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Abstract

In this paper we examine some of the intrahousehold decisionmaking dynamics that shape household's decision to adopt a mechanical rice transplanting technology that significantly reduces the demand for labor during transplanting. To study the adoption decision, we consider the willingness-to-pay for MRT services, both at the level of individual men and women within the same households, as well as at the household level. We find that women value MRT more than men, but this difference in valuation is not driven by differences in their individual characteristics, but primarily from differences in preferences. Despite women valuing MRT more than men, they do not significantly influence the household's technology adoption decision. The intrahousehold differences in valuation disappear when women engage in hired wage work, suggesting that women value MRT in order to potentially reallocate farm labor to other unpaid family work. These results have implications for rural labor market welfare because agricultural and labor productivity gains due to MRT adoption may push women into more traditional gendered labor divisions.

1 Introduction

Mechanization in agriculture can be both a cause and consequence of disruptions in rural labor markets. Economic growth and structural changes in the rural and urban sectors pull labor away from agriculture and increase rural wages (Lewis, 1954). Higher wages and lower labor availability, in turn, shift the production technologies used in agriculture towards more capital-intensive practices. At the same time, the increased mechanization of farm operations reduces the demand for manual labor, thus potentially displacing large swaths of farm laborers. The share of agriculture in rural employment decreased by 10 percentage points from 1993 to 2010, while the annual growth rate in wages was 2.7 percent in agriculture compared to 1.8 percent in non-agricultural employment (Chand and Srivastava, 2014). These rural wage and employment changes led to massive shifts in the agricultural technologies used in rice and wheat production, India's two most important food crops.

The rise in rural wages and the increase in agricultural labor productivity in India has led to a significant reshuffling of rural labor markets for both women and men. From 2004-05 to 2009-10, 17.8 million male workers left agriculture for one reason or another, though the majority were subsequently absorbed in other non-agricultural sectors, such as construction. The effects in female rural labor markets, however, has followed a very different trajectory. Over the same period, 36.4 million female workers left the agricultural sector (Raveendran and Kannan, 2012). Unlike their male counterparts, the majority of these women – many previously involved in unpaid family agricultural work or self-employment – were not absorbed in other non-agricultural employment. The displacement of women's labor from the agricultural sector has been a result of a complex set of factors including – but not limited to – rising household income, decreasing demand for farm labor, and growing availability of other non-agricultural opportunities.

When labor displacement arises as a consequence of technology diffusion, the division of economic welfare between male and female members of a community depends crucially on the nature of the technology and the operation for which machine labor is substituting for manual labor. In addition, a heretofore unexplored question entails the nature of intrahousehold preferences over the new technology and the division of bargaining power within the household, particularly around technology adoption decisions. Empirical studies examining intrahousehold differences in technology demand mostly rely on analyzing the adoption decisions made by women and men separately in a household. In contexts where agricultural decisions are jointly made and farm plots are managed together, individual demand for agricultural technologies is unobserved. This study attempts to fill this important knowledge gap by assessing intrahousehold variation in demand for a new agricultural technology along explicit gender dimensions. Each household member's demand for a technology is assumed to be a function of, among other things, the household member's gender as well as participation in the agricultural operation for which machine labor is being substituted. In this regard, this study represents one of the first efforts to understand gendered differences for an agricultural technology that has disproportionate impacts on one gender vis-á-vis the other. In addition, we go a step further and assess how these heterogeneous preferences converge through some bargaining process to arrive at a household technology adoption decision.

This study focuses specifically on the mechanization of rice transplanting in India. While women contribute to agricultural production in many ways, one of the primary operations that women undertake in much of India is in transplanting rice. Consequently, there are important gender dimensions to consider when evaluating technologies that substitute for labor during rice establishment. Manual transplanting is the most labor-intensive activity undertaken during rice cultivation, accounting for as much as 20 percent of all labor employed in rice production (Barker et al., 1985). On average, manual transplanting requires 10-12 labor days per acre, and hiring laborers for transplanting costs roughly INR 900-1000 per acre.[1] In addition, manual transplanting rice is a particularly grueling undertaking for

[1]These estimates are based on the sample data, described below in Section 3.

the laborers involved, often entailing long hours in flooded fields, hunched over under the blistering sun. Recently, transplanting has been mechanized through the use of mechanical rice transplanters (MRTs), which were first introduced into the Indian rice cropping system in 2006 (Kamboj et al., 2013). MRTs significantly reduce labor demand and improve labor productivity. An MRT can transplant 3-4 acres per day – approximately 25 times the area that could be transplanted using only manual labor.[2] Because the introduction of the technology disproportionately affects female laborers more than male laborers throughout much of India, women may be particularly vested in the household's decision to adopt this technology. This has implications for how the agricultural research community assesses the potential impacts of this technology at scale, both in terms of its potential to reduce drudgery as well as displacing female labor in the absence of other non-agricultural employment opportunities.

To disentangle the unobserved individual valuation for MRT custom-hire services from the observed household demand, we use a combination of stated preference and experimental valuation techniques. We capture MRT valuation from women and men belonging to same households using a stated valuation elicitation mechanism (a sequential, discretized contingent valuation mechanism), and measure the household's revealed demand for MRT custom-hire services using an incentive-compatible Becker-DeGroot-Marschak (BDM) experimental auction (Becker et al., 1964). Structurally, these valuation exercises are virtually identical, with the principal difference being the incentive compatibility of the binding BDM. These valuation exercises provide three comparable measures of willingness-to-pay (WTP): one for the female decisionmaker, one for the male decisionmaker, and one for the household as a unit, which is assumed to be a weighted average of the valuations for the two individual decisionmakers. Using the Oaxaca-Blinder decomposition, we separate the difference in stated

[2]While mechanical transplanting is similar to manual techniques, the biggest shift in practice is in nursery cultivation. When rice is mechanically transplanted, the nursery for rice cultivation is prepared on special mats with much shallower root structures. Seedlings are transplanted using machines after two weeks, which is approximately half the time it takes to grow saplings in a traditional nursery for manual transplanting.

WTPs into endowment and preference differentials (Oaxaca, 1973). We combine the heterogeneity in valuation between women and men with the unobserved parameters of a woman's "voice" in household decisions and her labor allocation to transplanting to assess women's ability to influence the resulting household technology adoption decision in her preferred direction.

To summarize our results, our empirical analysis suggests that women value MRT more than men, irrespective of their involvement in transplanting activities. The gap between women's and men's WTP is widest among households that use only family labor for transplanting, and accounts for approximately 12 percent of this sub-group's average WTP. Importantly, however, although the *gap* between women's and men's WTP is widest among these households, the *level* of women's WTP is lower among women in these households than among women in other households that also use hired labor for transplanting. We believe this is primarily because these women are expected to experience the highest level of labor displacement as a result of MRT adoption. This stated WTP difference includes the differences arising from women's and men's individual observable characteristics (endowment differentials) and the differences due to their preferences (preference differentials). By and large, however, the majority of this intrahousehold WTP difference can be attributed to preference differentials, suggesting a very stark demarcation in how male and female farmers and farm laborers view this technology, rather than innate differences in characteristics. Despite these WTP and welfare differences between women and men, we find men have a higher influence in the household's MRT adoption decision as compared to women when women participate in transplanting, suggesting a significant imbalance in bargaining power when it comes to these types of agricultural decisions.

2 Research Design

The study was implemented in 28 villages, spread across 13 districts, in the northern Indian state of Bihar, which is one of the poorest states in the country with a poverty headcount ratio of over 30 percent (Reserve Bank of India, 2013). Research activities were initiated during 2015 in the months leading up to the *kharif* (monsoon season) rice-growing season. A timeline of research activities along with the agricultural season calendar is shown in Appendix A.

Beginning in March 2015, we we conducted a survey to collect information on the household's demographic and social characteristics, as well as agricultural data on the labor and capital used in each agricultural task. At the same time, we also implemented survey with each of the male and female household members jointly identified as co-heads to collect data on individual assets, human capital, employment and earnings, and social and familial backgrounds. For women, this survey also collected data on assets they brought to the household when they were married (including money paid as dowry and jewelry received as wedding gifts, among other assets considered) as these assets should be considered exogenous to household formation. We use this information to construct a measure of a woman's "voice" or standing in household decisionmaking.

In April 2015, we revisited the male and female co-heads and introduced the individual-level preference and value elicitation exercises to assess the differential amounts men and women in a household would be willing to pay to utilize MRT services. The women and men were individually and separately introduced to the MRT technology through a brief verbal introduction, followed by a short informational video demonstrating MRTs operating in the field. They were shown an additional video of the MRT service provider who would offer custom-hire services to village members. In all cases, the service provider was *not* a member of the same village as the study participants, and was thus unknown to participants at the time we elicited their WTP for MRT services. Each individual was also read a set of frequently asked questions to provide clarification on the nature of nursery planting and MRT service provision.[3] We took care to provide complete, accurate, and uniform information to both individuals within a household. These individual interviews were conducted simultaneously but separately, with female enumerators interviewing female respondents, and male enumerators interviewing male respondents.

For each plot the household cultivates, we elicited willingness-to-pay as a dichotomous statement in response to 14 discrete price points, ranging from INR 600 to INR 1600 per acre (see Appendix B for the prices used to elicit the valuation).[4,5] Because some women do not participate in the households' agricultural activities, we also provided participants an approximate range of per acre manual transplanting costs to act as a point of reference. Throughout the valuation exercise, we used three strategies to minimize hypothetical elicitation bias (Aadland and Caplan, 2003; Cummings and Taylor, 1999; Jacquemet et al., 2013). First, we employed honesty priming to inform the subjects that they would not gain anything by lying to us about their valuation (Jacquemet et al., 2013). Second, we used "cheap talk" measures and told both women and men to state their valuations as if they were the household heads responsible for making the ultimate transplanting technology decision for their household (Cummings and Taylor, 1999). Finally, we elicited individual valuations and household WTP as a dichotomous choice question for each price point so individuals could decide if they wanted to pay each particular price for MRT services. At the end of the individual elicitations, participants were informed that the study team would return to discuss the opportunity to actually use MRT services, and that the participants should use this intervening period to interact with other household members and make their final decision.

[3]Nursery preparation for MRTs is considerably different than what would be undertaken for manual transplanting.

[4]On average, households in our sample owned 2.7 plots.

[5]INR = Indian rupee. At the time the study was conducted the exchange rate for INR to US dollar (USD) was approximately INR 62 per USD.

Activities culminated in May 2015 with household-level BDM auctions. Those members from sample households self-identified as "household heads" were invited to participate in a village-level, collective exercise where they would have an opportunity to actually hire MRT services for their farms.[6] On the day of the auction, the MRT service provider tasked with providing MRT services in the particular sample village visited the village along with the research team. After the research team informed the auction participants about the terms of the MRT services, we implemented the auction and elicited WTP for MRT services on each of his or her plots using the same 14 price points used during individual elicitations. Because of the possibility that the farmers would actually custom-hire MRT services if their WTP was greater than or equal to the village-drawn MRT price, the WTP is a revealed measure of the household demand.[7] In sum, the BDMs and individual-level valuation activities described above provide us with comparable measures of women's, men's, and households' WTP, with the caveat that the individual WTP is hypothetical and thus potentially biased upward.

3 Data and Descriptive Evidence

Table 1 provides a snapshot of the sample households. The vast majority of households (97 percent) are headed by men, who are, on average just under 50 years of age. The female decisionmakers selected for the study are primarily the wives of these household heads. Women in sample households spend, on average, three labor days per acre on transplanting, whereas

[6]The household head is the principal decisionmaker among the co-heads, and typically the person making decisions about transplanting. Although most households' head in the study are men, this aspect of the study is designed to mimic the way MRT services would have been offered to the household, for example by an MRT service provider.

[7]Because the auctions were organized at the village-level (rather than on an individual basis), attrition during this phase of the study was high. From the original set of 965 sample households, only 608 households had a representative attend the auction. The vast majority (92 percent) of those attending the auctions were men. Sample attrition appears to be random on observable household and individual characteristics. There is no significant difference in individual hypothetical valuation or the wealth index between those who attended the auction and those who did not.

men spend approximately five labor days on transplanting activities. On average, sample households also hire seven female and two male laborers per acre for transplanting. The average cost of hiring labor for transplanting alone is greater than INR 600 per acre.

Across the sample, households differ based on the level of hired and family labor used for transplanting. The average cost per acre for transplanting increases as the household shifts away from using family labor to using higher levels of hired labor. As Table 2 suggests, average transplanting costs are approximately INR 825 per acre if the household uses both family and hired labor, and increases by INR 85 per acre if the household does not use any female family labor but relies only on hired labor. Households using hired labor also cultivate more plots as compared to those using only family labor. We construct a household wealth index using factor analysis as an indicator of family's asset levels.[8] Households using more hired labor also rank higher on the wealth index than households using only family labor – an important dimension to consider for adoption of mechanical rice transplanting because women in households who may be most influenced by MRT technology may not be able to afford paying for the technology.

Within a household, women and men vary on several dimensions (Table 3). On average, men are about 4 years older and have 2 more years of education than women. Women and men do not appear to be significantly different on their risk and uncertainty measures.[9] Whereas 93 percent of the men in the sample are involved in agriculture, only 67 percent women are involved in agricultural activities. We constructed a composite index of technological know-how specific to agriculture, and women rank lower on the index as compared to men.[10] Although the overall access to agricultural extension is low for the entire sample, it is lower by

[8]The following variables were used in construction of the wealth index: ownership of cellphones, motorcycle, television units, cable television; expenditure on transport, education, and festival donations; ownership of diesel pump, rotavator, knapsack, and tractor; and the size of land owned (in acres).

[9]Risk and uncertainty are stated measures constructed from responses on subjective questions asked during the survey.

[10]This agricultural technology knowledge index is created as a simple summation of all the agricultural technologies (from a set of 18 technologies widely used among Indian farmers) about which the men and women are familiar.

18 percentage points for women vis-à-vis men. Despite having access to the same household assets, women consider their ability to acquire INR 20,000 cash in an emergency situation to be less than men.

3.1 Within and Across Household Differences in willingness-to-pay

The distribution of women's and men's stated valuation provides the first evidence of potential heterogeneity in individual MRT demand. Figure 1 shows the distribution of plot-level WTP for MRT services after subtracting off the actual manual transplanting cost. The figure shows two types of differences in valuation measures. First, responses in the second and fourth quadrants suggest that women and men clearly disagreed about the value of MRT operations relative to manual transplanting.[11] For example, in the second quadrant, women value MRT services in excess of the actual transplanting costs, while men value MRT services less than the actual transplanting costs. Contrarily, in the fourth quadrant, women value MRT services less than the actual transplanting costs, while men value MRT services in excess of the actual transplanting costs. The second type of variation arises from the extent of deviation from the 45 degree line signifying perfect harmony in men's and women's valuations for MRT services relative to the actual manual transplanting costs. Since the actual manual transplanting costs are the same for both household members, perfect harmony implies that both women and men stated the exact same bid for a particular plot. While there were a surprising number of such occurrences (as indicated by the fairly distinct 45 degree line), the plurality of observations deviated from perfect harmony. Even if both members stated bids that were either greater than or less than the actual manual transplanting cost (bids in the first and third quadrants), the further away their valuations are from the perfect harmony line, the greater is the difference in their individual valuation.

[11] In this figure, we adhere to the standard Cartesian system for numbering quadrants, with the first quadrant being the top right quadrant, and subsequent quadrants following in a counterclockwise fashion.

Table 4 reports the all-plot averages of male and female WTP for MRT services, with households classified based on the composition of their labor used during transplanting. There are clear differences in MRT demand between men and women within the same household, regardless of the composition of transplanting labor. Across the board, women value MRT more than men, regardless of whether they actively participate in transplanting. The difference between women's and men's stated valuation is highest for households using only family labor for transplanting, despite the level of the valuations in these households being lower compared to households that also employ hired labor. The difference in WTP between women and men in this group (INR 89) accounts for 12 percent of the average of mean WTP between men and women.

Consistent with these findings, the household-level valuations elicited during the auctions shows that households relying only on family labor for transplanting have the lowest WTP, at INR 710. Households using both family and hired labor have an average willingness-to-pay of INR 785 and those using only female hired labor have the highest average WTP, at INR 797.

3.2 Bargaining Power of Women

The degree of influence – bargaining power – represents the "voice" an individual member has in influencing joint household decisions, such as the household's decision about whether to adopt a specific agricultural. technology (Carter and Katz, 1997). Bargaining power is unobserved and difficult to identify within a household. Most studies on intrahousehold bargaining have relied on either a cooperative model or an exit model (non-cooperative) to measure bargaining (Manser and Brown, 1980; McElroy and Horney, 1981; Doss, 1996; Zepeda and Castillo, 1997; Kabeer, 1999; Quisumbing et al., 2003). In cooperative models, bargaining power specifies the sharing rule of individual members' contribution to the overall household welfare. Examples of proxies used in these models include whether a woman works for cash income, the share of non-land assets and land area under the woman's control, wage rates, and non-labor income (Smith, 2003; Briere et al., 2003; Gilligan et al., 2014). In non-cooperative models, bargaining power represents an individual's options for exiting the household in the event that conflict arises. Most methods used to capture exit options use variables that are exogenous to the formation of the household, such as differences in age, education, or familial background between the woman and the man at the time of marriage, or the size of the dowry that the women brings to the marriage.

When household decisionmaking pertains to adopting a technology like MRT that may disproportionately affect one member's labor allocation, the decision arguably embodies both cooperation and conflict simultaneously: both individuals want to cooperate in order to maximize household welfare by optimizing technology choice, yet each will independently decide on their individual allocation to transplanting labor such that it maximizes their individual welfare. Sen (1990) posits that bargaining power in such "cooperative conflicts" is a combination of an individual member's (perceived) contributions to the household welfare, exit options, and (perceived) interest or participation in the household activities. Even if these measures are endogenous to household formation, the"perceived" individual role in decisionmaking plays a role in influencing the actual outcomes a household achieves. We use proxies for each of these aspects of bargaining to compute a bargaining power index using principle component analysis. The variables we use are as follows.

- **Perceived contributions:** To capture the level of perceived contributions, we use variables based on whether a woman: has a bank account jointly or alone, takes out a loan jointly or alone, is a part of group and the extent of her participation, is satisfied with her leisure and work allocation.[12,13]

[12]The variables ultimately selected to capture perceived contribution was heavily influenced by the variables used in constructing the Women's Empowerment in Agriculture Index (WEAI; see Alkire et al., 2013), though the empirical approach is different. The WEAI is a composite index designed to measure the influence and the role of women in agriculture and comprises five components (or "domains of empowerment"): role in decisions regarding agricultural production, decisionmaking power in productive activities, decisionmaking on the use of income, participation and leadership in community, and labor and leisure allocation.

[13]A woman's work satisfaction is a binary variable constructed using the actual hours she works and

- **Exit options:** This category uses demographic factors contributing to a woman's household influence when she joined the household, at the onset of her marriage. The variables include the woman's age and education at the time of marriage, her father's caste, and the value of silver, bedding, and cash that she brought as dowry.
- **Perceived interests:** These variables capture a woman's influence in household decisions related to agriculture, productive assets, and income spending. One of the proxy variables is the proportion of agricultural decisions she contributes to from a list of 15 agricultural decisions such as selecting crop variety, selling product to the market, and choosing farm inputs. Another variable captures the proportion of decisions she makes pertaining to making capital investments, buying livestock, and spending remittances. We also use variables on whether the woman feels she has ownership of assets like land, livestock, house, and capital equipment and whether she feels she has the freedom to sell, rent, or buy any of these assets.

Figure 2 shows the distribution of the bargaining index for the three categories of households using hired and family female labor in transplanting. The bargaining index of women in households where they do not participate in transplanting is higher than in households where they are involved in transplanting. This difference may arise not only because women in these households may have better exit options but also because these women may *perceive* their degree of contribution is higher in household activities.

4 Intrahousehold Preference Heterogeneity

As noted above, women value the technology more than men. It is quite possible, however, the difference in valuation is due to differences in women's and men's individual endowments (or characteristics), rather than explicit differences in their preferences regarding the

equals one if it is less than 1.5 times the median hours worked in the sample technology. To test whether these differences persist after controlling for these endowment differences, we decompose the stated difference in MRT valuation between women and men into an endowment differential and a preference differential.

Intuitively, the stated difference between women's and men's MRT valuation contains four differences: the difference due to the varying characteristics of women and men (endowment differential), the difference in valuation assuming women and men are alike in their characteristics but simply have different preferences (preference differential), the hypothetical decision bias if women do not participate in transplanting, and the hypothetical elicitation bias due to the lack of incentive compatibility in the stated valuation. Regarding hypothetical elicitation bias, we assume the cheap-talk and framing techniques discussed above reduced (or in the extreme eliminated) the bias, and further we assume the magnitude of the bias is the same for women and men, thereby negating the effect of this bias in the stated WTP difference. In the following sections, we describe the conceptual and econometric framework for isolating the preference differential from the endowment differential and the hypothetical decision bias. Both the stated MRT valuation difference and the preference differential are relevant for understanding intrahousehold bargaining: the preference differential gives evidence of preference heterogeneity among women and men, whereas the household members negotiate over their actual differences in valuation to arrive at a valuation level for the household.

To isolate the preference differential from the endowment differential, we use the Oaxaca-Blinder decomposition (Oaxaca, 1973). When applied to these data, this method allows us to separate the monetary stated WTP difference into preference and endowment differentials. We also use the hedonic decomposition method to examine differences in non-monetary attribute-based elicitation as a validity check for the monetary *stated difference* (Fortin et al., 2011; Gustafson et al., 2016).

Suppose that $WTP_n,\ n \in \{m, f\}$ is assumed to be a linear and separable function in observable characteristics (X) and unobservable characteristics (ε). Then

$$WTP_{i,n} = X_{i,n}^{'}\beta_n + \varepsilon_{i,n} \tag{1}$$

where β maps individual characteristics into WTP. Note that X, β and ε are indexed by gender (n). For X, this merely reflects the possibility that men and women may differ in their individual observable characteristics. In the case of β, this permits for these observable characteristics to have differential effects on WTP. In the case of ε, this permits unobservable characteristics to have differential effects on WTP. We can write the difference in stated WTP as

$$\begin{aligned}
\Delta_{stated} &= E[WTP_f] - E[WTP_m] \\
\Delta_{stated} &= E[X_f\beta_f + \varepsilon_f] - E[X_m\beta_m + \epsilon_m] \\
\Delta_{stated} &= (E[X_f]\beta_f + E[\varepsilon_f]) - (E[X_m]\beta_m + E[\varepsilon_m])
\end{aligned} \tag{2}$$

Assuming that the average unobservable characteristics $E[\varepsilon_f]$ and $E[\varepsilon_m]$, are constant and equal in magnitude, and after adding and subtracting the average effect of women's observable characteristics under the men's distribution $E[X_f]\beta_m$, the stated difference can be written as follows.

$$\begin{aligned}
\Delta_{stated} &= (E[X_f]\beta_f - E[X_f]\beta_m) + (E[X_f]\beta_m - E[X_m]\beta_m) \\
\Delta_{stated} &= E[X_f](\beta_f - \beta_m) + (E[X_f] - E[X_m])\beta_m \\
\Delta_{stated} &= \quad \Delta_{preference} \quad + \quad \Delta_{endowments}
\end{aligned} \tag{3}$$

Equation 3 gives the proportion of the stated WTP difference resulting from a difference analogous to the unconditional difference in WTP ($\Delta_{preference}$) and a difference in observable characteristics ($\Delta_{endowments}$). The preference differential gives the difference in WTP assuming women and men are similar in their observable and unobservable characteristics. Intuitively, this approach is similar to separating the true treatment effect and the selection bias in the observed stated difference using the potential outcomes framework (Fortin et al., 2011).

4.1 Results: Preference heterogeneity

As has been previously noted, women value MRT more than men based on the stated difference, irrespective of the household's use of hired and family labor, so $\Delta_{stated} > 0$. To operationalize the decomposition, we need to specify the observable characteristics which may reflect the endowment differential. In this application, we use the demographic and agricultural involvement characteristics of women and men. Based on equation (3), we decompose this stated difference in WTP for each farm plot into the preference differential and the endowment differential. Women and men in the sample differ on the individual characteristics we use in the decomposition (see Table 3 and Section 3).

Table 5 reports the results from the decomposition of the stated WTP difference. Several insights can be drawn from this decomposition. First, the results suggest that after accounting for individual differences, the stated difference in WTP for all households is roughly INR 54 per acre. This stated difference in WTP appears to be driven by the stated difference in WTP from households using only family labor for transplanting, which is roughly INR 90 per acre. After controlling for individual characteristics, the differences in stated WTP for households that use a mix of family and hired labor for transplanting are not statistically different from zero at conventional levels. A second important result that emerges is that the preference differential for the full sample (approximately INR 80 per acre) is higher than difference in stated WTP, implying women have strong preference-driven values for MRT that are significantly higher than men. The preference differential is highest for households using only family labor: based only on preferences, the value that women in households that employ only family labor in transplanting place on MRT services is nearly INR 155 per acre more than men. Not only is the preference differential highest for households using only family labor for transplanting, this group also has the lowest average individual valuation compared to the rest of the sample. The average individual valuation is INR 705 per acre, which implies a preference differential accounts for approximately 20 percent of the average WTP. Finally, the the endowment differential shows that men value the MRT technology more than women by about INR 25 per acre, on average. This endowment differential is highest (nearly INR 65 per acre) for households that only use family labor for transplanting, but the men value the technology more than women based on the differences in their characteristics. Under no circumstances, however, is the endowment effect statistically significant, implying that the differences in stated WTP cannot be explained by differences in individual characteristics.

Turning to the factors contributing to the preference and endowment differential, we find that. Individual differences in education and access to extension contribute to the higher valuation of MRT by men. In households where both female family and hired laborers are involved in transplanting, differences in access to extension makes the men value MRT by INR 42 per acre more than women. However, the contribution of these factors differs in the preference differential. Conditional on women and men being alike on their risk preferences, women value MRT by INR 140 per acre more than men. In households where only family labor is involved in transplanting, if women and men were of the same age, men would have valued the technology by INR 420 per acre more than women, which is more than half the average WTP of this group. However, conditional on both women and men being involved in agricultural work, women value the technology more than the men by more than INR 350 per acre.

5 Intrahousehold Bargaining and Household Demand

In this section, we use stated WTP values to assess the bargaining power of men and women when it comes to binding household decisions. We begin by supposing that the household's demand for the technology is influenced by information exchanges between the man (m) and the woman (f) within the household, and with others (o) outside the household. Let WTP_f and WTP_m represent the woman's and the man's valuation, respectively, and let WTP_o capture the valuation of others outside the household. Let the function γ_f represent the weight of a woman's valuation – her "voice" or "standing" – in the household's demand for the technology. Similarly, γ_m denotes the weight of a man's valuation in the overall household demand, and γ_o denotes the weight of the valuation of others outside the household. When $\gamma_f = 0$ and $\gamma_m \neq 0$, only the man's valuation of the technology plays a dominant role in the household's demand for the technology, with the woman's valuation having no weight in the decision.

The overall household demand for the technology, as captured by the household's willingness-to-pay (WTP_h), is

$$WTP_h = \gamma_f WTP_f + \gamma_m WTP_m + \gamma_o WTP_o \quad (4)$$

We assume that γ_f is a function of, among other things, the woman's bargaining power. Suppose B_f represents the bargaining power of the woman. In a general household decision, $\gamma = \gamma_0 + \gamma_1 B_f$, where γ_0 represents the degree of a woman's influence on the decision based on whether the task falls under her sphere of influence and $\gamma_1 B_f$ captures the additional influence on the decision due to her bargaining power. While γ is a function of the bargaining power of the woman in the decisions that the man and woman jointly make in the household, the role of bargaining power comes into play especially in the context of MRT because MRT adoption may significantly influence a woman's farm labor allocation. Depending on the level of a woman's involvement in the household's transplanting activities (denoted by T), she may be disproportionately vested in the household's decision to adopt the technology and exercise her bargaining power when she transplants.[14] We re-write γ as a linear and separable function of these three components:

$$\gamma_f = \gamma_0 + \gamma_1 B_f + \gamma_2 B_f T \tag{5}$$

This composition of γ_f ties in closely with the concept of bargaining described in Section 3.2, in which a woman's overall influence on household decisions comprises her exit options (analogous to γ_0), her perceived contributions capturing the weight of her opinion (analogous to γ_1), and her perceived interests capturing whether transplanting falls under her domain of interest (analogous to γ_2).

Because technology adoption decisions are presumably made by men regardless of their transplanting labor allocation, and because there is no reason to believe that the influence of outsiders' valuation is conditional on other characteristics, we assume that γ_m and γ_o are simply scalar weighting parameters rather than functional weighting parameters. Equation 4 is then re-written as follows.

$$WTP_h = (\gamma_0 + \gamma_1 B_f + \gamma_2 B_f T) WTP_f + \gamma_m WTP_m + \gamma_o WTP_o \tag{6}$$

Equation 6 shows the conduits through which information exchanges within a household and with others outside the household influence the household's demand for the technology. Particularly, the relative magnitude of the γ_f allows us to test the degree of influence a woman has in household decisionmaking for MRT with respect to her bargaining power and labor allocation in transplanting.

[14] In the Indian context, agricultural technology adoption decisions fall predominantly under the man's sphere of influence in a male-headed household. Even when the woman has information about the transplanting technology (because of the information treatment given to the woman and the man in the household), if she does not participate in transplanting, she may not be inclined to participate in the adoption decision and exert her bargaining power in altering the household's demand for the technology.

Equation 6 forms the basis of the econometric estimation. Even though we have measures of WTP_f and WTP_m, we do not have an exact measure of WTP_o. We construct a proxy of outside women's demand measure $WTP_{f,o}$ and outside men's demand $WTP_{m,o}$ for each household as an inverse distance-weighted average of other women's and men's stated demand within the same village. The proxy assumes sample outsiders living close to a given household exert a higher influence on the household's WTP than those living further away. However, it is likely that $WTP_{f,o}$ and $WTP_{m,o}$ are endogenous with WTP_f and WTP_m if household location is non-random and individuals live at a given distance to others due to non-random reasons. To avoid this endogeneity issue, we estimate the model without any measure of WTP_o and test whether endogeneity is of concern.

In addition to the individual and outside demand variables, the differences between the experimental auction and the stated valuation procedures could have also influenced the household demand. Individual and household demand elicitation activities were different on three key fronts. First, the service provider was present during the auctions and not during the individual elicitations. Second, auctions were held in the presence of other study participants and followed a different method than individual elicitations, even though we elicited the actual household demand by asking the same question. Third, individual elicitations were hypothetical, so the members may have not fully internalized their household's income constraints. In order to account for these differences, we include the following variables in the estimation: whether the household knows the service provider, whether the auction participant understood the auction procedure, whether a household is upper caste, and the household's wealth index. We also included the plot's area (in acres) as a control variable.

We estimate the following equation.

$$WTP_h = [\gamma_0 + \gamma_1 B_f + \gamma_2 T + \gamma_3 B_f T] WTP_f + \gamma_m WTP_m + \gamma_{o,f} WTP_{o,f} + \gamma_{o,m} WTP_{o,m} + X'\alpha + \epsilon \tag{7}$$

where X represents the vector of methodological and control variables influencing household demand, α is the vector of coefficients we estimate for these controls, and ε captures the hypothetical bias or the measurement error in the estimation.

5.1 Results: Intrahousehold Bargaining and Household Demand

Table 6 shows the estimation results of the basic household model in Equation 4. The influence of a woman's WTP on the household demand when she is involved in transplanting is estimated as $\hat{\gamma}_0 + \hat{\gamma}_1 E[B_f] + \hat{\gamma}_2 E[B_f]$, where $\hat{\gamma}_0$ is the parameter estimate of her WTP, $\hat{\gamma}_1$ is her bargaining power's estimated influence, $E[B_f]$ is the mean bargaining power, and $\hat{\gamma}_2$ is the estimate of her bargaining power when she transplants. When she does not transplant, $\hat{\gamma}_2$ is 0. Table 8 shows the estimated weight parameters for women and men for households using hired and family labor. Panel A in Table 8 shows the estimated influence parameters based on the estimation of specification 1 in Table 6. The difference between men's and women's influence is 0.16 when women transplant, but men's influence is even higher ($\gamma_m - \gamma_f = 0.22$) in households where women do not transplant. Both differences in men's and women's influence are statistically significant, irrespective of their transplanting status.

We next estimate the full model as shown in Equation 7. Due to the potential endogeneity between individual WTP and the inverse-distance weighted WTP of other women and men in the village, we estimate the model after dropping these two variables. For the full model, a women's influence when she transplants is estimated as $\hat{\gamma}_0 + \hat{\gamma}_1 E[B_f] + \hat{\gamma}_2 + \hat{\gamma}_3 E[B_f]$. $\hat{\gamma}_2$ and $\hat{\gamma}_3$ are 0 when she does not transplant. Table 8, Panel A shows the influence parameters from the estimation of Table 7, specification (1). Whereas women's influence is lower by 0.39 as compared to men's when she transplants and is statistically significant, the difference lowers to 0.09 when she does not transplant, and is not statistically significant. This result contrasts the results obtained from the base model when women who did not transplant had a lower influence as compared to women who transplanted.

We examine the differences based on the household's use of hired and family labor. Women's influence on the household's MRT demand for each household group is estimated as follows.

$$\hat{\gamma}_f = \hat{\gamma}_0 + \hat{\gamma}_1 E[B_f] \tag{8}$$

Here $E[B_f]$ is the average bargaining index for each household group. The influence parameters estimated using specification 2, 3, and 4 in Table 6 are shown in Table 8, Panel B. The difference between men's and women's influence is the highest in households where women transplant, and is statistically significant ($\gamma_m - \gamma_f = 0.81$). Recall, women in this household group were willing to pay more for MRT compared to the men amongst all the household groups based on the composition of transplanting labor. Men's influence is about 4 times that of women's influence in households using both hired and family labor. The weight of a man's WTP is also higher than that of woman's WTP in households using only hired labor, but the difference is not statistically significant.

The influence parameters obtained from specification 2, 3, and 4 in the full model (Table 7) are also shown in Panel B, Table 8. Women's weight parameter in the full model for each household group is also estimated using Equation 8. Women living in households using only their labor have less influence as compared to the men, although the difference is not statistically significant. Women in households hiring transplanting labor also have a lower influence as compared to the men, but this difference is also not statistically significant. The difference in influence is highest amongst households using both hired and family labor. Here the difference in men's and women's influence is 0.22 and is also statistically significant. Because there are few observations in households using family labor only, when we combine households using any family female transplanting labor, we find the difference between the influence of women's and men's WTP on household MRT demand is statistically significant and increases to 0.24. Overall, these results show even though women's WTP is higher as compared to the men, their influence is lower as compared to the men's influence on household WTP.

We also run alternative specifications of the bargaining model to verify the robustness of the results. We estimate the bargaining model after including all the zero cases discussed in Section 3.1. We use different proxies of the bargaining index to capture exit options, *perceived interests*, and *perceived contributions* separately. We also restrict the sample to men and women who are husband and wives. All these robustness checks do not change the main findings of bargaining models significantly.

6 Intrahousehold Differences in Welfare

In this section, we analyze the welfare implications resulting from the women's and the men's individual MRT demand. We examine the heterogeneity in two welfare measures due to intrahousehold differences in MRT valuation: cash savings from hired female labor displacement and female family labor saving from their labor displacement. As discussed in section 4, the overall demand for MRT varies both across and within households based on the composition of labor used for transplanting. Figure 3 illustrates the heterogeneity in MRT demand across households for women and men based on the various compositions of labor during transplanting. Across these different household types, adoption of MRT – even if hired in from a service provider rather than being purchased – would displace some of the labor employed during transplanting. For households that employ only household labor for transplanting, for example, adoption of MRT would reduce the quantity of household labor used in transplanting. As we see in this figure, MRT demand increases progressively as households use a greater share of hired labor for transplanting. Households using only family labor have the lowest aggregate household and individual demand for MRT as compared to those using hired labor also.

Using these individual demand measures, we construct the amount of cash savings households receive from custom-hiring MRT services for different prices instead of using hired labor to transplant manually. Figure 4 shows the level of cash-saving for households using both family and hired labor and hired labor exclusively. The cash savings from women's and men's MRT demand is statistically indistinguishable, especially when MRT price is below INR 1000 per acre.[15] In addition to displacing hired labor, MRT adoption also reduces unpaid female family labor. Figure **??** depicts the reduction in family labor days from MRT adoption for households using only family labor and those using both family and hired labor. There is no statistical difference in family labor saving resulting from women's and men's MRT demand amongst households using family labor only for MRT price below INR 1000 per acre. However, for the same price range, women in households using both hired and family labor tend to select plots that save 114 more labor days, on average, than those chosen by men. Because this group of households use about 4 family labor days per acre, on average, this labor saving translates to a willingness-to-pay roughly INR 190 per day more by women. Average women's wage in the study area is INR 133 (ranging from INR 80 – INR 200) and the average men's wage is INR 175 (ranging from INR 100 – INR 250). This implies that women are willing to pay a little more than their wage and about the same as men's wage, on average, to reallocate labor away from transplanting. Even though women and men in this group do not have a statistically different willingness-to-pay for MRT (after controlling for individual differences) or the level of cash savings from hired labor displacement, women tend to save significantly higher level of their unpaid family labor as compared to men.

[15] The average cost of transplanting using hired labor exclusively is INR 910 per acre.

6.1 Potential Drivers of Women's MRT Valuation: Drudgery and Wages

As the analysis suggests, not only do women have a higher willingness-to-pay for MRT vis-à-vis men, but they also tend to select plots that save their unpaid labor more as compared to those chosen by men. Women may choose to lower their labor in transplanting in order to reallocate it to other unpaid and, perhaps, less arduous family work or engage in other wage work. In order to examine the potential drivers of women's valuation, we divide the sample of women working on their own farm into two groups: women working exclusively on their own farm and women working as hired farm laborers also during transplanting. Women in 180 households work on other people's farm and earn an average of INR 110 per day. Approximately 37 percent of women in households using only family labor work on other's farm during transplanting, and about 38 percent women in households using both family and hired labor engage in other paid farm work. The MRT valuation of women in these two groups is not statistically different amongst households that use only family labor for transplanting. However, women who work on other farms in households using both hired and family labor value MRT less by about INR 160 per acre as compared to those women who do not work outside. Moreover, the valuation of men is statistically indistinguishable from that of women who work outside during transplanting. The valuation of women working exclusively on their farm is higher by roughly INR 70 as compared to their male counterparts amongst these households, suggesting women's shadow value of their own time is higher than the men's valuation.

A comparison of the plots that the two groups of women would have chosen also suggests that women may value MRT more in order to avoid the drudgery of transplanting activities. Figure **??** shows the female family labor saving by women working as hired laborers versus women working exclusively on their family farm amongst households that use both family and hired labor. While there is no statistical difference in labor saving between women working outside and the men in those households, women not working outside choose plots that save 91 more labor days as compared to their male counterparts for MRT prices below INR 1000 per acre.

7 Conclusion

In this paper, we show that labor displacement induced by mechanization of gender-specific agricultural activities may in fact lead to intrahousehold heterogeneity in demand amongst potential adopters of the technology. These results suggest three broad implications for the labor welfare effects of mechanization. First, the research highlights the importance of improving women's bargaining power and raising their earning potential outside of transplanting, irrespective of whether MRT displaces women's unpaid or paid labor. The study's sample only includes rice-cultivating households — the potential adopters of MRT. The research design does not provide any information about hired laborer's MRT demand and the influence of MRT diffusion on their farm and off-farm work. Even if MRT adoption implies women losing wages, an overall improvement of women's bargaining power allows them to have greater control over their unpaid and paid labor allocation decisions.

Second, the heterogeneity in intrahousehold demand suggests both women and men should be included in extension efforts that provide information about new agricultural technologies. Even though the analysis shows men exert a higher influence relative to women in the household's technology adoption decisions, the results should be interpreted with caution because the research project had provided the first MRT exposure to these households. We cannot yet reject the possibility that women's valuation may eventually guide the household's adoption decision. If agricultural mechanization particularly influences women's labor allocation, then greater effort should be made to inform them of the technologies that could be beneficial to their household's production activities.

Finally, higher levels of MRT adoption may push women into more traditional gendered labor divisions, which may influence women's wage rates and bargaining potential in rural employment sectors. If households adopt MRT in order to reduce the drudgery of transplanting, then MRT adoption may limit women's work to only unpaid family house work and, in turn, lower their "voice" and mobility. Future work on this topic can explore the linkages between women's bargaining power and labor displacement. Although the ability to engage in activities outside of transplanting may be associated with an improvement in bargaining, this displacement may also lower their bargaining power if it reduces women's mobility and autonomy. Eswaran et al. (2013) find supporting evidence that when women withdraw from agricultural work to engage in "family status" production due to agricultural productivity gains, they lose their individual autonomy. These "family status" activities include providing greater attention to children, preparing nutritious meals, and improving the family's social capital. Another extension of the present research can examine the interaction between female and male wage rates and women's labor displacement, especially because women's and men's labor are not perfect substitutes in the Indian agricultural context. Mahajan and Ramaswami (2017) show that while women's labor supply does not influence male wage rates, men's labor supply has a significant effect on the female wage rates. If women's displacement from labor-intensive agricultural tasks implies a greater proportion of men working on the farm, such a shift in farm production technologies can influence the relative wage rates of women and men. Ultimately, this massive exit of women from agricultural labor markets has long-run implications for women's participation in remunerative employment, welfare, and empowerment.

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Table 1: Summary Statistics: Household Characteristics

Variable	**Mean**	**Std. Dev.**
Household Composition		
Age of household head	47.95	13.79
Sex of household head	0.97	0.16
Household size	6.08	2.95
Percent of household in agriculture	0.44	0.24
Household is nuclear	0.74	0.44
Percent husband-wife in sample	0.87	0.34
Household is upper caste	0.25	0.43
Household has Below Poverty Line ration card	0.44	0.5
Agricultural Characteristics		
Household owns agricultural land	0.82	0.39
Area owned (in acres)	1.64	3.89
Area cultivated (in acres)	1.28	2.27
Number of plots	2.7	2.0
Transplanting Cost and Labor-use		
Transplanting cost per acre †	614.92	753.53
Female family labor per acre	3.15	6.04
Male family labor per acre	4.86	6.17
Female hired labor per acre	6.96	12.16
Male hired labor per acre	1.96	6.77
N	965	

† Transplanting cost per acre only includes cost of hiring laborers for transplanting. It does not include any nursery or family labor-use cost.

Table 2: Descriptives: Labor-use in Transplanting

	Family labor only	Family & hired labor	Male family & hired labor
Number of plots	2.33	2.71	4.03
	(1.69)	(1.48)	(17.33)
Plot area (acres)	0.65	0.62	0.83
	(1.75)	(0.53)	(1.17)
Wealth Index	-0.37	-0.19	0.37
	(0.47)	(0.63)	(1.17)
Transplanting cost per acre	0	826.22	910.4
	(0)	(712.62)	(759.61)
Family female labor per acre	9.1	3.89	0
	(8.87)	(5.83)	(0)
Family male labor per acre	8.02	4.28	3.3
	(9.06)	(4.09)	(4.08)
Hired female labor per acre	0	10.18	7.92
	(0)	(15.4)	(10.41)
Hired male labor per acre	0	2.03	2.79
	(0)	(5.42)	(4.79)
Bargaining Index	-0.64	-0.46	0.78
	(0.74)	(0.93)	(1.34)
Observations	153	362	331

Standard deviation in paranthesess

Table 3: Individual Differences Within a Household

	Female	Male	Difference	t Statistics
Individual Characteristics				
Age	43.8	47.8	-4.0***	(6.54)
Education (years)	2.6	4.6	-2.0***	(6.64)
Literacy (percent)	.36	.71	-0.35***	(16.19)
Member of a group (percent)	.21	.03	0.18***	(-12.94)
Uncertainty index	.36	.32	0.04	(-1.80)
Risk	5.3	5.3	0.08	(-0.90)
Agricultural Involvement				
Involved in agricultural work (percent)	.67	.93	-0.26***	(15.09)
Involved in transplanting (percent)	.69	.76	-0.07***	(3.32)
Agricultural technology Index	24.6	29.6	-5.1***	(14.01)
Accessed extension last year (percent)	.03	.21	-0.18***	(12.71)
Access to Credit				
Have a bank account (percent)	.41	.66	-0.25***	(11.31)
Have a loan (percent)	.07	.05	0.02	(-1.84)
Credit worthiness (Rs.)	13145.1	33015.5	-19870.5***	(8.12)
Time Allocation				
Hours spent on household chores	7.4	5.2	2.2***	(-19.77)
Hours spent on farm work	1.9	3.3	-1.4***	(12.26)
Hours spent on leisure	2.3	2.4	-0.08	(1.19)

t statistics in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 4: Women Value MRTs More Than Men Based on their Stated willingness-to-pay

Composition of transplanting labor	Female (WTP_F)	Male (WTP_M)	$WTP_F - WTP_M$	Plot Observations
Family only	750	660.19	89.19**	236
Family & hired	867.57	818.90	48.67*	680
Male family & hired	965.2	915.135	51.11**	720
Overall	891.77	841.64	50.12***	1700

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Oaxaca-Blinder Decomposition of Individual Valuation

	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Equation 1 : Differential (FIWTP - MIWTP)				
Female Mean	890.39***	746.15***	867.26***	964.51***
	(19.36)	(52.29)	(30.24)	(29.30)
Male Mean	836.34***	655.82***	818.98***	907.83***
	(22.50)	(56.55)	(35.94)	(33.90)
Difference	54.05**	90.33*	48.28	56.69
	(23.95)	(52.04)	(37.28)	(38.97)
Equation 2 : Endowment Differential				
Age	0.36	12.48	-5.43	5.15
	(4.75)	(12.72)	(5.67)	(9.09)
Education (years)	-10.86**	6.40	-0.40	-11.82
	(5.41)	(16.65)	(8.04)	(7.53)
Involved in agricultural work(=1)	16.02	-14.92	2.03	15.88
	(11.06)	(16.87)	(14.56)	(21.55)
Accessed extension last year (=1)	-29.72***	-42.17	-41.74***	-23.23
	(9.85)	(30.27)	(13.34)	(16.79)
Risk	-0.00	-7.06	1.98	0.66
	(0.07)	(13.31)	(2.88)	(4.29)
Technology index	-0.55	-31.64	17.57*	-1.97
	(8.72)	(31.76)	(9.63)	(15.52)
Credit worthiness	-0.72	12.42	8.34	9.12
	(5.90)	(19.39)	(9.24)	(10.59)
Total	-25.46	-64.50	-17.65	-6.21
	(18.79)	(59.52)	(24.64)	(31.21)
Equation 3: Preference Differential				
Age	-1.59	-420.59**	27.28	82.48
	(88.61)	(205.19)	(133.86)	(144.78)
Education (years)	9.58	-3.74	20.69	-2.61
	(19.13)	(27.12)	(23.34)	(37.53)
Involved in agricultural work(=1)	45.39	351.25*	-84.81	27.20
	(88.71)	(199.43)	(185.18)	(103.08)
Accessed extension last year (=1)	-2.79	-3.75	-4.13	-7.45
	(5.67)	(16.34)	(11.24)	(7.39)
Risk	140.09*	262.86	100.17	250.81**
	(73.96)	(179.46)	(125.53)	(102.75)
Technology index	-63.07	-47.39	62.78	-253.77
	(103.29)	(264.11)	(159.19)	(162.69)
Credit worthiness	7.86	-84.82	3.44	20.18
	(8.57)	(57.08)	(26.73)	(12.81)
Intercept	-55.95	101.03	-59.50	-53.95
	(181.90)	(489.57)	(291.03)	(255.74)
Total	79.51***	154.84*	65.92	62.90
	(30.67)	(84.45)	(43.72)	(49.58)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at household level in parentheses

Table 6: Women Have a Lower Influence vis-à-vis Men in Household MRT Demand: Basic Bargaining Model

Dep: Auction WTP	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Male Individual WTP	0.44***	0.89***	0.37***	0.32**
	(0.08)	(0.10)	(0.07)	(0.13)
Female Individual WTP	0.25***	0.07	0.08	0.56***
	(0.08)	(0.15)	(0.09)	(0.19)
FWTP × Bargaining index	-0.05*	0.01	-0.01	-0.06*
	(0.02)	(0.10)	(0.05)	(0.03)
FWTP × Bargaining index × Women Transplants (=1)	0.07			
	(0.06)			
Outside Male WTP	0.17	0.17	0.32	0.04
	(0.15)	(0.21)	(0.35)	(0.13)
Outside Female WTP	0.31*	0.07	0.36	0.21
	(0.16)	(0.20)	(0.32)	(0.15)
Observations	575	66	219	272

Standard errors in paranetheses clustered at village-level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Bargaining Model of Household Demand

Dep: Auction WTP	(1) All	(2) Family labor only	(3) Fam. & hired	(4) Male fam. & hired
Male Individual WTP	0.25***	0.09*	0.15***	0.28***
	(0.04)	(0.05)	(0.06)	(0.05)
Female Individual WTP	0.22**	0.14	-0.07	0.35***
	(0.10)	(0.17)	(0.08)	(0.13)
FWTP × Bargaining Index	-0.07**	0.11	0.00	-0.11***
	(0.04)	(0.18)	(0.04)	(0.04)
FWTP × Women Transplants (=1)	-0.27***			
	(0.10)			
FWTP × Bargaining index × Women Transplants (=1)	0.06			
	(0.05)			
Women Transplants (=1)	255.94**			
	(130.04)			
Bargaining Index	24.20	-97.08	-15.98	90.07*
	(39.34)	(219.09)	(77.83)	(53.34)
Knows service provider	72.34	184.70	122.33	14.16
	(54.59)	(253.91)	(105.10)	(69.24)
Understood auction	-10.27	-97.30	31.34	-58.22
	(141.96)	(128.24)	(84.53)	(218.87)
Plot area (acres)	13.00	-30.60	39.25	16.38
	(10.30)	(49.19)	(33.54)	(11.53)
Household is upper caste (=1)	81.17	68.01	306.98**	6.82
	(61.26)	(352.84)	(144.76)	(76.59)
Wealth index	-8.45	-204.67*	11.75	-12.77
	(21.44)	(109.40)	(72.60)	(22.39)
Constant	515.17**	680.64	674.39***	496.57
	(232.43)	(614.25)	(193.03)	(330.46)
Observations	575	66	219	272

Standard errors in paranetheses clustered at village-level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Household-level random effects used

Table 8: Influence of Women and Men in MRT Demand

PANEL A		
	Base Model	Full Model
Men	.44	.25
Women when she transplants	.28**	-.14***
Women when she does not transplant	.22*	.16

PANEL B				
	Base Model		Full Model	
	Female	Male	Female	Male
Family labor only	.07***	.89	.06	.09
Hired & family labor	.08***	.37	-.07***	.15
Hired labor only	.51	.32	.25	.28

Chi-squared test *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Intrahousehold Heterogeneity in Distribution of Individual willingness-to-pay

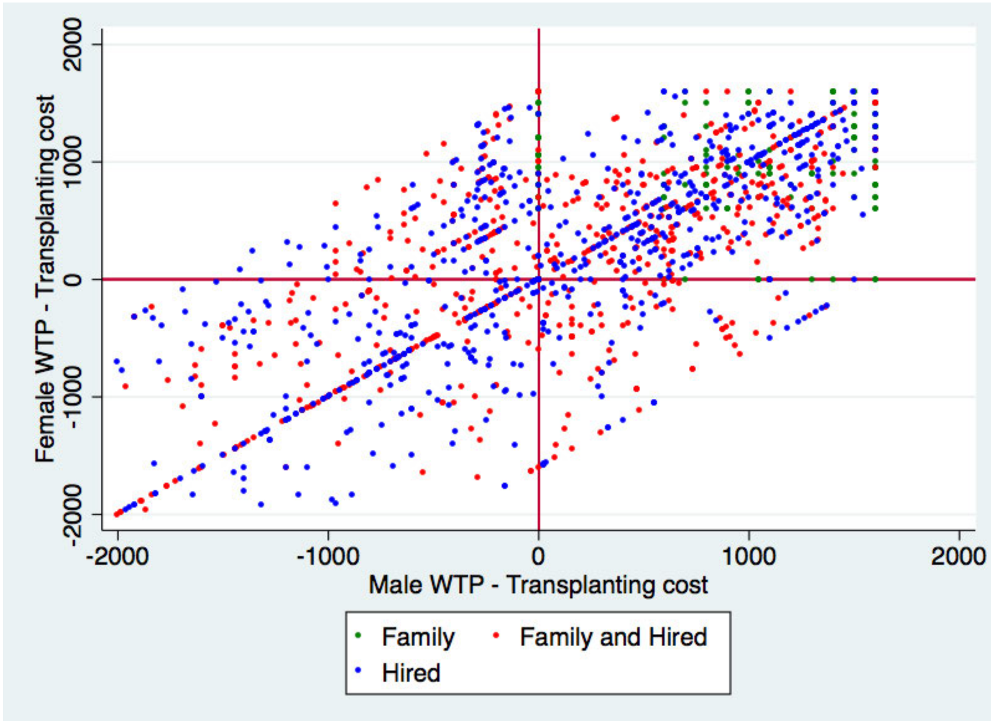


Figure 2: Bargaining Index for Different Labor-use Categories

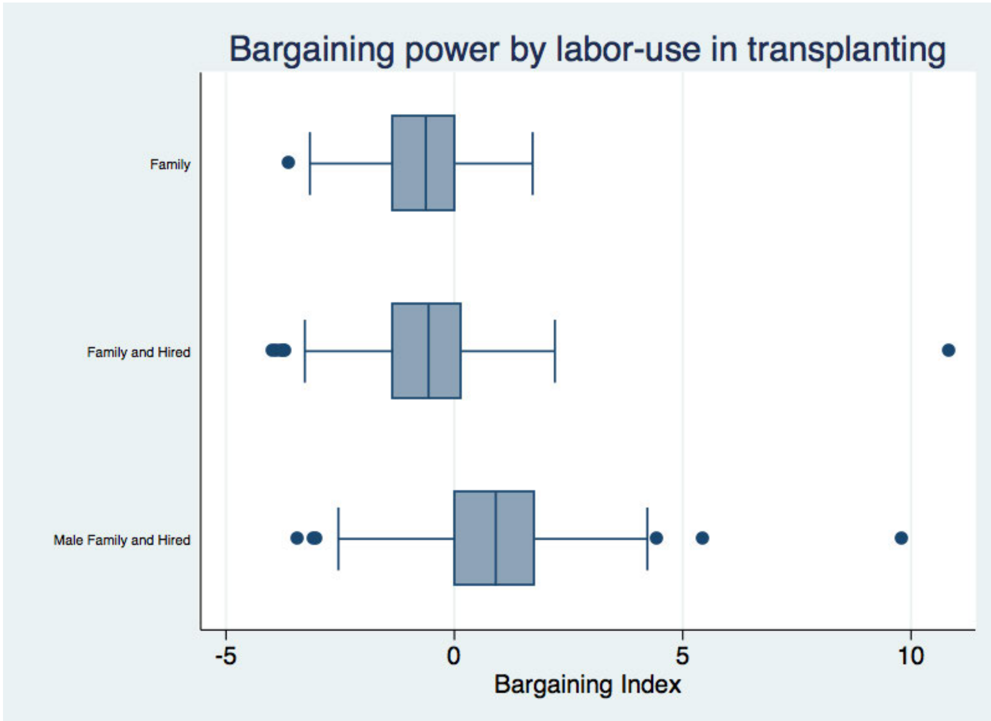
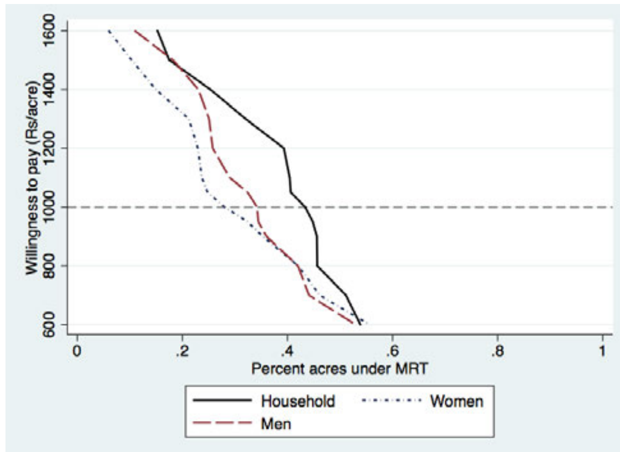
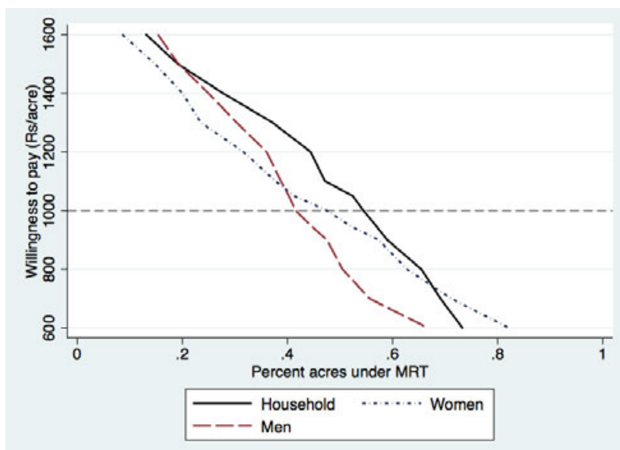


Figure 3: MRT Demand Based on Family and Hired Labor Displacement

(a) MRT Displaces Family Labor



(b) MRT Displaces Family & Hired Labor



(c) MRT Displaces Hired Labor

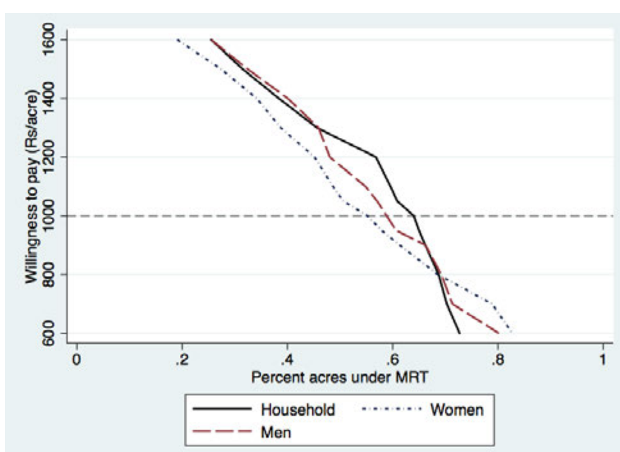
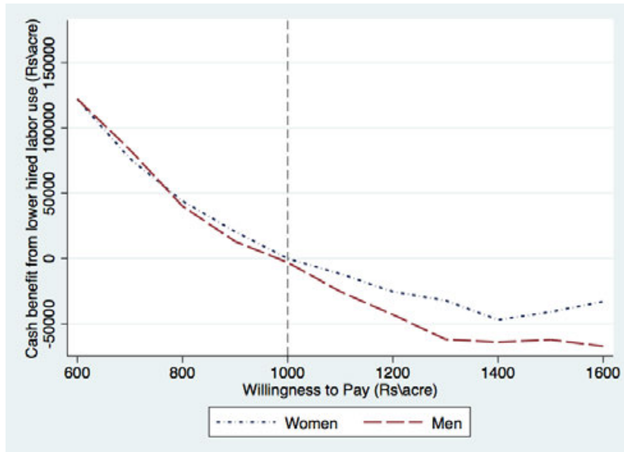


Figure 4: Cash Saving from Hired Labor Displacement from MRT Adoption

(a) MRT Displaces Family & Hired Labor



(b) MRT Displaces Hired Labor

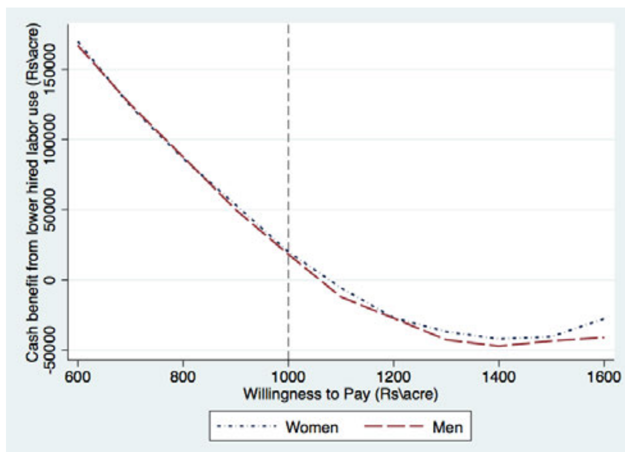
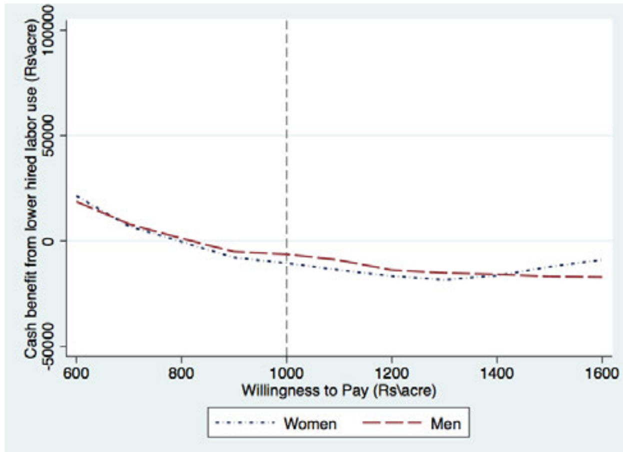
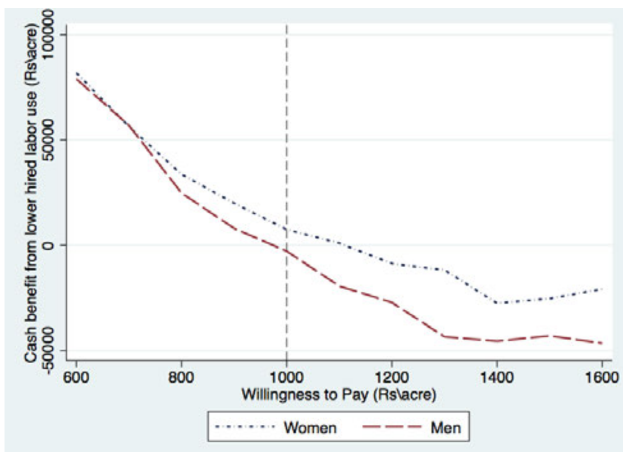


Figure 5: Cash Saving When Women Work as Family and Hired Labor

(a) MRT Displaces Female Family Labor Working as Hired Laborers



(b) MRT Displaces Female Family Not Working as Hired Laborers



Appendix A. Timeline of Field Activities

2015							
Wheat Season						Rice Season	
January	February	March	April	May	June	July	August
Service Provider Survey	Village Selection	Baseline Survey	Individual Demand Elicitation	Auctions		MRT Service Provision	
	Sample Selection	Individual Survey					

Appendix B. willingness-to-pay for the Technology on Different Plots

Own valuation of MRT (Rs/acre)															
	Plot ('name')	*Size (ac)*	600	700	800	900	950	1000	1050	1100	1200	1300	1400	1500	1600
A.			√	√	√	√	√	√							
B.			√	√	√										
C.			√	√											