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Evaluating the Gendered Credit Constraints and Uptake of an Insurance-Linked Credit Product among Smallholder Farmers in Kenya

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Abstract

Smallholder farmers in low- and medium-income countries lack sufficient access to agricultural production credit that can help them adopt new technologies and improve their farm production. Compared to men, women smallholder farmers face additional social, and economic barriers that further limit their credit access. Bundling agricultural credit with insurance, or risk contingent credit (RCC), provides a mechanism for addressing some of the credit access constraints and reducing credit rationing among smallholder farmers. In this paper, we evaluate the gendered determinants of credit rationing and the gender differences of the effects of RCC innovation on credit uptake decisions. We use three-wave panel data from a randomized control trial (RCT) in Kenya. We find that female-headed households (FHH) are significantly more risk rationed (or demand-side credit constrained) compared to male-headed households (MHH), however, the gender of the household head does not significantly determine the household quantity rationing status (supply-side constrained). We also find that farmers randomly assigned to be offered the RCC are up to four percent more likely to take up credit. RCC's impacts on credit uptake decisions do not vary with the gender of the household head, however, RCC has a differential positive and significant impact on the credit uptake decisions of farmers that were previously (at baseline) risk rationed. Based on these findings, we suggest that policies should focus on reducing gendered demand-side barriers to credit access, especially among poorer women households. Climate financing innovations such as RCC should also be designed and delivered in a gender-inclusive manner to accommodate women farmers who face time, liquidity, and financial literacy barriers.

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1) Introduction

Access to agricultural credit is considered one of the main mechanisms for promoting economic development in developing countries: credit access can aid farmers in purchasing agricultural inputs such as improved seed varieties, fertilizer, and labor, and in the adoption of modern agricultural technologies (Rosenzweig and Binswanger 1993; Okurut et al. 2005; Simtowe et al. 2009; Hailu et al. 2014); it can open opportunities for farmers to access high-value markets through contract farming (Meyer et al., 2017); it can facilitate the start-up of new enterprises (de Mel et al. 2008; Beaman et al. 2014; Banerjee et al. 2015); it can support productive asset accumulation; and it can allow households to smooth consumption in the face of income shocks (Binswanger and Khandker, 1995; Getachew 2016; Khandker and Koolwal, 2016). Imperfections in the credit markets, however, pose a challenge to the supply and farmer utilization of credit in most rural areas of low- and middle-income countries (LMICs) (Marjit and Mishra, 2020). Even when the credit infrastructure is well developed, research shows that most smallholder farmers in LMICs remain largely underserved (Karlan and Morduch, 2009; McIntosh et al. 2013; Shee et al. 2015).

Limited credit access and utilization by smallholder farmers is attributed to both demand and supply side limitations. On the supply-side, information asymmetry remains one of the key challenges to serving smallholder farmers. This includes challenges related to ascertaining the creditworthiness of borrowers' *ex-ante* and contract enforcement *ex-post* (Ghosh et al. 2010; Conning and Udry, 2007; Gine and Yang, 2009). Information asymmetry makes it risky and expensive to serve smallholder farmers, thus lenders ration the quantity of credit offered (*quantity rationing*) or they raise the interest rates and make the contracts too demanding in terms of collateral (Boucher et al. 2008; Farrin and Miranda, 2015). On the demand side, smallholders

might voluntarily withdraw from the credit market due to lack of adequate collateral or the fear of losing it when they are unable to repay the credit—*risk rationing* (Binswanger and Sillers. 1983; Boucher et al. 2008; Guirkinger and Boucher 2008). The transaction costs associated with complex loan application procedures, long travel distances to banking institutions, and low financial literacy might also ration some farmers out of the credit market (Balana et al. 2022). Although smallholder farmers can borrow from informal sources like local traders, who usually have more information about the borrowers, the informal sector is usually not accessible to all farmers, and the interest rates can be higher than those charged by formal lending institutions (Demont 2020).

Research on the gendered extent of credit rationing among smallholder farmers shows that compared to men, women face additional social and economic constraints that can significantly reduce their willingness to participate in the credit markets and the amount of credit available to them (Diagne and Zeller 2001; Fletschner, 2009; Fletschner and Kenney, 2011; Zins and Weill, 2016; Reboul et al. 2021). All forms of credit rationing, whether demand- or supply-side driven, affect smallholder farmers' —especially highly constrained women farmers—farm investment and production decisions, and it limits them to suboptimal low-risk/low-return production levels. This in turn lowers their farm productivity, food security, and resilience to climate shocks. This paper contributes to the literature on gender and credit access by evaluating the gendered differences in credit rationing, and whether a bundled credit product can enhance credit access among men and women smallholder farmers in Kenya.

Bundling agricultural credit with insurance—broadly referred to as insurance-linked credit or risk-contingent credit (RCC)— provides a mechanism of addressing some of the supply- and demand-side constraints to credit access and utilization. RCC embeds within its structure insurance protection which, when triggered, offsets the loan payments obligations to farmers, which in turn

removes, or at least reduces the default risk exposure of lenders. By minimizing borrowing risk and reducing collateral and guarantor requirements, RCC can improve the farmers' risk-bearing ability thereby promoting credit uptake and farm investment, as evidenced by studies from various pilots across the globe (Carter et al. 2011; Farrin and Miranda, 2015; Ndegwa et al. 2020; Mishra et al. 2020).

Given that men and women farmers face different supply- and demand-side constraints which differentially affect their ability to access and demand for agricultural production credit, knowledge gaps exist in understanding the potential of RCC in expanding agricultural credit access among different gender categories of small-holder farmers. Using data from a randomized control trial (RCT) for an RCC program in Kenya, the objectives of this study are to, (i) identify the gendered differences in credit rationing status (that is whether quantity- and risk-rationing vary by the gender of the household head), and (ii) evaluate the gender differences of the effects of RCC on credit uptake decisions.

We categorize our sample into male-headed households (MHH), and female-headed households (FHH). To capture the heterogeneity among women farmers we define two distinct categories of FHH (i) *de jure* FHH: households where a woman is the legal and customary head (e.g., due to being widowed); and (ii) *de facto* FHH: households where women identify as the household head because the husband is away from home (e.g., due to work or other reasons) or are in a polygamous relationship. For the econometric analysis, we employ a multinomial probit model to evaluate the determinants of credit rationing status and a binomial probit model to measure the gender differences in the impact of RCC on farmers' credit uptake decisions.

We find that pre-intervention (that is at baseline), although both *de jure* and *de facto* FHH are significantly risk rationed (or demand-side credit rationed) compared to MHH, the gender of the

household head does not statistically influence the household quantity rationing status (supply-side rationing). These findings suggest that contrary to previous research findings, gender gaps in credit market participation among smallholder farmers are not necessarily driven by gendered biases in credit lending practices, rather it is mostly driven by demand-side factors which could be attributed to lack of collateral and higher levels of risk aversion among women farmers. Moving to credit uptake decisions, we find overall, *de jure* FHH have higher credit uptake than both MHH and *de facto* FHH. We also find that RCC increased credit uptake by up to four percent. RCC's impacts on credit uptake decisions does not vary with the gender of the household head, however, RCC has a differential positive and significant impact on the credit uptake decisions of farmers that were previously (at baseline) risk rationed. From a policy perspective, these findings have a broader relevance beyond RCC. First, promoting gender equality in agricultural credit uptake requires addressing demand-side constraints that mostly ration women—especially *de facto* FHH— out of the credit market. Second, innovations such as RCC that are aimed at enhancing credit access for smallholder farmers should take into consideration unique challenges such as reduced mobility and time-burden barriers that might otherwise bar some groups of women from participating in these programs and accessing the products.

The rest of this paper is organized as follows. Section 2 briefly reviews the literature on gender and credit access, section 3 provides details of the research setting, the experiment and sampling design, the data and the variables used in the analysis. Section 4 discusses the estimation strategy used in the analysis, followed by a discussion of the main findings in Section 5. Section 6 concludes.

2) Literature review and theoretical approach

Compared to men, women smallholder farmers face a host of social, and institutional constraints that decrease their access and willingness to participate in the credit markets. Women in most cases have fewer rights over productive assets such as land and livestock (Quisumbing et al. 2015; Doss et al. 2020) that can serve as collateral against credit borrowing. Women also tend to have relatively lower trust levels, and higher degrees of risk aversion (Buchan et al. 2008; Eckel and Grossman, 2008), which locks them into a cycle of low-risk/low-reward agricultural production activities that do not require credit. Also, given that women spend most of their time performing unpaid domestic work (Dinkelman and Ngai, 2022), time poverty can limit their physical access to credit services, including physical access to banking facilities, opening bank accounts and the execution of time-demanding financial contracts. From the supply-side, lenders might find women to be more uncreditworthy due to a lack of credit history or 'thin files' (Björkegren and Grissen, 2020; Kramer et al. 2021), which can significantly reduce the amount of credit available to them and /or increase their interest rates.

Previous research on the gender dimension of climate resilience interventions has mostly employed a binary gender variable (that is MHH and FHH)[1], assuming homogeneity within each category (for instance, Mallick and Rafi, 2020; Bageant and Barrett, 2017; Kairiza et al. 2020; Nnaji et al. 2021; Timu et al. 2023a, among others). However, FHH are heterogeneous, and they can be broadly divided into two distinct categories, each with a unique set of opportunities and challenges: *de jure* and *de facto* FHH. *De facto* households have self-reported female heads whose

[1] Recent gendered studies are increasing using individual-level data collected using the domains and indicators from different versions of Women's Empowerment in Agriculture Index (Alkire et al. 2013; Malapit et al. 2019). It would be ideal to evaluate the intrahousehold credit rationing and uptake decisions but the data we use was collected at the household level.

husbands are absent for most of the time (usually more than 50 percent of the time; Quisumbing et al., 2001). In these households, husbands or other male relatives still play a role in basic decision-making and contribute to the household income. Research shows that *de facto* FHH are significantly poorer with fewer assets, and little savings, and they are particularly more vulnerable to poverty than other households (Kennedy and Haddad 1994). In *de jure* households, women are the legal and customary heads—examples are households headed by widows and unmarried, separated, or divorced women (Quisumbing et al., 2001). *De jure* FHH are characterized by older women, who are slightly poorer than MHH, they have significantly higher per capita incomes than *de facto* FHH and some MHH (DeGraff and Bilsborrow, 1992; Chant, 1997; Horrell and Krishnan, 2008).

In theory, RCC can have mixed outcomes on credit uptake decisions among men and women: On the one hand, by relaxing some of the demand-side constraints such as removing collateral and guarantor requirements, it is expected that women, who are disproportionately affected by these constraints, will equally demand credit as their men counterparts. The insurance protection provided by RCC might also change smallholder farmers' behavior towards risk, inducing the risk averse farmers (mostly women) in taking bigger risks and engaging in the credit market (Balana et al. 2022). RCC protection might also trigger some behavioral changes in lenders to equally reach both men and women in their lending practices.

On the contrary, RCC has the potential to widen the gender gap in credit access and use. This can happen under three different circumstances: First, by introducing the index-insurance trigger component, it becomes much more complicated for smallholder farmers to understand the complexities of the underlying risks and the trigger mechanisms associated with the index. Given that men and women smallholder farmers have differential financial literacy levels which is an

important determinant in the uptake of credit and other financial tools (Hill et al. 2016; Balana et al. 2022; Timu and Kramer, 2023), introducing another layer of financial complexity might widen the gender gap in credit demand. Second, in addition to the interest rates charged by the lending institution, RCC requires farmers to pay an insurance premium in order to insure the credit (Shee et al. 2019) which makes it expensive and not readily accessible to resource-constrained farmers. Third, in the presence of downside basis risk (that is when the insurance index fails to trigger payouts even after insured households experience significant yield losses due to the insured event), research shows that overall, the incentive to repay diminishes because the welfare costs of defaulting are lower, and lenders will, in turn, limit their credit supply (Giné and Yang, 2009; Farrin and Miranda, 2015; Belissa et al. 2020). Limited credit supply will especially affect women who often lack collateral and loan guarantors. Basis risk might also push risk-averse farmers—who are more likely to be women—out of the credit markets due to increased fear of future default risks and subsequent collateral losses. Given this background, understanding the heterogenous gender dimensions in credit rationing, and RCC's effect on credit uptake decisions is important in designing effective interventions that can increase credit access and uptake, and enhance agricultural investment among men and women farmers.

3) Context and Evaluation

3.1 RCC product design

The present study is part of a larger evaluation of the impacts of RCC on agricultural and other developmental outcomes. For the purposes of this broader impact evaluation, the RCC product was designed to promote credit supply and enhance credit access at the beginning of the cropping cycle among maize and bean farmers (the most important food and cash crops in the study area). Access to credit is expected to promote investment in modern farm inputs and enhance the farmer's

resilience to weather-related shocks during and after the cropping cycle. The product was offered as a short-term loan with a payoff structure that is linked to the cumulative seasonal rainfall. The insurance index of RCC is based on Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) rainfall measures. For each RCC period, the dekadal (10-daily) rainfall data for the study area were compiled for the past 40 years and accumulated over the long and short rains to represent the cumulative rainfall conditions.

Figure 1 shows the basic design of the RCC product, and the trigger mechanism associated with it (see Shee et al. 2019 for a detailed overview). The top panel shows the farmers' loan repayment obligation, and the bottom panel shows insurance payouts relative to the severity of the drought conditions. If the drought risk worsened and crossed the trigger levels, the total repayment obligation of the borrower falls due to insurance payment. However, if the drought risk is not severe enough to trigger a payout, the loan is repaid at the risk-contingent interest rate, which includes the insurance premium payment.

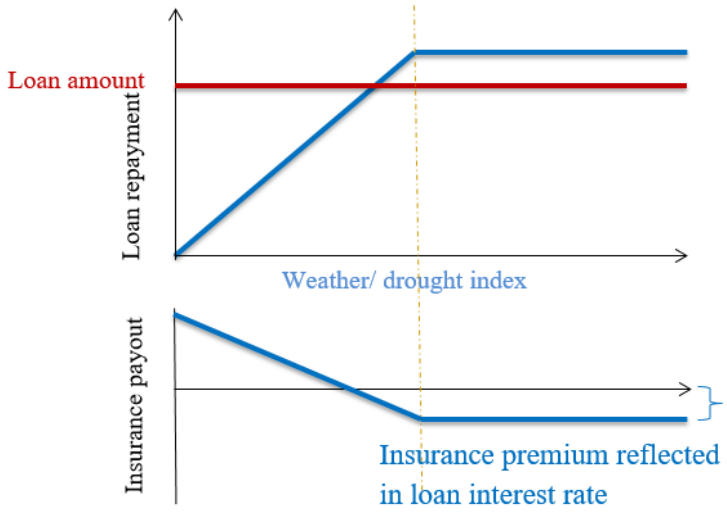

Figure 1: An illustration of the RCC trigger mechanism (Source: Shee et al. 2019)

RCC has two main characteristics that make it desirable compared to conventional credit and complementary agricultural insurance products. First, RCC links the farmers' ability to repay a loan with the most important crop produced (for instance, maize and beans in the study area), and the subsequent rainfall/drought outcomes rather than collateral. As such, smallholder farmers can access uncollateralized loans, and their repayment will be correlated with their farm yields. By transferring the climate risks facing borrowers and lenders to the insurance markets, it is also expected that both demand- and supply-side forms of credit rationing can be reduced thereby increasing the elasticity of credit demand and supply (Shee et al. 2019). Second, unlike the conventional, stand-alone agricultural insurance products that require upfront premium payment, premiums in insurance-linked credit are paid at the end of the cropping cycle, which can help in overcoming liquidity constraints that plague the agricultural insurance markets (Casaburi and Willis, 2018; Liu et al. 2019; Kramer et al. 2022).

3.2 Study setting and experimental design

This study was conducted in thirteen locations in Machakos County located in the eastern province of Kenya. The area is semiarid and characterized by hills and plateau landscapes. The pattern and intensity of rainfall exhibit spatial and temporal variation with a bimodal distribution: long rains falling between mid-October to mid-January and short rain between mid-March to mid-May. Most households in the region depend on farming as their main source of livelihood, mainly growing maize and other drought-tolerant crops such as sorghum, millet, and tropical fruits. Women are important actors in the agricultural value chain in the study region, participating as main farmers, laborers, traders, and consumers. Although there are a few commercial farming operations with irrigation systems to buffer the effects of the dry seasons, most households practice subsistence farming and their production is highly dependent on rainfall. However, low-intensity rainfall

causes frequent crop failures and reduces the reliability of agriculture as a main source of livelihood. The weather risk is further compounded by low credit access among farmers; recent urbanization has pulled financial services providers to the region, but lenders are reluctant to serve smallholder farmers because of the financial risks associated with climate-related crop failure and information asymmetry challenges.

Machakos County was purposively selected for the experiment because of its agroecological characteristics, access to commodity and financial markets given its rural-urban setting, and the importance of agriculture to smallholders in the county. Following the same criteria, five sub-counties (namely, Kangundo, Kathiani, Matungulu, Mwala, and Yatta) within Machakos County and thirteen locations across all the sub-counties were selected for the study. The locations also served as clusters for the sampling. For each location, a sampling frame was developed with the help of the local administration; these included a list of all the villages in each location and households in each village. Six villages were randomly selected and subsequently, fifteen households were selected from each village for inclusion in the study. Baseline data were collected from 1053 in mid-2017. Following the baseline survey, households were invited to training events that involved comprehensive financial literacy training, agricultural risk, risk management strategies, RCC training through games and role-playing, and agronomic practices. For each location, households were randomly assigned into one of three experimental groups: traditional credit (placebo group; N=351), RCC (treatment group; N=351), and no credit (control group; N=351). Treatment and placebo farmers received further training on the bank's loan processes and, where necessary, they were supported to open bank accounts with the lending institution (i.e., Equity Bank). Based on the average cost of farm production per acre, the loan amount was set at

Kshs 10,000[2]. The interest rate applied to the loan balance was 14% per annum. For the RCC group, an additional Ksh 1,400 was incorporated to cater for the insurance premium. The first and the second rounds of credits were offered in October 2017, and October 2018 for the long rains crop production cycle. To ensure that credit was to be used only in production processes, farmers were provided with vouchers which they used to collect inputs from local agrovet supply shops within their communities (Ndegwa et al. 2020).

Follow-up midline and endline surveys were conducted in mid-2018 and late-2020 respectively. Out of 1053 farmers who were originally shortlisted for the study, only 82 and 76 percent participated in the midline and endline respectively. We evaluate whether households that stayed in the program substantially vary from those that dropped out: we find no evidence of systematic attrition and conclude that farmer attrition was random. Households that had dropped out were replaced by households from the same study site and socioeconomic and demographic status. Each survey round included detailed questions about household and individual socio-economic characteristics, individual livelihood activities, agricultural land ownership, farm input usage and expenditure on inputs, livestock holdings, agricultural shock experience, credit rationing status, credit uptake decisions, food consumption, and non-food expenditure. The survey also recorded the individuals who identified as the household heads along with their marital status, that is, if they were single, married, divorced, or widowed. Finally, following Binswanger (1980), an experiment was conducted to elicit the risk preferences of the subjects in our sample. The experiment was performed as a lottery, whereby each respondent was offered a coin toss gamble, with real cash

[2] 1 USD=123.65 Kshs as of January 2023

payments in Kenya Shillings (Kshs). The possible choices include: (a sure payment of 250), (300, 300), (480, 270), (600, 240), (900, 120), and (1200, 0).

3.3 Construction and description of variables

Dependent variables

To identify the credit rationing status of the household, we adopt the framework outlined in Boucher et al. (2009) and define unordered categorical variables with three levels; (i) credit unconstrained (i.e., households that obtained the amount of loan required, did not need money because they could afford to finance their farm input purchases, or who prefer to work using own liquidity); (ii) risk-rationed (or demand-side constrained; households that select out of the credit market due to various reasons including risk-aversion such as the fear of defaulting on the loan and losing their collateral, do not want to be worried about loan repayment, or who believe that they are not creditworthy), and (iii) quantity-rationed (or supply-side constrained; households who applied for loan and their application was either rejected or they obtained less than the amount for which they applied because the lenders perceive them to be either completely or partially uncreditworthy). The three variables will be used to evaluate whether there are gender differences in credit constraint status. To evaluate the impact of RCC on credit uptake decisions, we define credit uptake as a binary variable that is equal to one if the household applied and received a loan and zero otherwise.

Independent variables

The independent variables used in the analysis are based on a review of the literature on factors that influence credit rationing status and determinants of credit demand (Boucher and Guirkinger, 2007; Boucher et al. 2009; Kumar, 2013; Beaman et al. 2014; van Tran, 2018; Balana et al. 2022;

Balana and Oyeyemi 2022). We include socio-economic variables such as the age of the household head, education level, household size, dependency ratio, and a dummy variable indicating whether crop production is the household's main economic activity. We also include wealth indicators such as livestock ownership, defined by the tropical livestock unit (TLU)[3], and the amount of land owned in acres. To capture the role of social capital on the credit constraint status and uptake, we include the number of mutual self-help groups the household belongs to, access to extension services, and whether the household attended the RCC program training. We also define three categories of risk attitude: risk averse, risk moderate and risk loving. Finally, for the credit uptake analysis, we include a binary variable indicating whether the household was in the RCC treatment group, and variables indicating the credit constraint status of the household at baseline.

3.4 Summary Statistics

Table 1 shows the summary statistics for the households in the sample based on farmer characteristics at baseline. Column (1) shows the pooled sample means. We also report coefficients and their standard errors from OLS regression comparing households in the control (N=351) and traditional credit treatment group (N=351) in columns (2) and households in the control and RCC treatment group (N=351) in Column 3. Column 4 reports the comparison between RCC and traditional credit treatment pools. In all regressions, we include location fixed effects, and the standard errors are clustered at the household level. Out of the total 1053 households in the sample, 70 percent had a man as the head of the household, 14 percent had a *de-jure* FHH, and 16 percent had *de-facto* FHH. The average age of the household head is 54 years, and the average household size is 5.5 persons. Household heads have an average of 8.3 years of formal schooling. The average

[3] TLU is a measure used to aggregate livestock across species in relation to a common average metabolic weight such that 1 TLU=1 cattle=0.7 camels=10 goats/sheep (shoats)

land farmed is 3.6 acres and about 54 percent of the land (1.96 acres) is under maize cultivation. The average livestock holding is 2.6 tropical livestock units (TLUs).

Table 1: Baseline summary statistics by treatment group

Household size	Pooled		Control vs. Traditional		Control vs. RCC		RCC vs. traditional	
	(1)		(2)		(3)		(4)	
	Mean	SD	Coeff	SE	Coeff	SE	Coeff	SE
Male headed	0.697	0.426	0.029	0.021	0.022	0.023	-0.007	0.029
De jure female heads	0.139	0.346	-0.020	0.025	-0.008	0.022	0.012	0.030
De facto female heads	0.163	0.297	-0.009	0.019	-0.014	0.014	-0.006	0.022
Age of household head (years)	54.179	16.666	0.016	1.057	-1.266	0.745	-1.283	0.982
Household size	5.542	2.577	-0.159	0.149	0.005	0.204	0.163	0.165
Dependence ratio	0.773	0.772	-0.108	0.062	-0.106*	0.055	0.002	0.055
Education level (years)	8.310	4.121	-0.061	0.249	0.058	0.273	0.118	0.317
Land farmed (Acres)	3.595	4.025	0.051	0.278	0.118	0.329	0.067	0.373
Area under maize (Acres)	1.968	1.982	-0.069	0.162	0.037	0.138	0.107	0.168
Tropical Livestock Unit (TLU)	2.656	3.406	0.316	0.373	0.183	0.223	-0.133	0.330
Access to extension service	0.069	0.294	0.001	0.017	-0.005	0.016	-0.005	0.02
Crop farming main occupation	0.637	0.481	-0.06*	0.030	-0.061*	0.034	-0.001	0.038
No. of groups (out of 7)	2.244	1.036	0.021	0.065	0.012	0.056	-0.008	0.058
Risk loving=1	0.272	0.445	-0.023	0.043	-0.019	0.041	0.004	0.022
Risk averse=1	0.527	0.500	0.06	0.041	0.05	0.033	-0.01	0.026
Risk moderate=1	0.166	0.372	-0.037	0.04	-0.031	0.038	0.006	0.032
Is risk rationed=1	0.398	0.490	-0.021	0.036	-0.030	0.034	-0.010	0.028
Is quantity rationed=1	0.141	0.301	0.009	0.013	0.014	0.018	0.006	0.021
Is credit unconstrained=1	0.462	0.499	0.012	0.038	0.016	0.037	0.004	0.028
Attended training first training	0.690	0.462	-0.080*	0.037	-0.038	0.026	0.042	0.044
Took credit in 2017/18	0.211	0.408	0.304***	0.034	0.351***	0.035	0.048	0.043
Took credit in 2018/19	0.092	0.289	0.115***	0.014	0.149***	0.023	0.034	0.022
Observations	1053							

About 7 percent of the households in the study have access to extension services which is lower than 21 percent reported from other regions in the country (Wanyama et al. 2014). About 64 percent pursue crop farming as their main source of livelihood. Out of 7 social and self-help groups, households belong to 2.2 groups on average. The results also show that 27 percent of the farmers in the sample are risk loving, 53 percent are risk averse, 17 percent are risk moderate. In terms of credit constraint status at baseline, we find that 40 percent of the sample households are risk rationed; that is, they self-selected out of the credit market. About 14 percent of the households are quantity rationed, implying that despite their effort to apply for credit, they were either denied

or given a smaller proportion than what they borrowed. Forty six percent of the households are credit unconstrained, meaning that they either received the amount of credit they applied for, or did not need credit because they had enough liquidity to finance their needs. The minimal pre-intervention difference in the various treatment arms shows minimal imbalances in crop production and household size (only significant at a 10 percent confidence level), however, the results largely indicate that the treatment assignment was random. Post-intervention, we find that about 21 percent of the households took credit for agricultural production during the 2017/18 production seasons. The credit uptake fell to 9 percent during the 2018/19 production seasons.

Table 2 shows the baseline summary statistics by the gender of the household head. Column 1 presents the MHH and columns (2) and (3), respectively, are the coefficients of the OLS regression comparing MHH with *de jure* (N=147) and *de facto* FHHs (N=168). Column 4 compares *de jure* and *de facto* FHH. We find that compared to MHH, *de jure* FHH are significantly older, less educated, have smaller household sizes, have significantly higher reliance on crop production as the main source of livelihood, and have significantly higher levels of risk rationing. Post intervention, *de jure* FHH had a higher, but non-significant credit uptake than the MHH. On the other hand, *de facto* FHH have significantly lower education levels, they own significantly smaller farm sizes, and livestock holdings, have significantly higher reliance on crop production as the main source of livelihood, and significantly lower access to agricultural extension services. We also find that similar to *de jure* households, *de facto* FHH are significantly risk-rationed than their male counterparts. As expected *a priori*, the *de facto* FHH were significantly less likely to borrow credit in both production periods.

Comparing the two FHH categories, we find that compared to *de jure* FHH, *de facto* FHH are significantly younger, have significantly lower TLU holdings, lower access to extension services,

and lower RCC training attendance. The lower training attendance could be due to time limitations, as *de facto* heads are younger and probably tasked with childcare and other domestic duties. We also find that post-intervention, *de facto* FHH also had significantly lower credit uptake rates than the de jure FHH. These findings confirm our prior expectations that conflating female-headed households might mask some gendered dynamics in credit rationing status and the effects of RCC on credit access.

Table 2: Baseline summary by the gender of the household head.

	MHH		***De jure* FHH vs. MHH**		***De facto* FHH vs. MHH**		***De facto FHH vs. De jure FHH***	
	(1)		**(2)**		**(3)**		**(4)**	
	Mean	**SD**	**Coeff**	**SE**	**Coeff**	**SE**	**Coeff**	**SE**
Age of household head (years)	55.139	13.195	6.995***	1.142	0.233	2.432	-6.762***	2.272
Household size	5.834	2.381	-0.586*	0.300	-0.057	0.237	0.529	0.367
Dependence ratio	0.802	0.765	-0.012	0.079	0.004	0.087	0.015	0.117
Education level (years)	9.324	3.483	-3.476***	0.327	-2.78***	0.637	0.696	0.667
Land farmed (HA)	3.837	4.064	-0.535	0.33	-0.541*	0.458	-0.006	0.451
Area under maize (HA)	2.058	1.946	-0.104	0.247	0.041	0.328	0.145	0.421
Tropical Livestock Unit (TLU)	2.781	3.279	0.256	0.348	-0.813***	0.240	-1.069***	0.343
Access to extension service	0.068	0.253	-0.021	0.02	-0.077***	0.017	-0.056***	0.016
Crop farming main occupation=1	0.605	0.489	0.291***	0.027	0.219***	0.063	-0.072	0.056
No. of groups (out of 7)	2.325	0.97	-0.007	0.077	0.034	0.187	0.040	0.217
Risk loving=1	0.264	0.441	0.098	0.061	0.033	0.065	0.030	0.058
Risk averse=1	0.562	0.496	-0.08	0.058	-0.044	0.067	-0.065	0.064
Risk moderate=1	0.174	0.379	-0.018	0.022	0.012	0.057	0.035	0.082
Is risk rationed=1	0.390	0.488	0.123***	0.047	0.110**	0.059	0.095	0.141
Is quantity rationed=1	0.112	0.315	-0.031	0.031	-0.038	0.032	-0.007	0.038
Is credit unconstrained=1	0.495	0.500	-0.073	0.050	-0.072	0.050	0.001	0.079
Attended training	0.720	0.449	0.036	0.042	-0.172**	0.072	-0.208**	0.080
Took credit in 2017	0.231	0.421	0.005	0.058	-0.087***	0.024	-0.056**	0.028
Took credit in 2019	0.097	0.296	0.009	0.045	-0.022*	0.012	-0.025**	0.024
Observations	738							

Figure 2 shows the gender differences in credit uptake for the two treatment arms—RCC and traditional credit. The results show that the uptake for the RCC product was higher than traditional credit across the three gender categories. In addition, the credit uptake for *de jure* FHH is surprisingly higher under both credit categories. *De facto* FHH have a significantly lower uptake than both MHH and *de jure* FHH ($p<0.01$).

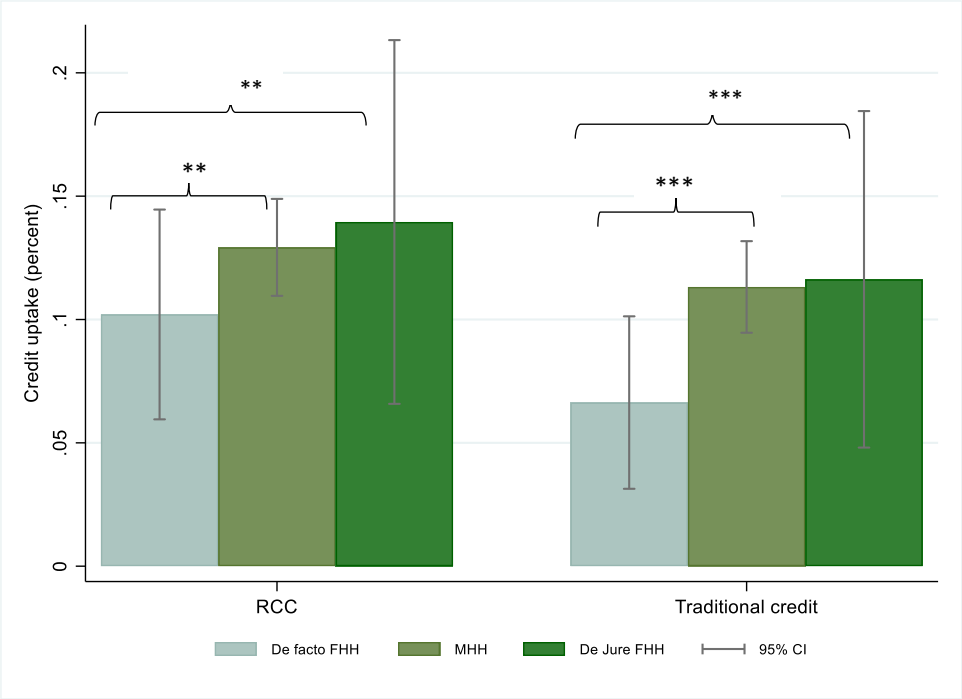

Figure 2: Credit uptake for different treatment arms by gender of the household head

4) Empirical Approach

This section highlights the empirical approaches used in the analysis. We estimate two regression models; *i)* a multinomial probit (MNP) model to evaluate the determinants of credit constraint among households in the study area *ii)* a binomial probit model to evaluate whether RCC can improve credit uptake and the subsequent gendered impacts of RCC on credit uptake decisions. We discuss the details of each empirical approach below.

Multinomial probit model

MNP is commonly used when the dependent variable is categorical and takes more than two categories (such that $j = 0, 1, \dots, m$), where m is the number of independent categories to which a particular indicator variable could be assigned. As discussed in section 2.3, our dependent variable is composed of three categories, namely credit unconstrained, risk-rationed, and quantity rationed

(such that $j = 0,1,2$) and each household i can only fall under one of these three categories. The latent regression characterizing a household's credit rationing status can be represented as follows:

$$y_{ij} = \gamma G_i + \beta X_i + \varepsilon_{ij} \quad (1)$$

where y_{ij} is the unobserved propensity of household i being in credit rationing status $j = 0,1,2$. The MNP probability model that household i belongs in the j^{th} credit rationing status j is the modelled as:

$$P_{ij} = P(y_i = j) = P\left(y_{ij}^* > y_{ik}^*\right) = \Phi(\gamma G_i + \beta X_i) + \omega_i + \varepsilon_i, \forall j \neq k \quad (2)$$

where P_{ij} represents the probability that household i falls into the j^{th} credit constraint category; X_i is a vector of covariates that influence household credit rationing (described in section 2.3); $G_i = 1, 2,3$ is a categorical variable representing the gender of the household head (where 1=MHH, 2=*de-jure* FHH, and 3=*de-facto* FHH); Φ is a probit functional evaluator (i.e.., the cumulative normal distribution function); ω_i are location fixed effects; and ε_i is an idiosyncratic error term that is identically distributed but only independently distributed across villages – not within villages. Consequently, we adjust the standard errors for the clustered nature of the sample design at the village level. In order to provide an *ex-ante* picture of the household credit rationing status and reduce endogeneity concerns, this analysis will be conducted using data drawn from the baseline survey only.

Binomial probit model

To evaluate the effects of RCC on credit uptake decisions, our dependent variable takes the value of 1 if a household borrowed credit in 2017/18 or 2018/19 long rain production period and 0 otherwise. The latent formulation of this credit uptake decision can be formulated as follows:

$$Y_{it} = \gamma G_{it} + \mu T'_{it} + \ \beta X'_i + \lambda y'_{ij} \ + \ \varepsilon_{it} \qquad (3)$$

where Y_{it} is a binary variable indicating whether in time t (where $t = 2$) household i took up credit ($Y_{it} = 1$) or not ($Y_{it} = 0$); T_{it} is a vector of binary variables indicating whether household i was randomly assigned to either the RCC or traditional credit treatment groups; X_i is a vector of time-invariant explanatory variables that are expected to influence the household decision to borrow on credit (as indicated section 2.3). We also include a vector of binary variables (y'_{ij}) indicating the credit constraint status of the household at the baseline. To account for heterogenous gender outcomes, we include interaction between the gender categories and the treatment variables. We also evaluate whether RCC specifically helped in improving credit uptake among households that were credit rationed at baseline by including an interaction term of y_{ij} and the treatment variables. We therefore estimate the following model,

$$Y_{it} = \gamma G_{it} + \emptyset T_{it} + \ \beta X'_i + \lambda y'_{ij} \ + \ \vartheta(T_{it} \,.\, G) + \ \varepsilon_{it} \qquad (4)$$

Where $(T_{it} \,.\, G)$ is the interaction term between treatment and the gender of the household head or the credit constraint status at the baseline. We also include an interaction term between the treatment and credit constraint status at the baseline to evaluate whether the intervention helped formally constrained households in accessing credit. The probability of credit uptake is estimated as.

$$P(Y^*_{it} = 1|T) = \emptyset\big(\gamma G_{it} + \emptyset T_{it} + \ \beta \ X'_i + \lambda y'_{ij} \ + \ \vartheta(T_{it} \,.\, G)\big) + \varepsilon_{ij} \qquad (5)$$

All X_i are drawn from the baseline data. We include location fixed effects to account for spatial heterogeneity. The error terms ε_{it} are assumed to be independently and normally distributed and are clustered at the village level.

5) Findings

Determinants of credit constraint status of the households at baseline

Table 3 reports the results of the MNP evaluating the determinants of credit constraint among households in the study area. The base category is credit unconstrained households, meaning that all interpretations are made against this base category. Columns (1) and (3) report the coefficients of the regression while columns (2) and (4) report the marginal effects. The marginal effects are interpreted as semi-elasticities, that is, the effect of a unit change of the explanatory variable on the probability (in percentage terms) of a household being in each credit rationing category.

The gender indicators show that pre-intervention, both *de jure* and *de facto* FHH are significantly more likely to be risk rationed. This means that even when rural credit markets are well developed, or credit is availed, households with women heads are less likely to participate in the credit markets. This could be due to various underlying reasons including lack of collateral, the fear of losing the collateral in case of a default, and/or lack of a guarantor. Unlike previous studies such as Balana et al. (2022), which find significant gendered supply-side constraints to credit access, our gender indicators show that there are no significant differences in quantity rationing (or supply-side constraints) among MHH and both categories of FHH. Overall, these findings suggest that the gender gaps in credit market participation among smallholder farmers are not necessarily because of lenders limiting credit to women, rather, it is mostly driven by demand-side constraints that limit women from participating in the credit market. RCC and other risk-insured credit products are expected to reduce these gendered demand-side imbalances in credit access by reducing the borrowing risks, especially those related to climate uncertainties and other barriers such as lack of collateral and guarantors.

We find households with higher dependency ratios are likely to be both risk and quantity rationed: an increasing dependency ratio increases the probability of being risk rationed by 3.2 percentage points, and that of quantity rationing by 5.4 percentage points. One plausible explanation for this finding is that an increase in the number of non-income-generating household members might insert pressure on already scarce resources, further reducing household's access to collateral and their creditworthiness. An increase in the level of education of the household head is associated with a significantly lower probability of being both risk and quantity rationed (1.4 percentage points and 3.2 percentage points, respectively), which is intuitive and aligns with previous studies (Saqib et al. 2016; Balana and Oyeyemi, 2022).

Table 3: Determinants of credit rationing status among farmers

Variables	Risk rationed.		Quantity rationed.	
	Coeff.	Marginal effects	Coeff.	Marginal effects
	(1)	(2)	(3)	(4)
De jure FHH [a]	0.363**	0.110***	-0.107	-0.040
	(0.175)	(0.044)	(0.243)	(0.043)
De facto FHH [a]	0.729***	0.199***	0.073	-0.040
	(0.248)	(0.045)	(0.342)	(0.031)
Household size	0.940	0.072	2.824	0.003
	(2.461)	(0.639)	(3.142)	(0.004)
Age of household head	0.290	0.066	0.226	0.018
	(0.468)	(0.122)	(0.600)	(0.077)
Dependency ratio	0.158**	0.032*	0.178*	0.054***
	(0.076)	(0.019)	(0.094)	(0.012)
Education level	-0.064***	-0.014***	-0.046**	-0.032***
	(0.017)	(0.004)	(0.022)	(0.003)
TLU	-0.035*	-0.007**	-0.046*	-0.005*
	(0.016)	(0.003)	(0.028)	(0.002)
Per capita land size	-0.044***	-0.011***	-0.013	0.001
	(0.015)	(0.003)	(0.018)	(0.002)
Number of groups	-0.131**	-0.039***	0.035	0.014
	(0.061)	(0.015)	(0.078)	(0.010)
Access to extension	0.120	0.037	-0.192	-0.034
	(0.240)	(0.064)	(0.330)	(0.043)
Crop farming main activity	-0.283**	-0.073**	-0.181	-0.005
	(0.128)	(0.033)	(0.162)	(0.021)
Risk averse=1 [b]	0.026	0.010	-0.009	-0.003
	(0.177)	(0.046)	(0.226)	(0.029)

Risk moderate=1 [b]	0.082	0.019	0.019	-0.003
	(0.159)	(0.041)	(0.202)	(0.026)
Constant	0.682*		-0.905*	
	(0.404)		(0.517)	
Mean dep. variable	0.442		0.102	
Chi-Square	77.25			
Prob>chi2	0.001			
Observations	1,049			

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1,
[a], The omitted category is MHH,
[b], The omitted category is Risk loving

Households with greater asset value in terms of livestock and land holdings are significantly less likely to be risk and/or quantity rationed. This could be attributed to the possibility that households can use these assets as security against borrowing and the lenders might find the household to be more creditworthy. We also find that households with stronger social networks—proxied by membership to local networks—are less likely to be risk-rationed; this could be because households with stronger social networks, can access information on farm investment and the various sources of credit available, and can possibly find guarantors within their social networks. Finally, we find that households that practice crop production as their main source of livelihood are less likely to be risk rationed.

Gendered effects of RCC on credit uptake

In this section, we describe the results of the regression analysis on factors determining credit uptake and whether RCC has differential impacts on men's and women's credit uptake decisions. As described in the methods section, we regress the binary variable indicating whether or not the household took agricultural production credit during the 2017/18 and 2018/19 long rain production periods. The sample in the regression includes only households that were in the treatment (RCC), and placebo (traditional credit), therefore the base category in the interpretation is the traditional credit group. All the control variables are drawn from the baseline data to increase efficiency and

minimize potential endogeneity. We include location fixed effects. Table 4 reports the marginal effects of the probit model.

Column (1) presents the regression results that include the gender of the household head and the key socio-economic variables described in section 2.3. We find that farmers in the RCC treatment arm were approximately four percentage points more likely to borrow credit for agricultural production purposes. Although the pathways to these findings are not quantitively evaluated in this study, a qualitative survey conducted in March 2023 showed that farmers prefer RCC over traditional credit due to the downside protection provided by the former under severe drought conditions. Farmers also prefer the RCC product because of reduced lender requirements in terms of collateral and guarantor (Timu et al. 2023b). In terms of gender, we find that compared to MHH, *de facto* FHH were significantly less likely to borrow credit of any form. This is in line with previous findings that *de facto* FHH have comparatively lower access and demand for agricultural production services and productive assets that can serve as collateral against borrowing. On the contrary, the coefficient for *de jure* FHH is positive but not statistically significantly different from zero. We also find that households with a higher dependency ratio are more likely to borrow credit for agricultural production activities. The education level of the household head is positively and significantly associated with the household's credit uptake decisions: past research shows that educated farmers are more risk-taking which can increase their propensity to adopt modern agricultural production technologies such as credit (Knight et al. 2003). Farmers who practice crop farming as their main source of livelihood are also significantly more likely to demand credit for agricultural production purposes. Social networks (proxied by membership to local groups), attending the program training, and access to extension services are positive and significantly associated with credit uptake. Social networks and access to agricultural extension have been

shown to have a transformative effect on technology use and productivity of smallholders because they serve as an important platform where people share experience, and farm production information (Krell et al. 2021). Finally, as expected *a priori*, risk averse farmers were significantly less likely to take up credit.

Table 4: Determinants of credit uptake

Variables	(1)	(2)	(3)	(4)
RCC	0.038*	0.039*	0.040*	0.026*
	(0.022)	(0.024)	(0.024)	(0.015)
De facto FHH [a]	-0.054*	-0.094**	-0.054	-0.053
	(0.033)	(0.041)	(0.036)	(0.036)
De jure FHH [a]	0.034	0.025	0.035	0.034
	(0.050)	(0.072)	(0.053)	(0.053)
RCC X *de jure* FHH [a]		0.094		
		(0.068)		
RCC X *de facto* FHH [a]		0.017		
		(0.091)		
Age of household head	-0.270	-0.260	0.418	0.409
	(0.926)	(0.929)	(1.022)	(1.022)
Dependency ratio	0.006***	0.006***	0.006***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Education level of head	0.070**	0.073**	0.038	0.043
	(0.033)	(0.033)	(0.036)	(0.036)
TLU	-0.055	-0.056	-0.072*	-0.072*
	(0.037)	(0.037)	(0.040)	(0.040)
Per capita land size	-0.008	-0.010	-0.015	-0.014
	(0.030)	(0.030)	(0.033)	(0.033)
Crop farming main activity	0.043*	0.043*	0.029	0.031
	(0.024)	(0.024)	(0.026)	(0.026)
Number of groups	0.027*	0.027*	0.018	0.018
	(0.012)	(0.012)	(0.013)	(0.013)
Access to extension	0.163***	0.168***	0.145***	0.139***
	(0.043)	(0.043)	(0.045)	(0.045)
Attended training	0.116***	0.114***	0.111***	0.113***
	(0.025)	(0.025)	(0.027)	(0.027)
Risk averse [b]	-0.075**	-0.076**	-0.077**	-0.080**
	(0.030)	(0.030)	(0.033)	(0.033)
Risk moderate [b]	-0.052	-0.050	-0.054	-0.057
	(0.034)	(0.034)	(0.037)	(0.037)
Quantity rationed [c]			-0.113***	-0.066
			(0.036)	(0.054)
Risk rationed [c]			-0.172***	-0.223***
			(0.025)	(0.034)
RCC X Risk rationed [c]				0.041**
				(0.020)

RCC X Quantity rationed [c]				-0.054
				(0.037)
Observations	1,404	1,404	1,404	1,404

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
[a], The omitted category is MHH,
[b], The omitted category is risk loving
[c] The omitted category is credit unconstrained

In Column (2) of Table 4, we evaluate the differential effect of RCC on credit uptake decisions among men- and female-headed households by introducing interaction terms between the different gender categories and RCC. The coefficients of the interaction terms between RCC and the different household head gender categories are non-significant, implying that the effects of RCC on credit uptake decision do not vary with gender. Despite the non-differential gender impacts of RCC, one would be interested in understanding whether RCC helped households that were previously credit rationed in accessing credit for agricultural production purposes. Given that RCC cushions both the lender and the farmers against drought-related default risk, *a priori* it is expected that previously constrained households will have an increased incentive to participate in the credit markets once these services are availed to them. In column (3), we include indicators for household credit rationing status at the baseline, while column (4) presents a regression that incorporates the interaction between RCC and the household's baseline credit rationing status. Column (3) shows that compared to credit unconstrained households, both risk and quantity rationed households have significantly lower probabilities of participating in the credit markets, even when the credit services are made available, such as in the current case. However, the interaction terms in column (4) shows that previously risk rationed households who were in the RCC treatment group are significantly more likely to take up credit for agricultural production services. The interaction term between RCC and quantity rationed is not statistically different from zero.

These findings have two implications: First, the findings on the significant impacts of RCC on risk rationed farmers suggest that the product is more effective at addressing demand-side credit constraints as opposed to supply-side constraints. Second, by helping farmers who were previously risk rationed, RCC is living up to its promise of improving financial access among smallholder farmers. However, these benefits are not necessarily experienced by women—specifically those in *de facto* FHH who experience disproportionate credit rationing. From a policy perspective, it is important for RCC to specifically develop mechanisms to ensure that smallholder farmers drawn from all gender categories can access, adopt, and benefit from the innovation. This could be achieved by the provision of targeted subsidies that can reduce the cost of the product, in terms of insurance premiums and interest rates, to make it affordable to poorer households. Second, research practitioners should ensure that both men and women have equal opportunity to access and benefit from the product. One approach could be by incorporating the gendered reach, benefit, empowerment, and transformation approach (RBET; Johnson et al. 2008; Quisumbing et al. 2022) into the program activities. RBET provides a framework for ensuring gender equality in all program outcomes. Under RCC, this can be achieved by ensuring gender equality in program recruitment, and participation, use of gender-friendly training modules that can facilitate optimal learning across all genders, individually monitoring men and women to make sure that they equally draw benefits from the program outcomes and enhancing the capacity of local institutions to equally support men and the different categories of women smallholder farmers.

6) Conclusion

Smallholder farmers in low- and medium-income countries lack sufficient access to agricultural production credit that can help them adopt new technologies and improve their farm production. Low credit access is attributed to both supply-side constraints (mostly due to information

asymmetry challenges), and demand-side constraints (due to lack of collateral and/or guarantor, and the fear of credit default). Research shows that female-headed households (FHH) are disproportionately more credit constrained than their MHH counterparts. Bundling agricultural credit with insurance, or risk contingent credit (RCC), provides a mechanism for addressing some of the supply- and demand-side constraints to credit access and utilization. RCC embeds within its structure an insurance protection which, when triggered, offsets the loan repayment obligations to farmers, which in turn removes, or at least reduces the credit exposure of lenders.

While there exists a small amount of literature explaining credit rationing among smallholder farmers and the uptake of RCC products, evidence on the effects of RCC on credit uptake decision among men and women is still missing. This paper fills this gap by evaluating the gendered extent of credit rationing status, and the gender differences of the effects of RCC on credit uptake decisions. We use data from a multi-arm randomized experiment conducted among farmers in Machakos, Kenya between 2017 and 2019 and categorize household heads into three groups: male-headed households (MHH), *de jure* FH, and *de facto* FHH. We employ a multinomial probit model to evaluate the determinants of credit rationing status, and a binomial probit model to measure the gender differences in the impact of RCC on farmer credit uptake decisions.

We find significant differences among MHH, and *de jure* and *de facto* FHH in terms of age, education level, resource ownership, access to extension services, and credit rationing status. Pre-intervention (at baseline), more households self-report to be risk-rationed (demand-side constrained) as opposed to being quantity-rationed (supply-side constrained). Although both *de jure* and *de facto* FHH are significantly risk rationed compared to MHH, the gender of the household head does not significantly determine the household quantity rationing status. We also find that asset ownership in terms of land and livestock, large social networks, and practicing crop

production as the main source of livelihood significantly reduces credit rationing among smallholder farmers across the three gender categories. These findings on credit rationing suggest that gender gaps in credit market participation are not necessarily driven by the gendered biases in credit lending practices, rather it is mostly driven by demand-side factors such as higher levels of risk aversion among women farmers.

The bivariate probit analysis shows four key findings; (i) compared to MHH, *de facto* FHH are significantly less likely to take credit, (ii) farmers in the RCC treatment group are significantly more likely to take up credit, (iii) RCC's impact on credit uptake decision does not vary with the gender of the household head, and (iv) RCC has positive and significant impacts on the credit uptake decisions of farmers that were previously (at baseline) risk rationed.

Our study has two major policy implications. First, promoting gender equity in smallholder credit access requires addressing demand-side constraints that prevent women, specifically *de facto* FHH, from accessing credit services. This includes innovations that can help them in overcoming resource constraints such as limited collateral due to low asset ownership and help them to be more risk-seeking. Second, although innovations such as RCC can mitigate some demand-side constraints, the current design and delivery mechanisms may limit access to women who face larger constraints in credit access. For instance, we show that *de facto* FHH were significantly less likely to attend the RCC program training activities. If researchers want innovations such as RCC to significantly reach and increase credit among women, then they should recognize unique challenges such as reduced mobility and time-burden barriers that might otherwise bar some women from accessing these products. Therefore, the delivery mechanisms of future innovations should consider the differential gender constraints that men and various women farmers face. Promoting gender-inclusive approaches such as equality in men's and women's recruitment and

participation in the programs, inclusive and accessible gender training modules that encourage self-paced learning among time-constrained women, and enhancing the capacity of local institutions to equally support men and women farmers can promote gender equality in the uptake and impacts of such innovation. Finally, while not sustainable in the long term, targeted RCC premium subsidy programs might offer a temporary solution to encourage gender equality in program participation as evidenced from insurance pilots across the globe.

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