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Girl Power in Agricultural Production: How Much Does it Yield? A Case-Study on the Dairy Sector in India

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Abstract

It is often argued that women have an important role to play in fostering sustainable and inclusive development. Several empirical studies indeed find a correlation between intra-household bargaining power and spending on children's nutrition, health and education. The general perception of the impact of gender on agricultural productivity is far less favorable. As a result of constrained access to input markets, output markets, and land markets, female-headed households are usually found to be less productive in agriculture than male-headed households.

This paper provides empirical evidence of the impact of female intra-household decision-making power on dairy productivity in India, based on evidence from a household-level dataset which was collected in 2008 in 50 villages spread over 5 districts in Andhra Pradesh, a state in the South of India.

The results of our analysis suggest that equal, if not higher, productivity is achieved in households where a woman, rather than a man, is the primary decision-maker over production-related decisions. While caution is due in drawing overly strong conclusions, and more research is needed to corroborate these findings, our results provide a more nuanced view on the impact of gender on agricultural productivity than the one which is usually put forward in the literature.

Keywords: agricultural productivity, dairy sector, gender, female decision-making power

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1. Introduction

The last two and a half decades witnessed great improvement in the absolute status of women and in gender equality across the globes. Yet, in many of these countries gender bias still creates a substantial problem, with women lagging behind men in many dimensions: access to productive resources, education,[2] labor market opportunities, and legal rights and representation. By means of illustration, the United Nations Gender Inequality Index, which measures the extent of inequalities between men and women at a country-level, had an average level of 0.46 in 2011, ranging from 0.28 in Europe and Central Asia to nearly 0.58 in Sub-Saharan Africa.[3]

Promoting gender equality is a crucial objective for development policies, not only in its own right, but also as an instrument for development from a broader perspective. Female economic empowerment was described as the "magic potion" of development by Blumberg (2005), inspired by a growing empirical literature suggesting that many key development outcomes, such as improved child nutrition, health and education, depend on women's ability to negotiate favorable intra-household allocations of resources. In addition, giving women equal access to opportunities and resources can contribute to aggregate growth through productivity gains (World Bank, 2011). Several international development organizations have in recent decades strengthened the emphasis on gender in their development strategies. Female empowerment is not only one of the Millennium Development Goals in itself (UN Millennium Project, 2005), it is also considered a crucial channel to achieve several other Millennium Development Goals, including the promotion of universal primary education, the reduction of under-five mortality and of HIV, and the improvement of maternal health. Like

[2]Despite the substantial reduction of gender gaps in primary schooling, it remains pervasive at secondary and tertiary levels, especially in South Asia and SSA (World Bank, 2011).

[3] The Gender Inequality Index (UNDP, 2011) is a composite index of three dimensions of gender inequality: reproductive health, economic (labor force) participation, and empowerment - including post-primary educational attainment and parliamentary participation.

many other development organizations, the Asian Development Bank (ADB) Strategy 2020 includes promoting gender equity as one of the five key drivers of change (ADB, 2011).

The role of gender for development has recently made a revival as a popular topic for academic research as well. As mentioned before, a burgeoning empirical literature has found a positive influence of female intrahousehold bargaining power on development outcomes. For instance, many authors argue that women's control over household (financial) resources shifts expenditures towards basic needs,[4] and promotes child nutrition,[5] health and education. Another strand of literature has focused on the impacts of gender equality at the macro-level, and found important improvements in fertility rates, child mortality and aggregate growth. It has been argued that increased social and political participation of women may lead to better or more inclusive governance in a society (World Bank, 2011).

But women do not always perform better. For example, it has often been argued in the literature that women are at a disadvantage when it comes to agricultural productivity. Potential reasons which have been put forward in this respect include reduced access to, or lower bargaining power in, input and output markets (Handschuch and Wollni, 2013), and uncertainty over land property rights as in many countries, inheritance rights are substantially weaker for women (e.g. Htun and Weldon, 2011).

In this paper, we contribute to this literature as we are exploring differences in agricultural productivity between households where men are the main decision-makers over the allocation of productive resources in agriculture; and households where these decisions are made by women.

Our main contribution is that, rather than focusing on crop production, we look at dairy production. To the best of our knowledge, no other study on gender differentials in dairy

[4] Note that "basic needs" are not defined in their strictest, traditional sense of food (water), shelter and clothing, but in the broader sense which prevails nowadays in most development organisations and includes sanitation, education and healthcare (see e.g. Hicks and Streeten, 1979).

[5] In addition, an improved nutritional status of mothers has been associated with better child health and survival (Htun and Weldon, 2010).

productivity is available in the literature. Dairy production is often considered a responsibility of women, especially in South Asia (FAO, 2011). Dairy farming requires less physical efforts and strength compared to crop farming. Moreover, dairy activities are usually based on the farm and women can carry them out without leaving the farm, as in many developing regions (including India), rural women prefer (and/or are preferred) not to work out-of-home. Hence, dairy production may be a source of female empowerment if it allows them to take decisions over productive resource allocation and on how to spend the returns from sales.

Our empirical analysis draws on a unique micro-level dataset on rural households which was collected in 2010 in Andhra Pradesh, a state in the South of India. Our dataset has demographic data on households and household members. It contains information on dairy production systems and the identity of the major decision-maker in agricultural production. We will explore the impact of female decision-making power[6] within predominantly male-headed households on dairy productivity.

In contrast with many other studies on gender differentials in agriculture which look at productivity differentials between female- and male-headed households, we look at the gender of decision-makers within 'complete' households. As such, we avoid picking up the effects of vulnerability and fragility of households headed by widowed women, which may encounter themselves in distressed situations as they are solely responsible for managing a household and may have constrained access to family labor, legal rights, and social safety nets.

India serves as a particularly interesting region to examine female bargaining power given the historical legacy of discrimination against women and the lower position in society they have traditionally been assigned. A striking example of discrimination against women is the phenomenon of "missing women", as first described by Amartya Sen in 1990 (Sen, 1990). It is estimated that in 2008, 3.9 million women - of which 22% in India - went missing (World

[6] Female decision-making power is considered a strong indicator of female bargaining power (Allendorf, 2007; Mabsout and Van Staveren, 2010).

Bank, 2012). Anderson and Ray (2012) find that in developing countries over 25 million of women who could potentially be alive today, are "missing", as a consequence of sex selection at birth and the mistreatment of young girls.

As the largest milk-producing country in the world, India presents, moreover, also a particularly interesting case to study gender issues in dairy. Dairy production is a traditional rural activity in India, with the majority of rural households traditionally keeping their own dairy animals (cows or buffaloes). Milk is used primarily for own consumption within the household, but the surplus is sold (in very small volumes) to small milk traders or local milk collection centers in the village. Dairy is often argued to be an important income source for rural women in India (e.g. Achaya and Huria, 1986), which is why governments and NGOs have often promoted dairy development as a strategy for female empowerment in rural areas.

This paper is structured as follows. Section 2 starts with a review of the existing literature on the relation between gender equality and development outcomes and the determinants of bargaining power. Section 3 and 4 describe the dataset used for the empirical analysis, and provides descriptive evidence on the context of our study. Section 5 elaborates on the conceptual framework and empirical methodology. Finally, Section 6 discusses the regression results and Section 7 formulates conclusions and implications.

2. Literature review

Gender inequalities are still pervasive in many developing countries. Reducing these gaps offers substantial potential for development, and not only development of women themselves. As Sen (1999) argues, enlarging the possibilities that women have improves not only their own quality of life, their ability to earn an income and to be free of income-poverty; it also has positive spillover effects on their households, and the broader society.

In this section, we review in more detail the existing evidence on the role of female empowerment for development – at the micro- and the macro-level. We then zoom in on the – generally bleaker – findings on female management of agricultural production, which is where our study will contribute most. Finally, we review the literature on the potential determinants of female intra-household decision-making power, as we will need these insights in setting up our empirical strategy.

2.1 The impact of female empowerment on development

A first channel through which women's empowerment affects development outcomes, is through its effects on household spending patterns. Various authors find a positive correlation between a higher share of income controlled by women and increased spending on children's education (Blumberg, 1993; Thomas, 1993; Behrman and Skoufias, 2006; Bussolo et al., 2009; Schmidt, 2012).[7]

Other studies that have used assets brought to marriage by either husband or wife as an indicator for their respective control over financial resources, also find a positive correlation between the value of assets brought to marriage by a woman and the household budget share spent on food, expenditures on child schooling and child health, and a negative correlation with expenditures on alcohol and cigarettes (Quisumbing and de la Briere, 2000; Quisumbing and Maluccio, 2000; Dercon and Krishnan, 2000).

A second channel is through education. The benefits of female education affect the whole society through its impact on age of marriage, contraception, fertility, child malnutrition and mortality, female paid modern sector employment, and female earnings (Hess, 1988; Blumberg, 1989; Thomas and Chen, 1994; Govindasamy and Malhotra, 1996;

[7] Other authors who examine the relation between women's control over financial resources and spending patterns come to more nuanced conclusions and argue that women also tend to spend more money on luxury items such as clothing and make-up; and the role a woman assumes within a household (e.g. the degree of responsibility she carries) matters (see e.g. Lundberg et al., 1997; Duflo and Udry, 2004; Aromolaran, 2009; Bobonis, 2009; Colen, 2012).

King and Mason, 2001). An important channel through which education influences these outcomes is through increased bargaining power.

Third, improving women's access to jobs will ensure that women are able to improve their bargaining position within the household, maximize their productivity, earn a decent wage and have access to social protection benefits (Duflo, 2004; OECD, 2012). Interestingly, a recent study by Qian (2005) shows that the number of missing women (due to female-selective abortion and infanticide), which is particularly high in China, decreased in tea producing regions compared to other regions, as a consequence of female labor participation and the comparative advantage women have over men in the production of tea.

At the macro-level, increased social and political representation of women has been argued to lead to higher aggregate and more inclusive growth (Klasen and Lamanna, 2008; Agenor and Canuto, 2013; Lechman and Okonowicz, 2013), and less corruption (Dollar et al. 2001; Swamy et al. 2001; Chattopadhyay and Duflo, 2004; Esary and Chirillo, 2013; Rivas, 2013).

2.2 Gender and agricultural productivity

An area where female decision-making power has been much greater cause of concern, is agricultural production. In order to improve rural livelihoods and food security, increasing agricultural productivity is of major importance. This holds especially in India, where the majority of poor people lives in rural areas and largely depends on agriculture for a living.

Traditionally, development policy makers and practitioners have regarded women as less efficient crop producers (World Bank, 2002; Quisumbing, 1994). For example, a study of gender-based productivity differentials in Nepal suggests that male-managed farms use more commercial inputs and produce more output per hectare. In addition, adult male labor is found to be more productive in agriculture than adult female labor (Thapa, 2009). Peterman et al.

(2011) find persistent lower crop productivity on female-owned plots and among female-headed households in Nigeria and Uganda.

Many of these studies however suffer from important flaws. These studies often ignore crucial variables, such as the quality of land and of inputs used. This may be important, for example, if men assign the most productive plots to themselves, as has been argued by Quisumbing (1996). Moreover, they often compare male-headed and female-headed households; of which the latter may be widowed, and by consequence comparatively income-poor and disadvantaged with regard to access to inputs and security of tenure (Quisumbing et al., 2002).

Studies who control for these issues find, in general, that the gender gap in agricultural yields is not due to the fact that women are worse farmers than men, but rather from their constrained access to inputs, resources, and services (Quisumbing, 1996; Rozelle et al., 2006; Croppenstedt et al., 2013). As a result, women may achieve lower efficiency in agricultural production as well as agricultural commercial activities than man. A recent study by Handschuch and Wollni (2013) indicates that women receive lower prices in marketing of finger millet than men (at least if they market individually, rather than collectively), suggesting reduced access to output markets.

2.3 Determinants of female bargaining power

One of the key challenges encountered in the assessment of the impact of decision-making power on dairy yields is that certain characteristics which may enhance female decision-making power may as well lead to higher yields such as, for instance, female education. Hence, in our empirical strategy we will need to control for this potential source of endogeneity by using a two-stage regression. This requires us to model female decision-making power based on exogenous household characteristics.

Factors which have been highlighted in the literature as influencing female decision-making power include value of household assets owned by women, education, labor market participation and social and cultural factors.

First, female asset ownership is often considered an important determinant of female intra-household bargaining power. The share of household assets owned by women has been found to be positively associated with food expenditure (Doss, 1997) and better reproductive decisions (Beegle, et al., 2001) – and this could be driven by increased female bargaining power. While asset accumulation by married women in itself depends on the intra-household bargaining process; the value of assets brought to marriage may be a more exogenous source of bargaining power (Thomas et al., 1997).[8] Assets brought to marriage by women often take the form of marriage payments, such as dowry.[9] Prevalence and magnitude of marriage payments vary across countries depending upon economic conditions, societal structures, institutions, and family characteristics (Anderson, 2007). These payments can be substantial enough to affect the welfare of women and a society's distribution of wealth.[10] Dowry payments are practiced in about 93% of Indian marriages. They are said to be largest amongst the highest ranking castes (Rao, 1993; Dalmia and Lawrence, 2005).

Second, also education can increase female bargaining power. Agenor and Canuto (2013) assume relative bargaining power of women to be a function of her education level

[8] The underlying rationale is that these assets are assumed to ensure the spouse's financial independence if the marriage dissolves. From a game theoretical perspective, those women who expect to receive more assets upon divorce are assumed to have a better bargaining position compared to those who expect to get nothing, as they have a better 'fall-back option' when the cooperation ends (Manser and Brown, 1980; McElroy and Horney, 1981; Adam et al., 2011). However, the question arises whether assets brought to marriage will effectively be excluded from settlements if the marriage dissolves, especially in poor countries, often characterized by a complex and opaque legal system.

[9] Payments from the bride's family can either go to the bride herself, referred to as "dowry," or be directly transferred to the groom and his family, termed "groomprice". Dowry is often seen as a pre-mortem inheritance that remains the formal property of the bride throughout marriage. However, in practice, these property rights are not always respected (Anderson, 2007).

[10] Estimates document transfers per marriage amounting to six times the annual household income in South Asia (Rao, 1993), and four times in sub-Saharan Africa (Dekker and Hoogeveen, 2002). A study by Anderson (2003) shows that in India dowry payments have undergone significant inflation over the last five decades, in contrast to most dowry-oriented societies in which payments have declined with modernization. Despite the relative unavailability of data on dowry payments which has limited the scope of empirical analysis, the escalation in Indian dowries has been previously recognized by numerous social scientists.

relative to her husband's. The pathways from education to a woman's bargaining power could be through exposing her to ideas that promote her independence via increasing her access to resources and skills through employment opportunities (Malhotra and Mather, 1997). Obviously, these effects are context-specific: education is expected to matter less for female empowerment when women are culturally allowed to have more control over household resources (Malhotra and Mather, 1997).

Third, next to asset ownership, also labor income could be a source of female bargaining power, especially if employment is away from home (e.g. Anderson and Eswaran, 2007; Yusof and Duasa, 2010). A key challenge in identifying the impact of labor income on female bargaining power is, again, potential reverse causality: it is not clear whether women are allowed to work out of home because of their bargaining position; or whether they have obtained this bargaining position as a result of their job and the ensuing income.

Fourth, women's bargaining power also depends on social and cultural factors. An often heard hypothesis is that there are innate differences in personality traits between men and women which may contribute to gender biases in intra-household bargaining power, for example because men are better equipped to compete (Lawrence, 2006). However, research has shown that nurture also matters. A fascinating study by Gneezy et al. (2009) shows that in a matrilineal society (such as the Khasi in India), women show stronger competitive behavior than men – in contrast with patrilineal societies (such as the Maasai in Kenya), where men compete more. This confirms the importance of social and cultural background for gender-specific behavior. In India, important determinants of female bargaining power may therefore include religion and caste. Although most authors agree on the important influence religion has throughout cultures and societies, the findings on the religion-power relationship have been ambiguous or contradictory (Morgan et al., 2002; Jejeebhoy and Sathar, 2001).

Interestingly, Luke (2013) finds that higher caste women tend to support male authority more than lower caste women in India.

Finally, other factors which have been named in the literature as influencing female bargaining power within the household include a woman's age, the age difference between her and her husband, marital duration, the number of children, and the number of sons (Gupta, 1995; Morgan and Niraula, 1996; Schuler et al., 1996; Malhotra and Mather, 1997; Luke, 2013).

3. Data

The dataset we use for our analysis was collected in 2010 in Andhra Pradesh, a state in the South of India. The region covering Rayalaseema (in particular, the districts Kurnool, Cuddapah, Ananthapur, and Chittoor) and the Southern part of Coastal Andhra (more specifically the districts Nellore, Prakasam, Guntur, and Krishna) was first subdivided into four subregions, based on climatic and dairy production system characteristics. In each of these subregions, one district was selected at random for inclusion in our sample. In the four selected districts, 50 villages were randomly selected. In a next step, 20 households from each village were selected using a stratified random sampling strategy and interviewed. The survey provides extensive data on household and household member demographic characteristics, household economic activities (including detailed agricultural production data) and data on intra-household decision-making over agricultural production activities (Vandeplas and Squicciarini, 2011). In our analysis, as our focus is on dairy productivity, we only focus on the subsample of 800 households which are engaged in dairy production.

4. Descriptive statistics

4.1. General descriptive statistics

As in most of India, dairy production in Andhra Pradesh is largely dominated by rural farm households who derive most of their income from crop farming, and keep a few cows or buffaloes on the side. The produced milk usually serves mostly for consumption within the household; but any surplus milk is sold, mostly within the village, to itinerant traders or at a milk collection center (see Vandeplas and Squicciarini, 2011 for more details).

Table 1 presents the summary statistics of the population under study, using appropriate sample weights to correct for oversampling of specific household categories. We restrict the survey sample to households with at least one dairy animal, which leaves us with 800 observations. In addition, observations are dropped if one of the variables in our analysis has a missing value, leading to a final sample size of 669 observations – which is the same sample that will be used for our regressions. Throughout our analysis, we will often refer to the 'male household head' as the 'husband' and the 'wife of the household head or female household head' as the 'wife' for improved readability. For similar reasons, we will refer to the "mother of the wife of the household head or female household head" as "the maternal mother".

The average household in our study is headed by a man of 47 years old, with 3.3 years of education. The wife is 41 years on average, and received 1.6 years of education. Hence, apart from the significant gap in age, we find a significant gender gap in education. The years of education the maternal mother received is 0.12 years, indicating that female education has at least improved somewhat over time. Furthermore, 80% of the households adhere to Hindu belief, 12% to Christian, and 7% to Islam. 37% of the households under study belong to a

general (or a 'higher' caste). 22% of the households belong to a scheduled tribe (ST) or scheduled caste (SC) and 41% belong to the class of other backward castes (OBC).[11]

The households in the population under study own on average 2.03 acres of land and 2.58 female adult dairy animals (comprising both cows and buffaloes) – which reflects the small scale of dairy production units in our sample. These dairy animals can either be traditional, "desi" breeds, which tend to be fairly well adapted to local environmental conditions, or crossbreds, which have some "exotic" genetic content and (usually) higher dairy yields. In our analysis, we will use the share of crossbred animals to local breeds as an indicator of the "technology level" of a dairy production system. In the population under study, this share is 31% on average. The average wealth of households is represented by an asset index, which varies between -1.4 and 10.7. This index is calculated through factor analysis based on ownership of a list of "large" assets such as diesel engines, pickups, or cars as well as "small" assets such as fridges, bicycles, and mobile phones (Squicciarini et al., 2013).[12] The average log yield from milk production in the year prior to the survey was 6.41 – corresponding to a dramatically low value of 607 l per cow per year, which is roughly 1/10 of yields generally obtained in developed countries.

In 15% of the households engaged in dairy, the wife is the primary decision maker in dairy production (see further for a more detailed discussion). In 36% of the households, the wife receives a wage income, indicating that she has found employment outside the household farm. When zooming in on the gender-based division of specific dairy activities, we find that

[11] Scheduled castes (SC) and scheduled tribes (ST) are castes which have historically experienced social discrimination in India. They respectively represent 16.2% and 8.2% of the total Indian population (Census of India, 2011) and benefit from different types of affirmative action policies. These castes broadly correspond to the populations formerly referred to as "dalits" and "adivasis". In this paper, we will refer to members of SC and ST as 'SC/ST'. Other backward castes (OBC) are castes which faced less discrimination than SC and ST, but are considered by the government to be 'sufficiently' economically disadvantaged to also deserve affirmative action policies in education and public employment (Census of India, 2011). Most families in this category historically belonged to the "shudra" caste of unskilled workers.

[12] The asset index is a relative measure of asset ownership; rather than an absolute one. In the original dataset of 1000 households, the asset index has been centered around 0, with a variance of 1 (Squicciarini et al., 2013).

women are primarily responsible for milking animals: in 72% of the households under study, it is a woman who spends most hours on this dairy activity. Women are also to an important extent involved in grazing and/or stall-feeding dairy animals, for which the corresponding number is resp. 33% and 40%, washing animals (43%), cleaning sheds (50%), and selling milk (42%). Only in 7% of the households, women are responsible for providing veterinary care to the dairy animals.

Hence, while milking the animals seems to qualify as a rather "feminized" activity, female involvement in selling milk is considerably lower. Veterinary care, which may consist of much more technical acts, or of attending (predominantly male) livestock health professionals, seems to be largely taken care of by men.

As involvement in dairy activities could be influenced by what men and women experienced and learnt at home before marriage, we also consider whether the paternal and maternal parents (the parents of the husband and his wife, respectively) engaged in milk production and selling activities. 69% of the household heads in our study had parents which produced milk, and for 58%, these were also selling (part of) their milk. The corresponding figures for their wives are respectively 62% en 48%. Thus, not all of the milk producing parents were selling their milk. Possible explanations for this could be that they were not productive enough to generate a surplus or that milk production activities were not meant to generate income (production for home consumption only).

4.2. Decision-making power in agricultural production

We noted earlier that livestock rearing is often considered the responsibility of women in developing countries, and in particular in South Asia (Achaya and Huria, 1986; FAO 2011). Responsibility in itself is however a broad term. It may mean women spend most hours on taking care of livestock; it may mean they are the main decision-makers when it comes to

production decisions on animal purchase and sales, and on milk sales. It could even mean that they are the main decision-makers when it comes to deciding on how to spend the money earned in dairy activities. For example, in Bangladesh, women often have control over every aspect of the productive process in livestock rearing, except for marketing, which largely remains masculine territory (Goetz and Gupta, 1996; Siddiquee et al., 2011).

Table 2 shows the results on the extent of control by women over production and spending decisions in dairy production – as compared to crop production. In 25% of the cases, the household member spending most hours of labor on dairy is a woman. For slightly more than two-thirds of these (18% of the households), women are reported to be the primary decision maker in dairy production. If there is sufficient milk surplus for sales, on the other hand, women do often keep the income from milk sales – in 39% of the cases on average. However, this does not mean that they decide on how to spend this income. In only 28% of the milk-selling households in our sample, women are the primary decision maker when it comes to spending the income from milk sales. While this is a minority, it is still substantial in comparison with female decision-making power in crop production, for which only in respectively 5.5% and 7% of the cases, production and spending decisions are made by a woman. Hence, the descriptive statistics confirm that female involvement in dairy is indeed much stronger than in crop production.

Hence, our data show that women's involvement in dairy is much stronger than in crop production. Nevertheless, the overall numbers are lower than what we had expected. Furthermore, in almost one third of the households where women spend most hours on dairy production, they are not allowed to decide on the allocation of productive resources. In one third of the cases, they are not allowed to decide on how the income from dairy is spent. This finding points at continued gender inequalities in control over household productive and financial resources in the region under study.

4.3. Characteristics of women with decision-making power

As this paper is primarily concerned with the impact of female decision-making power on dairy productivity, in the remainder of this paper we will focus on the variable which reflects control over dairy production. In this section, we explore whether there are observable characteristics which distinguish households where women have control over household productive resources in dairy from those where men have control, using simple F-tests.

Table 3 shows that there is a difference – albeit not significant with a p-value just over 10% – in the education level between women allowed to take production decisions or not: the average years of education women allowed to take production decisions receive is 1.25, versus 1.80 for the other group of women. Hence, education is (insignificantly) negatively correlated with being allowed to take production decisions. The same accounts for her husband who receives 2.60 years of education if his wife takes production decisions, and 3.40 otherwise. The effect of education is reversed for the maternal mother, who receives on average 0.26 years of education in case her daughter is allowed to take production decision and 0.08 years if she's not.

Interestingly, 18% of the women allowed to take production decisions are Christian, 80% are Hindu and only 1% is Muslim. Of those women not allowed to take these decisions, typically 11% are Christian, 82% are Hindu, and 6% are Muslim. Thus, Christian women seem to have more decision power in dairy production, while Muslim women seem to have much less. 31% of women with decision power belong to the other backward castes (OBC), 29% to a scheduled tribe or caste (SC/ST), and 40% to higher castes. In contrast, 42% of women without decision power belong to OBC, 23% to SC/ST, and 35% to higher castes. Hence, OBC women seem to have less bargaining power in dairy production. SC/ST and higher caste women have slightly more, but the difference is not statistically significant. Neither is receiving a wage income, although the difference is worth mentioning: 30% of the

women with decision power receive a wage income, while this applies to 35% of the women without such power. Hence, in contrast with many empirical studies (see Section **Fout! Verwijzingsbron niet gevonden.**), we find an (insignificant) negative correlation between receiving a wage income and taking production decisions. This could be due to the fact that women who are employed outside their husband's farm are less involved in dairy production.

Quite remarkably, the average farm's level of dairy technology (proxied by the share of crossbred cows over traditional, low-yielding cow breeds) is significantly lower for women with decision-power than for women without (resp. 0.24 vs 0.32). This seems to confirm the general finding in the literature that men tend to use better technologies in production than women. On the contrary, the number of dairy animals a household holds, asset ownership, and the amount of land owned doesn't seem to differ between both groups.

Whether maternal parents produce milk does not seem to matter either, while selling milk does matter significantly. A possible explanation for this could be that if a woman's parents were productive enough to generate a surplus of milk to be sold later on, they had strong production knowledge which could have been passed on to their daughter, making it more likely that the latter will be allowed to take production decisions after marriage.

Finally, we take a closer look at the relationship between having a male or female decision maker in dairy production and the milk production yield in the 12 months prior to the survey. The results of the F-test indicate that households having respectively a woman taking primary production decisions, display a higher milk production yield. Figure 1 presents this result graphically: households with a woman (solid line) deciding display a higher expected yield compared to household where a man takes the decisions (dotted line). This is striking, especially given the fact that men tend to use better technology. It may mean that women take better care of the dairy animals, or follow-up on production variables more closely – or differently. Furthermore, the opportunity cost of labor for women might be smaller than for

men, which means they may decide to spend more hours on dairy production if they are empowered to take production decisions.

In sum, Table 3 shows that characteristics like being Christian, belonging to other backward castes, the farm technology level, and maternal parents selling milk differ significantly between households where a either a man or a woman is the primary decision maker in production. These differences in observable characteristics across socio-cultural groups, households and individuals highlight that it is important to control for as many of these factors as possible when examining the data. Importantly, we also find a significant yield difference between female and male decision makers. Considering the fact that women traditionally are regarded as less efficient farmers than men, this finding is particularly interesting.

5. Conceptual Framework and Empirical Methodology

Empirical evidence suggests that individuals within households have heterogeneous preferences on how best to combine time, goods purchased in the market, and goods produced at home to produce commodities that maximize some common welfare index (Thomas, 1990; Hoddinott and Haddad, 1995; Quisumbing and Maluccio, 2000). Evidence exists that men and women may have different production priorities (Dey, 1985; Jones, 1983; Mukhopadhyay, 1984; Hill, 1978; Gladwin, 1982). As a result, the unitary model, in which households are groups of individuals with homogeneous preferences who pool their resources (including capital, labor and land) to maximize household utility subject to a budget constraint, has been criticized and largely abandoned. Non-cooperative models of the family, as developed by Ulph (1988), Lundberg and Pollak (1993), Carter and Katz (1996) and Chen and Woolley (2001), provide a more realistic description of household economics. Contrary to the

cooperative collective household model, this model does not assume that the household reaches Pareto efficient allocations in either production or consumption and is therefore more in line with available empirical evidence (Udry, 1996; Jones, 1986). It does assume, moreover, that resource allocation for each member in the household is determined by a bargaining process.

The major implication is that different outcomes can be achieved in household production, depending on which household member is exerting control over the resources used in production. In this study, in particular, we explore the difference in outcomes obtained by households where dairy production is controlled by women, versus households where dairy production is controlled by men.

5.1. Female decision-making power

Before digging into the productivity effects of women's control over production processes, we need to model female decision-making power based on its most important determinants as identified in Section 2.3.[13] This means that our first stage regression takes the following form:

$$Femdecd_i = \alpha_i + \beta_1 Education_i + \beta_2 Education\_maternalmother_i + \beta_3 Age_i + \beta_4 Wage\ income_i + \beta_5 Parentswife\_producing_i + \beta_6 Parentswife\_selling_i + \beta_7 Dairy\ activities_i + \beta_8 Household\ characteristics_i + \mu_i + \varepsilon_i \quad (1)$$

Our dependent variable is a binary variable reflecting female decision-making power. It takes the value 0 if a man makes production-related decisions in dairy, and 1 if a woman does. As explanatory variables, we include the education level of the male household head, his wife,

[13] Note that we do not have data on gender-segregated ownership of assets within the household. Collection of reliable data on this issue is generally difficult.

and of the maternal mother. We hypothesize the latter variable is a proxy for her mother's intrahousehold bargaining status, which might affect the bargaining status of a woman through learning effects. In addition, the age of the husband and his wife are included. Furthermore, we control for labor market participation by using a dummy *wage income* that takes the value 1 if the woman earns an income outside the farm. We would also like to examine the effect of maternal parents producing or selling milk on a women's agency in the household by adding 2 dummy variables to the equation (*parentswife_producing, parentswife_selling*). Other variables of interest reflect the involvement of the wife in dairy activities, measured through a dummy variable which takes the value 1 if the wife spends most time on specific activities such as grazing and stall-feeding dairy animals, milking animals, washing the animals and cleaning the sheds; selling milk, and veterinary care.

'Household characteristics' consists of a group of control variables, including land ownership, livestock herd size, and an index for asset ownership in 2010. We also account for the level of technology of the farm, proxied by the ratio of crossbred animals over traditional breeds. Finally, we include a set of socio-cultural variables: a religion dummy taking the value of one for Christians and zero for Hindus and Muslims;[14] a dummy variable *OBC* which indicates whether the household belongs to 'Other Backward Castes', comprised of economically disadvantaged castes. The dummy variable *SC/ST* indicates whether the household belongs to a scheduled caste or scheduled tribe, referring to the castes which have historically experienced even worse social discrimination in India. μ is the unobserved district-level effect, and ε the error term.

We estimate this model using a Probit model. Next, we cross-check the Probit regression results using a linear probability model. In both regressions, we use a set of household-level characteristics as control variables, to avoid omitted variable bias. We also

[14] Unfortunately, we cannot add a dummy for Muslims due to the low number of observations in this category.

include a set of district-level dummies, to control for local conditions which may be relevant in the determination of yields. Unfortunately, the dataset at hand is not large enough to allow for inclusion of a full set of village-level dummies.

5.2. The impact of female decision-making power on agricultural productivity

In a second step of our analysis, we assess the impact of female decision-making power on dairy productivity using the following model specification:

$$Yield_i = \alpha_i + \beta Femdecd_i + \beta_2 Education_i + \beta_3 Age_i + \beta_4 Parents\_producing_i + \beta_5 Parents\_selling_i + \beta_6 Household\ characteristics_i + \mu_i + \varepsilon_i, \quad (2)$$

where $yield_i$ reflects the log-transformed average yield of dairy milk production by household *i*, over the 12 months prior to the survey (July 2009 to June 2010), obtained by dividing the average milk production in the aforementioned period by the number of female adult dairy animals (desi and graded buffaloes and cows). The variable of interest is *femdecd*, the dependent variable in the previous section.[15]

As we believe yields could be influenced by dairy management skills learned from observing parents engaged in dairy, we generate a dummy (*parents_producing*) which takes the value 1 if the parents of the primary decision maker (which may be either the husband or wife) were involved in milk production before marriage. The dummy *parents_selling* reflects whether the parents of the primary decision maker were involved in milk sales.[16]

[15] Given our log-linear specification, the impact of *femdecd* switching from 0 to 1 on yield is $(e^{\beta} - 1)*100$. This can be approximated by $\beta*100$ at lower levels of β. However, as some of our coefficients are relatively high, we do not use the usual approximation.

[16] Hence, this dummy reflects whether the paternal parents were involved in respectively milk production or selling in case the man is the primary decision-maker in production activities, and the maternal parents' involvement if the woman is deciding.

Once again, the education level and age of husband and wife are included. Furthermore, we control for the same household-level characteristics as in previous regressions. Regressions are run both including and excluding district dummies.

Our first regression model specification comprises a simple ordinary least squares (OLS) model. However, as we already highlighted before, the female decision-making dummy is likely to be correlated with the error terms in this regression, creating a problem of endogeneity. Therefore, in a second set of regressions, we run a two stage instrumental variables regression (iv2SLS). In the (first stage) selection equation, the female decision making dummy (*femdecd*) is instrumented using the education level of the maternal mother (*education maternal mother*) and a set of dairy activity dummies which reflect the involvement of the woman in dairy activities. More specifically, we use the regression specified in section 5.1 as a first stage regression to control for endogeneity of female decision-making power.

The usual iv2SLS regression model uses a linear model in the first stage regression, which means it does not take into account the binary nature of the dependent variable in the first stage regression. Therefore, we run a third regression model which combines 2SLS estimation with a Probit model in the first stage (Cerulli, 2012). This so-called Probit-2SLS model is run in three steps: first, we apply a Probit of *femdecd* on the same instruments as the previously mentioned for the 2SLS selection equation. From here the predicted probabilities of *femdecd* are obtained. Second, we apply a 2SLS model where in the first stage *femdecd* is regressed on the previously predicted probabilities using an OLS regression; and as such fitted values for *femdecd* are obtained. In the second stage of the 2SLS model, the dependent variable *Yield* is regressed on the fitted values for *femdecd,* again using OLS. According to Cerulli (2012), the coefficients on the *femdecd* fitted values in this second stage regression are

the most efficient estimator for the average treatment effect of our variable of interest, *femdecd*.

6. Results and discussion

6.1. Determinants of female decision-making power

Table 4 reports the results of the Probit and linear probability model regressions of female decision-making power in dairy production on several individual and household level determinants, with and without including village-year dummies. For most of the regression variables used, the linear and Probit model give similar significance results: receiving a wage income, having parents producing or selling milk, spending most hours on grazing or milking of dairy animals, the age of the husband, the years of education of the maternal mother, and being Christian seem to be significant determinants of intra-household decision power. In addition, the level of technology maintained by the household (ratio of crossbred over purebred dairy animals), and the asset index are significant as well. On the other hand, belonging to other backward castes or a scheduled tribe or caste, spending most hours on stall feeding and washing of dairy animals, cleaning of sheds, and selling milk appear to be unimportant, as well as the livestock herd size. However, having the wife spending most hours on veterinary care has no effect in the linear model, but becomes significant in the Probit model.

These observations largely correspond to the results from the F-tests (see Section 4.3) and the evidence from several empirical studies (see Section 2.3). Looking at the Probit marginal effects, we find that households where the wife receives a wage income, there is 5% more chance of having a woman taking production decisions within the household. This result is in line with the argument of several authors, that labor market participation is an important determinant of female decision-making power (Anderson and Eswaran, 20007; Yusof and

Duasa, 2010). However, our F-test (Section 4.3) suggested the opposite: 30% of the women with decision power receive a wage income, while this applies to only 35% of the women without such power. Though, this contradiction could be caused by omitted variable bias as the F-test does not control for the "other factors" that we control for in the regression.

Similarly, when the wife, compared to other household members, spends most hours on grazing, milking, and veterinary care of dairy animals, this leads to an increase in the probability of having a woman taking production decisions of 8%, 6%, and 16%, respectively. When the wife spends most hours on stall feeding or washing dairy animals, cleaning sheds and selling milk, there seems to be no significant change in the probability of taking production decisions.

Interestingly, if the wife's parents were producing milk, this leads to a decrease of 11% in the probability that she can take production decisions, whereas it is 13% more likely when her parents were also selling milk. This is surprising. Possibly, if the wife's parents were productive enough to generate a surplus of milk to be sold later on, they had strong production knowledge which could have been passed on to their daughter, making it more likely that the latter will be allowed to take production decisions during her adult life. On the other hand, families which were only producing but not selling milk, might have been less efficient at dairy farming, limiting (the appeal of) potential intergenerational learning effects.

Education of the husband and his wife has no effect. On the other hand, one additional year of education for the maternal mother is associated with an increase of 3% in a woman's decision making power. In rural India, very few women of this generation have received education – with an average of 0.12 years of education in our sample. One could consider the ones who did receive a noteworthy education as particularly privileged and attribute this to the fact that they are stemming from a family with more attention for girls' education, which might be related to a stronger empowerment of women in the household. The age of the

husband seems to matter to some small extent (0.5%) in determining whether the wife can take production decisions.

The coefficient of livestock herd size is negative but insignificant. As mentioned before, belonging to the other backward castes or a scheduled tribe or caste does not seem to impact female decision-making power significantly, in contrast with our expectations. On the other hand, our observations suggest that in Christian households, a woman has more decision-making power (13%) than in Hindu or Muslim households, confirming the importance of religion in influencing social relations.

An interesting finding is that when the level of technology (crossbred over traditional breeds) increases with one unit, there is 9% less chance of having a woman deciding.[17] Finally, the asset index is found to have a small positive effect on the female decision-making power (3%). Hence, our regression results suggest that wealthier households are more inclined to allow women to take production decisions. This is in line with earlier empirical findings (Dito, 2011). The same accounts for the amount of land owned: we find a small effect (2%) on decision-making power, in contrast with the outcome of the F-test.

Hence, our analysis suggests that most of our variables of interest – having parents involved in both producing and selling milk, spending most hours on grazing, milking, or veterinary care of dairy animals, and receiving a wage income – are important positive determinants female decision-making power. In addition, being Christian has a strong positive effect and the education of the maternal mother and the age of the husband also matters somewhat. Furthermore, household characteristics like the assets and amount of land owned, have a small positive effect, while a higher level of farm technology decreases female decision-making power.

[17] There could be reverse causality at play here.

6.2. Impact of female decision-making power on dairy productivity

We now turn to the effect of a woman's decision power in the household on milk production yield. Looking at the different sets of regressions we find a positive but insignificant coefficient in all three models: having a woman taking production decisions is associated with – after transformation of the coefficients[18] – a 15% increase in dairy productivity in the linear model, 53% in the two-stage linear model and 20% in the two-stage treatment regression (Table 5). Still, this is an important observation. In contrast to the traditional view that women would be less efficient farmers than men, we find no significant difference in productivity outcomes between households where either a man or a woman is the primary decision maker on dairy production. The positive sign of the regression coefficient even suggests that households where the woman has decision power achieve at least equal, if not higher, productivity from milk production. Finally, we also note that on a 85% confidence level, the effect is significant in the linear and iv2SLS model.

Overall, the significance and size of the coefficients of control variables remains largely the same in all models. We analyze the results of the Probit-2SLS treatment regression – the most appropriate model given the binary nature of our dependent variable – more deeply. After controlling for the selection effects, the treatment regression indicates no significant difference in productivity between the two groups. There is a positive – but insignificant – impact on productivity when women are allowed to take production decisions (as compared to not being allowed): our results indicate a 20% increase in productivity (Table 5). In addition, if the maternal or paternal parents were producing but not selling milk, this leads to yield decrease of 26%, whereas yield increases with 61% when the parents were also selling milk. Thus, if the parents were productive enough to sell (part of) their milk, their children will

[18] The dependent variable changes by $(e^{\beta} - 1)*100$ when a dummy variable takes the value of 1, or for continuous variables, when the independent variable increases with 1 unit. $(e^{\beta} - 1)*100$ can be approximated by $\beta*100$ at lower levels of β. However, as some of our coefficients are relatively high, we do not use the usual approximation.

achieve higher levels of productivity. Analogous to the findings in Section 6.1, this confirms that strong production knowledge seems to be handed over from parents to offspring.

According to our expectations, we find as well a positive impact from the level of technology and the assets owned by the household. Quite likely, increasing household wealth results in better access to input and output markets, higher quality and quantity of inputs used, etc. Livestock herd size on the contrary has a negative impact. This could be due to the fact that the smaller the size of the farm gets, the better the care for the animals, the more attention for animal welfare and the closer the follow-up of production data. Land owned by the household has a negative effect as well: doubling the amount of land owned, reduces productivity with 8%.

The age of the wife and husband also matters to some extent. Whereas the effect of the wife's age impact is slightly positive (1%), the age of the husband seems to slightly impact productivity negatively (1%). The latter accounts as well for the education of the husband (1%). Belonging to other backward castes decreases productivity with 13%. This finding suggests that lower castes tend to have lower productivity outcomes – which points at a caste gap in agriculture, possibly driven by constrained access to production inputs as compared to higher castes. Belonging to a scheduled tribe or caste has a negative effect as well (14%), but remains just below the 90% confidence level.

In an alternative specification, we allow for non-linearities in the impact of herd size on yield, as smaller dairy farms are based on subsistence production and therefore might have a different production system than bigger dairy farms. Hereto, we replace the variable 'number of dairy animals' (*livestock herd size*) by two size indicator dummies (*sc3* and *sc4*), corresponding respectively to farms of medium size (3-5 dairy animals) and large size farms (more than 5 dairy animals) (Table 5). This specification yields similar results, confirming the robustness of our regressions.

In sum, our analysis suggests there is no significant difference in productivity between households where production decisions are taken by either a man or woman. The positive sign of the regression coefficient even indicates that productivity outcomes are rather higher than lower when the woman controls production decisions. This finding largely confirms the trends which were evident from the descriptive statistics in Section 0.

7. Conclusions and implications

Many studies have found a "gender gap" in agricultural productivity (Croppenstedt et al., 2013). This gender gap is often attributed to unequal access to productive resources, technology, and input and output markets. The existing literature has mostly focused on female productivity in crop production.

Based on household-level data from Andhra Pradesh (India), this paper looks at female productivity in dairy production, where female involvement is usually higher than in crop production. In a first step, we study what are the determinants of female decision-making over dairy production. We find that having parents involved in both producing and selling milk, spending most hours on grazing, milking, or veterinary care of dairy animals, and receiving a wage income are important positive determinants female decision-making power. In addition, being Christian has a strong positive effect and the education of the maternal mother and age of the husband also matter somewhat. In a second step, we measure the impact of female-decision making on dairy yields, accounting for endogeneity of female power. In contrast to the traditional view that women would be less efficient farmers than men, the results of our analysis shows there is no significant difference in productivity outcomes between households where either a man or a woman is the primary decision maker on dairy production. The positive sign of the regression coefficients suggest that households where women are in control of production, arrive at equal – possibly even higher – productivity from milk

production. A tentative explanation for the latter could be that women might take better care of the dairy animals, use different inputs, or follow-up on production more closely – or differently. Furthermore, the opportunity cost of labor for women might be smaller than for men, so that more hours can be spend on production activities.

The absence of a negative gender gap in dairy production adds a positive note to the existing literature, which usually assumes women are at a disadvantage in agricultural production. Investigating in more detail differences in specific production practices provides an interesting venue for future research. Hence, while further research is needed, it may imply that if men delegate control over dairy production to women – especially in those cases where women are already exerting most of the effort in terms of labor hours – better development outcomes may be obtained.

A word of caution is due, however, in the interpretation of our results. As we discussed in Section 4, dairy production in Andhra Pradesh is generally still very inefficient according to international standards; with yields averaging 607 l per cow per year. In general, technology used in the dairy sector is still very basic, and cattle are fed with grasses collected from sideways or with leftovers after the crop harvest. Formal input markets have not developed yet; which may be one reason why no inequalities in access to input markets can be observed.

An interesting venue for future research lies in studying the gender gap in dairy profitability: do women receive better, or worse prices than men if they market the milk?

Apart from the fact that we do not find a negative gender gap in dairy, we do find a negative "caste gap" in dairy: SC/ST and OBCs have consistently lower dairy yields – even after controlling for livestock herd size, asset and land ownership. These results add to an earlier study by Vandeplas et al. (2013) on the dairy sector in the North of India who find a significant impact of low caste status on dairy profitability, pointing at continued inter-caste

inequalities in rural India, which should be addressed by development policy makers and practitioners who aim to establish a broad-based development process.

8. References

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9. Tables and figures

Figure 1: Probability density of yield for households where a woman (solid line) versus a man (dotted line) takes the production decisions

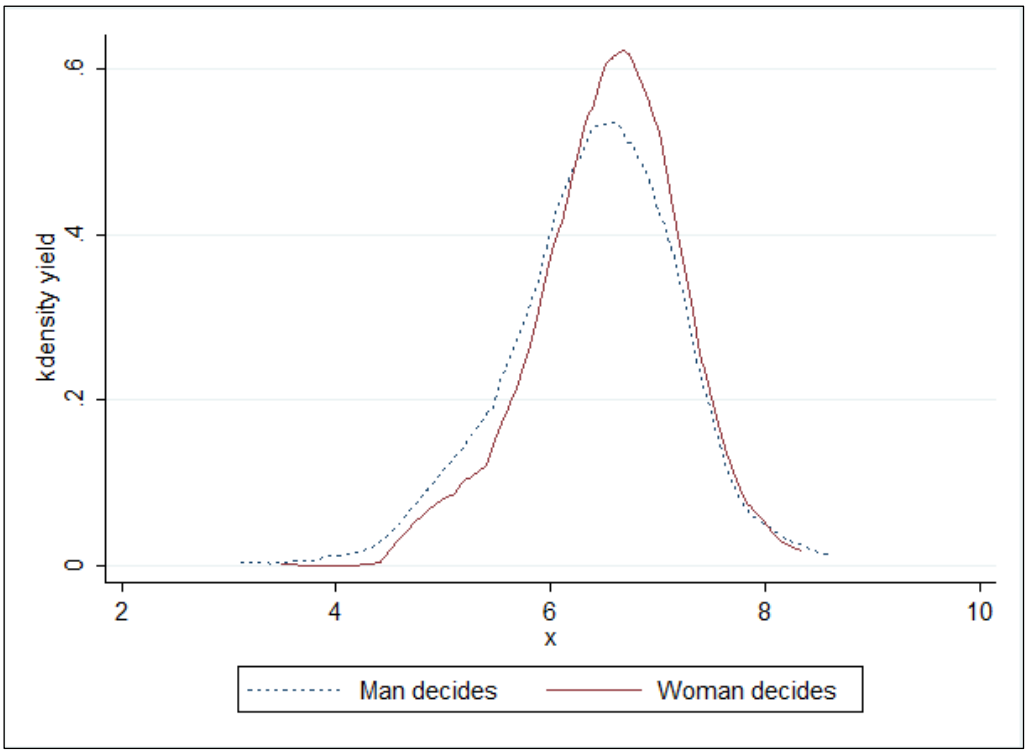

Table 1: Description of dependent and explanatory variables
(Sample weights have been used)

Variable	Obs	Unit	Mean	St. Dev.	Min	Max
education level wife	669	years	1.63	3.16	0	15
age wife	669	years	40.97	1.06	16	110
education level husband	669	years	3.30	4.53	0	18
age husband	669	years	47.41	1.12	23	82
education level maternal mother	669	years	.12	.85	0	10
Christian	669	1 if Christian	.12	.32	0	1
SC/ST	669	1 if SC/ST	.22	.46	0	1
OBC	669	1 if OBC	.41	.49	0	1
land owned	669	(log) acres	1.11	.91	0	4.33
asset index	669		3.30	.98	-1.40	10.8
technology	669	% crossbred DA	.31	.45	0	1
livestock herd size	669	number of DA	2.58	1.91	1	17
yield	669	(log) l/cow*year	6.41	.78	3.11	8.59
female decision-making power (femdecd)	669	1 if wife decides over dairy	.15	.36	0	1
wife has wage income	669	1 if wife receives wage income	.36	.48	0	1
parentshusband_producing	669	1 if parents produced milk	.69	.46	0	1
parentshusband_selling	669	1 if parents sold milk	.58	.49	0	1
parentswife_producing	669	1 if maternal parents produced milk	.62	.49	0	1
parentswife_selling	669	1 if maternal parents sold milk	.48	.50	0	1
wife most hours on grazing DA	669	1 if wife most involved in grazing	.33	.47	0	1
wife most hours on stall feeding DA	669	1 if wife most involved in stall feeding	.40	.49	0	1
wife most hours on milking DA	669	1 if wife most involved in milking	.72	.45	0	1
wife most hours on washing DA	669	1 if wife most involved in washing	.43	.49	0	1
wife most hours on cleaning sheds	669	1 if wife most involved in cleaning	.50	.50	0	1
wife most hours on selling milk	669	1 if wife most involved in selling	.42	.49	0	1
wife most hours on veterinary care	669	1 if wife most involved in veterinary care	.07	.26	0	1
district dummies	669		.30	1.02	1	4

Table 2: Comparison of responsibilities in dairy and crop production, labor hours spent, income keeping and spending of this income
(Sample weights have been used, sample restricted to households with at least one dairy animal)

Percentage females	Dairy production	Crop production
Spending most hours of labor on production	24.49 (800 observations)	6.37 (672 observations)
Primary decision maker in production	17.70 (800 observations)	5.50 (672 observations)
Keep the income from sales	38.71 (657 observations)	6.29 (661 observations)
Primary decision maker for spending income from sales	27.59 (657 observations)	7.00 (661 observations)

Table 3: Two-sample F-tests with equal variances: group 0 has a male, group 1 a female decision maker in dairy production
(Sample weights have been used)

Characteristics	**Man decides** (673 observations)	**Woman decides** (127 observations)	**F-test**
Education wife	1.80	1.25	2.68
Education husband	3.40	2.59	1.95
Education maternal mother	.08	.26	1.46
Wage income	0.35	0.30	0.84
Christian	.11	.18	2.81*
Hindu	0.82	0.80	0.61
Muslim	0.06	0.01	14.34***
SC/ST	.23	.29	1.52
OBC	.42	.31	4.72**
Higher caste	0.35	0.40	0.94
Asset index	-.04	.10	1.52
Livestock herd size	2.54	2.40	0.95
Technology level	.32	.24	3.01*
Land owned	1.08	1.03	0.24
Maternal parents produced milk	.59	.57	0.08
Maternal parents sold milk	.43	.55	4.13**
Yield	6.40	6.53	2.90*

Table 4: Female decision power (production) and household characteristics

Dependent variable: female decision-making power (femdecd)	**OLS Cluster robust SE (district dummies included)**	**Probit Cluster robust SE (district dummies included)**	**Probit marginal effects Cluster robust SE (district dummies included)**
	coef (se)	**coef (se)**	**coef (se)**
education level wife	-0.007	-0.044	-0.007
	(0.004)	(0.032)	(0.005)
age wife	-0.004	-0.024	-0.004
	(0.003)	(0.016)	(0.003)
education level husband	-0.004	-0.027	-0.004
	(0.003)	(0.019)	(0.003)
age husband	0.004*	0.028*	0.005*
	(0.003)	(0.015)	(0.003)
education level maternal mother	0.041**	0.194***	0.031***
	(0.020)	(0.072)	(0.010)
wife has wage income	0.059*	0.307*	0.053*
	(0.032)	(0.162)	(0.029)
wife most hours on grazing DA	0.086***	0.440***	0.078***
	(0.027)	(0.143)	(0.027)
wife most hours on stall feeding DA	-0.020	-0.147	-0.023
	(0.027)	(0.163)	(0.025)
wife most hours on milking DA	0.067***	0.451***	0.063***
	(0.024)	(0.153)	(0.019)
wife most hours on washing DA	0.029	0.141	0.023
	(0.034)	(0.174)	(0.028)
wife most hours on cleaning sheds	-0.004	-0.016	-0.003
	(0.034)	(0.196)	(0.031)
wife most hours on selling milk	-0.009	-0.094	-0.015
	(0.026)	(0.133)	(0.021)
wife most hours on veterinary care	0.129	0.689**	0.158**
	(0.083)	(0.279)	(0.079)
parentswife_producing	-0.083**	-0.608**	-0.108**
	(0.033)	(0.241)	(0.049)
parentswife_selling	0.113***	0.767***	0.128***
	(0.037)	(0.239)	(0.041)
land owned	0.021	0.139*	0.022*
	(0.014)	(0.074)	(0.012)
asset index	0.040***	0.182***	0.029***
	(0.015)	(0.059)	(0.009)
technology	-0.105***	-0.580**	-0.092***
	(0.038)	(0.229)	(0.035)
livestock herd size	-0.005	-0.022	-0.004
	(0.006)	(0.039)	(0.006)
Christian	0.131**	0.588**	0.125*
	(0.065)	(0.232)	(0.065)
SC/ST	0.063	0.364*	0.067
	(0.043)	(0.221)	(0.044)
OBC	-0.026	-0.167	-0.026
	(0.032)	(0.191)	(0.030)
_cons	-0.022	-2.151***	
	(0.090)	(0.526)	
Number of observations	669	669	669
Adjusted/Pseudo R2	0.093	0.172	0.172

note: *** p<0.01. ** p<0.05. * p<0.1

Table 5: Milk production yield and female decision making power (production)

Dependent variable: (log) yield	**OLS Cluster robust SE (district dummies included)**	**iv2SLS Cluster robust SE (district dummies included)**	**ivtreatreg Cluster robust SE (district dummies included)**
	coef (se)	**coef (se)**	**coef (se)**
female decision-making power (femdecd)	0.140	0.428	0.184
	(0.089)	(0.290)	(0.265)
parentswife_producing	-0.310***	-0.293***	-0.307***
	(0.117)	(0.113)	(0.090)
parentswife_selling	0.482***	0.463***	0.479***
	(0.095)	(0.093)	(0.080)
land owned	-0.078	-0.081	-0.078**
	(0.052)	(0.051)	(0.038)
asset index	0.130***	0.118***	0.128***
	(0.035)	(0.032)	(0.034)
technology	0.426***	0.458***	0.431***
	(0.096)	(0.106)	(0.082)
livestock herd size	-0.092***	-0.090***	-0.092***
	(0.015)	(0.015)	(0.014)
education level wife	0.014	0.016*	0.014
	(0.010)	(0.009)	(0.010)
age wife	0.010*	0.010*	0.010*
	(0.006)	(0.006)	(0.005)
education level husband	-0.012	-0.011	-0.012*
	(0.008)	(0.008)	(0.007)
age husband	-0.011*	-0.012*	-0.011**
	(0.006)	(0.006)	(0.005)
Christian	-0.089	-0.121	-0.094
	(0.128)	(0.122)	(0.128)
SC/ST	-0.146	-0.160	-0.148
	(0.153)	(0.147)	(0.105)
OBC	-0.136*	-0.125*	-0.134**
	(0.070)	(0.069)	(0.062)
_cons	6.778***	6.731***	6.770***
	(0.162)	(0.158)	(0.181)
Number of observations	669	669	669
Adjusted R2	0.314	0.301	0.314
note: *** p<0.01. ** p<0.05. * p<0.1			