results of the IV-Probit model. Column 3 reports the results of the IV-Probit model after correcting for sample					

bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the IV-Probit model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and a dummy for the presence of an agricultural cooperative in the village (*dmy_agri_coop*).

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Hansen's J statistic.

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.

Additional Table A10: Impact of household non-farm diversification and agricultural feminization on female autonomy in the farm

Dependent Variable: *hhld_female_autonmy*	1 Probit	2 IV-Probit	3 (2) + Heckman Correction	4 (3) + Non-Farm Dummy	5 (3) + Gender-relations Controls
ln_nonfarm_inc	0.01*	0.02	0.04		0.09
work_nonfarm				-0.08	
hhld_sh_fem_farm	2.62***	1.07**	1.15**		1.38**
hhld_male_farm				-0.15***	
dmy_land_female	0.60***	0.62***	0.61***	0.05***	0.57***
hhld_assets05	0.02**	0.01	0.01	0.00**	0.01
ln_land_own05	-0.06	-0.07	-0.06	-0.01*	-0.04
female_radio	0.12	0.11	0.11	0.00	0.11
female_news	0.11	0.10	0.10	0.02***	0.07
female_tv	0.24**	0.29***	0.29***	0.02***	0.20
Hindu	0.01	0.01	-0.01	-0.01*	0.02
caste_obc[a]	0.17**	0.22***	0.21**	0.01	0.17*
caste_sc[a]	0.03	0.08	0.07	-0.01	0.05
caste_st[a]	0.09	0.20	0.17	0.01	0.14
head_male	-2.74***	-3.09***	-3.07***	-0.71***	-2.97***

head_educ	0.01	-0.01	-0.01	0.01	-0.01
hhld_educ_female	-0.01	-0.01	-0.01	0.01***	0.02
hhld_extended_family	-0.06	-0.09	-0.11	0.01	-0.19**
hhld_prop_elder	0.48***	0.52**	0.60**	0.03	0.89***
State Fixed Effects	YES	YES	YES	YES	YES
Heckman Correction	NO	NO	YES	YES	YES
Gender relations Controls	NO	NO	NO	NO	YES
Weak Identification test [F-statistic] [c]		39.83	33.25	17.92	26.83
Over-identification test [p-value] [d]		0.31	0.17	0.38	0.12
No. of observations	13,756	13,341	13,310	13,310	10,639

Note: Column 1 reports the results of the probit model. Column 2 reports the results of the IV-Probit model. Column 3 reports the results of the IV-Probit model after correcting for sample bias. Column 4 reports the results of the 2SLS model with sample selection bias taking the non-farm dummy instead of non-farm income. Column 5 reports the results of the IV-Probit model with sample selection bias controlling for gender relations in the household.

Additional control variables used in the model include age of the household head (*head_age*); education of the father/husband's father of the household head (*educ_head_father*); household agricultural assets (viz. *dmy_tube_pump05*, *dmy_bullock_cart05* and *dmy_tractr05*); dummies for household livestock holdings (viz. *dmy_draft*, *dmy_milch*, *dmy_goat*, *dmy_poultry* and *dmy_othranml*); and exposure to media of male household members (viz. *male_radio*, *male_news* and *male_tv*).

Significant levels *** 1%, ** 5% and * 10% are based on robust standard errors.

[a] *caste_gen* is the reference category.

[b] *shrtge_labrs_peak* is the reference category.

[c] Statistic reported are for Kleibergen-Paap rk Wald F-statistic.

[d] Statistic reported is the p-value corresponding to the Amemiya-Lee-Newey minimum chi-square statistic in case the IV-Probit model is utilized (Column 2, 3 and 5) and the p-value corresponding to the Hansen's J statistic in case the 2SLS model is used (Column 4).

Source: Authors calculations based on IHDS-I (2004-05) and IHDS-II (2011-12) data.