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Abstract

An important factor that enhances agricultural productivity is land fertility. While the benefit of using fertilizer is well known, its level of adoption and use is relatively low among farmers in developing countries. Several constraints are identified in the literature to explain the lack of use of fertilizer among farmers, which includes liquidity and credit constraints. In this paper, we investigate whether remittances have the potential to remove these constraints by promoting fertilizer use among Filipino farmers. We use a unique periodic farm household survey data spanning 50 years that began in the Green Revolution in a key rice bowl of the Philippines to undertake a study using panel data. The farm household survey was conducted in the wet and dry seasons every four to five years from 1966-1967 to 2015-2016. We find that remittances recipient families invest more in fertilizer to enhance rice productivity. Furthermore, overseas remittances have a significantly more positive impact on fertilizer investment than domestic remittances. The impact of remittances varies with the level of household expenditures on fertilizer and the size of the farm. The results indicate that remittances can partially remove credit and liquidity constraints and promote fertilizer use among rice in farmers Philippines.

Keywords: Fertilizer, fertilizer expenditure, rice farming productivity, remittances, Philippines

JEL Classification: F24, N55, O13

1. Introduction

A key factor that improves agriculture productivity is land fertility. If a given land does not possess sufficient nutritive components, then fertilizer is an appropriate input that can be applied to overcome poor land fertility. Fertilizers are also a key ingredient in increasing rice production and improving productivity. Even though there are a host of benefits to be acquired from using fertilizer, its adoption and use are relatively low in developing countries (World Bank, 2016). The majority of the farmers in the Philippines have been applying fertilizer because they recognize its importance in attaining high rice yield. From 1988 to 2002, fertilizer application increased yield by nearly 1 ton per hectare 1 in rainfed areas, even higher in irrigated areas (Balisacan and Sebastian et al., 2007). However, the rate of adoption and use of fertilizer in rice farming can be further improved by removing several liquidity and credit constraints that prevent farmers from purchasing this input (Croppenstedt et al., 2003; Morris 2007). Because of imperfect credit markets, farmers have difficulties covering the upfront cost of fertilizer purchases. Our study was motivated by the conditions of Filipino rice farmers, whose situation is accentuated due to the rising cost of fertilizer in the world market in the wake of Russia's invasion of Ukraine. According to World Bank's commodity market outlook, urea and DAP prices have gone up more than 100% compared to 2020 levels[1]. Doubling fertilizer prices necessitate more investment than before in agricultural inputs by Filipino farmers. It is therefore important to know the sources of finance that will alleviate the constraints of adopting and promoting the use of fertilizers in rice farming in the Philippines.

Because of an imperfect credit market or not having access to a loan, farmers will have difficulty covering upfront costs such as fertilizer. In addition to credit constraints, the other problem is the absence of risk-management tools or lack of access to insurance to cover risky events such as bad weather destroying crops planted on fertilized land. Migration has been

[1] https://www.worldbank.org/en/research/commodity-markets

proposed as a solution to such household problems under the so-called "New Economics of Labour Migration" (NELM) framework. In the NELM literature, migration is a collective decision that can serve to diversify the income sources of a given household.

In terms of the adoption and use of technology, several studies have attempted to find if access to and use of credit impact the fertilizer usage level. It is found that farm households' access to credit has a weak link to fertilizer usage (Mataia and Dawe, 2007). In other words, credit has not been one of the key constraints for Filipino farmers. However, liquidity or insurance constraints could be a barrier to investing in fertilizer. There are many different sources of income that may increase household cashflows besides credit. One such factor is the transfer from overseas migrants.

The Filipino diaspora has been at the forefront of the migration movements since the late 1950s. International migration has since become a prominent strategy for economic advancement among Filipino households. The growth of the diaspora has accelerated even more in recent times. Since the 1980's, Overseas Filipino Workers (OFWs) have been hailed as modern-day heroes for keeping the Philippines afloat through remittances, which in 2019 reached USD 30 billion (PhP 1.56 trillion), or about 8% of the Philippines' USD 377 billion (PhP 19.52 trillion) economy.

Migration, domestic and overseas, is a collective household strategy to diversify income to overcome liquidity, credit, and risk constraints through sending remittances that smooth consumption when the household at the origin faces negative income shock (Stark and Levhari, 1982). Studies such as Yang and Cho (2007), Jack and Suri (2014) and Blumenstock et al. (2016) show that households that face a negative income shock receive higher amounts of remittances. Accordingly, we might expect families to receive more remittances from investing more in riskier inputs, such as fertilizer. Remittances can either act as a substitute for credit because they offer liquidities; or encourage risk-averse agents to take loans (Richter, 2008). When there are market imperfections, households' decisions are not independent of decisions to migrate and their consequences. The literature has strong evidence that migration and remittances impacted agricultural decisions. For example, even if migration can be perceived as an on-farm labour loss, remittances can partially compensate for this loss and improve agricultural productivity (Rozelle et al., 1999; Atamanov and Van Berg, 2012).

There are many other indirect ways remittances perform beneficial functions in the household. Remittances are instrumental in generating savings and accumulating productive assets by removing investment constraints (see, for example, Arun and Ulku, 2011; Chiodi at al., 2012). They are compensatory flows generating transfers to recipients to mitigate income shocks and smooth consumption (see, for example, Yang and Choi, 2007; Combes and Ebeke, 2011; Kurosaki, 2006). Most importantly, remittances can relax the credit constraints of households (see, for example, Aggarwal et al., 2009; Guiliani and Arranz, 2009; Gupta et al., 2009).

Scholars frequently find that remittances income is often invested in the formation of the physical and human capital of the family (see, for example, Adams, 2005; Edwards and Ureta, 2003; Yang, 2005; Alderman, 1996) to increase the productivity of household labour. Even if remittances are not directly used for agricultural investments, they can act as a fungible income that changes household expenditure patterns (Taylor and Mora, 2006). In this sense, it would still allow households to use the rest of their income for agricultural investment and therefore, can overcome credit and liquidity constraints. Given the circumstances, remittances received by migrant families in the Philippines may be invested in adopting technology to finance fertilizer expenditures. To the best of our knowledge, the only work that tests the impact of remittances on fertilizer use is Veljanoska (2021), which utilizes Ugandan Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA). Because of the limited study on the topic, our study is one of the pioneering in this research area endeavouring to investigate the impact and relative effectiveness of access to credit and remittances on-farm fertilizer investment using the loop survey data on Filipino rice. We believe the impact of this aspect on Filipino rice farmers has not been studied before, so our contribution is impactful.

2. Data and Summary Statistics

In this study, we use the Central Luzon Loop Survey data collected and maintained by the International Rice Research Institute (IRRI). The Loop Survey collected data for two consecutive cropping cycles, namely: wet and dry seasons. The Loop Survey was conducted in every 4 to 5 years interval on rice farm households in four provinces of the Philippines, namely Bulacan, Nueva Ecija, Pampanga, Tarlac and some parts of Pangasinan and La Union (see, for example, Moya et al., 2015 for detailed description of the survey process).

The sample size of each survey varied according to the availability of households willing to participate. It was 95 in the beginning and afterwards increased to 148 in 1979. Eventually, the sample size declined to double-digit in the latter part of the survey. The sample farmers for the first three periods 1966, 1970, and 1974 were the same respondents, so it had a pure panel structure. But additional households were added since the 1979-1980 survey to increase the sample size. The panel identifier in the data set is rice plots, although it still retains some household-level panel structure. The number of sampled farmers during the DS was smaller than the WS because only those farmers who planted rice were interviewed.

[*Table 1 about here*]

Table 1 summarizes the data used in the paper. The data were obtained for 207 households over a period of 25 years, starting in 1966 and ending in 2016. However, there are 51 periods, as data were collected twice in each season. The farm × year × season observations of the variables in Table 1 vary according to data availability and the unbalanced structure of the dataset. The primary variable of interest, the total real amount of fertilizing farm expenditure per year per season (fertilizer expenditure), has 1,906 unique observations and a mean of PhP 5,114.617 with a standard deviation of PhP 8,589.37. Figure 1 shows that the distribution of fertilizer expenditure is highly skewed to the right.

[*Figure 1 about here*]

The variable remittances were not available in a clear-cut form as they included cash and non-cash multiple transfers in a year made to a household. To simplify the matter, remittances were coded into a binary variable with a value equal to 1 if the household received any form of remittances in any given year. When qualitative information on remittances is included to analyze the distribution of fertilizer expenditure, a distinct picture emerges. Figure 2 shows the histograms of fertilizer expenditure separately for the households that received remittances during the period under consideration and those that did not. It shows that the pattern and frequency of fertilizer spending differ for households receiving remittances (panel A).

[*Figure 2 about here*]

Specifically, the average expenditure on fertilizer (PhP 3,456.381) by the remittance recipient household is almost double that of the non-remittances recipient counterpart (PhP 1,218.195). Other important potential explanatory variables used in our econometric model include household credit (mean = 660.08) and a climate variable measuring average annual rainfall (mean = 2141.20). Table 1 also reports the mean and standard deviations of several other control variables including household characteristics, farm size, expenditures on seed and whether household has at least 1 irrigated plot. About 18 percent of the household has received remittances. The average household size is 5.2. About 12.9 percent are male aged between 20-34 years and the proportion of female for the same age group is 10 percent. The mean farm size is 1.8 hectare and about half farm has got irrigated plots. The average real expenditure on seed by the farms is PhP 640.67.

3. Estimation models

For estimation purposes, we estimate a regression of the following form:

$$y_{it} = \beta x_{it} + \delta z_i + \epsilon_{it} \quad (1)$$

In this model i = cross-section unit, i.e. farm and t = time period of the loop survey. y_{it} represents household expenditures on fertilizer. The variable x_{it} represents observable characteristics of the households. These characteristics may be constant for a household across all time, such as gender, or may be time-varying, such as age. The variable z_i is unobservable characteristics such as skills or entrepreneurial ability, responsible for model heterogeneity. Finally ϵ_{it} is the stochastic error term.

We estimate Eq. (1) first assuming there are no unobservable individual-specific effects and δz_i is constant across farm households. In that case Eq. (1) becomes:

$$y_{it} = \beta x_{it} + \propto + \epsilon_{it} \quad (2)$$

This implies that the panel data can be treated as one large, pooled dataset when there is no dependence within individual groups. The model parameters, β , and, $\propto$, can be directly estimated using pooled ordinary least squares.

If farm household-specific effects are correlated with the observed characteristics, the unobservable component, δz_i, acts like an individual-specific intercept. The intercept term, $\propto_i$, varies across individuals but is constant across time which can be estimated fixed-effect estimator to control for the differences in farm household-specific effects. In that case Eq. (1) becomes:

$$y_{it} = \beta x_{it} + \propto_i + \epsilon_{it} \quad (3)$$

the unobservable component, δz_i were estimated using household dummies to compare results with the preferred pooled estimate. The resulting estimated equation is:

The intercept term, $\propto_i$, varies across individuals but is constant across time.

[*Table 2 about here*]

4. Results

The pooled estimates based on Eq. (2) are presented in Table 2. Because the data obtained in the loop survey is close to being repeated cross-sections than a panel, so a pooled estimation is preferred. The two sources that alleviate households' liquidity constraints are probably remittances and credit. In columns 1 and 2, we separately show the effects of these two variables because otherwise, the effects can be confounded by the existence of potential multicollinearity. It is found that remittances recipient households spent PhP 790.4 compared to non-recipient households. Another significant finding is the role of real seed expenditures which induce farmers to undertake more investment in fertilizers. The results show for every PhP investment in seed expenditure, fertiliser expenditure increases by approximately PhP 2

Furthermore, the result represents the estimated value in the absence of credit. We also check if the climate conditions have had any effect on fertilizer usage. In the end, in column 4, we estimate the final regression where we include all three variables – remittances, credit and climate, and a host of observable household characteristics and find that the impact of remittance on fertilizer expenditure is positive on average.

The linear independence within the groups of a panel is unlikely; therefore, a fixed effects model such given by Eq. (3) would be better than the pooled estimations, but the loop survey is not guaranteed to have collected data from the same household in all cases. The sample farmers for the first three periods 1966, 1970, and 1974 were the same respondents, so it had a pure panel structure. But additional households were added since the 1979-1980 survey to increase the sample size. So, a fixed-effect regression is not strictly applicable. However, to control for the differences in farm household-specific effects, the unobservable component, δz_i can be identified with household dummy variables. Specifically, the intercept term, $\propto_i$, varies across individuals but is constant across time, is estimated using household dummy variables although for a limited number of cases there may not be unique identification due to the data structure. The regression with household dummies can be compare with the preferred pooled estimate.

The resulting pooled with household dummies estimations are provided in Table 3. We find that the results are to the pooled regression counterparts; therefore, we are confident with the pooled results. The estimated coefficients for remittances are similar in sign and magnitude. According to column (4), remittances recipients' households spend on average PhP 887.2 more than their non-recipient counterparts, which is statistically significant.

[*Table 3 about here*]

We do a robustness check by estimating separate pooled regressions across different quantiles of household expenditure on fertilizer. Figure 3 shows the box plot for fertilizer expenditure across five quantiles and a box plot for the overall data. The overall data distribution of fertilizer expenditure in the fifth quantile appears skewed with extreme observations than in the others. Naturally, it is important to check if this influenced our results. Therefore, we undertook separate pooled- regressions for each quantile and the results are presented in Table 4. We find that the effect of remittances is only positive and significant in the fifth quantile. It means that the households whose investment in fertilizer is at the highest range tend to benefit through the receipt of remittances.

[*Figure 3 about here*]

[*Table 4 about here*]

In the migration literature, a distinction is often made between domestic and overseas remittances. It is argued that migrants exposed to the superior social and economic system in the destination countries develop a mindset of investing in their home country and thereby look for ways to ensure a greater return on the remittances they send after meeting the family's basic needs. Therefore, foreign remittances are more likely to get invested in projects increasing farm households' crop productivity compared with domestic remittances which are sent from within the country. Our data set categorizes the sources from which remittances are sent: foreign, local and unknown. We undertake a pooled estimation of our model in Eq. (1) by segregating foreign vs local remittances. Due to the nature of data which do not strictly have a clean panel structure, the fixed effect estimator is not valid or significant in these regressions. The pooled estimation is shown in Table 5. Based on these regressions, we find that households receiving foreign remittances (see column 1) spend a significant amount (PhP 1,059) on fertilizer. Therefore, foreign remittances have a significantly positive impact on fertilizer investment.

On the contrary, the impact of domestic remittances on fertilizer investment is negative (column 2), which means domestic remittances recipient substitute expenditure away from fertilizer to invest in other areas. The impact of remittances originating from unknown sources is also positive, but it is difficult to speculate whether the sources are domestic or foreign. It could be both, but due to the data collection problem was not recorded correctly. There may be less difficulty in recalling and recording names of local towns or cities than foreign names, so the unknown sources of remittances are most likely foreign.

[*Table 5 about here*]

Finally, we undertake sample splitting of the data with respect to the farms' size. Categorizing the sample into five quintiles, we run pooled regressions on the impact of remittances on farms in different quantiles. Our results in Table 6 show that the impact of remittances is significant for the farms in the higher quintile, especially in the third and the fifth quantiles. The magnitude of the impact is highest in the fifth quantile (PhP 2.527). The reasons could be linked to purposes remittances fulfil. Remittances become a substitute for credit for smaller farms faced with liquidity constraints. However, for larger farms, it is not liquidity constraint but the role of insurance that remittances play to assume risk in the investment in fertilizer input.

[*Table 6 about here*]

5. Conclusion

In this paper, we studied the determinants of Filipino farm household expenditure on fertilizer. We use Central Luzon Loop Survey in the Philippines conducted in the wet and dry seasons every four to five years from 1966-67 to 2011-12. Previous studies found that credit, while important, has no significant impact on fertilizer expenditures among rice farmers. However, many different sources of income may increase cashflows in the household, particularly remittances which also alleviate liquidity constraints like credit for the household.

We find that, unlike credit, remittances have a robust role in alleviating household liquidity constraints and channelling funds to fertilizer investments. One reason for this could be that remittances are unrequited transfers, unlike credit which must be paid back with interest. In this sense, remittances are costless, having soft budget constraints. Another significant finding is the role of real seed expenditures which induce farmers to undertake more investment in fertilizers. Not all households in the range of the distribution of fertilizer expenditure can utilize the benefit of remittances. Those who have invested enough in fertilizer may complement investment by injecting additional funds from remittances. Similarly, larger farms are gained from remittance income because these allowed them to e manage the risks associated with investing in agricultural inputs, including fertilizer expenditure The importance of finding that overseas remittances help boost farmers' investment in fertilizer can no longer be under-emphasized. While we see that large farms tend to invest remittance income for fertilizer, policymakers may induce medium or small farms to invest in fertilizer by enabling complementary services such as remittances securitized credit.

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Figure 1
Total Real Fertilizing Farm Expenditure Per Year Per Season (PhP)

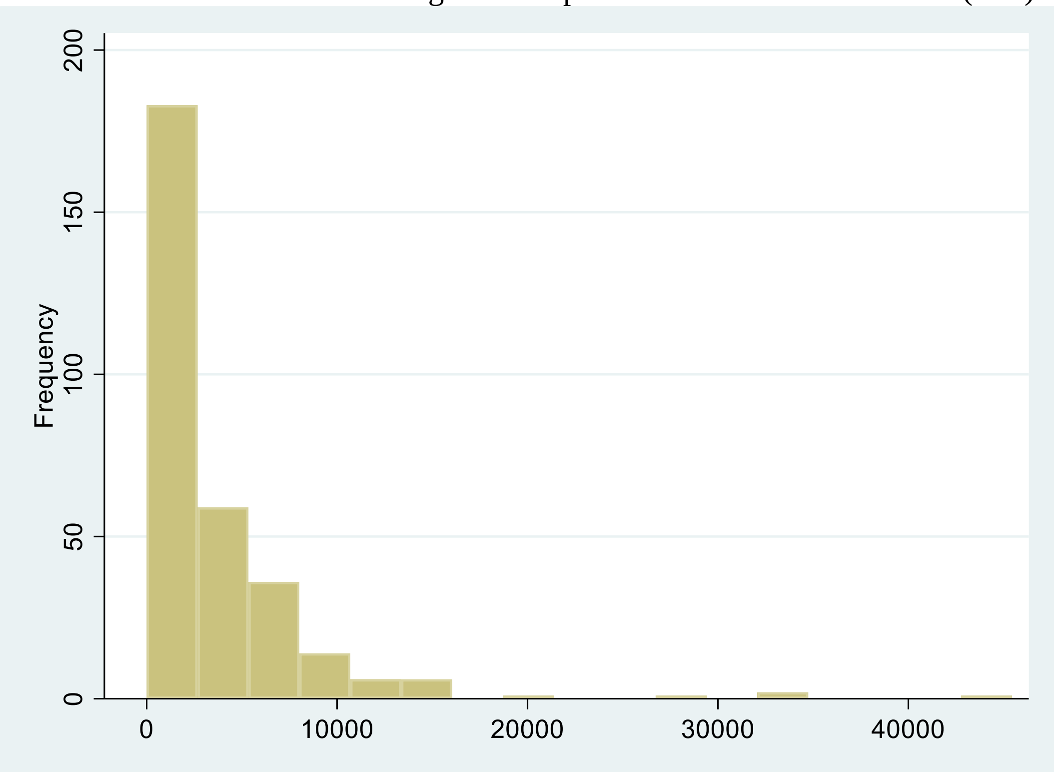

Figure 2
Total Real Fertilizing Farm Expenditure Per Year Per Season (PhP)

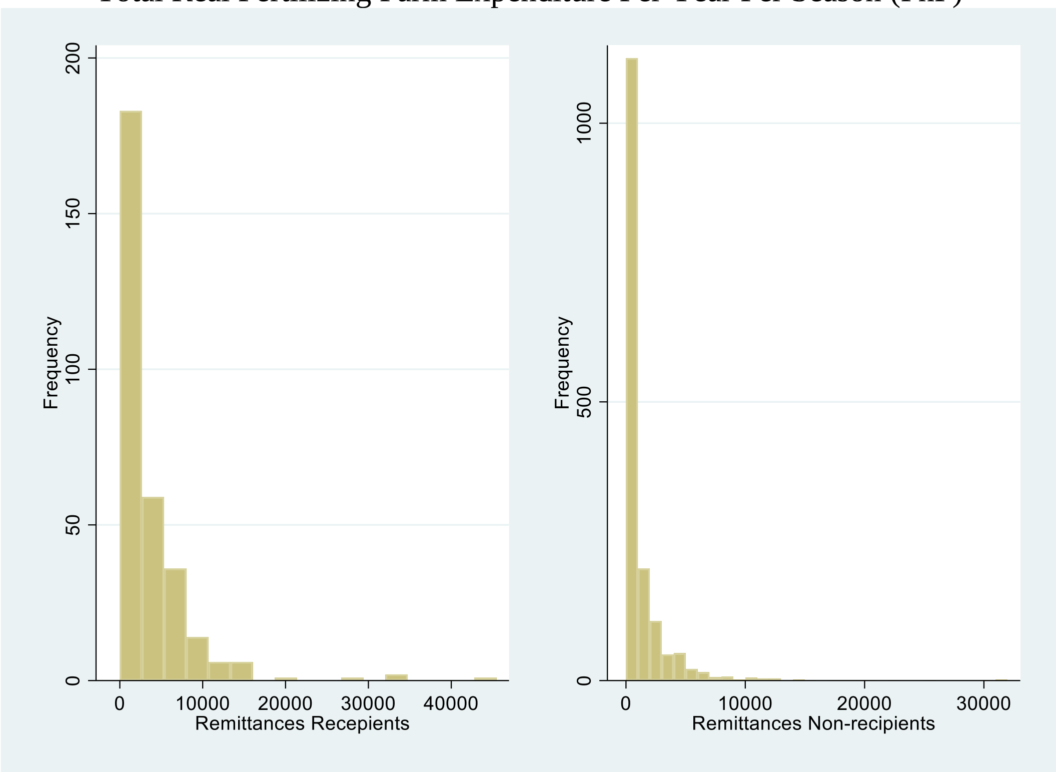

Figure 3
Total real fertilizing farm expenditure per year per person (PhP)

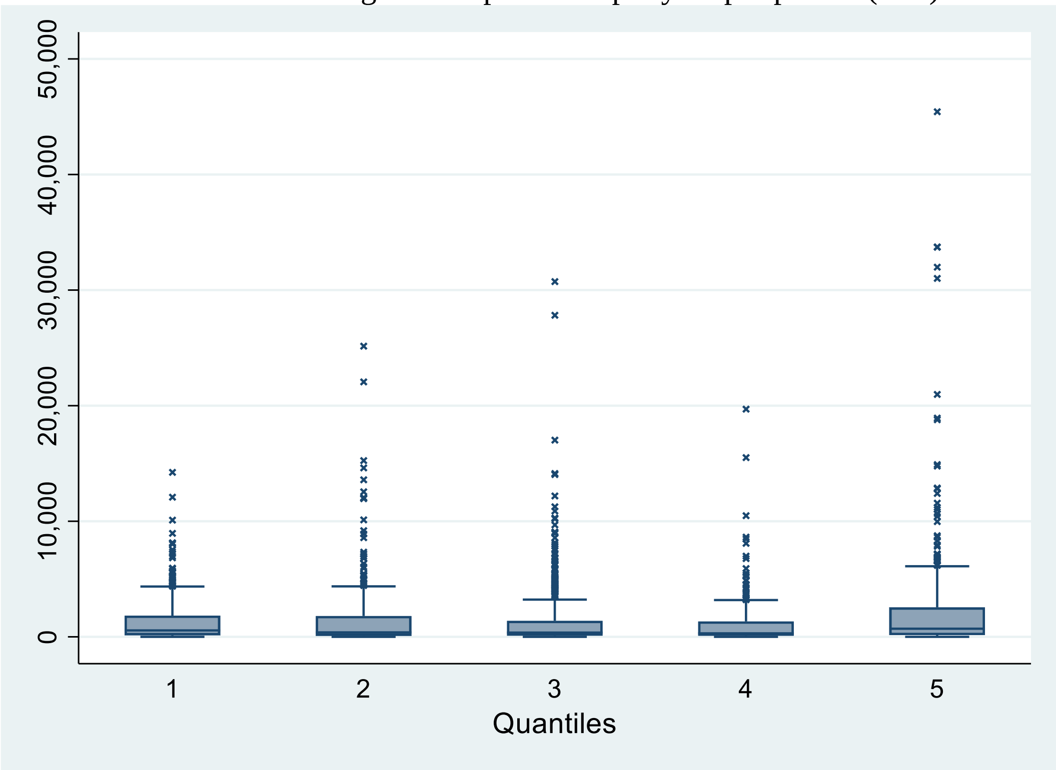

Table 1

Summary Statistics

Variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Fertilizer expenditure	1,906	1581.049	3201.252	0	45437
Remittances	2,175	0.189	0.391	0	1
Credit	1,907	660.081	3821.618	0	92610
Rainfall	1,115	2141.201	350.771	1583.214	3254.666
Mother's age	1,996	52.055	13.863	21	94
Father's age	1,740	50.144	13.686	20	87
Mother's education	1,994	7.238	3.378	0	16
Father's education	1,738	7.318	3.387	0	16
Household size	2,160	5.265	2.604	1	16
% Males age 20-34	2,160	0.130	0.182	0	1
% Males age 35-49	2,160	0.110	0.212	0	1
% Females age 20-34	2,160	0.101	0.125	0	0.666
% Age 35-49	2,160	0.070	0.109	0	1
Farm size	2,174	1.858	1.444	0	16.3
Irrigated	2,174	0.546	0.498	0	1
Seeds expenditure	1,907	640.673	1145.891	0	19125

Table 2

	Dependent. variable: Real fertilizer expenditure			
	(1)	(2)	(3)	(4)
Remittances	790.4***			977.5***
	(197.2)			(280.1)
Credit		0.0141		0.0153
		(0.0172)		(0.0193)
Rainfall			0.271	0.363
			(0.260)	(0.260)
Mother's age	-7.210	-2.173	-0.397	-3.981
	(8.865)	(8.816)	(16.12)	(16.27)
Father's age	14.39	15.21	19.34	14.41
	(9.396)	(9.517)	(17.09)	(17.03)
Mother's education	100.00***	111.3***	178.9***	163.2***
	(24.76)	(24.59)	(49.30)	(49.40)
Father's education	3.833	11.24	-13.07	-21.68
	(19.65)	(19.50)	(41.02)	(39.63)
Household size	5.046	3.731	9.461	16.20
	(31.95)	(32.22)	(59.86)	(59.98)
% Males age 20-34	-326.8	-328.6	-836.2	-707.4
	(351.6)	(359.0)	(662.1)	(662.5)
% Males age 35-49	847.4	712.4	1,053	1,443
	(695.4)	(691.7)	(1,166)	(1,162)
% Females age 20-34	-187.1	-272.9	-359.3	-204.4

	(426.7)	(433.6)	(671.1)	(646.3)
% Females age 35-49	-983.1	-1,158	-1,343	-1,116
	(782.4)	(775.2)	(1,287)	(1,309)
Farm size	75.87*	47.19	50.94	95.64
	(44.38)	(44.96)	(60.02)	(59.47)
Irrigated	-40.44	-79.64	-96.85	-44.04
	(115.9)	(114.9)	(201.8)	(202.9)
Seed expenditure	2.086***	2.116***	2.112***	2.077***
	(0.216)	(0.222)	(0.247)	(0.238)
Constant	-1,027***	-1,238***	-2,323**	-2,330**
	(345.4)	(354.2)	(979.7)	(964.9)
Observations	1,387	1,387	755	755
R-squared	0.607	0.600	0.563	0.572

Notes: Pooled regressions are reported in each column with robust standard error in parentheses. The dependent variable is real fertilizer expenditure. The detailed variable definitions are available in Appendix 1. Each column represents a separate regression for quantiles 1 to 5 of farm size respectively.
*** p<0.01, ** p<0.05, * p<0.1

Table 3				
	Dependent. variable: Real fertilizer expenditure			
	(1)	(2)	(3)	(4)
Remittances	607.3***			887.2***
	(224.5)			(342.3)
Credit		0.00645		0.0104
		(0.0143)		(0.0182)
Rainfall			0.505*	0.671**
			(0.3)	(0.317)
Mother's age	-10.81	-3.908	-19.65	-29.44
	(11.19)	(11.28)	(23.1)	(22.44)
Father's age	31.58***	31.03**	45.03**	40.49*
	-(11.97)	-(12.23)	-(21.98)	-(21.5)
Mother's education	80.41*	99.29**	123.5	87.59
	(46.4)	(45.74)	(77.27)	(76.55)
Father's education	20.84	31.7	72.53	34.47
	(26.98)	(27.74)	(67.94)	(66.04)
Household size	37.91	34.22	70.19	75.81
	(39.09)	(38.98)	(65.31)	(64.93)
% Males age 20-34	-189.5	-150.6	-30.16	-21.18
	(385.7)	(388.1)	(729.8)	(726.3)
% Males age 35-49	1,394**	1,391**	2,076**	2,119**
	(641.8)	(642.6)	(955.8)	(960.1)
% Females age 20-34	-407.6	-479.1	-1,164	-971
	(492.4)	(492.9)	(826.9)	(802.9)
% Females age 35-49	-1,456*	-1,566**	-3,640***	-3,310***
	(750.3)	(741.7)	(1195)	(1217)
Farm size	46.26	20.18	3.434	43.01
	(48.61)	(47.47)	(67.45)	(70.89)
Irrigated	236.3	225.2	189.2	165.8
	(159.9)	(161)	(233.5)	(227.9)
Seed expenditure	1.969***	1.978***	1.897***	1.885***
	(0.24)	(0.246)	(0.29)	(0.28)
Constant	-1,932***	-2,380***	-5,350***	-4,408***
	(562.4)	(566.2)	(1545)	(1435)
HH dummies	Yes	Yes	Yes	Yes
Observations	1,387	1,387	755	755
R-squared	0.607	0.600	0.563	0.572

Notes: Pooled regressions are reported in each column with robust standard error in parentheses. The dependent variable is real fertilizer expenditure. The detailed variable definitions are available in Appendix 1. Each column represents a separate regression for quantiles 1 to 5 of farm size respectively.
*** p<0.01, ** p<0.05, * p<0.1

Table 4				
Dependent variable: Real Fertilizer Expenditure				
	(1)	(2)	(3)	(4)
Remittances	15.78	32.56	38.72	852.0*
	(138.7)	(223)	(256.9)	(504.4)
Credit	0.0189	0.0229	0.0328	0.011
	(0.0187)	(0.0199)	(0.0387)	(0.0205)
Rainfall	-0.101	0.00331	0.353	1.724**
	(0.083)	(0.135)	(0.252)	(0.81)
Mother's age	-9.635	-1.562	-14.01	-26.68
	(7.456)	(7.183)	(13.03)	(45.78)
Father's age	6.959	2.222	15.79	33.08
	(4.765)	(7.725)	(15.23)	(44.55)
Mother's education	14.69	1.368	96.94**	55.76
	(28.16)	(25.76)	(41.9)	(89.31)
Father's education	25.02	89.89***	6.411	-54.65
	(30.78)	(25.58)	(36.24)	(68.63)
Household size	-0.829	31.03	33	58.4
	(24.07)	(25.16)	(38.93)	(135.7)
% males age 20-34	43.77	90.97	-440.4	-805.2
	(298)	(459.8)	(609.7)	(1296)
% males age 35-49	-614.6*	-142.2	1,351	-462.8
	(340.3)	(769.8)	(1218)	(2522)
% females age 20-34	-74.59	382.9	-10.8	-1,162
	(274.6)	(356.6)	(636.3)	(2114)
% females age 35-49	62.07	634.2	-737.9	-1,173
	(337.8)	(600.2)	(1119)	(2730)
Farm size	-97.8	-135.5*	-287.9***	-14.28
	(69.42)	(79.51)	(91.69)	(79.78)
Irrigated	79.71	-222.3**	-350.6*	-319.3
	(83.42)	(99.81)	(210.5)	(461.3)
Seed expenditure	0.519***	0.689***	1.217***	2.459***
	(0.0813)	(0.0954)	(0.107)	(0.412)
Constant	456	-199.6	-254.5	-2,746
	(619.4)	(620.1)	(903.7)	(2162)
Observations	51	170	236	288
R-squared	0.795	0.542	0.602	0.631

Notes: Pooled regressions are reported in each column with robust standard error in parentheses. The dependent variable is real fertilizer expenditure. The detailed variable definitions are available in Appendix 1. Each column represents a separate regression for quantiles 2 to 5 respectively.
*** p<0.01, ** p<0.05, * p<0.1

Table 5

Dependent variable: Real fertilizer expenditure

	(1)	(2)	(3)
Foreign remittances	1,059**		
	(494.4)		
Domestic remittances		-965.9***	
		(292.8)	
Unknown source remittances			772.5**
			(344.2)
Credit	0.0161	0.014	0.0135
	(0.0192)	(0.0191)	(0.0192)
Rainfall	0.277	0.279	0.346
	(0.26)	(0.26)	(0.26)
Mother's age	0.108	0.626	-2.78
	(16.29)	(16.12)	(16.08)
Father's age	15.71	19.7	18.45
	(17.64)	(17.18)	(16.83)
Mother's education	172.0***	182.1***	174.4***
	(49.91)	(49.02)	(48.56)
Father's education	-14.68	-11.07	-17.31
	(40.44)	(40.71)	(40.4)
Household size	-3.563	7.283	22.53
	(55.98)	(60.11)	(59.3)
% males age 20-34	-841.3	-881.8	-768.9
	(653.1)	(667)	(668.2)
% males age 35-49	1,376	975.6	1,059
	(1165)	(1165)	(1169)
% females age 20-34	-373.9	-324.2	-199.2
	(665.8)	(664.7)	(648.4)
% females age 35-49	-1,395	-1,390	-1,162
	(1296)	(1294)	(1306)
Farm size	62.76	51.78	78.27
	(59.51)	(60.35)	(60.66)
Irrigated	-79.1	-107.2	-76.46
	(200)	(202.2)	(204.1)
Seed expenditure	2.103***	2.106***	2.086***
	(0.243)	(0.248)	(0.246)
Constant	-2,179**	-2,426**	-2,522***
	(970.9)	(986.5)	(975.3)
Observations	755	755	755
R-squared	0.629	0.626	0.630

Notes: Pooled regressions are reported in each column with robust standard error in parentheses. The dependent variable is real fertilizer expenditure. The detailed variable definitions are available in Appendix 1. Each column represents a separate regression for quantiles 1 to 5 of farm size respectively. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6

	Dependent variable: Real Fertilizer Expenditure				
	(Quantile1)	(Quantile2)	(Quantile3)	(Quantile4)	(Quantile5)
Remittances	526.8	204.9	1,394***	1,002	2,527**
	(347.7)	(708.2)	(425.6)	(779.1)	(1029)
Credit	0.0672	-0.00752	0.197*	-0.0265	0.0207
	(0.0977)	(0.0242)	(0.107)	(0.0277)	(0.0141)
Rainfall	0.632**	0.883	0.281	-0.0433	1.613
	(0.313)	(0.873)	(0.333)	(0.393)	(1.47)
Mother's age	-20.24	-85.31	-19.67	-6.681	36.56
	(22.26)	(51.47)	(19.01)	(32.88)	(76.01)
Father's age	54.32**	61.49	15.03	41.65	13.76
	(23.2)	(55.21)	(22.66)	(34.47)	(66.31)
Mother's education	18.25	11.95	184.0***	325.8*	96.92
	(67.82)	(193.9)	(57.2)	(168.5)	(124)
Father's education	52.52	127.2	0.718	-133.9	43.12
	(56.8)	(191.5)	(53.15)	(102.1)	(127.2)
Household size	111.3*	101.3	-53.59	-269.9**	110.5
	(62.11)	(123.6)	(60.2)	(128.4)	(274.7)
% males age 20-34	-948.5	-1,832	-761.3	402	-1,404
	(852.1)	(2381)	(1366)	(1040)	(2788)
% males age 35-49	5,300***	5,430	396.7	4,228*	-6,022
	(1171)	(3636)	(1863)	(2493)	(3941)
% females age 20-34	-1,124*	-1,142	-98.92	3,504**	-3,816
	(662.7)	(1115)	(1005)	(1578)	(3729)
% females age 35-49	-4,340***	-5,425*	-410.1	2,430	3,657
	(1432)	(3012)	(1604)	(2178)	(5616)
Irrigated	264.7	508.7	66.63	696.6*	-812.2
	(265.8)	(690.2)	(308.6)	(410.3)	(818.7)
Seed expenditure	1.927***	2.068***	1.288***	2.031***	2.431***
	(0.316)	(0.497)	(0.164)	(0.438)	(0.498)
Constant	-3,518***	-1,224	-1,007	-2,503	-6,726
	(1006)	(3118)	(1438)	(2207)	(4940)
Observations	159	138	219	108	131
R-squared	0.611	0.468	0.568	0.63	0.70

Notes: Pooled regressions are reported in each column with robust standard error in parentheses. The dependent variable is real fertilizer expenditure. The detailed variable definitions are available in Appendix 1. Each column represents a separate regression for quantiles 1 to 5 of farm size respectively. *** p<0.01, ** p<0.05, * p<0.1

Appendix 1: Variable Definitions

Variable Name	Definitions
Fertilizer expenditure	Total real amount of fertilizer farm expenditure per year per season
Remittances	Indicator of remittances receipt either cash or non-cash per household per year
Credit	Value of share of harvest to pay creditors
Rainfall	Average annual rainfall
Mother's age	Mother's age
Father's age	Father's age
Mother's education	Mother's education
Father's education	Father's education
Household Size	Number of people in the household
% males age 20-34	Share of males in household age 20-34
% males age 35-49	Share of males in household age 35-49
% females age 20-34	Share of females in household age 20-34
% age 35-49	Share of females in household age 35-49
Farm size	Farm size
Irrigated	Household has at least 1 irrigated plot
Seeds expenditure	Total real amount of expenditure on seeds