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A Gender-Responsive Approach to Designing Agricultural Risk Management Bundles

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Key Messages

- Bundling agricultural insurance with risk-reducing agricultural technologies can lower the cost of insurance for farmers, but before implementing bundled solutions, it is important to analyze how these bundles would impact men and women differently.
- Using a survey with 900 men and women farmers in Odisha, India, we find that women and men have similar farming practices and input use in general, but women face more difficulties in hiring labor and transplant rice later than men.
- Using biophysical crop models, we show that this delay in transplanting lowers expected yields and increases risk exposure for women farmers.
- Direct-seeded rice (DSR) is a promising alternative method for establishing rice that can help to mitigate the risks posed by climate change. Our findings indicate DSR is especially beneficial for women farmers.
- Gender-responsive policies are needed to ensure that women farmers have equitable access to agricultural insurance and risk-reducing technologies.

Introduction

The impact of climate change on agriculture is expected to become more severe, given that higher temperatures and increased weather variability pose a significant threat to agricultural production. Developing countries are disproportionately exposed to the effects of climate change and more vulnerable due to the higher prevalence of subsistence farming, food insecurity, and extreme poverty. Within these developing countries, women smallholder farmers—who rely more heavily on agriculture and natural resources and have less diversified livelihoods than their male counterparts—are more vulnerable to climatic shocks and stressors (Koo et al. 2022).

Women have fewer and lower-value assets and limited access to land, finance, labor, agricultural inputs, and social and institutional networks, which makes it harder for them to respond, adapt, or mitigate climate change (Koo et al. 2022). Achieving equitable and effective climate adaptation in agriculture requires understanding the differential impacts of climate change on men and women farmers, as well as gender disparities in access to risk-reducing agricultural technologies. Identifying the technologies that can reduce risks for both men and women farmers is crucial for developing gender-responsive and equitable climate adaptation strategies in agriculture.

This project note examines whether risk-reducing technologies can limit exposure to production risks for male and female farmers in Odisha, India. Such reductions in risk exposure could help lower insurance premiums to create a reinforcing cycle of risk protection. There is a wide disparity between farmers' willingness to pay for insurance and the premiums that are commercially viable, which renders insurance schemes unsustainable (Kramer, Pattnaik, and Ward 2021). Given that high insurance premiums in Odisha are often attributed to farmers' high exposure to risks, reducing risk exposure could be a significant breakthrough in lowering insurance premiums. However, if men and women do not have equitable access to risk-reducing agricultural technologies bundled with insurance, gendered livelihood gaps could be further aggravated. Moreover, it is a priori unclear to what extent risk-reducing technologies reduce risk exposure.

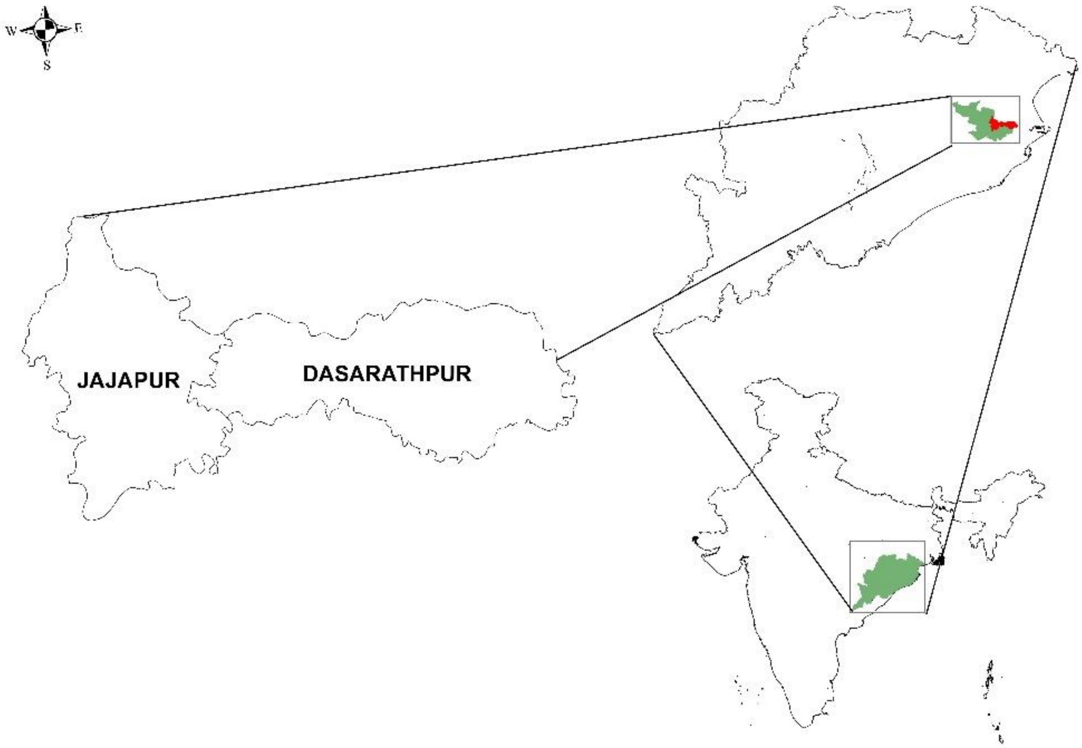
This study therefore seeks to understand: (1) what access do men and women farmers have to alternative risk-reducing technologies; (2) to what extent does adoption of these alternative risk-reducing technologies affect expected yields and agricultural incomes, and reduce exposure to extreme weather risk, and what are the implications for indemnity-based crop insurance premiums, given prevailing cultivation practices adopted by women and men; and (3) given current access to risk-reducing technologies, and cultivation practices currently used by women and men, along with their effects on yields and risk exposure, which risk-reducing technologies can be bundled with insurance to lower insurance premiums in a gender-responsive way?

Methods

This study employed a two-part methodology. First, we conducted a household survey to observe gender gaps in management practices, productivity, and cost of agricultural production. Second, we utilized insights from the survey to parameterize and calibrate the Agricultural Production Systems sIMulator (APSIM) (Holzworth et al. 2014), a biophysical crop model, to quantify the impacts of different agricultural management practices on crop yields and yield variability.

As a first step, we conducted a survey on agricultural production practices during the 2021 *Kharif* (monsoon) season with 814 farmers (423 men and 391 women) in Odisha, India (Figure 1). The survey included questions on irrigation practices, including the frequency, duration, and cost of irrigation events on the largest plot cultivated by the household. We also inquired about specific rice planting processes, such as transplanting dates and agricultural yields, because transplanting rice requires a significant amount of farmer input, including labor and irrigation. As the region's major crop, rice is conventionally farmed using the transplanting method, in which nursery beds are established and rice seedlings are transplanted into puddled soil after 20–30 days. Delays in transplanting rice will lead to the use of older seedlings, which causes a reduction in rice yields and increases susceptibility to end-of-season drought (Singh et al. 2019).

Figure 1 Location of surveyed households in Odisha State, India



Source: Map created by authors using ArcGIS.

As a second step, to explore how agricultural management practices affect agricultural output under a range of weather conditions, we used the collected household data to parametrize and calibrate the APSIM model. APSIM is a modelling framework that simulates the agricultural system by linking sub-models representing crop, soil, and atmospheric processes. The crop sub-models simulate crop development, growth, water, and nitrogen uptake, and are responsive to abiotic stress. We parameterized, calibrated, and verified the APSIM model for a long-duration rice cultivar (MTU7029, 150-day duration) that is most commonly grown in our study area. In the model, we varied when the rice variety was established to explore how yields would differ across 10 different transplanting dates, reflecting the transplanting dates reported by farmers in our sample. Using the same genetic coefficients for the MTU7029 rice cultivar, we also evaluated APSIM for direct-seeded rice (DSR), where the crop was sown across the same dates as the transplanted rice and supplied with recommended fertilizer. These simulations were conducted using 30 years of historical weather data (1990–2020) from our study location. We used gridded rainfall and temperature data from the Indian Meteorological Division. Solar radiation data was obtained from the Prediction of Worldwide Energy Resources (POWER) database provided by NASA.

Findings

We first compared cultivation, input use, and the hiring of labor among male and female farmers. Table 1 shows notable gender-based disparities in the amount of land cultivated, but not in the use of other inputs. Specifically, our findings indicate that male farmers tend to cultivate more land compared to their female counterparts, with mean plot sizes of 2.07 and 1.81 acres, respectively. In contrast, our analysis did not reveal any significant gender-related differences in seed usage per acre or the adoption of stress-tolerant seeds. Additionally, the data indicate that men and women exhibit similar irrigation practices, as shown by comparable frequencies of irrigation events. We also observed that the hiring of labor for rice cultivation was equally common among male and female farmers in our sample.

Table 1 Input use among male and female farmers

	Female (n=391)	Male (n=423)	Difference
Plot size (acres)	1.81	2.07	–0.26***
Seed used per acre (kilograms)	15.12	14.64	0.48
Proportion of farmers using stress-tolerant seed	0.87	0.90	–0.03
Irrigation events (number)	7.69	7.81	–0.12
Proportion hiring labor for cultivation	0.94	0.95	–0.01

Note: *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 2 provides evidence of gender disparities in hiring labor. While our study found no significant difference in the percentage of men and women who hired labor for rice cultivation, it is important to note that women face unique challenges in hiring labor for agriculture, which has implications for their overall agricultural productivity and livelihoods. In our sample, 52 percent of women faced challenges in hiring labor, as compared to 14 percent of men. Additionally, 26 percent of women had to pay extra for labor, compared to 8 percent of men. Access to labor was also a significant issue, with 69 percent of women (compared to 62 percent of men) reporting that finding labor was time-consuming. Moreover, 30 percent of women reported that laborers did not respect them, compared to 8 percent of men. These gender-based disparities in access to and use of labor led to significant differences in labor cost per acre between men and women. Men paid INR 9,299 per acre for labor, whereas women paid INR 12,306 per acre.

Table 2 Challenges faced by male and female farmers in labor access and use

	Female (n=391)	Male (n=423)	Difference
Challenges faced in hiring labor	52%	14%	38%***
Had to pay extra	26%	8%	18%***
Finding labor was time consuming	69%	63%	6%
Laborers engaged in other jobs	34%	52%	18%*
Laborers did not respect respondent	30%	8%	22%***
Labor cost (INR) per acre	12,306	9,299	3,007***

Note: *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

We also find that transplanting dates for rice represent the most significant discrepancy in labor between men and women. All farmers in our sample utilized the transplanting method for rice cultivation, which involves preparing a nursery bed, raising seedlings, uprooting them, and transplanting them onto the main field, a highly labor-intensive process. Access to labor has a significant impact on transplanting dates for rice, with the lack of labor availability being the primary limiting factor for women farmers (Table 3).

Table 3 Deciding when to transplant rice, by male and female farmers

	Female (n=391)	Male (n=423)	Difference
Deciding when to transplant rice			
With the onset of rains	47%	70%	–23%***
Based on irrigation availability	3%	4%	1%
Based on labor availability	40%	16%	24%***

Note: *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

Women farmers who faced difficulties in accessing labor in a timely manner transplanted their rice late (Figure 2). While most male farmers start transplanting on June 1 and finish by August 1, female farmers tend to start transplanting in mid-June, with some completing this task as late as September 1. The median transplanting dates for male and female farmers in our sample were June 15 and July 1, respectively. These findings reflect disparities in labor access and use, with female farmers experiencing greater difficulty in securing labor.

Given the differences in transplanting dates between male and female farmers, it is important to understand how these variations affect agricultural yields. To evaluate how rice yields vary with transplanting dates, we used the household survey data to characterize current agricultural practices and parametrize the APSIM model for an ex-post simulation study (1990–2020). The findings from this simulation are presented in Figure 3.

Figure 2 Gender differences in rice transplanting dates

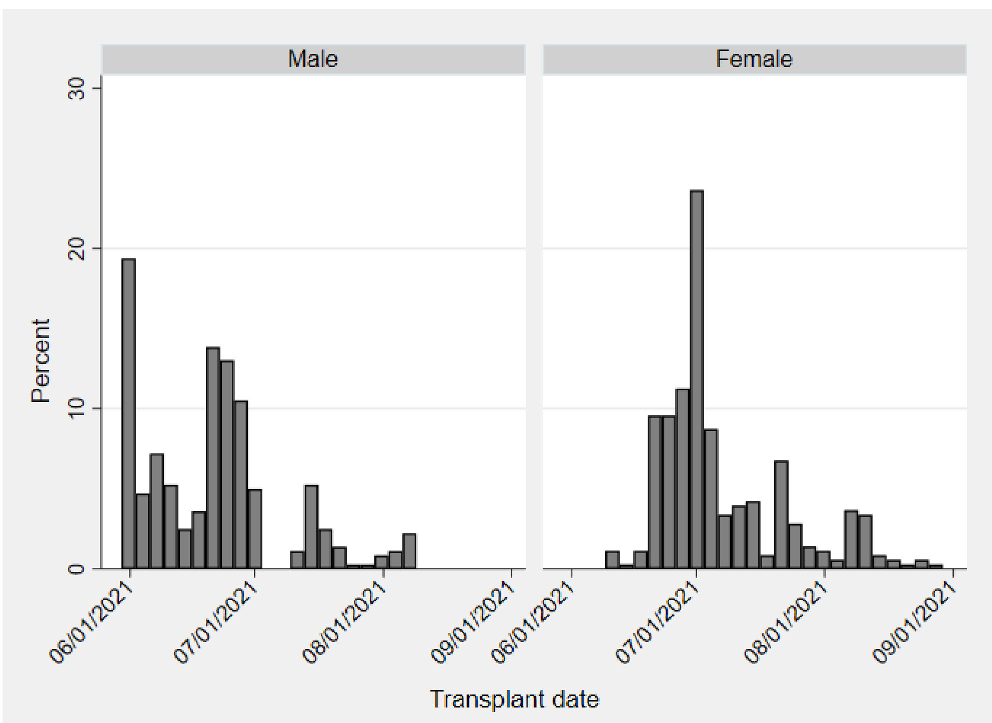
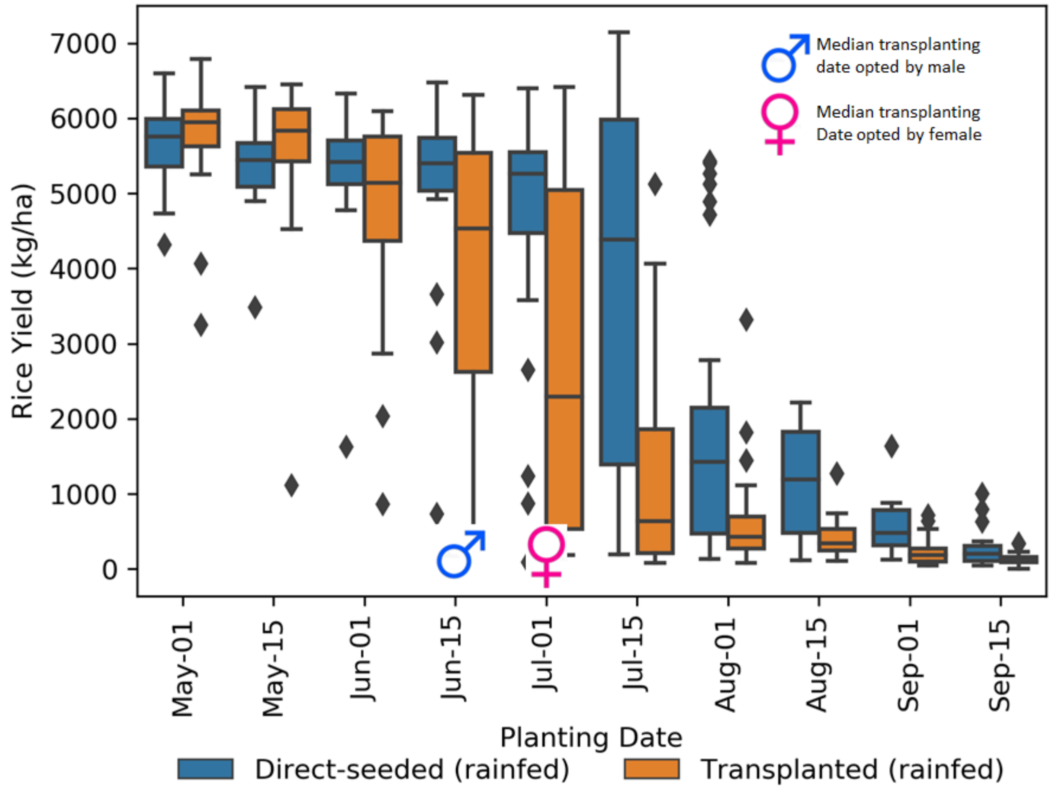


Figure 3 Distributions of simulated rice yields by crop establishment date



Note: ♂ and ♀indicate median transplanting dates from survey data for male and female farmers, respectively.

The simulations demonstrate that DSR yields steadily decline as transplanting dates shift from May 1 to June 15, the period in which men are more likely to transplant their rice than women. Furthermore, a significant decline in average yields and a sharp increase in yield variance, or production risk, is observed when transplanting is conducted on or after July 1. This is when most women transplant their rice, putting them at a disadvantage relative to men. For later transplanting dates (after July 15), average yields decline and production risk increases even further. The highest, most stable yields result from transplanting on May 15, which is considerably earlier than current transplanting dates practiced by farmers in the region. This finding highlights the elevated risk exposure for farmers, especially women, who transplant their rice later. Differences in transplanting dates between male and female farmers can generate substantial variance in production risk because of the threshold effect, or sensitivity, in how yields respond to transplanting dates. These findings underscore the importance of timely transplanting to optimize rice yields and reduce agricultural risk exposure in Odisha, as well as the vulnerability faced by women in finding labor.

In addition to timely transplanting, alternative practices that facilitate well-timed rice establishment could provide another solution to increase rice productivity in Odisha. One such practice is DSR, wherein rice seeds are sown directly in the main field, thus avoiding the processes of raising and transplanting. DSR has potential to address some of the challenges associated with traditional transplanted rice systems in India, particularly in relation to labor availability and utilization. To explore the potential benefits of DSR, we used the same parametrization of the APSIM model to conduct an ex-post simulation study (1990–2020).

Based on the simulation results presented in Figure 3, our study reveals the highest and most stable yields during the May 1-July 15 period. Rice yields show a consistent decline until July 1, followed by a sharp decrease after August 1. Our findings indicate that DSR outperforms transplanted rice across all transplanting dates, with a notable advantage observed around the median transplanting dates of June 15 and July 1 for male and female farmers, respectively. Even when compared to rice transplanted at later transplanting dates, DSR yields are higher and more stable, indicating lower risk exposure for farmers. These results suggest that DSR may offer a more efficient alternative to traditional transplanting methods, especially for farmers who are constrained by labor and transplant rice later in the season.

Conclusion

Our study highlights the significance of labor access in rice transplanting decisions made by farmers in Odisha and the associated gender disparities in labor access and utilization. Women report facing challenges in accessing labor, which could explain why they transplant rice much later in the season than men. Our simulation results demonstrate that late transplanting dates significantly reduce agricultural yields and increase farmers' risk exposure. Alternative rice establishment methods, such as DSR, have consistently shown better performance across a range of planting dates and have the potential to benefit all farmers in Odisha, especially women, given that they transplant rice later in the season due to a shortage of labor.

Our findings align with other studies that document the advantages of DSR across a range of planting dates (see, for example, Singh et al. 2019). Moreover, our findings contribute to the growing body of literature on the advantages of labor-saving technologies (LSTs) for women farmers (Vemireddy and Choudhary 2021). Women assign greater value to LSTs like DSR than men (Khan et al. 2016), highlighting the importance of gender-responsive approaches in agricultural interventions. To reduce risk exposure from late transplanting, interventions like agricultural insurance could be made more gender-responsive by prioritizing the promotion of LSTs that minimize labor expenses, particularly by female farmers. If insurance could increase women's access to DSR, risk exposure and insurance premiums could be reduced for all farmers, while also avoiding the difficulties that women face in accessing labor to transplant their rice.

The implications of our findings lend themselves to further investigation. It is important to note that DSR may not be a viable option for all farmers, and other agronomic factors should be considered before implementing it as a solution for labor-related issues in rice cultivation. To provide more information on efficient risk-reducing practices in the future, ex-ante simulations can be conducted to analyze yield and variability across various transplanting dates, and performance can be compared with alternative planting systems like DSR under a range of future climate scenarios, instead of with past weather realizations. Finally, while timely planting and alternative methods like DSR are positive steps toward mitigating risks, additional research is needed to fully understand their impact on farming outcomes.

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