Do Sharing Rules Affect Technology Adoption?
The Role of Intra-household Income Transfers
in the Adoption of Improved Maize Varieties in Mozambique
Job Market Paper

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Abstract

In credit constrained agrarian households in much of sub-Saharan Africa, resource transfers between spouses provide key incentives for intra-household economic cooperation given individual property rights over household income streams. My novel empirical estimation shows that the limited liability structure of transfers in Mozambican households would provide wives little incentive to supply more labor to new, male-controlled agricultural technologies that improve average returns, but which increase downside risk due to their capital intensity. Absent an efficient labor response, the full benefit of crucial, yield enhancing technologies, like improved maize varieties, risks remaining untapped. I conduct a lab-in-the-field game with asymmetric information to explore whether transfer functions are sufficiently elastic to induce wives to increase their supply of labor to risky, but more profitable technologies. I elicit wives' labor allocation to their husbands' maize production, given the income sharing rules husbands choose in Old technology (low productivity) and New technology (high productivity) experimental frames. I find no effect of the New technology on wives' labor, despite the increase in incentives husbands provided. Husbands prove willing to depart from the empirical sharing rule when returns to labor are known and sharing rules are private, which suggests that factors besides husbands' knowledge may constrain sharing in real life.

This research was pre-registered with the American Economic Association's RCT registry under ID AEARCTR-0014775 and received ethical approval from the University of California, Davis Internal Review Board, ID 2156679-1. This research was funded by the Feed the Future Innovation Lab for Markets, Risk & Resilience and made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents of this publication are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. I am grateful for the invaluable guidance provided by Michael Carter, Stephen Boucher and Ashish Shenoy, for the meaningful contributions of Jonathan Malacarne, Jon Einar Flatnes, Anujit Chakraborty, Arman Rezaee, Marco Castillo, Diana Moreira and Giuseppe Ippedico, and for the research management of Lourenco Manuel and Luis Bota. All errors are my own.

1 Introduction

In much of sub-Saharan Africa, Green Revolution technologies have not yet taken hold in smallholder agriculture. A large share of poor, capital-constrained agricultural households still cultivates local or first-generation varieties of key food staples, thus eking out very low yields. Fortunately, improved varieties of staple crops that offer greater average returns are increasingly available in rural markets. Nevertheless, the relative capital intensity of new cultivars increases downside risk; so while productivity enhancing varieties would optimally engender a shift in labor from risk neutral adopters, risk averse households might divert labor to safer activities instead.

This paper provides an understanding as to how intra-household dynamics may exacerbate the risk-induced allocative inefficiency that capital-intensive technologies can generate. These dynamics are particularly relevant in developing economies, where imperfect labor markets and credit constraints necessitate a reliance on household labor for agricultural production. Household cooperation in production need not imply that its product is held communally, however, as individuals often exercise property rights over productive assets and their rents. In many agrarian societies in sub-Saharan Africa, for example, men not only decide which varieties and inputs to adopt, but also, control income from plots that do not specifically belong to their wives. While a unitary household that has a single decision-maker and pools resources might seamlessly reallocate labor in response to a technology induced change in its risk-return trade-off, seminal work by Udry (1996) cautions that individual property rights regimes may entrench misallocation within a household's portfolio.

Assuming that wives enjoy some autonomy in allocating their time, husband-to-wife income transfers provide a key modality by which husbands incentivize wives' effort in male-controlled production, which wives provide at the expense of their own activities. In principal, husbands cannot contract wives' effort, given that it is infeasible to devise enforceable contracts that stipulate how wives perform delegated tasks (Williamson (2000)), though husbands can contract on observable agricultural output, sharing income or crops with their wives. Because agricultural output is a stochastic function of labor and other inputs, contracts governing the intra-household allocation of resources must balance the costs of wives' risk bearing against the incentive gains that result. These costs may be particularly high in settings where women's socially constructed caring and expenditure responsibilities implicate them as the providers of "last resort" and generate strong incentives to self-insure. Yet if income sharing rules have been optimized for lower risk, lower return technologies, contractual stickiness could dampen an efficient labor response in households that adopt a risky, but profitable technology, leaving the full scope of its benefits untapped.

This paper investigates how intra-household income sharing responds to technology adoption. My first contribution is the novel survey data I collect on husband-to-wife income transfers in Mozambique. To my knowledge, this is among the first datasets to link transfers to agricultural production, thus enabling estimation of an empirical transfer function, or intra-household contract. I find that transfers increase in maize yields over the first tercile and level off for the top two thirds of the distribution of maize yields, where maize is the primary consumption and market

crop. The transfer function I estimate invokes a limited liability contract in that husbands default on the fixed transfer when they cannot meet their transfer obligation to their wives. This contract exposes wives to downside risk, and second, suggests that wives' expenditures increase little with husbands' positive productivity shocks, all else equal. Its structure intuitively would provide wives little incentive to shift their labor to technologies that improve average returns, but which decrease downside risk due to their capital intensity. Additionally, I find no significant difference in the transfer function parameters that I estimate separately for households who have adopted improved maize seeds.

These findings motivate exploration of whether transfer functions are sufficiently elastic to incentivize wives to increase their labor supply to risky, but productive technologies. I thus conducted a framed field experiment with 540 couples to study how intra-household resource allocation responds to a change in technology. I exposed each couple to an Old and then New frame, where the simulated cultivation of improved maize in the New frame featured greater expected returns to wives' labor, increased variance of maize income, and greater downside risk relative to the local, unimproved variety that was cultivated in the Old frame. The expected yields of both varieties, as well as input costs and prices, were carefully calibrated to mimic mean maize growing conditions in sample communities.

Couples played an incentivized, resource allocation game with asymmetric information under both frames. The husband first declared how he would share his stochastic maize income with his wife in all states. The wife then reacted privately by choosing how much labor to allocate to her husband's maize production versus a safe, fixed outside option. The wife's labor choice determined the conditional probability distribution from which maize income was drawn. Payouts were paid for a randomly selected frame, enforcing the contract. The within-subjects experimental design eliminated selection in the adoption decision and thus enables a causal interpretation of the effect of adopting the New technology on wives' labor supply decisions and husbands' sharing rules.

I find that intra-household resource allocation is quite inelastic in response to an increase in labor productivity. Wives did not increase labor to maize production, despite an increase in incentives provided by husbands. Husbands proved willing to depart from the limited-liability empirical sharing rule, choosing contracts that shared income at a rate of 25% on average, across both technologies. For a selfish, risk neutral wife, the incentives embedded in the median New technology contract were predicted to have induced a 59% increase in wives' labor, relative to the Old technology. Differences in within-game versus empirical sharing rules may imply that factors besides husbands' knowledge of when and how to provide incentives constrain sharing in real life. One such factor could be the costs husbands incur when deviating from norms that stipulate how much financial autonomy or responsibility wives should have. For example, husbands may derive prestige from limiting their wives' financial independence. By studying the effect of the game treatment on income sharing outside the game using endline data that will be collected in 2026, I hope to provide evidence on the relevance of norm costs in curbing husbands' provision of incentives.

Meanwhile, stickiness in wives' labor response points to a new barrier that may constrain the

optimal exploitation of profitable technologies. Wives tendency to over-allocate labor under the Old technology relative to the incentives they are provided, taken together with the lack of correlation between wives' labor supply and different measures of incentives, could indicate that wives feel obligated to supply a particular quantity of labor, irrespective of their husbands' sharing rule, but are loathe to supply any more, despite the economic rationale to do so. An alternate explanation is that wives who participated in the game may have perceived a difference in their husband's ability to expropriate money that he was certain of having transferred, compared to outside earnings whose value was unknown to husbands.

I contribute to four strands of literature. First, I contribute to the literature on intra-household resource allocations. I connect to the vast literature on bargaining within the household started by Manser and Brown (1980), McElroy and Horney (1981) and Chiappori (1992). As reviewed by Buchmann et al. (2025) the main frictions considered to date in this literature are limited commitment, with transfers within the household determined by the outside options of both spouses, and private information within the household. The hiding of income (Hoel (2015); Boltz et al. (2019)), spending (De Laat (2014)), and savings (Anderson and Baland (2002); Ashraf (2009); Dupas and Robinson (2013); Schaner (2015)) has been well documented, while a nascent literature has considered the implications of different preferences on information diffusion within the household (Apedo-Amah et al. (2020); Ashraf et al. (2022)).

I present empirical and theoretical evidence that income transfers as a function of stochastic output provide wives incomplete incentives, given private information within the household. I am able to reject the explanation that husband's knowledge of how to provide incentives explains the incomplete incentives that I document empirically.

Second, I contribute to the literature on reputation inside the household. Reputation concerns have been proposed as an explanation for intimate partner violence (Tauchen et al. (1991)), whereby husbands can have a strategic incentive to build a reputation as non-lenient and thereby dissuade certain behaviors. They have also been proposed as an explanation for low rates of technology adoption by wives, whose incentive to cultivate their reputation as savvy investors and resulting risk aversion serves to protect their flow of transfers from husbands (Buchmann et al. (2025)). My finding that husbands are willing to share income in a lab-in-the-field game in departure from empirical sharing rules suggests that husbands do not appear to be bound by the concern that wives will exploit their relative generosity in future negotiations.

Third, I contribute to the literature on gender norms. Gender norms have been proposed as drivers of women's labor market engagement (Field et al. (2021)), as well as harmful behaviors like child marriage, even where these may be misperceived (Bursztyn et al. (2020)), or where individuals favor deviating from the norm (Cassidy et al. (2024)). The literature further considers gender norms as a source of market failure in their own right (Fiala et al. (2017); Bakhtiar et al. (2022)).To my knowledge, this is the first paper to suggest that the structure of wives' state contingent payment schedule itself constitutes a gender norm that may matter for the design of social policies.

Fourth, I contribute to the literature on the role of intra-household dynamics on technology

adoption (Carter and Katz (1997); Gulati et al. (2024)) and on the distributional effects of technology adoption (Katz (1995)).

The remainder of this paper proceeds as follows. Section II presents the novel evidence that motivated the paper. Section III presents theoretical insights on the impact of the empirical sharing rule on productive efficiency. Section IV describes the framed resource allocation experiment, designed to estimate the elasticity of the intra-household allocation of resources, given technological change. Section V presents results. Section VI tests for heterogeneity by household familiarity with improved maize varieties, for which I am able to instrument using randomized receipt of a voucher for an agricultural input bundle. Section VIII concludes.

2 Motivating Evidence: intra-household Dynamics and Technology Adoption

This section provides evidence of the key stylized facts that motivate this paper. First, I describe the organization of small-holder production in Mozambique and its reliance on household labor, and wives' labor in particular. Second, I document the ubiquity and economic importance of husband-to-wife income transfers. Third, I link my novel survey data on transfers to household agricultural production, enabling estimation of a stochastic household transfer function, whose structure, I show in section 3 might contribute to the low adoption of productivity enhancing technologies.

2.1 Organization of smallholder agriculture in Mozambique

The insights, presented in this paper, on the role of intra-household income sharing rules in household labor allocation and technology adoption, draw on household characteristics and gender norms among rural households in the province of Manica in Mozambique that were enumerated by Malacarne et al. (2025). The panel survey, administered annually from 2022-2024, follows 1,120 maize growing households. The sample comprises 14 households from each of 80 communities that are distributed across 5 districts in Manica.

Tables 16 and 17 in the Appendix present descriptive statistics from the 2023 survey. Average landholdings in the sample are 1.1 hectares. Maize represents 70% of cultivated area and contributes 60% of household income, and 80% of income in households that rely exclusively on agricultural income. Only 30% of the sample cultivated an improved variety of maize on at least some of their land, while the remaining 70% cultivated local, open-pollinated varieties of maize. Local varieties lack specific genetic modifications designed to increase yields or mitigate climate risk. Average maize yields are 500 kilograms per hectare on average, which represents less than 30% of the yields attained by regional seed producers on demonstration plots. The low agricultural productivity of these households is evidently a function of low rates of and partial adoption, as well as a near total reliance on rain-fed irrigation and the use of chemical or animal fertilizers by less than 5% of households.

The table speaks both to the importance of household labor for agricultural production and women's significant contribution of labor to agricultural production. Households that hire agricultural labor still supply 70% of all labor themselves. Women supply 32% of household labor in agriculture, compared to the 41% supplied by men. Despite wives labor contributions, the data evidence husbands' control of decisions around agricultural technology adoption, and management more generally. In 92% of households that comprise a husband-wife unit, men generally decided what to plant and what inputs to buy for the household's most important maize plot. 53% of married women state that cash crop farming decisions are taken only by men in their households, while only 5% say that only women take related decisions in their households.

The novel survey data I collect suggests that husbands' obligation to transfer income to their wives is characterized by limited liability, insofar as husbands transfer less when they produce less, but that transfers level off even as output increases. I observe household-level adoption and production decisions, as well as yields, income, and food security across a panel that will be repeated annually over four years.

2.2 Economic importance of transfers

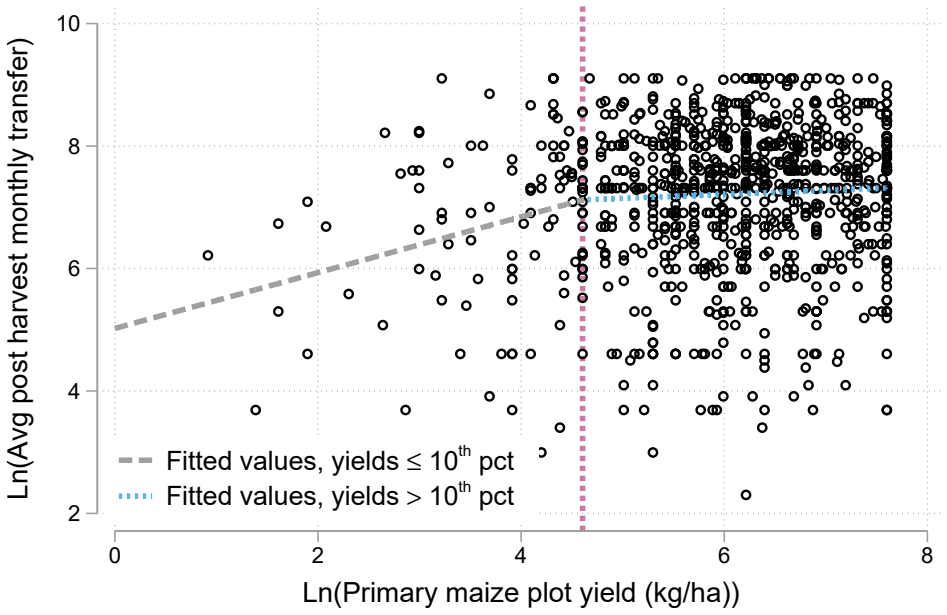
A novel survey module I developed, which elicits detailed information on monetary transfers from husbands-to-wives, was enumerated as a part of Malacarne's panel data collection in 2023 and 2024. The module recalls three distinct types of transfers from the previous twelve months: 1) transfers for routine household expenditures, 2) discretionary transfers not for routine household expenditures, and 3) lump sums that were transferred from relevant sources of the husband's income or husband's and wife's joint production. The thee-part methodology was designed to accommodate multiple models of household finance, including those where husbands frequently provide income for specific expenditures or at the wives request, as well as models in which wives receive a share of their husbands' income, which they manage to cover their expenditure responsibilities.

Table 16 reports that wives received 450 USD annually, on average. This represent 64% of husbands' 702 USD annual income from sole and joint income generating activities. A regression of total monthly transfers on month dummies (see Table 11 in the Appendix) provides no statistically significant evidence of seasonality in transfers, though the coefficient on June, the month in which most households first harvest dry maize is large and positive, and the coefficient on May, potentially the last pre-harvest month in many households is negative relative to the January base year.

2.3 Transfers as incentives

In what follows, I provide descriptive evidence of the relationship between income transfers from husbands to wives and with output from households' primary maize plots. Maize yields are a useful proxy for agricultural output at the household level given that maize is the primary crop cultivated by sample households and is the largest source of crop income. Furthermore, agricultural production is the primary income generation activity to which husbands and wives jointly contribute labor, and husbands and wives jointly provide labor to maize in X % of sample households. Taken together,

Figure 1: Transfer function fitted values | Transfers > 0



Transfers are top-coded at the 98th percentile.

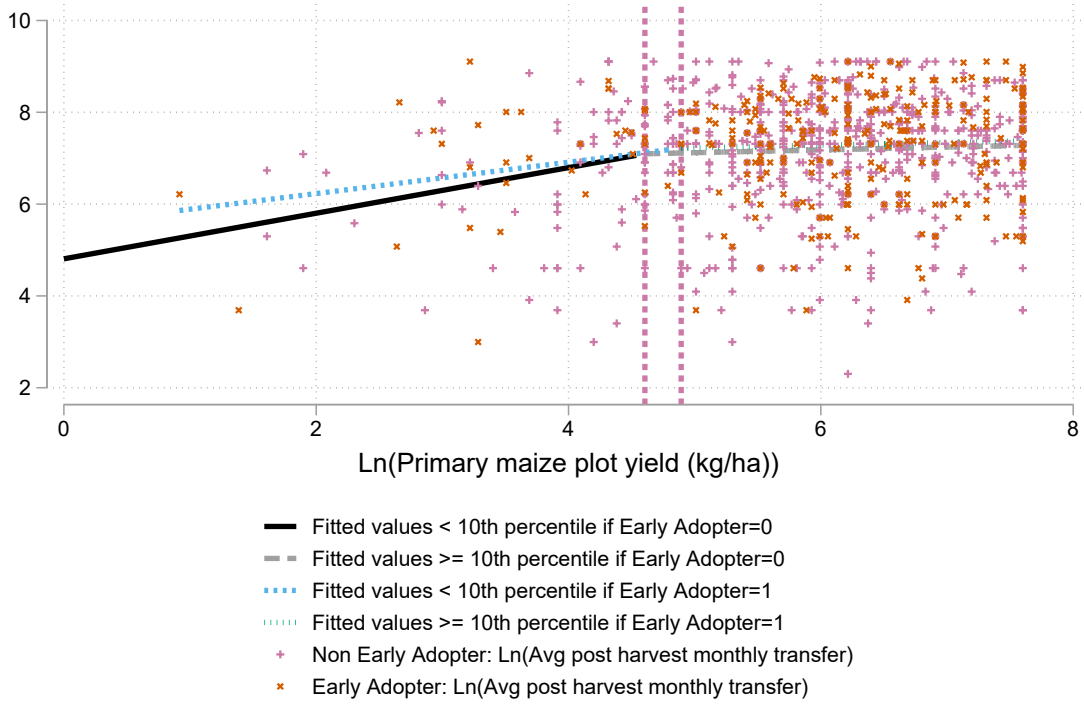
these facts suggest that the provision of incentives would have a strong economic motivation in maize production.

Figure 1 plots fitted values from the segmented regression

$$y_{it} = \beta_0 + \beta_1 \text{plot yield}_{it} + \beta_2(\text{plot yield}_{it} - \theta)\mathbb{I}(\text{plot yield}_{it} > \theta) + \boldsymbol{\beta_3'}\mathbf{X}_{it} + \epsilon_{it} \tag{1}$$

for household i in survey round t. To investigate whether transfers exhibit limited liability for negative shocks to production, I estimate the correlation between primary maize plot yields and average monthly transfers below and above threshold, θ. I define θ as the 10^{th} percentile of the log of primary maize plot yields, but later estimate θ using the data. Here, my choice of θ is theoretically motivated, and redroughly corresponds to the percentage of households comprising a husband and wife that experienced food insecurity in a given survey round. As women are generally responsible for household food expenditures in Central Mozambique, food insecurity is an obvious predictor of differential transferring behavior and thus provides a starting point to test for threshold effects. Later, I present results in which I also estimate θ. To estimate the differential effect of yields on transfers above the threshold, given by β_2, I interact primary maize plot yield, which I center at θ, with an indicator that is equal to one if the primary plot yield is greater than θ. I control for a vector of household characteristics, $\mathbf{X}$, which, theoretically, might co-determine output and transfer behavior, including total land holdings, non-labor agricultural expenditures per hectare, and the number of both household adults and children. I focus on the intensive margin of transferring and

Figure 2: Transfer function fitted values by adoption of improved maize seed | Transfers > 0



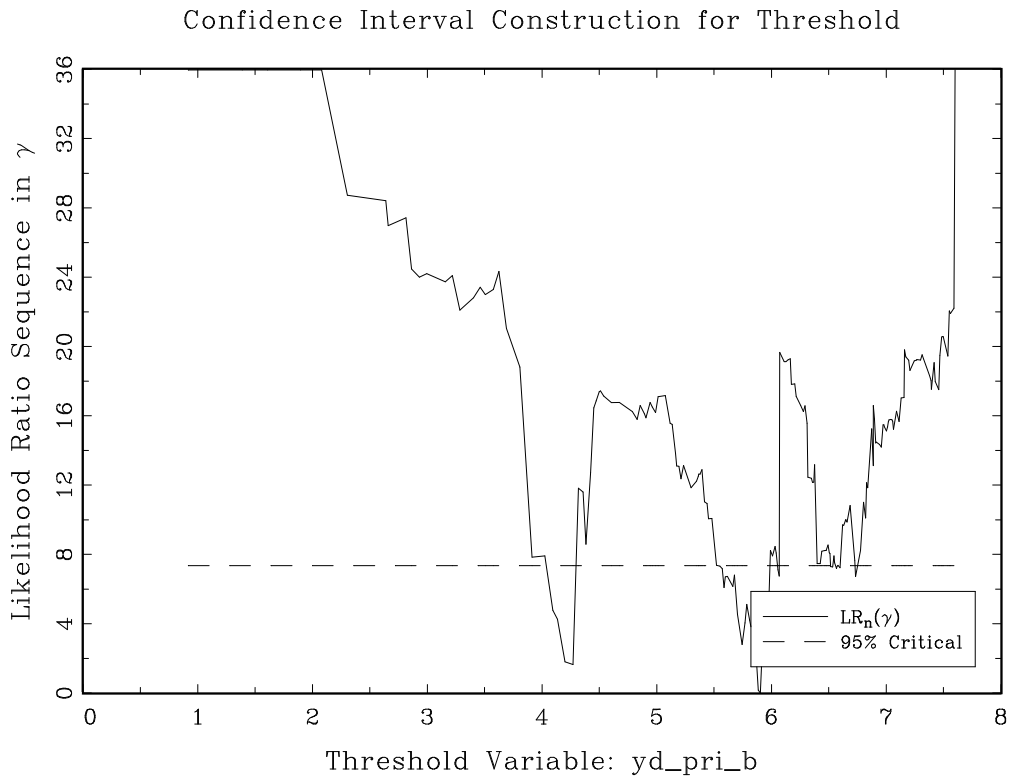
thus restrict my analysis to households in which husbands transferred positive income to their wives in the last twelve months.[1]

As reported in column 6 of table 18 in the Appendix, I find that a 10% increase in the yield of the primary maize plot is associated with a 4.5 % increase in monthly transfers for the tenth percentile of yields, and a 0.6% increase for yields above the tenth percentile, ceterus parabus. Both slope parameters are statistically significant at the five percent level. I reject the null hypothesis of equality of β_1 and β_2 at the one percent level and fail to reject the null hypothesis that $\beta_1 + \beta_2 = 0$. The grey dashed line in Figure 1 plots $y_{it} = \hat{\beta}_0 + \hat{\beta}_1 \text{plot yield}_{it}$, while the blue line plots $y_{it} = \hat{\beta}_0 + \hat{\beta}_1 \text{plot yield}_{it} + \hat{\beta}_2(\text{plot yield}_{it} - \theta)$. These estimates suggest that husband-to-wife transfers fail to insure wives against negative shocks to maize output and that benefits to wives from positive shocks to output, in terms of wives expenditures and savings, reach their maximum at a rather low level of output. As a robustness check in Appendix table X, I estimate equation 1 but relating wives average monthly transfers to jointly produced agricultural income. Though these income data are substantially noisier than our data on maize yields, the finding that transfers level off beginning at the 10th percentile of joint agricultural income holds.

It is important to note that the households plotted in figure 1 are heterogeneous in their adoption

[1]Restricting the data in this way further enables me to exclude households in which husbands never provide income transfers, though I am unable to distinguish such husbands from those whose zero transfers were state contingent, as under limited liability.

Figure 3: Test statistic of threshold estimates



The independent variable is the logarithm of primary maize plot yield (kg/ha).

of improved maize varieties. Cultivators of improved varieties (30% of the sample) versus local varieties obtain significantly higher yields and are more likely to use complementary inputs like fertilizers and tractors, as summarized in table 19 in the Appendix. Despite the implied difference in labor productivity across these types of households, the relationship between husband-to-wife transfers and maize output is largely similar. As figure 2 illustrates, both functions are non-increasing in yields for positive shocks. Importantly, wives continue to contribute an important share of labor even in households with more capital intense production, which suggests that at this scale of production, adopting households are not yet increasing their reliance of non-household labor to an extent that providing incentives to wives no longer matters.

The striking similarity across transfer functions suggests that sharing rules may change little, even when a productive technology increases returns to labor, and presumably, a principal's returns from strengthened incentives. In section 3, I provide a theoretical exposition of the role of the empirical sharing rule in allocating household labor. Further, I present simulations that show how the empirical sharing rule can generate productive inefficiency where a New technology improves average returns while increasing downside risk.

2.3.1 Threshold estimation

I test for the existence of a threshold in my data, following an empirical literature (Carter et al. (2007)) that relied on Hansen (Hansen (2000)) to test for the presence of an asset threshold as it relates to differentiated coping strategies. The estimation method tests each possible threshold value θ, by splitting the sample into upper and lower regimes around each θ and testing whether splitting the sample at θ is statistically significant as compared to a null hypothesis that no such threshold exists. I graph the relevant test statistic against the support of primary maize plot yield, shown on the horizontal axis. For values of the test statistic below the dashed horizontal line, which is the 90% critical value of the test statistic, I can reject the null. The preferred estimate of θ is the yield with the lowest value of the test statistic. If a sharp discontinuity separates regimes of the data, the graph will reflect this with a sharp v-shaped pattern in the test statistic. A less precise discontinuity might yield a flatter, or u-shaped relationship.

As can be seen in figure 3, the test statistic for reduced transfers reveals a relatively sharp discontinuity, with candidate threshold values ranging from about 60 (exp[4.09]) to 837 (exp[6.73]) kilograms per hectare. The best estimate is a threshold of 365 kilograms per hectare (exp[5.9]). While somewhat higher than the ad hoc threshold used in figures 1 and 2, splitting the data at this point reveals a much stronger difference in the effect of yield on transfers in high versus low regimes. Furthermore, a higher threshold implies that husbands default on their transfer responsibilities even for relatively higher yields, which would imply that default is a concern for wives in a greater subset of households, potentially lending even greater significance to wives' valuation of downside risk.

3 Theoretical insights on the impact of empirical sharing rules on productive efficiency

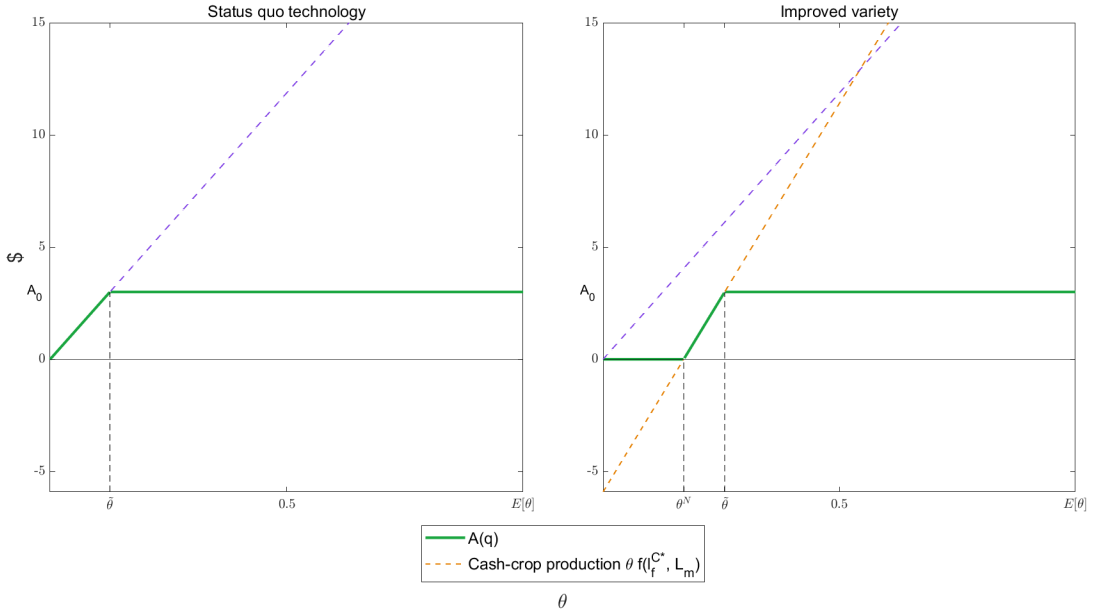
In this section, I consider the theoretical implications of the empirical sharing rule I estimate in Section 2.3 for the intra-household allocation of labor, given adoption of technologies that improve average returns, but which increase downside risk due to their capital intensity.

Assuming that agricultural production is a multiplicative function of a uniformly distributed random variable, θ, and production technology f, downside risk intuitively increases in the value of the investment because a better productivity shock, or yield, is needed for investing households to break even and earn positive income. The first key insight obtained from considering an increase in downside risk in the context of the limited liability that characterizes empirical husband-to-wife transfers is that wives face an increased probability of receiving low levels of transfers in households where transfers are constrained by the husband's agricultural income.[2] Thus, in states with low output, wives' may find themselves with less in the way of transfers than had their husbands not invested in improved technologies.

I glean a second theoretical insight by considering the interaction of the flat region of the transfer

[2]Wives report that transfers increase in maize production in X percent of the couples who participate in the experimental game that is the centre piece of this paper, which suggests that maize income constrains transfers.

Figure 4: Stochastic maize production and transfers given fixed labor



function and the greater probability of higher levels of output that an increase in productivity connotes. The constancy of transfers over the upside of production implies that wives' derive equal transfer benefits from 10th percentile yield realizations as from better yields. To preview the implications of flat transfers for wives' labor supply decisions, transfers over this range provide no marginal incentives for wives to supply effort that makes higher yields more probable, except where that effort increases the probability that wives receive their maximal transfer.

Figure 4 illustrates the dual features of the empirical sharing rule that curtail wives' benefits from profitable, but risky technologies. Both panels depict agricultural income, which is a function of the random variable, θ, and labor, as well as husband-to-wife transfers, which are a function of agricultural income. The left panel depicts a technology with relatively low productivity whose cost is negligible, as is the case with local varieties of maize seed which are recycled from year to year. The key feature of this stylized representation of the empirical sharing rule is that transfers are positive, even for low levels of output. In contrast, the relatively high cost of a more productive technology implies that transfers are strictly positive only for higher values of the productive shock, that is for $\theta > \theta^N$. Though the technologies in the right panel are calibrated such that wives receive their maximum transfer for realizations of the random variable that are greater than under the lower productivity technology. It is of course possible to imagine a technology that is a steep enough function of θ such that wives would obtain their maximum transfer for $\theta < \tilde{\theta}$; nevertheless, the high cost of capital will still give rise to states in which wives would have received positive transfers under the Old technology, but receive none under the very productive technology.

Finally, figure 4 shows clearly that across technologies, wives' labor supply decision has little

effect on the benefits she derives from the upside of production. Graphically, the rotation of either production function counter-clockwise in line with an increase in wives' effort serves only to increase the support of θ for which wives receive their maximum transfer.

In what follows, I show that the efficiency cost of resource allocation in a non-unitary, separate spheres household, increases with the adoption of a productivity enhancing, yet costly technology. As formalized by Carter and Katz (1997), the separate spheres household is the site of independent preferences and resource allocation decisions. In the Mozambican context, heterogeneous preferences, and especially, attitudes towards risk can be understood as the byproduct of wives' socially constructed responsibility for household reproduction and its related expenditures. The independent resource allocation decisions that distinguish the separate spheres household flow from individual property rights over specific streams of income and individuals' autonomy in allocating their labor. Given the choice to allocate labor to their husbands' risky agricultural production versus a safe, but low return activity, women's caring responsibilities may provide strong incentives for them to self-insure, that is, to invest in low risk activities that enable them to smooth household consumption. Though information asymmetries foreclose the direct contracting of household labor, income transfers play a key role in inducing members to modify their labor allocation decisions, in this case, towards husbands' risky agricultural production.

4 Experimental design and procedures

To study the adjustment of the intra-household allocation of resources given adoption of a risky, but profitable technology, I conducted a framed field experiment with 496 maize producing couples in central Mozambique. To construct the sample, I randomly selected 20 of the 40 villages that comprise the sample of an ongoing agricultural panel study in southern Manica province (Malacarne et al. 2025). Of the 14 participating households in each village, those with a married couple were invited to participate in the experiment. Additional married couples were randomly selected from village lists of maize producers to yield a total of 28 couples per village.

Table 20 in the Appendix provides summary statistics for participating couples. Couples have been married for 23 years and have X children on average. 74% of couples have children under 10 years living in the household. 90% are monogamous. Husbands are 50 years old on average and have 5 years of education, while wives are 40 years old on average and have 2 years of education. 56% of wives reports having earned off-farm income in the last 12 months, and 34% report owning part of the household's land holdings solely. Wives report receiving an average of X per month in transfers from their husbands. Relative to the 800 couples that comprise Malacarne's panel, game participants are 9 percentage points more likely to grow improved maize, and have considerably larger land holdings. Nevertheless, they obtained lower maize yields in 2024 relative to Malacarne's sample. The two samples are indistinct in husband's control over agricultural production decisions.

4.1 Intra-household resource allocation game

The experiments were designed to closely mimic the reality of small-scale maize production. In the study area, maize is the most common crop and is an important source of income for small-scale farmers. The Malacarne et al. survey data reveal that sample husbands and wives invest near equal amounts of labor in maize production, though husbands control maize income. Maize production thus provides a natural setting in which to explore intra-household labor contracts. Finally, sample households are generally aware of the existence of high productivity technologies in the context of maize production, namely improved maize seeds, many of which are commercially available in the study area. Study activities were framed using realistic production costs and returns. Participants were told that they had two hectares of land that could yield a maximum of 100 bags of maize (5 tons), valued at 100,000 meticals ($1,565) when cultivating a local maize variety.

The decisions taken by couples in the experiments provide a stylized representation of an intra-household contract. Husbands first declare how they will share their maize income with their wives in all states of the world. Transfers in each state cannot exceed maize income, thus the contracts husbands offer exhibit limited liability. Wives react privately by choosing how much effort to allocate to maize production versus an outside option for which they receive a private, risk-free wage. As couples keenly appreciated, good harvests are not guaranteed. Possible maize harvests ranged from zero to 100 bags of maize in a first scenario, and from zero to 180 bags in a second scenario. Maize output was a stochastic function of effort. In particular, the wife's decision to devote 2, 3, 4, or 5 days per week to maize determined the conditional probability distribution from which her husband randomly selected his maize income. The greater the number of days a wife chose to allocate to maize production, the greater her husband's expected maize income. To conclude, husbands drew a maize income at random and monetary payouts were made enforcing the intra-household contract.

4.2 Experimental technological frames

Couples undertook the sequence of decisions under two scenarios. In the first, couples cultivated low productivity maize, and in the second, they cultivated high productivity maize. Comparing intra-household contracts across scenarios reveals the extent to which households coordinate to exploit a profitable technology.

The low productivity maize variety in the first scenario closely approximated open-pollinated, local maize varieties that are familiar to sample producers. In the experiment, the cost of low productivity maize seed was zero, reflecting the assumption that seed is recycled from previous harvests. The improved maize variety, whose introduction in the second scenario represents an exogenous positive shock to household production, mimics high-yielding hybrid maize varieties, which have seen low levels of adoption. The cost of planting two hectares with 50 kilograms of improved maize seed was 20,000 meticals ($313). Couples were told they would purchase the improved seed on credit from an agro-input dealer who had first claim on output. As such, net maize income in all states was non-negative and voluntary default was not possible.

Table 1: Old Technology

Maize gross income state and probability											
Maize Days	Wage Income*	0	200	400	800	1,200	1,600	2,000	Expected Income	Unitary CRRA Range	Prop. in sample
2	120	5%	20%	20%	30%	20%	5%	0%	679	$(0.834, \infty)$	0.11
3	80	5%	15%	15%	30%	25%	10%	0%	788	–	
4	40	5%	10%	15%	25%	30%	15%	0%	878	$(-\infty, 0.835)$	0.89
5	0	5%	10%	15%	25%	30%	10%	5%	898	–	

*All financial values given in Meticals per week.

Table 2: New Technology

Maize gross and net income state and probability														
Maize Days	Wage Income*	0 0	200 0	400 0	800 400	1,200 800	1,600 1,200	2,000 1,600	2,400 2,000	2,800 2,400	3,200 2,800	3,600 3,200	Expected Income	Unitary CRRA Range	Prop. in Sample
2	120	5%	0%	10%	15%	20%	20%	15%	10%	5%	0%	0%	1,019	$(0.9, \infty)$	0.11
3	80	5%	0%	10%	10%	15%	15%	20%	15%	10%	0%	0%	1,199	–	
4	40	5%	0%	5%	10%	10%	15%	15%	20%	15%	5%	0%	1,439	–	
5	0	5%	0%	5%	5%	10%	10%	15%	15%	20%	10%	5%	1,679	$(-\infty, 0.895)$	0.89

*All financial values given in Meticals per week.

The returns to an additional day of the wife's labor were greater in the second scenario for all labor allocations. This implied that the efficiency loss associated with diverting effort from maize production was much greater under the high productivity scenario. However, in the second scenario, a better draw was needed to earn positive maize income net of the cost of the high productivity maize seed. Specifically, the probability of drawing zero maize income was two to three times greater than in the low productivity scenario, depending on the wife's choice of effort.

The low productivity scenario presented couples with the risk-return tradeoffs shown in Table 1. As can be seen from the table, a risk-neutral unitary household that maximized the utility of their payoff would choose to allocate 4 days to maize production. However, increasing risk aversion would lead to diversion of effort to the risk-free wage labor activity. The last column in Table 1 shows the range of risk aversion coefficients that corresponds to each labor choice, assuming constant relative risk aversion preferences.

The high productivity scenario presented couples with the risk-return tradeoffs shown in Table 2. A risk-neutral unitary household would optimally increase effort in maize production to 5 days per week.

The 40 meticals ($0.63) daily wage was low relative to the marginal revenue product of the wife's labor in maize production, even in the low productivity scenario. This reflects the limited outside options available to women in the study area. It further heightened the wife's tradeoff in the high productivity scenario. Finally, the low wage helped to ensure variation in wives' optimal choice of effort even where husbands offered contracts with low levels of profit sharing, as observed in the pilot and now in the experimental data.

4.3 Experimental procedures

Sample couples were invited to join one of two sessions conducted per day, each lasting 3.5 hours. Before introducing the maize production experimental frame, all participants undertook an individual risk preference elicitation exercise. They also answered questions about how much they gave their wives (received from their husbands) per week on average in past years with very bad, poor, normal and good harvests. Couples then played the labor contracting game, first in the low productivity scenario, and then, in the high productivity scenario.[3] All instructions were presented in Portuguese with the aid of a posterboard displaying the possible maize incomes and their associated probabilities for each choice of effort. Following the experiments, participants completed a short survey that elicited information on demographics, past investments, recent experience with negative shocks and understanding of the game.

The elicitation of average weekly transfers in past years served to encourage husbands to think of within-experiment transfers as they would transfers outside the game.[4] To strengthen the framing and encourage husbands to declare contracts that reflected their knowledge of their wives' preferences, wives were assigned an expenditure responsibility of 100 meticals ($1.56) per week for household expenses that they could satisfy with their combined transfer and wage income. This framing draws from survey evidence that transfers for routine household expenditures account for most husband-to-wife transfers in sample households. To calculate wives' payoffs, 100 meticals were subtracted from their total income.

At the beginning of each session, participants were provided with game sheets on which enumerators recorded their decisions, outcomes, and payoffs. During the instruction for each scenario, participants practiced drawing tokens from each of 4 bags, each corresponding to a different choice of effort and each containing 20 colored tokens representing different harvest outcomes. Couples first played non-incentivized practice rounds before playing for potential payoffs in each scenario.

To ensure the anonymity of wives' effort diversion choices, husbands and wives were physically separated for the duration of game play. Enumerators circled between husband and wife to elicit and record each spouse's decision. Wives chose among 4 bags that were labeled with the number of tokens of each color and the income associated with each color. Husbands then selected a token from an unlabeled bag.

To incentivize careful game play, supervisors paid participants in cash based on their earnings from a randomly chosen scenario. Each spouse's net income from the chosen scenario was divided by 4 to compute cash payouts. Total payouts, including a show-up fee of 50 MT per spouse, ranged from 50 MT ($0.78) to 850 MT ($13.30). The average payouts were 260 MT ($4.07) for husbands

[3] I did not randomize the order of the low and high productivity technologies, which implies that couples' behavior in the second scenario may reflect learning in the first scenario. The experimental design is an analogue for households who adopt improved maize seed for the first time, having previously produced local varieties. Indeed, less than one third of study participants cultivate improved maize.

[4] Data on transfers under different harvests further allows the identification of households in which monetary transfers are characterized by limited liability as in the experiment. Husbands in this subset of households bargain in the game just as they do in real life.

and 126 MT for wives ($1.97).

The experimental protocol was first tested with graduate students in Davis, California and then in 21 pilot sessions in non-sample villages.

4.4 Predictions under benchmark models of the household

4.4.1 Unitary model

Before analyzing the empirical effect of the experimental change in technology on wives' labor allocation, it is useful to consider the optimal responses of wives in two distinct unitary household, both of which seek to maximize pooled income, but which differ in their risk aversion. Wives in risk neutral unitary households are predicted to allocate labor where its expected marginal return is greatest, which is to say that the distribution of income declared by husbands has no bearing on the ultimate allocation. Under the Old technology, the expected returns to the second, third and fourth days of maize labor exceed wives' outside option; however the household gains less in expectation from allocating wives' fifth day to maize than the outside option would pay. Thus, a household that efficiently allocates labor to maximize total household income would choose four days under the Old technology. Under the New technology, in contrast, the expected marginal return from allocating the fifth day of wives' labor to maize production exceeds the wage; thus allocative efficiency prescribes allocating all of wives' time endowment to maize production.

Convexity in the utility function of risk averse households induces labor allocations that facilitate income smoothing, at the expense of greater expected value. Under both technologies, the single labor allocation that guarantees a positive payout in all states is two days. Assuming that the unitary household has standard CRRA preferences

$$U(x) = \frac{1}{r} x^{\frac{1}{1-r}}$$

wives in unitary households with $r \in (-\infty, 0.835)$, that is, risk seeking households as well as households that exhibit considerable risk aversion are predicted to choose an efficient allocation of labor to maize production, thus increasing effort on maize from four to five as technology changes. Wives in unitary households with $r \in (0.835, 0.9)$ are predicted to increase labor on maize from two to five days as technology changes. Finally, wives in unitary households with $r \in (0.895, \infty)$ are predicted to allocate two days to maize under both technologies.

4.4.2 Separate spheres households

As mentioned in Section 3, spouses in separate spheres households maximize expected utility individually, subject to individual budget constraints. It follows that contracts that stipulate wives' state-contingent share of maize income provide key incentives for wives to allocate labor to maize production. Assuming that wives are selfish and have CRRA preferences over their own consumption, wives labor allocation is predicted to increase in their share of maize income for

$r \in (-\infty, 0.8)$, under Old and New technologies. Wives with $r \in (-\infty, 0.2)$ get off the corner, allocating 3 days to maize under the Old technology for a 40% share of maize income. Wives with $r \in (-\infty, 0.4)$ allocate 4 days for a 50% share, while wives with $r \in (0.4, 0.6)$ allocate 4 days for a 60% share and wives with $r \in (0.6, 0.8)$ allocate 4 days for a 90% share. That husbands would need to allocate more than half of maize income to wives to obtain an efficient labor allocation under the Old technology speaks to the Old technology's low productivity: its returns are too meager to compensate husbands well while counterbalancing wives' risk aversion. In fact, husbands would do better were they to keep all maize income for themselves, and were wives to allocate minimal labor to maize production.

The high productivity of the New technology provides incentives for wives with $r \in (0.0, 0.4)$ to allocate their full endowment to maize production for a 20% share of maize income, compared to the 40% share required under the Old technology. Wives with $r \in (0.4, 0.6)$ allocate five days for a 30% share, and wives with $r \in (0.6, 0.8)$ allocate four days for a 50% share, and 5 days for a 60% share. Though maize income nearly doubles under the New technology, the doubling of the probability of zero maize income implies that there is no feasible allocation of maize income that would induce wives with $r > 0.8$ to get off the corner of two days allocated to maize.

The labor choices discussed above are wives' predicted response to intra-household contracts that exhibit full income sharing at the fixed rates I specify. Needless to say, the promise of large maize income realizations of which wives would receive a significant share provides high powered incentives to offset the increase in downside risk in the New technology frame. Empirical sharing rules differ markedly from these reference fixed-rate contracts insofar as they circumscribe wives' benefit from high yield realizations. In fact, wives in separate spheres households who receive the stylized contract shown in figure 4, that is, who receive all maize income for $\theta < \tilde{\theta}$ and $Y(l, \theta = \tilde{\theta})$ for $\theta > \tilde{\theta}$ are predicted to allocate X under the Old technology and Y under the New technology.

5 Results

5.1 Outcomes and variable definitions

My experimental design allows me to study the effect of adopting risky, but high productivity agricultural technology on household resource allocation. I consider effects on the decisions of each spouse, that is, wives' labor supply decisions and husbands' sharing rules.

Wives' labor supply decision refers to the discrete number of days chosen from the set $(2, 3, 4, 5)$ that wives allocate to their husbands' maize production per week for the duration of the maize growing season. Husbands' choice of transfer function a more complicated decision, not only because it comprises the husband's decision as to how to share maize income for each state in the support of maize incomes, but also, because different characteristics of the transfer transmit distinct, and sometimes countervailing incentives. I focus on two measures of the incentives that are embedded within the transfer function. The first is a measure of the wife's income incentive; the second is a measure of her downside risk bearing.

The wife's income incentive measures the additional transfer compensation she is expected to receive for increasing maize labor from its minimum value to an allocation that maximizes total household income. As noted in Section 4.4.1, the efficient allocation of labor, l^*, is four days under the Old technology and five days under the New. Thus, I define the income incentive provided to wife i from session s in game g to be

$$\mathbb{E}[\text{transfer} \mid \text{Days} = \text{efficient } l^*] - \mathbb{E}[\text{transfer} \mid \text{Days} = 2]_{isg}.$$

Recall that the distribution of maize income, and of transfers in turn, is conditional on the wife's labor choice, and that expected maize yields are increasing in the wife's labor on maize. Therefore, the wife's labor choice, and not just the state-contingent transfers declared in the transfer function, strongly influences her expected transfer. The advantage of the proposed measure is that it indicates how incentives differ as a function of wives' hypothetical labor choices, while being independent from wives' actual choice. In comparison, were I to estimate the effect of the New technology on wives' expected transfer, I might spuriously conclude from a positive relationship that husbands had strengthened incentives across technologies, though an increase in wives' maize labor would have engendered the same correlation, all else equal.

Just as increasing labor from two days to l^* increases expected maize income, and presumably expected transfers if husbands decide to incentivize their wives' labor supply to maize, so too does increasing maize labor expose wives to increased downside risk. The wife's downside risk bearing measures the effect of increasing labor from two days to l^* on the probability that she earns zero payout. I define the downside risk bearing of wife i from session s in game g to be

$$\mathbb{P}[\text{payout} = 0 \mid \text{Days} = \text{efficient } l^*] - \mathbb{P}[\text{payout} = 0 \mid \text{Days} = 2]_{isg}.$$

Recall that for wives to earn a positive payout from the game, their total transfer and wage income had to exceed the 100 MT child subsistence expenditure for which they were responsible. Under Old and New technologies alike, allocating the minimum two days to maize production guaranteed wives a positive payout. This is because their 120 MT wage income would have enabled them to cover their 100 MT expenditure responsibility, irrespective of their husbands' maize income realization and contingent transfers. It follows that the second term in the definition is equal to 0 for all households.[5] As wives' labor outlay on maize increased, husbands would have needed to increase their transfers in order for wives to meet their expenditure responsibility expenditure responsibility and earn positive payouts. Even so, allocating more than two days to maize implied that wives would face a positive probability of zero payout, as no matter wives' labor choice, husbands had a positive probability of earning zero maize income, in which state transfers were necessarily nill.

Finally, I construct two additional outcomes that aggregate my measures of wives' income incentives and risk bearing by applying structure to the wife's labor allocation decision. These

[5] I have chosen to retain the second term in the definition of wives' risk bearing to emphasize that it's construction is analogous to wives' income incentive. These measures communicate how the wife's risk-return tradeoff would change were she to allocate l^* days, rather than the minimum two days to maize production.

outcomes are 1) the wife's predicted labor allocation given risk neutrality; and 2) the wife's predicted labor allocation given an individual risk parameter that I recover from wives preferences over a subset of the Holt-Laury lotteries.[6]. To generate these predictions, I identify the expected utility maximizing labor choice for wife i of session s in game g, conditional on the transfer function her husband declared in that game. I assume that wives are selfish and have CRRA utility. I back out the CRRA parameter in 2) using the first set of lotteries in which the wife preferred the more risky option and use the middle point of the risk aversion range associated with each particular choice and assuming that the lower bound is $r_i = -2$ and the upper bound is $r = 2$.

5.1.1 Empirical strategy

To estimate the effect of adopting the New technology on household resource allocation, I estimate the equation

$$\text{Outcome}_{isg} = \alpha + \beta_1 \text{New tech}_g + \boldsymbol{\beta}_3' \mathbf{X}_{is} + \eta_s + \epsilon_{isg}. \tag{2}$$

The outcome_{isg} of household i from session s in game g is defined in Section 5.1. New tech_g, the New technology indicator, equals one in the second game. $\mathbf{X}_{is}$ is a vector of household level control variables, including measures of technological savviness, exposure to a negative productivity shock in the 2024 season, and relevance of the experimental framing. η_s is a session level fixed effect.

The research design eliminates selection in adoption of the New technology by exposing all participants to both Old and New technology conditions. Thus $\hat{\beta}_1$ is an unbiased estimate of the effect of adopting a New technology on wives' labor supply decisions and husbands' sharing rules for households that were first exposed to the Old technology. I argue that this is the policy relevant treatment effect in low-income settings in which most households grow unimproved varieties of key staples and in which adoption of improved varieties is a policy goal.

5.2 Impact of New technology on labor allocation

To study the effect of the New technology on wives' labor allocation, I estimate 2 using two-limit Tobit regression, given that labor choices of two and five days are corner solution responses (Wooldridge (2010)). I find no effect of the New technology on the number of days wives allocate to maize production. The magnitude of the coefficient is very small, especially when scaled by the scale factor to obtain the marginal effect, and insignificant. Table 3 reports that wives' mean allocation under the Old technology was 3.6 days, which is close to the household income maximizing labor allocation of 4 days. In addition, tests for differences in the distribution of labor across treatment conditions fail to reject equality of the distribution by technology.

The average effect and static distributions nevertheless masks considerable heterogeneity. From the transition matrix in table 5 and the distribution of changes in figure 6, we see that 42% of

[6]See Brañas-Garza et al. (2021) for an assessment of the comparability of risk preferences elicited using five lotteries instead of Holt and Laurie's ten lotteries

Table 3: Effect of adoption on wife's labor allocation to maize production

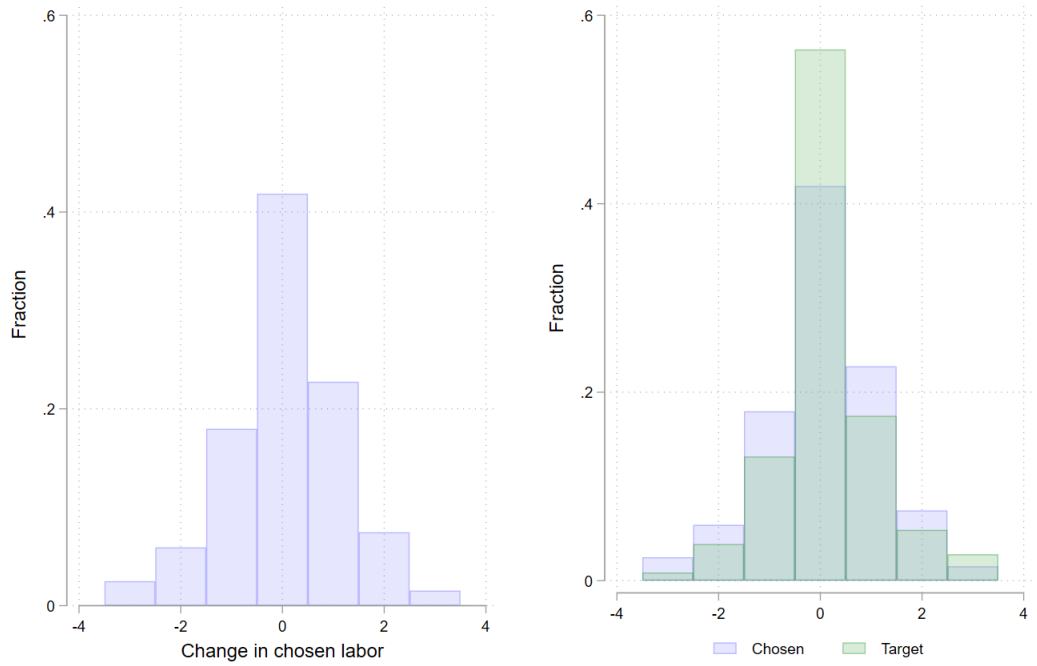
	2-limit Tobit
	Days
New tech	0.0652
	(0.08)
Old tech mean	3.587
Controls	yes
Session FEs	yes
Observations	1016
Log likelihood	-1451.0
Scale factor	0.994

Notes: Regression estimated using 2-limit Tobit MLE with session fixed effects. Standard errors in parentheses are clustered at the session level. Total ha, non-labor expenditures/ha, and number of household adults and children are included but not reported. * p < 0.10, ** p < 0.05, *** p < 0.01.

Figure 5: Wife's choice

	New				
Old	2	3	4	5	Total
2	26	24	17	8	75
3	25	61	70	22	178
4	20	43	80	25	168
5	13	11	26	52	102
Total	84	139	193	107	523

Figure 6: Changes in chosen labor



wives lie on the diagonal, having held their allocation constant across technologies, 32% of wives lie in the upper triangle, having increased their labor on maize, and 26% lie in the lower triangle. The probability of having increased labor under the New technology varies conditional on wives' choices under the Old technology. Of the 48% of wives who chose either two or three days under the Old technology, the conditional probability of maintaining one's choice was approximately 35% and 36%, respectively. In comparison, for the 52% of wives who chose four or five days under the Old technology, the conditional probability of holding labor constant at its initial value was 48% and 51%, respectively. In short, wives who had greater scope to increase their labor were more likely to do so, relatively to wives who initially allocated more of their time endowment to maize production.

Of note are the lower triangle allocations chosen by 26% of wives. These have no analogue among the unitary benchmark households, which are predicted to increase labor both if they are risk loving and risk averse, or to hold maize labor constant at its minimum level if very risk averse. Wives who choose three or more days under the Old technology and maintained effort under the new likewise have no behavioral analogue among the benchmark unitary households. Variation in risk aversion in the unitary model explains just 22% of the observed responses to the experimental change in technology. These are the wives represented by matrix cells (2,2), (2,5) and (4,5). No single risk parameter reconciles the two labor allocations chosen by the remainder of the sample.

Table 17 in the Appendix reports some of the reasons that wives reported motivated their labor choices across experimental conditions. Wives were asked which factors among the following answer

Table 4: Wives' reported motivations for labor choices

Variable	(1) $\Delta < 0$	(2) $\Delta = 0$	(3) $\Delta > 0$	(4) (2-1)	(5) (3-2)	(6) (3-1)
Worried about zero payouts	0.20	0.17	0.16	-0.04	-0.00	-0.04
Wanted to help husband	0.49	0.49	0.47	0.00	-0.02	-0.02
Everything shared	0.45	0.48	0.45	0.02	-0.03	-0.00
Chose real life allocation	0.55	0.55	0.55	0.00	0.00	0.00
Feared shirking revealed	0.03	0.06	0.06	0.03	0.01	0.03
Observations	139	219	166	358	385	305

choices were important for their labor allocation decisions: 1) I was worried about not being able to pay for the household expenses and not earning anything from the game; 2) I wanted to help my husband earn as much money as possible; 3) My husband and I share everything so it did not matter to me who earned the money; 4) I choose to work the number of days that is most similar to what I do in real life; 5) I was worried that my husband would find out if I did not work enough on the maize field; and 6) None of these were important to me. Table 4 shows how wives' motivations varied depending on whether they chose to decrease, keep constant, or increase their allocation of labor to maize. Columns 4-6 show that there is no statistically significant difference in reported motivations by subgroup of wife.

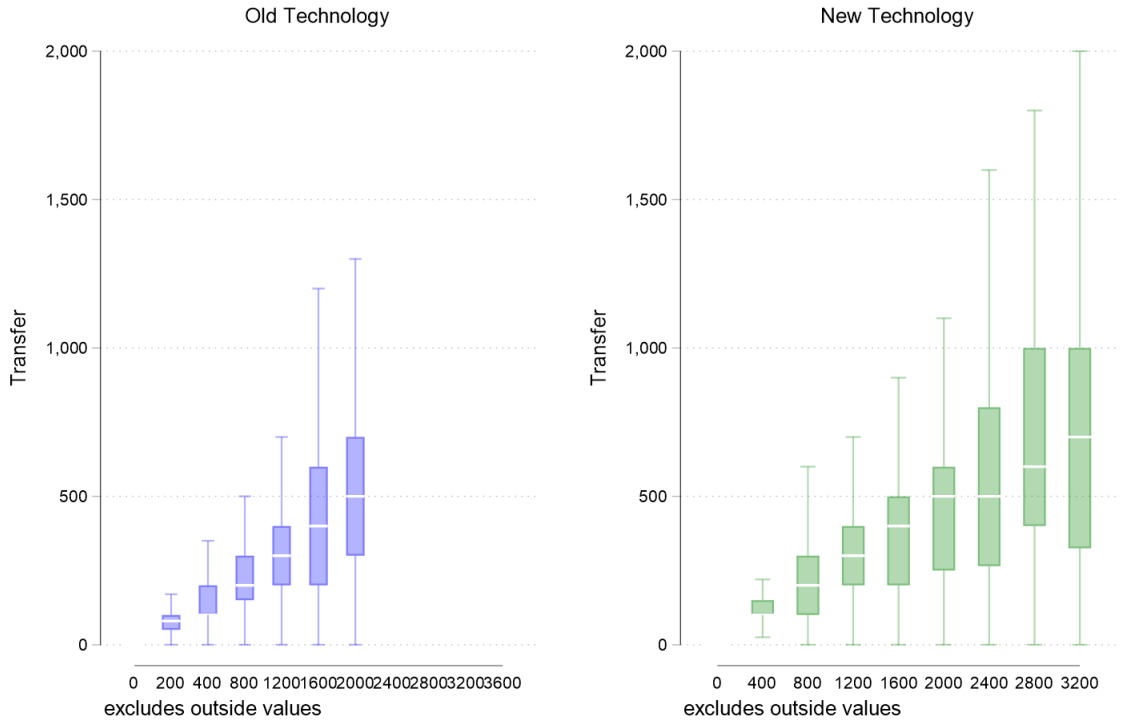
5.3 Impact of New technology on sharing rules

A defining feature of the empirical contract I estimate in Section 2.3 is that the wife's income transfer is non-increasing in maize yields for yields greater than 367 kilograms per hectare. As mentioned in Section 3, the observed structure of the transfer function would suggest that wives' marginal incentive to supply labor to maize production operates only in low yield states, which, with the adoption of a productivity increasing technology, might be less probable. Investigation of the sharing rules husbands chose under the Old technology frame of the field experiment reveals their willingness to provide transfers that increase in maize income, in departure from the empirical sharing rule. As reported in table 21 in the Appendix, 60% of Old technology transfer functions are monotonically increasing, and of these, less than one third are constant over states with high maize income. Figure 7 clearly shows that median transfers over the support of Old technology maize income are increasing.[7] On average, husbands transferred 31% of their maize income to wives.

To study the effect of the New technology on the contractual incentives husbands provide their wives, I estimate 2 using ordinary least squares. Column 1 of table 5 reports that increasing labor on maize production from two days to the total income maximizing allocation would increase wives' transfer income by 1.7 USD in expectation, compared to the 0.8 USD incentive provided under the Old technology. Figure 8 traces the rightward shift of the distribution of incentives that gives rise to this effect. This increase in income incentives was nevertheless accompanied by a 10.3 percentage

[7]Transfers to wives in a given state were constrained by husbands' budgets and could not fall below zero. This feature of the experimental design imposes some linearity on the distribution of transfers.

Figure 7: Central tendencey and variance of transfers under Old technology



point increase in wives' risk bearing in the New technology contract, on average. So while increasing maize labor from two to four days under the Old technology exposed wives to a 14% probability of earning zero payout, wives would have been exposed to a 24.3% probability of earning zero payout, on average, were they to increase their labor to its efficient New technology allocation.

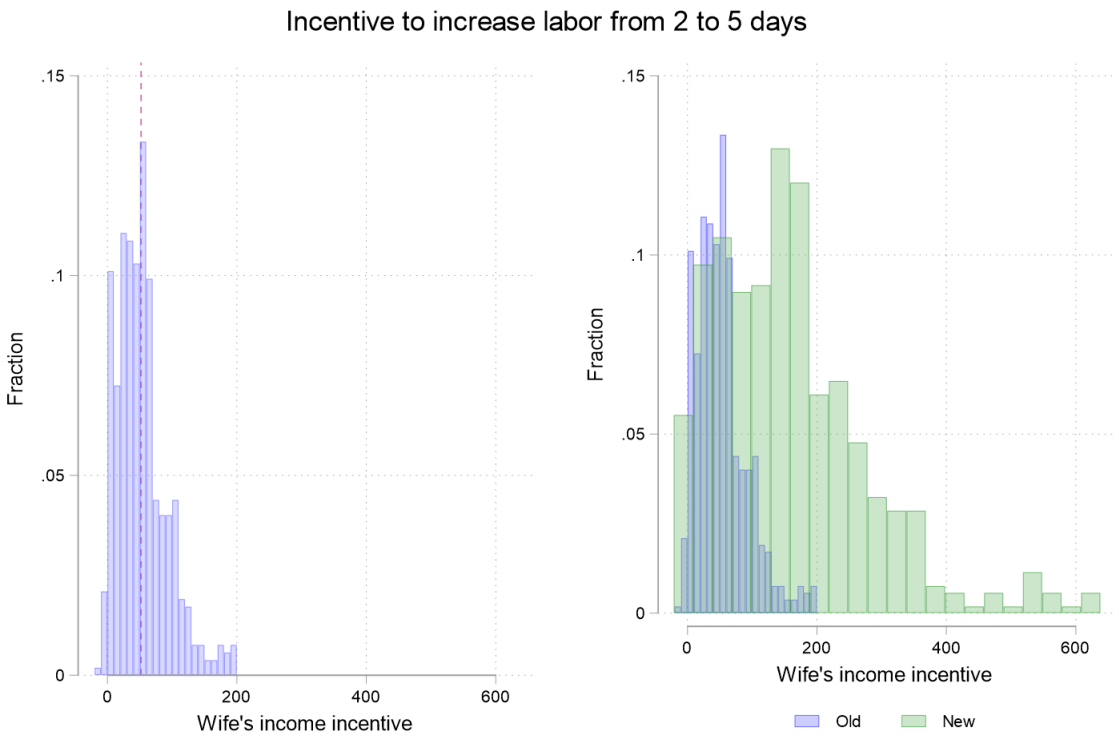
How do these effects compare to the increase in returns to labor afforded by the New technology? The return to increasing labor from two days to its efficient allocation increased by 7 USD. Thus less than 25% of the productivity gains that would accrue to husbands from a shift to 5 days were transferred to wives. In terms of risk sharing, the average contract exposed wives to more risk than what husbands, themselves, bore. Under the Old technology, households faced a 5% chance of earning zero maize income, independent of wives' labor choice. That wives faced a 14% chance of receiving zero transfers when allocating four days of labor implies that husbands shared 60 MT or less in states with 9% probability on average, despite earning 200 MT in maize income themselves. Similarly, under the New technology, wives faced a 24.3% chance of receiving zero transfers when allocating five days of labor, though husbands had just 10% chance of earning no maize income. Wives' increased downside risk exposure under the New technology, which is more than nearly 2.5 times what husbands themselves faced, suggests that husbands had limited knowledge of the potential for larger transfers in bad states to substitute proportionate transfers in good states as a strategy for providing wives incentives.

Table 5: Change in incentive associated with increasing labor from 2 days to efficient l^*

	Wife's income incentive (USD)	Wife's downside risk bearing	Predicted choice | sharing rule, r_i	Predicted choice | sharing rule, $r = 0$	Predicted choice | sharing rule, $r = 0.8$
New tech	1.675***	0.103***	1.010***	1.455***	0.482***
	(0.07)	(0.01)	(0.07)	(0.07)	(0.05)
Old tech mean	0.832	0.140	2.413	2.417	2.031
Controls	yes	yes	yes	yes	yes
Session FEs	yes	yes	yes	yes	yes
Observations	1048	1048	1016	1016	1016
R^2	0.337	0.169	0.304	0.371	0.187

Notes: Regression estimated using OLS with session fixed effects. Standard errors in parentheses are clustered at the session level. Total ha, non-labor expenditures/ha, and number of household adults and children are included but not reported. * p < 0.10, ** p < 0.05, *** p < 0.01.

Figure 8: Shift in income incentives across technologies



Columns 3 and 4 of table 5 report the effect of the New technology on wives' predicted choice of labor, given the contracts their husbands chose and conditional on risk neutrality or wives' elicited CRRA parameter, r_i, respectively. As the effects on wives' income incentives and risk bearing foreshadow, the New technology contract is predicted to have been particularly attractive for selfish, risk neutral wives, who would have increased their maize labor from 2.4 days under the Old technology[8] to 3.866 under the New, a 59% increase. Accounting for wives' elicited risk aversion dampens their predicted labor response: wives were predicted to increase maize labor by one day from the Old technology mean allocation. These positive effects imply that husbands are adept in incentivizing wives' economic cooperation when the economic rationale to do so is clear. Though the incentives embedded in the mean contract were not predicted to have delivered the efficient allocation of labor on average, they clearly were expected to induce a greater shift in labor among selfish, expected utility maximizing wives than the null effect I estimate in table 3.

What structure of contract delivered this increase in incentives? Table 6 compares the increase in mean incentives provided by husbands' chosen contracts to the incentive gains that alternative choices of contract would have provided. First, I consider the effect on incentives had husbands simply continued to share income at the same rate they did under the Old technology. To conduct this exercise, I estimate the heterogeneous effects model

$$\text{transfer}_{it} = \alpha_i + \beta_i \text{maize income}_{it} + \epsilon_{it} \tag{3}$$

for household i in state t for states in which maize income is greater than zero, and project the household specific slope coefficient β_i over the support of the New technology. I find that income incentives would have increased by 1.76 USD under the New technology, had husbands continued to share income at their Old technology rate. Second, I consider the effect on incentives had husbands continued to share their maximum transfer under the Old technology over the expanded support of the New technology. This stylized structure of the contract provides a meaningful comparison to the observed New technology contracts insofar as it captures the non-increasing segment of the empirical contract, with the experimental finding that median transfers median tendency of the New technology contract, which is increasing over the support of the Old technology, but levels off for larger values of maize income. Such a sharing rule would have resulted in a 1.25 USD average increase in incentives. Comparison of column 1 with columns 2 and 3 suggests that the contractual structure embraced by husbands under the New technology features proportional income sharing, rather than fixed income sharing for high values of maize income.

While the positive and significant average treatment effect on incentives supports the conclusion that husbands were generally effective in providing incentives, husbands' income sharing rules nevertheless varied widely. Figure 9 captures heterogeneity in the risk-return tradeoff of observed contracts. Contracts in the southwest quadrant promised wives an expected return of 100-200 MT, were they to shift labor from the minimum two days to the efficient allocation of five days,

[8] Under the Old technology 76% of wives were predicted to allocate the minimum two days to maize production. Thus the 3.6 day mean allocation points to an "over" allocation, relative to what a self-interested agent would choose.

Table 6: Comparative incentives under linear income sharing and empirical sharing rule

	Observed	Linear projection of old contract slope over new support	Max old contract transfer projected over new support
	(1)	(2)	(3)
New tech	1.675***	115.3***	83.53***
	(0.07)	(4.60)	(3.11)
Control mean	0.832	51.99	51.99
Observations	1048	1048	1048

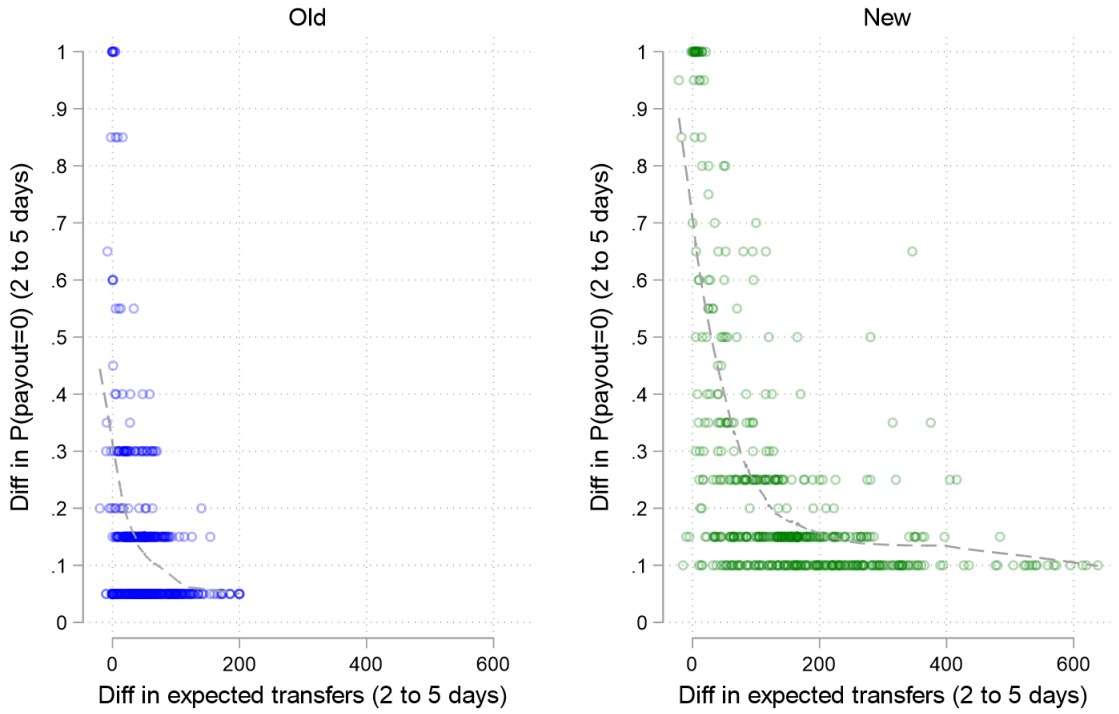
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes:

in exchange for a 15% increase in wives' probability of receiving zero payout. Contracts in the southeast reflect a greater rate of income sharing that leaves wives exposed only to the unavoidable income risk that husbands themselves face. In stark contrast, husbands who offered contracts in the northwest quadrant would have provided wives insufficient transfer income to cover her 100 MT expenditure responsibility, were she to allocate five days to maize production.

Figure 9: Tradeoff of income incentives and risk bearing



5.3.1 Within-couple heterogeneity in risk preferences as a determinant of contractual incentives

In the present analysis, I consider how the contractual incentives provided by husbands varied as a function of the degree of alignment in husband and wife's risk aversion. Theoretically, if husbands and wives share homogeneous preferences over household consumption, the intra-household distribution of income will have no bearing on the wives' labor allocation. Likewise, as husbands' and wives' preferences diverge, husbands intuitively will need to provide higher powered incentives. I test for a relationship between the misalignment in husband/wife risk preferences and various measures of the incentives that are embedded in husbands' contracts. The independent variable is the difference between the wife's elicited CRRA parameter, r_w and the husband's, r_h. I find no evidence of a relationship between within-couple preference heterogeneity and the income incentives or the risk bearing implicit in the contracts husbands offered.

Table 7: Relationship between contractual incentives and within-couple heterogeneity in risk preferences

	$\Delta\mathbb{E}$[transfer (100 MT)], corner to efficient l*	$\Delta\mathbb{P}$(payout$^w = 0$), corner to efficient l*	Contract slope
	(1)	(2)	(3)
Difference in risk aversion, W - H	-0.00572	0.000548	-0.00178
	(0.02)	(0.00)	(0.00)
Husband's endline comprehension %	0.193	-0.141*	0.00530
	(0.24)	(0.06)	(0.05)
Control mean	0.516	0.140	0.140
Observations	1010	1010	1009
R^2	0.109	0.151	0.167
Controls	yes	yes	yes
Session FEs	yes	yes	yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes:

6 Mechanisms

6.1 Wives' responsiveness to incentives

So far, we have seen that in response to an exogenous change in technology wives adjusted labor less than expected utility maximization would predict, under both unitary and separate sphere models. How exactly did wives' choices deviate from predicted allocations? Table 8 compares wives predicted and chosen allocations. Panel a shows strikingly that 71% of wives allocated more labor than their individual contracts and risk preferences would have predicted under the Old technology. This observation is driven by the 66% of wives who allocated 3 or 4 days, though two days were predicted to be optimal for 76% of wives. Just 12% of wives allocated less labor than predicted. Under the New technology in contrast, wives were equally likely to choose larger (41%) or smaller (39%) allocations than predicted.

As the predicted allocations in Table 8 represent the optimal choices of selfish expected utility maximizing agents, the tendency to allocate more labor than would be rational under strict self interest can be interpreted as a measure of wives' altruism towards their husbands. Under this lense, the densely populated upper triangle of Table 8 Panel a is consist with pervasive altruism among wives. In contrast and if viewed in isolation, Panel b seems to suggest that wives are just as likely to act altruistically as to attach dis-utility to altruistic allocations, as would be the case, for example, if wives in the experiment were to value hidden and non-hidden income differently. A more likely explanation may be that wives have a tendency to choose central values and that apparent changes in altruism across technologies are an artefact of the stark discontinuity in optimal self interested choices that result from the game's probability structure and parameterization. In particular, the

Table 8: Predicted versus observed labor choices

(a) Old

	Wife's choice				
Predicted labor	2	3	4	5	Total
2	55	132	140	82	409
3	3	11	7	4	25
4	13	21	18	14	66
5	4	14	3	2	23
Total	75	178	168	102	523

(b) New

	Wife's choice				
Predicted labor	2	3	4	5	Total
2	40	68	103	49	260
3	0	2	5	0	7
4	3	3	9	8	23
5	41	66	76	51	234
Total	84	139	193	108	524

Notes: Predicted labor choices are the expected utility maximizing allocation for wife i, given the contract her husband offered and the wife's elicited CRRA parameter, r_i.

optimal labor allocation increases from two days only for contracts with 40% profit sharing and among wives with slight risk aversion (that is a CRRA parameter $r_i < 0.2$). Despite the inherent limitations of this definition of altruism, I nonetheless find that altruistic behavior in the first game is a strong predictor of altruistic behavior in the second game (see Appendix table 24).

Considerable heterogeneity in wives' response to the New technology, combined with the tendency for wives to "over" allocate labor to maize begs the question, to what extent do contractual incentives seem to drive wives' labor choices. Table 9 reports the relationship between wives' choice of days in maize production and various measures of the incentives embedded in the contract. As previously mentioned, the wife's choice of two or five days should be understood as a corner solution response. All regressions pool observations across experimental conditions and include household level means of the reported independent variables to help address endogeneity in the husband's choice of contract. Column 1 shows that the relationship between the income incentive and downside risk bearing outcomes defined in Section 5.1 and wives' labor is not statistically significant. While the weakly positive relationship between income incentives and labor is consistent with my theoretical predictions, the large positive coefficient on downside risk bearing is perplexing. Though insignificant, it states that the average partial effect of increasing the probability of zero payout from zero to one is 0.3 (Tobit coefficient $0.303 \times .995$ scale factor). Columns two and three regress wives' labor on alternate measures of income incentives and risk. None of these alternate measures adequately captures the probabilistic information that would inform an expected utility maximizing agent's decision. Instead, they are probability unweighted measures of contractual incentives that less sophisticated wives may have grasped more readily. In column 2, these are the wife's share of maize income (averaged across the number of maize income states) and the count of states in which transfers are less than wives' expenditure responsibilities of 100 MT and labor. In column 3 this is the probability unweighted mean transfer, averaged across income states. I find no evidence that these measures are statistically significant drivers of wives' labor decisions.

Finally, I explore how contractual incentives differed for wives who decreased, held constant, and increased labor under the New technology, focusing on wives who answered 75% or more of the post

Table 9: Correlation of labor choice and different measures of contractual incentives

	Days		
Income incentive (USD)	0.0354		
	(0.03)		
Downside risk bearing	0.303		
	(0.31)		
Wife's average share		-0.0134	
		(0.71)	
# states: transfer < subsistence req.		0.0198	0.0525
		(0.04)	(0.05)
Unweighted mean transfer (USD)			0.0339
			(0.03)
Observations	1047	1047	1047
Log likelihood	-1608.1	-1608.3	-1608.2
Scale factor	0.994	0.994	0.994

Notes: All columns are estimated using Correlated Random Effects 2-limit Tobit MLE. Standard errors in parentheses are clustered at the session level. Household-level means of independent variables are included but not reported. * p < 0.10, ** p < 0.05, *** p < 0.01.

game comprehension questions correctly. Wives in column 1 decreased their allocation from 4.13 days to 2.78 days on average, while wives in column 3 increased their labor from 2.88 days to 4.22 days. Column four reports a significant difference in the risk neutral predicted labor response for column 1 wives compared to wives in columns 2 and 3. This finding implies that column 1 husbands increased their wives' expected income incentives more than other husbands. The predicted labor response for wives with CRRA parameter $r = 0.8$ paints a different picture, however. Were they homogeneously risk averse, column 1 wives would have been predicted to increase labor by only .41 days, compared to 0.48 and 0.57 days for column 2 and 3 wives, respectively. While these differences are not statistically significant, they suggest that the husbands of wives who decreased labor may have been less adept in mitigating their wives' downside risk than other husbands.

6.1.1 Heterogeneity in responsiveness of labor to incentives by revealed unitary behavior

As discussed in section 4.4.1, wives' labor allocation is predicted to respond to a change in the marginal product of labor, but not to the incentives dictated by the sharing rule in a unitary household that pools income (and thus game payouts). It follows that unitary and non-unitary households ought to respond differentially to contractual incentives, with non-unitary wives responding more elastically to a change in incentives. Conveniently, the experimental design enables classification of wives by revealed preference. As the information in tables 1 and 2 conveys, only labor choices (2,2), (2,5) and (4,5) can be reconciled by a single CRRA parameter under the unitary model. I thus define the indicatory variable $unitary_i$, which is equal to one for the 90 households

Table 10: Differences in incentives by directional change of the wife's decision

Variable	(1) $\Delta < 0$ $\geq$ 75% comp	(2) $\Delta = 0$ $\geq$ 75% comp	(3) $\Delta > 0$ $\geq$ 75% comp	(4) 1-(2+3)	(5) (2-1)	(6) (3-2)	(7) 3-(1+2)
Days	4.13	3.79	2.88	0.72***	-0.35***	0.90***	-1.03***
Days: new	2.78	3.79	4.22	-1.19***	1.01***	-0.43***	0.81***
Wife's endline comprehension %	0.90	0.91	0.90	-0.01	0.01	0.01	-0.01
CRRA using Holt-Laury lotteries	-0.16	-0.03	-0.32	-0.01	0.13	0.30***	-0.25**
Δpredicted labor, r_i	1.19	0.95	0.93	0.25	-0.25	0.02	-0.11
Δ predicted labor, r=0	1.67	1.40	1.40	0.27*	-0.27	-0.00	-0.10
Δ predicted labor, r=.8	0.41	0.49	0.57	-0.11	0.08	-0.08	0.11
Δ marginal incentives, 100 MT	1.01	1.02	1.19	-0.08	0.01	-0.18	0.18
Δ marginal risk exposure	0.08	0.12	0.10	-0.04	0.04*	0.02	-0.00
Observations	114	192	138	444	306	330	444

Notes: Sample is restricted to wives who answered 75% or more of post game comprehension questions correctly.

in which wives chose one of these pairs, and zero for the 450 household in which wives chose one of the 11 other possible combinations of labor across rounds. To test for differential responsiveness to contractual incentives household type, I regress wives' choice of days on the interaction of $unitary_i$ and the various measures of contractual income incentives and risk bearing that I first present in table 9.

Surprisingly, column 1 in table 11 presents precise statistical evidence that a 100 MT increase in wives' expected incentive to shift labor from two days to an efficient allocation is predicted to have no effect on wives' labor allocation for non unitary households, in contrast with the positive and statistically significant relationship for unitary households. Though descriptive, these effects are opposite in sign relative to my theoretical predictions. Figure 10 urges caution in over-interpreting these correlations, however. The sparsity of the unitary subsample, combined with the exclusion of the choice of three days as a result of the definition of the unitary subsample appears to drive the difference in the relationship between income incentives and wives' labor choice.

6.2 Husbands' target allocation

In this section, I investigate the relationship between husbands' preferences over wives' labor allocation and both the contracts they provided and wives' labor decisions. Recall that husbands and wives were prevented from discussing both income sharing and labor allocation decisions during game play in order to simulate an environment in which wives' effort was private.[9] The research team did, however, elicit husbands' preferred labor allocation, which was not shared with wives. Husbands responded to the question "If you could decide how many days your wife works in the cornfield, how many days would you choose?" This question also served to nudge husbands to think carefully about how they wanted to share maize income; therefore, husbands responded to the question before declaring the contracts that would determine game payouts (with 50% probability). The nudge question followed a practice round of resource allocation and maize income realization

[9]Asymmetric information about wives' effort need not preclude husbands and wives from bargaining over wives' transfers. However, in the experimental setting, allowing husbands and wives to discuss transfer functions would have opened the door to quid pro quo, thus undermining the private information setup.

Table 11: Differential responsiveness to incentives by household model

	No unitary risk parameter predicts choices		No unitary risk parameter predicts 1st choice		
$\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l	0.357***	0.839*	0.0494	-0.0461	0.0663
	(0.08)	(0.35)	(0.04)	(0.09)	(0.04)
Downside risk bearing	0.295	0.419	-0.104	-0.466	-0.113
	(0.35)	(0.47)	(0.21)	(0.51)	(0.20)
Wife comprehension $\geq$ 75%	0.242*	0.193	0.216*	0.0732	0.237*
	(0.10)	(0.17)	(0.09)	(0.17)	(0.10)
Non unitary	0.873***	0.935***			
	(0.20)	(0.21)			
Non unitary=1 $\times$ $\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l	-0.358***	-0.905*			
	(0.08)	(0.35)			
Non unitary=1 $\times$ Downside risk bearing	-0.350	-0.545			
	(0.39)	(0.55)			
Non unitary=1 $\times$ Wife comprehension $\geq$ 75%=1 $\times$ $\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l		0.0774			
		(0.09)			
Non unitary=1 $\times$ Wife comprehension $\geq$ 75%=1 $\times$ Downside risk bearing		0.0858			
		(0.31)			
Non unitary: game 1			0.280**	0.284**	
			(0.09)	(0.09)	
Non unitary: game 1=1 $\times$ $\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l			0.00626	0.0254	
			(0.05)	(0.12)	
Non unitary: game 1=1 $\times$ Downside risk bearing			0.0852	0.421	
			(0.28)	(0.54)	
Non unitary: game 1=1 $\times$ Wife comprehension $\geq$ 75%=1 $\times$ $\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l				0.0865	
				(0.11)	
Non unitary: game 1=1 $\times$ Wife comprehension $\geq$ 75%=1 $\times$ Downside risk bearing				0.0173	
				(0.30)	
Nonuni: disagree					-0.0561
					(0.11)
Nonuni: disagree=1 $\times$ $\Delta\mathbb{E}$[transfer (100 MT)], efficient l* - corner l					-0.0425
					(0.06)
Nonuni: disagree=1 $\times$ Downside risk bearing					0.128
					(0.30)
Mean labor	3.607	3.607	3.607	3.607	3.607
Observations	1016	1016	1016	1016	1016
R^2	0.229	0.233	0.219	0.221	0.202
Controls	yes	yes	yes	yes	yes
Session FEs	yes	yes	yes	yes	yes

Figure 10: Labor as a function of incentives by unitary versus non-unitary model

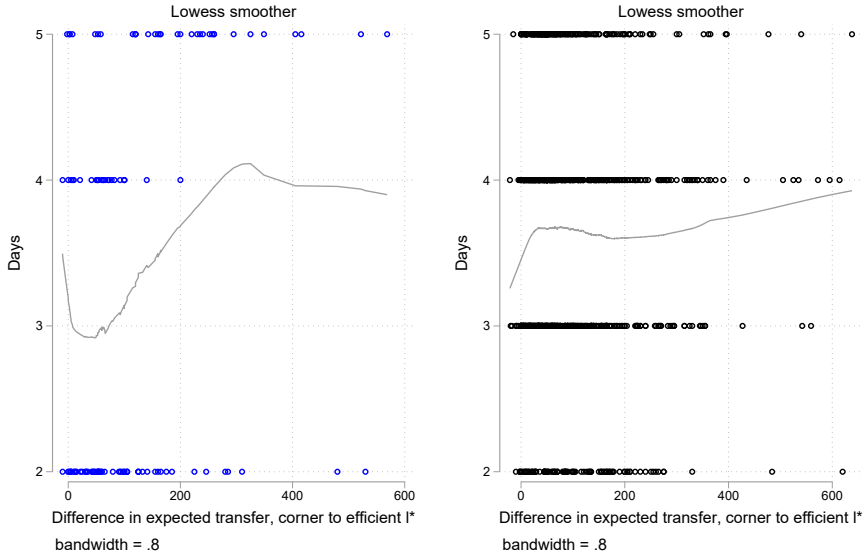


Table 12: Husband's target labor across technologies

			New		
Old	2	3	4	5	Total
2	25	15	10	13	63
3	17	101	42	15	175
4	5	29	94	24	152
5	4	13	15	41	73
Total	51	158	161	93	463

and was repeated in Old and New frames.

On average, husbands targeted a 0.14 day increase in their wives' allocation labor in response to the change in technology. The transition matrix represented in Table 12 decomposes this average effect. Only 18% of husbands targeted a decrease in labor, compared to the 24% of wives who decreased their labor across technologies. 56% of husbands targeted no change in their wives' labor allocation, compared to 44% of wives, reflecting a greater propensity for husbands to target a static labor allocation than wives. Finally, 26% of husbands targeted an increase in labor, compared to 32% of wives. Husbands who sought to maximize their households' expected income or their own private expected would have left money on the table, were they to prefer allocations smaller than five days; thus, the relatively unpopulated upper triangle is inconsistent with either objective. The non-increasing allocations favored by 74% of husbands are consistent with husbands internalizing their wives' risk-return tradeoff in a model without pooling.

Table 13 compares husbands' targeted allocations to predicted allocations under the Old technology in panel a, and under the New technology in panel c. Panels b and d compare husbands' targeted allocations and chosen allocations under the old and New technology, respectively. Strikingly, Panel a shows that 70% of husbands under the Old technology offered contracts that would have optimally induced less maize labor than targeted. In particular, 76% offered contracts that were predicted to induce two days on maize though only 13% of husbands targeted two days under the Old technology. Panel b reveals that effective misalignment—the difference in targeted and chosen allocations—is less pronounced than predicted. Only 32% of wives allocated less labor than their husbands targeted. Thus while 70% of husbands are predicted to have provided insufficient incentives to their wives, given their stated preferences, only half as many wives under-supplied labor relative to their husband's preferences. In fact, wives were similarly likely to choose a greater allocation than targeted (33%), or to align (35%). Providing fewer incentives than necessary to obtain a targeted labor allocation is nevertheless associated with a higher probability that a wife will allocate less labor than her husband's target. Table 14 Column 1 reports that the odds a wife under-allocated labor relative to her husband's state preferences were 208% greater if her husband undershot his target relative to the case in which he did not.

Under the New technology, husbands were much more likely to provide contracts predicted to meet or exceed their preferred allocation: only 40% of husbands lie in the lower triangle of

Table 13: Misalignment in target versus optimal and target versus chosen labor

(a) Old

	Predicted labor				
Husband's target	2	3	4	5	Total
2	50	4	7	2	63
3	143	6	27	6	182
4	120	8	22	5	155
5	57	5	7	5	74
Total	370	23	63	18	474

(b) Old

	Wife's choice				
Husband's target	2	3	4	5	Total
2	10	20	18	15	63
3	34	72	52	24	182
4	17	51	59	28	155
5	0	25	22	26	73
Total	61	168	151	93	473

(c) New

	Predicted labor				
Husband's target	2	3	4	5	Total
2	31	0	1	19	51
3	77	4	8	69	158
4	80	2	8	74	164
5	46	0	5	43	94
Total	234	6	22	205	467

(d) New

	Wife's choice				
Husband's target	2	3	4	5	Total
2	16	15	16	4	51
3	30	54	51	23	158
4	19	40	77	28	164
5	8	11	30	45	94
Total	73	120	174	100	467

Table 14: Likelihood that wife under supplies target conditional on husband providing underpowered incentives

	Old	New
	(1)	(2)
Chosen allocation smaller than target		
Contract predicts smaller allocation than targeted	3.127***	2.272***
	(4.78)	(4.42)
Observations	524	524
R^2		

Exponentiated coefficients; t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Misalignment in targeted versus predicted labor across technologies

	New: Target - predicted							
Old: Target - predicted	-3	-2	-1	0	1	2	3	Total
-2	1	2	2	4	1	0	0	10
-1	3	14	3	1	2	1	0	24
0	5	14	19	31	8	5	2	84
1	8	35	19	22	41	23	9	157
2	5	10	34	17	15	38	9	128
3	1	4	11	12	6	4	22	60
Total	23	79	88	87	73	71	42	463

Panel C, compared to 70% under the Old technology in Panel a. Still, there is considerable misalignment between husbands' target allocations and the predicted allocations of selfish expected utility maximizing wives. In particular, though 69% of husbands targeted allocations of three or four days, around half would have offered too generous of contracts, had their wives behaved as selfish expected utility maximizers, while the other half would have offered too few incentives. As under the Old technology, wives' chosen allocations limited the predicted misallocation. Panel d shows that 30% of wives under-allocated labor relative to their husbands' targets (compared to the 45% under-allocation predicted), 41% of wives allocated labor in accordance with their husbands' targets (compared to the 18% predicted), and 29% over-allocated labor (compared to the 37% under-allocation predicted). Nonetheless, the odds that a wife under-allocated labor relative to a target were 168% greater if her husband had undershot his target.

Table 15 speaks to the persistence of misalignment across technologies. The northeastern quadrant is unpopulated, which implies that there is little probability that a husband who overincentivized his wive relative to his target allocation under the Old technology under-incentivized her under the New technology. In contrast, 49% of husbands who under-inctivized their wives under the Old technology continued to under-incentivize them under the new, while 36% over-incentivized. The behavior of the former group may be explained if husbands underestimated their wives' attitudes towards risk. In contrast, learning, the greater salience of wives' marginal productivity under the New technology or the relative ease of obtaining larger allocations under the New technology could explain the behavior of the latter.

7 Discussion

Husbands' deft ramping up of incentives in response to an experimental increase in labor productivity contrasts starkly with the weak incentives that characterize the intra-household contract I estimate from survey data. This suggests that factors besides husbands' knowledge of the importance of incentives and how to provide them constrains the incentives they provide their wives outside the game. One such factor could be the costs husbands incur when deviating

from norms that stipulate how much financial autonomy or responsibility wives should have. For example, husbands may derive prestige from limiting their wives' financial independence. I propose to study the relevance of norm costs in curbing intra-household incentives by studying the effect of the game treatment on income sharing outside the game.

Exposure to the game could feasibly have challenged norms that restrict income transfers by providing a public forum in which the dominant strategy for 89% of husbands was to incentivize wives to allocate the maximum quantity of labor to maize production and thus to deviate from the empirical intra-household contract. This exposure may have led husbands to update their beliefs about the likelihood that other husbands adhere to income sharing norms outside the game, and about the probability of being sanctioned for deviating from the norm in turn. If transfers are a steeper function of maize yields in communities that were randomly selected for game play than in control communities, and conditional on there being no difference in maize production technology by treatment status, this would provide suggestive evidence that norms around income sharing constrain intra-household incentives.

I propose to collect retrospective data on husband-to-wife monetary transfers made that were effected in the 7-8 month period subsequent to game play, as well as inputs and labor invested in maize production in the 2024/2025 growing season. Given that game play occurred subsequent to planting decisions, it is likely that I will find no effect of assignment to the game treatment on the production technology households chose, namely the use of improved versus local maize seed.

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APPENDIX

Empirical estimation using Malacarne's sample (2025)

Table 16: Descriptive Statistics I

	mean	count	sd	min	max
Decision-making					
What to plant on primary maize plot generally decided by a man	0.90	1428	0.36	0	8
Which inputs to buy for primary maize plot generally decided by a ma	0.91	1433	0.29	0	1
Whether to sell from primary maize plot generally decided by a man	0.91	1431	0.29	0	1
Food crop farming decisions taken only by men	0.57	53	0.50	0	1
Food crop farming decisions taken only by women	0.40	53	0.49	0	1
Cash crop farming decisions taken only by men	0.70	23	0.47	0	1
Cash crop farming decisions taken only by women	0.26	23	0.45	0	1
Routine household purchase decisions taken only by men	0.02	206	0.14	0	1
Routine household purchase decisions taken only by women	0.97	206	0.17	0	1
What to plant decisions taken only by men	0.43	46	0.50	0	1
What to plant decisions taken only by women	0.52	46	0.51	0	1
Household labor on-farm					
Proportion of hh labor on primary maize plot supplied by wife	0.24	1131	0.22	0	1
Proportion of hh labor on primary maize plot supplied by husband	0.06	1129	0.15	0	1
Proportion of labor on primary maize plot supplied by hh	0.71	480	0.24	0	1
Transfers					
Total income transfers (USD)	449.47	477	488.03	0	2883
2022/23 income from husband's sole and joint activities (USD)	702.04	853	1405.16	0	9920
Observations	2473				

Table 17: Descriptive Statistics II

	mean	p50	count	sd	min	max
Income sources over last 12 months						
HH sold own crops	0.67	1.00	989	0.47	0.00	1
HH earned non-ag self employment income	0.33	0.00	988	0.47	0.00	1
HH earned salary	0.15	0.00	989	0.36	0.00	1
HH earned off-farm ag wages	0.27	0.00	988	0.44	0.00	1
HH non-ag wages	0.21	0.00	986	0.40	0.00	1
Proportion of hh income						
Proportion of income from own crops	0.60	0.60	666	0.27	0.00	1
Proportion of income from own crops | > 0	0.62	0.60	649	0.26	0.05	1
Proportion of crop income from maize	0.33	0.30	649	0.26	0.00	1
Proportion of crop income from maize | > 0	0.41	0.40	523	0.23	0.02	1
Proportion of total income from maize	0.22	0.18	649	0.22	0.00	1
Proportion of total income from maize | > 0	0.28	0.24	523	0.21	0.00	1
Proportion of total income from non-maize crops	0.39	0.36	649	0.22	0.00	1
Proportion of total income from non-maize crops | > 0	0.40	0.38	634	0.22	0.04	1
Proportion of total maize harvest for sale						
Proportion of all maize for sale	0.17	0.07	975	0.22	0.00	1
Proportion of all maize for sale | > 0	0.31	0.26	534	0.21	0.01	1
Proportion of primary plot maize harvest for sale						
Proportion of primary maize for sale	0.22	0.11	974	0.26	0.00	1
Proportion of primary maize for sale | > 0	0.39	0.35	534	0.23	0.01	1
Quantity for sale						
Primary plot kgs for sale	626.89	100.00	980	1268.10	0.00	8000
Primary plot kgs for sale | > 0	1150.47	500.00	534	1533.03	4.00	8000
Observations	989					

2023 survey data. Kilograms for sale winsorized at the 99th percentile.

Figure 11: Seasonality of transfers

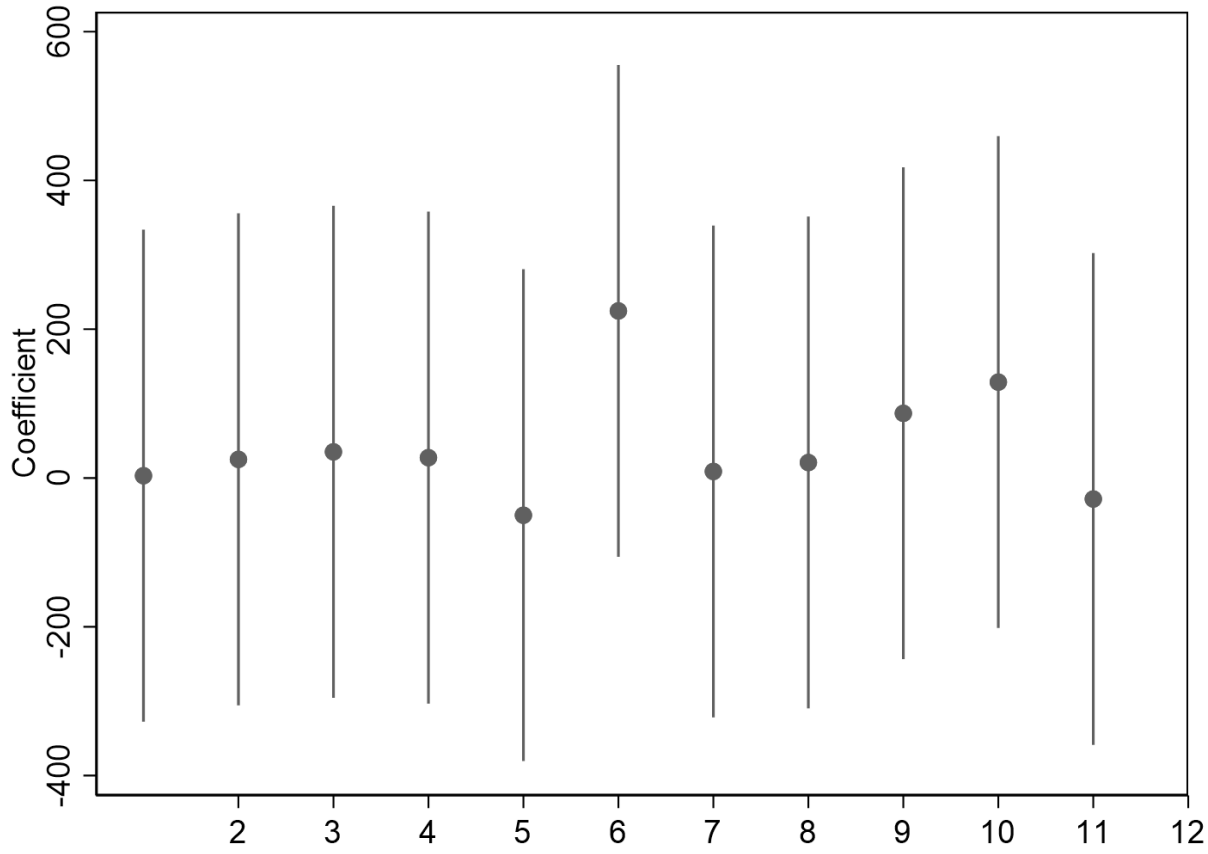


Table 18: Piece-wise estimation of transfers using threshold estimated on balanced sample | Transfers > 0

	Avg transfer	Avg transfer Dec - Apr	Avg transfer May - Sep	Ln(Avg transfer)	Ln(Avg transfer Dec - Apr)	Ln(Avg transfer May - Sep)
Primary plot yield (kg/ha)	2.027***			0.198***		
	(3.75)			(3.49)		
(Ln(Primary plot yield (kg/ha)) - p10)×𝕀(Ln(Primary plot yield	-1.965***	-3.299***	-2.016*	-0.176	-0.408*	-0.267*
	(-3.62)	(-4.92)	(-2.62)	(-1.70)	(-2.62)	(-2.15)
Hectares cultivated	-0.310			-0.000245		
	(-1.16)			(-1.74)		
Mean investment per hectare	0.0309*			0.0000238**		
	(2.29)			(3.02)		
Adults in household	45.24	16.78	12.17	0.0491*	0.0425	0.00622
	(1.37)	(0.49)	(0.35)	(2.08)	(1.62)	(0.28)
Children younger than 14 in household	-28.31	-67.60*	-3.835	-0.0253	-0.0677**	-0.00854
	(-1.05)	(-2.06)	(-0.13)	(-1.44)	(-3.34)	(-0.50)
Primary plot yield (kg/ha)		3.044***			0.212*	
		(5.04)			(2.56)	
Hectares cultivated		23.24**	-0.265		0.0144*	-0.0000657
		(3.16)	(-1.33)		(2.28)	(-0.74)
Mean investment per hectare		0.00776	0.0343*		0.0000116	0.0000232**
		(0.82)	(2.35)		(1.72)	(3.00)
Ln(Primary plot yield (kg/ha))			1.984**			0.273***
			(2.77)			(3.87)
Constant	1355.2***	1088.0***	1646.1***	5.724***	5.833***	5.659***
	(5.99)	(3.76)	(6.23)	(16.91)	(11.56)	(13.76)
Observations	1631	968	933	1631	968	933
Threshold estimator	312.5	466.7	320	5.927	6.146	5.768
Threshold effect F statistic						
Threshold effect p-value						
Trimming proportion						
$\beta_1 + \beta_2 = 0$	0.062	-0.255	-0.032	0.022	-0.196*	0.006
t-statistic	0.533	-1.516	-0.208	0.306	-1.898	0.078
$\beta_1 = \beta_2$	-3.992***	-6.343***	-4.000***	-0.374**	-0.620***	-0.540***
t-statistic	-3.704	-5.011	-2.709	-2.500	-2.730	-2.917

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: Input intensity by improved maize status

Variable	(1) 2022 Non-improved	(2) 2022 improved	(3) 2022	(4) 2023 Non-improved	(5) 2023 improved	(6) 2023	(7) 2024 Non-improved	(8) 2024 improved	(9) 2024
Used local seed on primary plot	1.00	0.54	-0.46***	1.00	0.55	-0.45***	1.00	0.51	-0.49***
	(0.00)	(0.50)	(0.04)	(0.00)	(0.50)	(0.03)	(0.00)	(0.50)	(0.03)
Expenditure on local seed on primary plot	1.74	3.27	1.53	1.40	1.06	-0.34	2.51	0.74	-1.77**
	(13.96)	(31.99)	(1.99)	(22.02)	(11.40)	(1.12)	(20.33)	(5.07)	(0.87)
Used improved seed on primary plot	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Expenditure on improved seed on primary plot	0.00	54.91	54.91***	0.00	144.57	144.57*	0.00	69.09	69.09***
	(0.00)	(126.85)	(7.96)	(0.00)	(1337.50)	(76.35)	(0.00)	(216.04)	(10.89)
Used npk on primary plot	0.00	0.10	0.09***	0.01	0.05	0.04***	0.00	0.05	0.05***
	(0.05)	(0.29)	(0.02)	(0.09)	(0.22)	(0.01)	(0.00)	(0.22)	(0.01)
Expenditure on npk on primary plot	0.04	7.31	7.27*	0.22	5.80	5.59*	0.00	3.40	3.40***
	(0.86)	(46.31)	(3.86)	(3.76)	(48.92)	(3.14)	(0.00)	(22.12)	(1.10)
Used urea on primary plot	0.00	0.05	0.04***	0.00	0.05	0.04***	0.00	0.05	0.05***
	(0.05)	(0.21)	(0.01)	(0.07)	(0.22)	(0.01)	(0.04)	(0.22)	(0.01)
Expenditure on urea on primary plot	0.05	4.70	4.65**	0.30	5.41	5.10**	0.00	3.72	3.72***
	(1.31)	(27.65)	(2.00)	(4.55)	(39.16)	(2.32)	(0.00)	(20.35)	(0.98)
Used organic fertilizer on primary plot	0.00	0.04	0.04***	0.01	0.02	0.00	0.00	0.02	0.02***
	(0.00)	(0.19)	(0.01)	(0.11)	(0.12)	(0.01)	(0.00)	(0.14)	(0.01)
Expenditure on organic fertilizer on primary plot	0.00	0.00	0.00	0.05	0.00	-0.05	0.00	0.21	0.21
	(0.00)	(0.07)	(0.00)	(1.31)	(0.00)	(0.05)	(0.00)	(3.03)	(0.15)
Used irrigation on primary plot	0.00	0.04	0.03**	0.00	0.02	0.02**	0.00	0.01	0.01*
	(0.05)	(0.19)	(0.01)	(0.04)	(0.15)	(0.01)	(0.04)	(0.12)	(0.01)
Expenditure on irrigation on primary plot	0.16	1.85	1.69	0.00	1.55	1.55	0.00	0.94	0.94
	(3.32)	(27.68)	(1.60)	(0.00)	(21.48)	(1.54)	(0.00)	(19.38)	(0.95)
Used oxen on primary plot	0.28	0.35	0.08**	0.25	0.38	0.13***	0.28	0.36	0.08*
	(0.45)	(0.48)	(0.04)	(0.43)	(0.49)	(0.04)	(0.45)	(0.48)	(0.04)
Owns oxen	0.14	0.17	0.03	0.13	0.23	0.10***	0.14	0.16	0.03
	(0.35)	(0.37)	(0.03)	(0.34)	(0.42)	(0.04)	(0.34)	(0.37)	(0.03)
Expenditure on oxen rental on primary plot	6.06	9.68	3.62**	6.10	8.95	2.86	7.60	8.93	1.33
	(21.14)	(28.30)	(1.76)	(25.66)	(42.01)	(2.29)	(37.56)	(26.22)	(2.24)
Used tractor on primary plot	0.02	0.08	0.06***	0.01	0.06	0.05***	0.02	0.08	0.06***
	(0.13)	(0.27)	(0.02)	(0.10)	(0.25)	(0.02)	(0.12)	(0.26)	(0.02)
Owns tractor	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01
	(0.06)	(0.10)	(0.01)	(0.04)	(0.10)	(0.01)	(0.04)	(0.08)	(0.00)
Expenditure on tractor rental on primary plot	1.45	6.98	5.53*	0.42	5.91	5.49**	1.15	10.03	8.88***
	(14.31)	(39.04)	(3.01)	(5.17)	(37.10)	(2.12)	(10.90)	(59.96)	(3.36)
Improved seed share on primary maize plot	0.00	0.59	0.59***	0.00	0.62	0.62***	0.00	0.64	0.64***
	(0.00)	(0.40)	(0.03)	(0.00)	(0.37)	(0.02)	(0.00)	(0.38)	(0.03)
Mean investment per hectare	6.39	31.69	25.30***	4.03	37.02	32.99***	6.51	36.38	29.87***
	(35.16)	(51.99)	(3.93)	(15.63)	(136.16)	(9.29)	(23.62)	(78.02)	(4.10)
Total exp not including seasonal labor on all plots	17.81	99.98	82.17***	10.09	177.42	167.33**	18.78	112.96	94.18***
	(118.75)	(190.92)	(13.00)	(39.82)	(1368.45)	(77.71)	(101.56)	(292.49)	(15.29)
Investment per hectare on primary plot	4.86	36.78	31.93***	4.26	48.47	44.21***	5.54	39.80	34.26***
	(14.19)	(62.71)	(5.09)	(16.60)	(201.30)	(12.53)	(15.78)	(79.43)	(4.12)
Optimal seed expenditure at avg 2022 price	0.00	38.04	38.04***	0.00	39.90	39.90***	0.00	40.86	40.86***
	(0.00)	(25.52)	(2.20)	(0.00)	(23.77)	(1.48)	(0.00)	(24.51)	(1.79)
Primary maize plot yield (kg/ha)	582.13	790.33	208.19***	877.73	1070.28	192.55***	302.42	389.41	86.99**
	(510.86)	(684.10)	(48.38)	(803.64)	(947.51)	(65.03)	(467.14)	(492.01)	(37.26)
Total yield (kg/ha)	573.74	767.97	194.23***	823.70	983.95	160.24**	311.46	372.20	60.74*
	(506.74)	(649.08)	(47.49)	(788.42)	(908.66)	(65.81)	(459.63)	(446.43)	(34.30)
Observations	791	303	1,096	602	387	1,022	510	426	959

Theoretical model

$$\max_{x_f, l_f^S, l_f^C} \mathbb{E}[U_f(x_f, U_m) | A_0] \qquad \max_{x_m, l_m^S, l_m^C} \mathbb{E}[U_m] = \mathbb{E}[x_m | A_0]$$

$$\text{s.t. } px_f \leq w_f l_f^S + A(q) \qquad \text{s.t. } px_m \leq w_m l_m^S + q + e_m - A(q)$$

$$A(q) = \min\{A_0, q(\theta)\} \qquad A(q) = \min\{A_0, q(\theta)\}$$

$$q = \theta f(\hat{l_m^C}, l_f^C) \qquad q = \theta f(l_m^C, \hat{l_f^C})$$

$$l_f^S + l_f^C = L_f \qquad l_m^S + l_m^C = L_m$$

Field experiment

Table 20: Descriptive statistics: control variables

	mean	count	sd	min	max
Husband's comprehension: % correct	0.86	524	0.16	0	1
Wife's comprehension: % correct	0.85	524	0.17	0	1
Husband literate	0.83	523	0.37	0	1
Wife literate	0.46	522	0.50	0	1
Years married	22.52	524	13.72	0	59
Number of wives	1.37	521	0.77	1	6
Children under 10 yrs live in hh	0.74	524	0.44	0	1
Wife receives transfers at least on a monthly basis	0.74	524	0.44	0	1
Wife earned off-farm income in last 12 months	0.56	524	0.50	0	1
Wife owns some of household's land solely	0.34	524	0.47	0	1
Proportion of total income from maize	0.07	522	0.15	0	1
Proportion of income from own crops	0.26	519	0.30	0	1
Hectares cultivated	4.35	522	3.83	0	31
Primary plot yield (kg/ha)	368.28	513	328.68	0	1500
Planted improved seed on primary maize plot	0.39	522	0.49	0	1
Improved seed share on primary maize plot	0.20	521	0.34	0	1
Hired full time agricultural workers in 2024	0.06	522	0.23	0	1
Days of day labor hired	7.65	522	16.39	0	80
Crops planted on primary maize plot decided by wife	0.03	524	0.18	0	1
Whether to sell from primary maize plot decided by wife	0.05	524	0.21	0	1
Total harvest of food staples was bad in 2024	0.49	524	0.50	0	1
Worried about zero payouts	0.17	522	0.38	0	1
Wanted to help husband earn money	0.48	522	0.50	0	1
My husband and I share everything so distribution did not matter.	0.46	522	0.50	0	1
Chose allocation most similar to real life	0.55	522	0.50	0	1
Worried that husband would discover she worked too little	0.05	522	0.22	0	1
Observations	524				

Table 21: Transfer function descriptive statistics

Variable	(1) Mean Old	(2) Mean New	(3) Difference
Monotonically increasing	0.615	0.384	-0.231***
	(0.487)	(0.487)	(0.030)
Non-increasing	0.385	0.616	0.231***
	(0.487)	(0.487)	(0.030)
Strictly monotonically increasing	0.267	0.141	-0.126***
	(0.443)	(0.349)	(0.025)
Transfer under max y > Transfer under min y > 0	0.933	0.924	-0.010
	(0.250)	(0.266)	(0.016)
Max transfer - min transfer $\mid y > 0$	514.797		0.000
	(333.980)	()	(0.000)
Monotonic, plateaus over high shocks	0.170	0.000	-0.170***
	(0.376)	(0.000)	(0.016)
Coefficient of variation	0.832	0.945	0.114***
	(0.186)	(0.191)	(0.012)
Observations	524	524	1,048

Notes:

Table 22: Summary statistics by chosen labor: Old technology

Chosen labor	E(Payout)	E(Transfer)	P(zero payout)	Contract intercept	Contract slope	Risk aversion	Altruism
2	73	73	73	73	73	73	73
	239.4548	219.4548	0	26.21014	.2854749	3.09589	0
	130.3058	130.3058	0	73.97658	.2502056	1.608695	0
3	177	177	177	177	177	177	177
	214.8935	233.7932	.0587571	30.0781	.2608831	3.135593	.7344633
	125.9533	126.0752	.060487	70.83637	.191541	1.652728	.4428714
4	165	165	165	165	165	165	165
	203.4424	259.0985	.1363636	29.81291	.2595638	3.248485	1.636364
	135.163	136.2527	.1417835	56.70705	.1611636	1.59804	.7497228
5	100	100	100	100	100	100	100
	168.7302	258.5312	.2965	31.03666	.2535939	3.52	2.6
	111.1363	115.5857	.1896641	66.28775	.1503849	1.560109	.8040303
Total	515	515	515	515	515	515	515
	205.7425	244.6718	.1214563	29.63099	.2625308	3.240777	1.281553
	128.3628	128.6584	.1551666	66.02428	.1845779	1.613503	1.042086

Reported statistics are the number of observations, conditional mean and standard deviation.

Table 23: Summary statistics by chosen labor: New technology

Chosen labor	E(Payout)	E(Transfer)	P(zero payout)	Contract intercept	Contract slope	Risk aversion	Altruism
2	84	84	84	84	84	84	84
	291.7911	271.7911	0	26.79083	.2425964	3.071429	. 952381
	160.7769	160.7769	0	127.438	.1928544	1.542848	1.016784
3	136	136	136	136	136	136	136
	282.7768	299.593	.1591912	35.23741	.2252215	3.125	1.102941
	181.8614	182.1153	.0755724	122.6871	.1762442	1.639501	.8884394
4	190	190	190	190	190	190	190
	320.4474	373.4263	.1613158	47.40415	.2258383	3.373684	1.342105
	237.8282	238.8678	.1462615	106.6609	.1837815	1.587765	.9779667
5	105	105	105	105	105	105	105
	365.2352	451.3686	.24	21.21294	.2580887	3.295238	1.647619
	280.467	285.4288	.2461629	123.7342	.1968501	1.66943	1.232422
Total	515	515	515	515	515	515	515
	314.9569	353.2423	.1504854	35.48906	.2349841	3.242718	1.27767
	224.6423	233.0512	.1644019	118.1665	.1860073	1.611402	1.043129

Reported statistics are the number of observations, conditional mean and standard deviation.

Table 24: Autocorrelation of altruism

	Altruism new
Altruism old: max(Observed labor - predicted labor, 0)	0.196^{***}
	(4.65)
Constant	0.455^{***}
	(6.33)
Observations	524
R^2	0.0398

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$