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Factors Affecting the Decision and Extent of Rice-milling before Sale among Ugandan Farmers

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Abstract

The number of rice mills in Uganda increased rapidly during the past decade, in response to increasing demand for milling services. However, despite the notable improvement in access to milling services, recent studies have shown that some farmers still sell rice in unmilled form which attracts lower prices. This study was undertaken to examine why some rice farmers still sell un-milled rice in the advent of improved access to milling services. Descriptive statistical methods of data analysis were used to characterize rice-growing households by the form in which they sell rice, before fitting a Tobit model to determine the factors influencing the proportion of rice sold as grain after milling. The returns (gross margins) to rice-milling were also estimated. The study findings show that rice production is profitable regardless of the form in which it is sold; and the majority of households invest in milling all or part of their rice before sale. However, although milling households incurred higher costs, they also had higher gross margins, implying that selling milled rice is more profitable than selling paddy. The price of milled rice, volume of harvested rice, household size and group membership have significant and positive relationships with the proportion of rice sold as grain; while distance to the nearest rice mill is negatively and significantly associated with the proportion of rice sold as grain.

Keywords: Rice, Rice-milling, Profitability, Uganda

Introduction

Rice is becoming increasingly popular in Africa judging from the steady growth in its production. The annual production is estimated at 14 million metric tons while consumption is within the range of 16 million metric tons per annum, (UNRDS, 2009). Given this deficit in production and the rapid urbanization and population growth in Africa, it is likely that the area under rice production in Africa will continue to expand in the foreseeable future. As part of the efforts to enhance rice yield as a means to reduce the gap between supply and demand, and to curb food insecurity and income poverty in Africa, New Rice for Africa (NERICA) was developed during the past decade by the West Africa Rice Development Association (WARDA) (Africa Rice Center, 2006).

In Uganda, NERICA was introduced in 2002 as one of the government's strategies for achieving its overarching development goals of reducing poverty and food security, as well as import substitution. The introduction of NERICA elevated Uganda to a new level in the history of rice production. The total area under rice increased from 80,000 hectares in 2002 to 119,000 hectares in 2007 (UBOS, 2007), with upland rice area increasing from 1,500 hectares in 2002 to 35,000 hectares in 2007 (Tsuboi, 2008). Despite this impressive growth in production, Uganda still needs to import 60,000

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metric tons of rice, as total domestic production is estimated at 165,000 metric tons, which is lower than total consumption estimated at 225,000 metric tons (UNRDS, 2009). With Uganda's population growing at a rate of 3.2% per year (UBOS, 2002), the demand for rice is expected to rise even further, which calls for sustained efforts to increase production to meet the growing demand.

Recent research shows that rice production in Uganda still faces many challenges not only in production, but also in post harvest handling and marketing. Kijima *et al.,* (2006) found that many farmers did not have enough information on how to grow, harvest and dry rice, which negatively affected the harvested yield and milling rate. Absence of rice millers in nearby towns was cited as a major constraint to NERICA adoption by farmers in 2004. The common transportation means from the homestead to the rice mill was the bicycle, and a typical farmer had to travel 15 to 35 km by bicycle to take rice to the nearest rice mill (Kijima *et al.,* 2006). These problems are not unique to Ugandan rice farmers. In Ethiopia, for example, poor post-harvest handling leads to high post harvest losses that arise from threshing and lack of proper storage facilities, which dents the quality of locally produced rice (inundated with gravel, uneven or broken grains) and renders it less desirable to consumers than imported rice. There are a few millers who directly buy rice from farmers, and these millers also double as traders (wholesalers and retailers) who dictate the prices (Asmelash, 2012).

In the case of Uganda, however, a follow up study by Kijima *et al.* (2008) shows that the number of rice mills nearly doubled between 2004 and 2006 (from 360 to nearly 600), likely because of increasing demand for rice milling services by farmers. This is also reflected in the considerably shortened distance to rice mills from between 15 and 30 km in 2004 to between 6 and 11 km in 2006. This distance is believed to have reduced even further in recent years, with increased investments in rice milling services by the private sector. Despite this notable improvement in farmers' access to milling services, some farmers still sell rice in unmilled form as paddy, which attracts a lower price than milled rice (Kijima, 2008). This paper examines why some rice-growing households in Uganda mill their rice before sale and others don't; and how this affects the profitability of rice production.

The rest of the paper is organized as follows. Section 2 gives an overview of rice production, processing and marketing in Uganda. In section 3, we describe the methods used in the study, including the sampling procedure and data sources. Section 4 presents the data analysis procedure and results, while Section 5 discusses the policy implications and conclusions.

Rice Production, Processing and Marketing in Uganda

In Uganda, efforts to promote rice production and marketing have been championed by the Office of the Vice President (OVP), National Agricultural Advisory Services (NAADS), and Non-Government Organizations (NGOs) such as Sasakawa Global 2000. Rice is grown mainly under three production systems, namely rain-fed upland; rain-fed lowland and irrigated. Of the three, rain-fed lowland is the most common system, covering 65,000 hectares of land, followed by rain-fed upland with 40,000 hectares and finally irrigated rice which covers 5,000 hectares of land (UNRDS, 2009). Most rice in Uganda is grown in eastern and western regions, due to the higher presence of lowlands and wetlands with sufficient soil moisture throughout the growing season (UNRDS, 2009). More than half of the rice produced by Ugandan farmers is sold for cash income (Sserunkuuma, 2008), meaning that rice is primarily grown as a cash crop; but the contribution of rice to smallholder farmers' income is linked to the availability of functional milling services and markets for rice.

Smallholder rice farmers in Uganda sell their rice in two forms, namely; un-milled form and milled form (NPA, 2007). Un-milled rice (also known as paddy) refers to rice in the form it is harvested from the field, before the husks and bran layer are removed in the process of milling. Milled rice, also referred to as white rice or grain, has the husks and bran layer removed. After harvesting, some farmers transport paddy to rice mills and only sell after milling. The common means of transport is by bicycle and

motorcycle if the distance between the farm-gate and the rice miller is not very long or by loading the rice on buses and pick-up trucks if the distance is long. Rice millers charge milling fees to the producers, who after milling sell grain to traders who wait for producers to come to the rice millers. Therefore, rice millers seem to play the role of intermediary between producers and traders, and they facilitate rice marketing. Other farmers sell their rice in paddy form usually at the farm-gate for various reasons that may include lack of access to mills, high milling costs, price of milled rice relative to the farm-gate price offered for paddy rice and poor quality of mills. According to Fujiie (2009), since the quality of milling machines in Uganda is poor yet selling rice in paddy form transfers the risk of getting low quality milled rice to traders, some farmers may prefer selling paddy to milled rice while the converse is true for traders.

Data and sample

Data for this study were collected in October 2009, through a household survey of rice farmers in Pallisa, Bugiri, Bukedea and Mayuge districts of Eastern Uganda by Makerere University and the Japan International Corporation Agency (JICA) under the project entitled "An Empirical Analysis on Expanding Rice Production in Sub Sahara Africa". The project's aim was to analyze the impact of the CARD (coalition for Africa Rice Development) initiative on rice productivity and poverty reduction, and to assess the effectiveness of various means of improving agricultural production, typified by the development of a new agricultural technology and its dissemination.

The data were gathered using a structured questionnaire administered through one-on-one face to face interviews with sampled rice farmers. The study sample was drawn following a purposive sampling procedure, with sub-counties being the primary sampling units. In each of the four districts (Mayuge, Bugiri, Pallisa and Bukedea), sub-counties were purposively selected based on participation in JICA's project entitled "Sustainable Irrigated Agriculture Development Project in Eastern Uganda" This project targeted households that grew rice in wetland areas in irrigation schemes or swamps in the first season of 2009 and second season of 2008, and the majority of these are located in the selected sub-counties, which include Busakira and Buwunga in Mayuge and Bugiri districts, respectively; Butebo, Petete and Bulangira sub-counties in Pallisa district; and Bukedea and Kolir sub-counties in Bukedea district.

In each sub-county, local agricultural officers, sub-county community officers, local council chairmen and Farmer Group Leaders led the exercise of generating lists of households that grew rice in wetland areas in the first season of 2009 and second season of 2008, from which households were randomly selected for the survey. Based on these criteria, 75 households were selected in each of the four districts to give a total sample of 300 households. However, the analysis for this paper is based on 194 households that harvested and sold rice, because the rest (106 households) did not harvest any rice in the first season of 2009 and second season of 2008 because of serious drought or flooding conditions on their rice plots.

The household survey gathered data on socio-demographic characteristics of the households and household heads, including gender, age, and education level of the household head; household income and size, farm size, rice growing experience, access to markets and extension services, and membership to farmers groups. Data was also gathered on inputs into rice production, including type, quantity and cost of seed, fertilizer and chemicals, the area planted to rice, family and hired labor used, and quantities of rice harvested and sold. Information on the form in which rice was sold, the selling price, place of sale, distance and transportation costs to rice mills or other selling places, as well as milling fees was also gathered during the household survey.

Data analysis and results

Conceptually, data analysis and hypothesis testing in this paper is guided by the theory of behavior of agricultural households under imperfect market conditions. These market imperfections create differences in the environment within which different households

operate due to differences in household endowments. This in turn creates differential access to markets and other agricultural services (like milling or processing in general, credit, and extension) across rural households, with some households facing lower transaction costs of accessing markets and other services than others (Sadoulet and de Janvry, 1995).

Rice farmers have various types of buyers, including wholesale traders, retailers, rice millers, and individual consumers to whom they can sell their rice either as grain or paddy; and at different locations or markets (farm-gate, local mill, distant mill, local market). Those who sell at the mill after milling their rice receive higher prices but also incur higher marketing and transactions costs, including the costs of transporting the paddy to the mill, milling charges and waiting at the mill for their rice to get milled, which may take a few days depending on availability of electricity, among other things. If these costs are sufficiently higher relative to potential returns from milling the rice before sale, they may render rice-milling unprofitable. In this case, farmers will choose to sell unmilled rice even in areas where rice mills and premiums for milled rice exist. A similar situation may arise when farmers with limited training and experience in rice production and post-harvest handling have low confidence in the milling quality of their rice and thus prefer to sell it at a lower price as paddy rather than facing the risk of investing in milling and not getting the premium price if the milling quality turns out to be low.

Thus, it is hypothesized that the decision to sell rice as paddy or grain is influenced by location-level factors that operate at community scale (such as prices, distance and transportation cost to the nearest mill, availability and reliability of electricity, milling charges) as well as household-level factors, such as training and experience in rice production and post-harvest handling, education and age of the farmer which affects their risk preference and ability to decode and use available information on rice production and marketing for decision-making.

To test these hypotheses, survey data were analyzed to generate summary statistics of the factors hypothesized to affect the decision to sell paddy versus grain, and to fit a Tobit model to estimate the effect these factors on the proportion of rice sold as grain. Also estimated are the returns to milling, since the profitability of milling (or lack of it) could explain why some farmers sell milled rice and others don't despite the increased availability of rice mills. The profitability of selling milled versus un-milled rice was estimated using gross margin analysis, and compared using difference of mean tests between households that sold grain and their cohorts that sold paddy rice.

The surveyed households were grouped into three categories based on the form in which they sold their rice harvested in the first season of 2009 and second season of 2008. The first category, "unmilled", consisted of households that sold all their rice as paddy; while the second category, "milled", consisted of households that sold all their rice as grain; and the third category, "both", consisted of households that sold part of their rice as paddy and the other part as grain. Nearly half of the sampled households (48.5% or 94 out of 194 households) sold all their rice as grain and about one third (34.5%) sold part of their rice as grain and the other part as paddy. The rest (17%) sold all their rice as paddy. These results show that the majority of the sampled households (83%) invest in milling all or part of their rice before selling because milled rice attracts a higher price than paddy.

Results of the analysis on profitability of rice-growing show that it is associated with positive gross margins regardless of the form in which rice is sold (see Table 1), suggesting that rice production is a profitable venture. However, although households which mill all their rice before sale incur significantly higher variable costs than their cohorts who sell all or part of their rice as paddy, they receive higher gross margins or profits from rice sales. This suggests that the higher price of milled rice relative to paddy more than offsets the higher costs incurred by households which sell milled rice to make the selling of milled rice more profitable than selling paddy, as hypothesized.

Table 1: Returns to rice production and the associated costs

Variable	Mean values			
	Overall sample (N=194)	**"Unmilled" (N=33)**	**"Milled" (N=94)**	**"Both" (N=67)**
Total Revenue (Ushs/acre)	966,056.7 (811,797)	590,170[a] (800,877.5)	1,197,713[b] (783,756.7)	826,185[a] (763,955.2)
Total Variable Cost (Ushs/acre)	219,000 (199,279.8)	132,589.5[a] (174,032.7)	280,756.3[b] (220,495.2)	174,917.1[a] (147,643.6)
Gross margin (Ushs/acre)	748,927.9 (647,315.1)	457,580.5[a] (644,861.1)	920,977.6[b] (612,287.2)	651,044[a] (633,321)
Milling cost (Ushs/kg)			84.16 (17.91)	
Price (Ushs/kg)		900.30[a] (195.42	1,437.77[b] (312.87)	

Note: pair-wise t test with equal variances assumed. Superscripts for two categories ab, ba, ac, bc indicates that the variable is statistically different between the categories; A number marked with aa, bb indicates that the variable is not significantly different between the categories. Figures in parentheses are standard deviations.

Tests of difference of the means (for continuous variables, e.g., education of the household head, family size and distance to rice mill) and chi-square (for discrete variables, e.g., group membership) were used to determine the differences in demographic and socio-economic characteristics between households that sold paddy rice and those that sold grain or a combination of paddy and grain. The results of the analysis (see Table 2) show that nearly all the sampled households (94.6%) are headed by men, although the proportion of male-headed households is lower among households that sold paddy only (91%) than their cohorts who sold grain only (98.9%) and those who sold both paddy and grain (95.5%).

Table 2: Socio-economic characteristics of rice-growing households

Variable	Mean values			
	Overall sample (N=194)	**"Unmilled" (N=33)**	**"Milled" (N=94)**	**"Both" (N=67)**
% male headed households	96.4	90.9[a]	98.9[b]	95.5[b]
% households with group membership	39.7	24.2[a]	35.1[b]	53.7[c]
Age of HH Head	40.093(11.902)	40.485[a] (12.324)	39.191[a] (11.381)	41.164[a] (12.476)
Education of HH Head (years)	5.881 (3.778)	6.424[a] (4.323)	5.947[a] (3.748)	5.522[a] (3.548)
Household size	7.387 (3.512)	6.788[a] (2.770)	8.043[b] (4.122)	6.761[a] (2.686)
Rice plot size (acres)	1.075 (0.955)	0.629[a] (0.505)	1.533[b] (0.893)	0.653[a] (0.918)
Landholding(acres)	4.581 (4.446)	3.746[a] (3.306)	5.330[b] (4.757)	3.942[a] (4.364)
Rice Output (Kg)	776.304 (666.258)	271.879[a] (300.556)	982.192[b] (692.033)	735.896[c] (624.652)
Experience (years)	8.526 (7.761)	6.818[a] (7.338)	8.723[a] (7.482)	9.090[a] (8.326)
Distance to rice mill (km)	3.512 (3.877)	4.841[a] (4.838)	3.280[b] (3.452)	3.184[b] (3.839)

Note: pair-wise t test with equal variances assumed. Superscripts for two categories ab, ba, ac, bc indicates that the variable is statistically different between the categories; A number marked with aa, bb indicates that the variable is not significantly different between the categories. Figures in parentheses are standard deviations.

Forty percent of the households had membership in farmers groups, but the "both" category had a significantly higher proportion of households with membership in farmers' groups (53.7%) than the "unmilled" (24.2%) and "milled" (35.1%) categories. On average, households which milled all their rice before selling were endowed with significantly bigger landholdings (5.33 acres) and households (8 people), which, among other factors enabled them to cultivate bigger rice plots (1.53 acres) and harvest bigger volumes of rice (982 kg) than their cohorts in the "unmilled" and "both" categories. However, those who sold all their rice as paddy were faced with significantly longer distance to the nearest mill (4.8 km) than households that milled all (3.28 km) or part (3.18 km) of their rice before sale. These results suggest that rice-milling is directly constrained by the distance traveled by farmers to access milling services, but is indirectly enabled by household endowment of land and family labor through their effect on the size of rice plots (and rice output) that households can cultivate.

Results of regression analysis on the determinants of proportion of rice sold as grain are presented in Table 3. The results show that the harvested volume of rice (output), household size, price of milled rice, distance to nearest rice mill and membership in farmers' group significantly affect the proportion of rice sold as grain. The positive relationship between price of milled rice and the proportion of rice sold as grain implies that as the price of milled rice rises, it triggers increasing proportions of rice to be sold as grain. A one shilling increase in the price of milled rice increases the proportion of harvested rice sold by 0.1%; increases the proportion of rice sold as grain by 0.04%; and increases the likelihood of making a sale by 0.1%.

Table 3: Results of the tobit model

Explanatory Variables	Coefficients	Marginal effects		
		$\frac{\partial Ey}{\partial X_i}$	$\frac{\partial Ey^*}{\partial X_i}$	$\frac{\partial F(z)}{\partial X_i}$
Experience	-0.007 (0.005)	-0.005	-0.003	-0.006
Education	0.007 (0.010)	0.005	0.003	0.005
Household size	0.024** (0.012)	0.016	0.009	0.019
Price of milled rice	0.001*** (0.0001)	0.001	0.0004	0.001
Distance to rice mill	-0.045*** (0.012)	-0.030	-0.017	-0.036
Group- Membership^	0.136** (0.076)	0.135	0.077	0.148
Rice Output[a]	0.145*** (0.043)	0.097	0.056	0.115
Other income sources	-0.032 (0.110)	-0.021	-0.012	-0.026
Constant	-1.121*** (0.305)			

Observations =194, Log likelihood = -94.00516, Pseudo R2 = 0.5090 ^=dummy variable [a]= Logarithm *, **, *** Represents significance of coefficients at 10%, 5% and 1% levels respectively, in parentheses are standard errors

The volume of rice harvested by the household is also positively and significantly associated with the proportion of rice sold as grain. This is because the fixed transaction costs of milling can be spread over a larger volume of produce, making it cheaper to invest in milling before sale. Increasing the harvested volume of rice by 1 kg increases the proportion of harvested rice sold by 9.7%; increases the proportion of rice sold as grain by 5.6%; and increases the likelihood of selling rice by 11.5%. Also, the number of people in a household positively influences the proportion of rice to be sold as grain. Increasing the number of people in a household (family labor) by one person would lead to an increase in the proportion of rice sold as grain. This is likely because the higher family labour endowment enables the household to produce more, thereby reducing per unit fixed transaction costs of milling as explained above.

Membership in a rice-farmers' group is associated with a significantly higher proportion of rice sold as grain. This is because it enables easier access to milling services through transport-pooling, for example, and entitles member farmers to other benefits that could explain the higher tendency to mill before sale. Having membership in a rice-farmers' group increases the proportion of harvested rice sold by 13.5%; increases the proportion of rice sold as grain by 7.7%; and increases the probability of making a sale by 14.8%.

Distance to the nearest rice mill negatively influences the proportion of rice sold as grain. This is because households that are closer to milling services face lower transactions costs of milling and are thus more likely to mill their rice before sale than more distant households. Increasing the distance to the nearest rice mill for example by one kilometer reduces the proportion of rice sold by all rice-growing households by 3%; reduces the proportion of rice milled before sale (for households selling milled rice) by 1.7%; and reduces the probability of making a sale by 3.6%.

Conclusions and Policy Recommendations

Although rice production has been shown to be a profitable venture regardless of the form in which farmers choose to sell their rice, milling rice before sale makes rice production even more profitable. It is important, therefore, that farmers are encouraged and assisted to mill their rice before sale through training and extension; and through interventions that reduce the transactions costs of milling. Such interventions include those that enable farmers to produce more (e.g., by facilitating their access to yield-enhancing inputs) and spread the milling costs over a larger volume of produce; and to market/mill their rice in groups for easier access to milling services and reduction of the fixed transactions costs of milling that they would otherwise face as individuals. This recommendation is supported by the positive relationships between the proportion of rice sold as grain and membership in farmers' groups and volume of rice harvested.

The negative relationship between the proportion of rice sold as grain and distance to the nearest rice miller suggests that interventions that enable milling services to be brought closer to farmers in major rice-growing areas (e.g., by facilitating private entrepreneurs to set up milling plants closer to farmers through rural electrification and reduction of electricity tariffs or to invest in mobile rice mills through rural road network improvement) would go further to reduce the transactions costs of accessing milling services and encourage rice-milling before sale.

The positive relationship between the price of milled rice and the proportion of rice sold as grain suggests that the above interventions need to be complemented by efforts to get and keep prices right, such as developing new markets for rice and rice products to ensure that the intervention-driven increase in production and marketing of rice does not undercut the incentive for production and milling embodied in the prices received by farmers. There is also need for further research to assess the quality of available milling services, because this also could affect farmers' willingness to mill their rice before sale.

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