J. ISSAAS Vol. 25, No. 1: 43-54 (2019)

TECHNICAL EFFICIENCY OF WOMEN IN INDIGENOUS RICE PRODUCTION IN SAGADA, MOUNTAIN PROVINCE, PHILIPPINES

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(Received: April 24, 2018; Accepted: May 23, 2019)

ABSTRACT

This study assessed the technical efficiency (TE) of *Kankanaey* women in rice production in Sagada, Mountain Province, Philippines. Primary data were collected in February 2016 for cropping period December 2014 to May 2015. From 120 respondents interviewed, 139 male-headed and 139 female-headed rice parcels were studied. The factors of production and TE were determined using stochastic production frontier analysis while mean differences between genders were t-tested. Small rice parcels had lower production because they were more difficult to cultivate, used lesser seeds, high-yielding variety (HYV) and rodenticide. These constraints, along with problems of *saktoto* worm infestation and lack of water were more often experienced in women-managed parcels. These parcels had lower TE and production due to: non-participation of women in *dap-ay*; inadequacy of man-labor; smaller size of parcels; inadequate logistical and infrastructure support for dilapidated terraces and pathways; lack of irrigation water; and lack of organic inputs for rice production. Women inclusion in the *dap-ay* especially in determining the agricultural calendar and declaration of ubaya; reviving the *lampisa* system for irrigation management; expansion of rice parcel area; practicing *ub-ubbo*; provision of logistical and infrastructure support for indigenous rice farming; and provision of rice technical support for organic rice farming were recommended.

Key words: stochastic production frontier analysis, Indigenous Peoples, women empowerment

INTRODUCTION

In the Mountain Province of the Philippines, where historically rice self-sufficiency had been attained, rice is grown in mountainous areas with slopes varying from 0° to 30° and have more complex irrigation systems. One of the rice farming communities in the province is the *Kankanaeys* of Sagada, traditionally referred to as indigenous peoples (IP) belonging to the *Igorots* or the "people of the mountains" (ILO, 2007). They are known for their stone-walled rice terraces with areas ranging from few square meters to half a hectare. The use of advanced agricultural machineries and high yielding varieties (HYVs) are usually prohibited by their environment and culture. They follow an agricultural calendar determined by biophysical, meteorological and hydrological factors. Community rituals like *ubaya* (observance of holiday or no workday) are observed during occurrences of human sickness or death or crop pest infestation and prohibit villagers to work on their farms. The traditional practices of both men and women have made their rice production sustainable for centuries (Corpuz, 2002).

The decline in *Kankanaeys*' rice production is partially attributed to their integration into the cash economy leading them to favor production of cash crops, and the men's entry into the labor market. Specifically, starting the 1980s, small-scale gold mining became popular, shifting man-labor from farming to mining. Thus, gender division of labor and source of management in their rice farming were affected. Currently, women are the common source of management and labor in their rice production. They take the roles of men in rice farming which include heavy works in sloping and high stone-walled rice fields. Although land preparation is still usually done by men, increasingly, their rice fields are becoming female-headed, worked by women and their children (Corpuz, 2002).

Several studies claimed that despite the increasing role of women in agriculture, still there are gender gaps when it comes to access to land, extension, technology, finance, time, mobility and information which affect technical efficiency (TE). Women have smaller and more dispersed parcels and are less likely to secure tenure. They have less access to extension services usually provided for male farmers on the invalid hypothesis that information will drip across to women. They use lower levels of technology due to limited access or cultural restrictions. They have less access to formal financial services due to high transaction costs, limited education, socio-cultural constraints and collateral requirements. They have greater time constraint and are less mobile due to childcare and household works. Lastly, they are less educated which hampers access to and ability to understand technical information and they also have less access to agriculture-related trainings and seminars (Fong and Bhushan, 1996 as cited by Lamug, 2004). Meanwhile, according to FAO (2010), while productivity is affected by various factors such as climate, temperature, quality of seeds, fertilizers, among others, the technical knowledge of farmers is the most important factor to increase productivity. Also, even with the availability of new agricultural machineries and seed varieties, some farmers chose to continue their traditional practices which are commonly less productive, such that many have not yet achieved full potential yield, giving rise to technical inefficiency.

In the context of *Kankanaey* women who are increasingly assuming major roles in rice farming, the question of whether such claims of some authors are true or not needs hard evidences. It is essential therefore that gender studies in agricultural productivity, particularly in rice, which is the major crop of the *Kankanaeys* be done, for empirical support. With these, the question of whether or not *Kankanaey* women are able to efficiently manage their indigenous rice production and increase rice productivity, given their existing resources and technology can be answered. The current study attempted to answer this question and to find out other issues related to TE of women rice farmer-managed parcels, as well as how they can be addressed. Specifically, it: described the indigenous rice production practices of *Kankanaeys*; assessed the TE of their managed rice parcels; determined the factors affecting their TE; and identified the problems in their indigenous rice production.

This study was anchored on the hypotheses that female-headed parcels are more technically inefficient than male-headed, and that certain socio-economic characteristics and adherence to cultural practices of rice parcel head and characteristics of rice parcels affect TE of indigenous rice production.

CONCEPTUAL FRAMEWORK

Figure 1 shows that there can be differences in TE between rice parcels being managed by males and females because of socio-economic diversities among the farmers themselves. Foremost of these is the shifting of male labor into mining thus increasing women management of farms. This is very important because there are inherent disparities between what women and men can physically do in the farm and this can impose some limitations on the efficiency of farm management. The characteristics of rice parcels can also be critical in farm management, particularly the size and distance from irrigation facility, seedbed, input supplies, and place of residence of rice parcel head. Difference in location between own parcel and co-managed parcels and their bio-physical characteristics may likewise affect TE due mainly to the terrain and the sloping nature of the terraces. Furthermore, observance of agricultural calendar and rituals such as *ubaya* can be diverse between men and women, since there is gender division in the management of their ancestral domain and its resources. *Ubaya* refers to the unifying community holiday similar with Sabbath. The traditional leadership institution for men (*dap-ay*) is responsible for the observance of their farming calendar while women are commonly tasked to oversee activities of villagers during *ubaya*. Farm management practices (input utilization) are affected by differences between genders and directly affect TE which affects output.

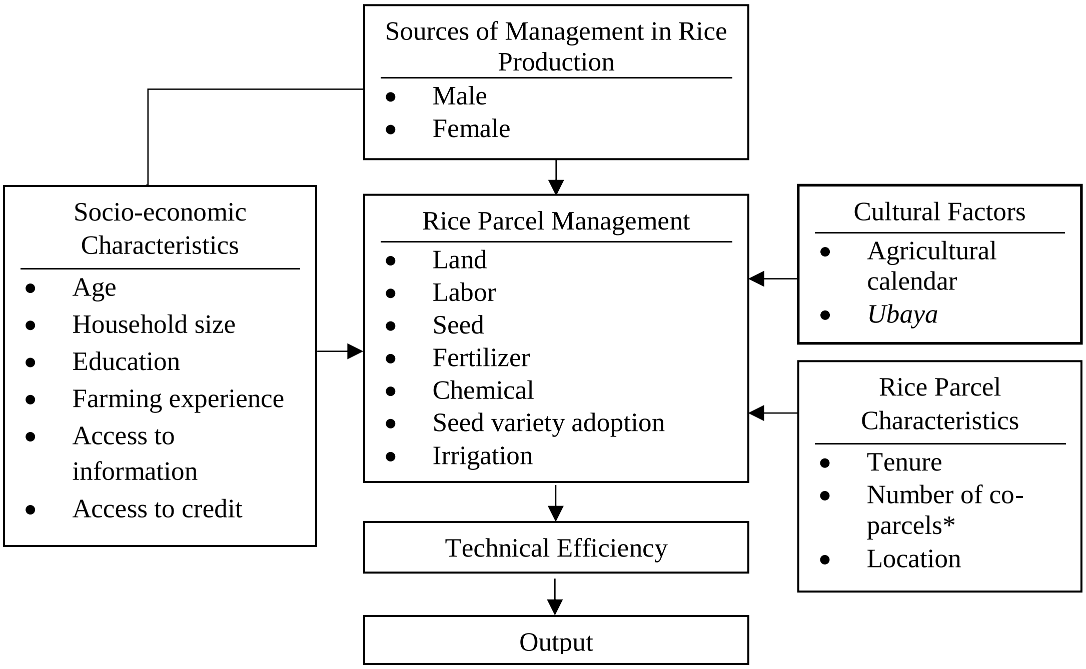

Fig. 1. Conceptual framework used in analyzing the effects of gender on TE of indigenous rice production in Sagada, Mountain Province, Philippines
*Co-parcel is defined in this study as other rice parcels simultaneously managed by the same farmer.

RESEARCH METHODOLOGY

The study was conducted in Pidlisan, Sagada, Mountain Province, consisting of barangays Aguid, Bangaan, Fidelisan and Pide. Personal interviews of 120 rice parcel heads (60 males and 60 females) selected through stratified random sampling were performed using pre-tested interview schedule for detailed rice production data for single cropping year December 2014 to May 2015.

Rice parcels of different locations were treated as separate units of the parcel head due to differences in bio-physical characteristics such as soil fertility, temperature, slope, source of irrigation, and distances from seedbed, input supplies and residence of the parcel head which could affect input utilization. In total, 278 rice parcels (139 male-headed and 139 female-headed) were studied.

Descriptive analysis (using frequency, percentage, and means) and test of two means were employed. The study also utilized the TE effects frontier model (using Frontier 4.1) to obtain the maximum likelihood estimates (MLE) of the production function and TE parameters of the stochastic production frontier. The significant factors affecting production and TE, as well as the TE levels were determined using Equations 1 and 2 (Battesse and Coelli, 1993), respectively.

$$\ln(\widehat{Q}_j) = \beta + \sum_{i=1}^{14} \beta_i \ \ln(X_{ij}) + (v_j - u_j) \qquad \text{Equation 1}$$

where:

$\widehat{Q}_j$ = predicted aggregate quantity of harvested rice (kg) of the j^{th} rice parcel
X_1 = land (per 100 sqm)
X_2 = seed (kg per 100 sqm)
X_3 = Nitrogen (kg per 100 sqm)
X_4 = Phosphorous (kg per 100 sqm)

X_5 = rodenticide (L per 100 sqm)
X_6 = pesticide (kg per 100 sqm)
X_7 = adult male labor (man-hour labor per 100 sqm)
X_8 = adult female labor (man-hour labor per 100 sqm)
X_9 = middle-aged male labor (man-hour labor per 100 sqm)
X_{10} = middle-aged female labor (man-hour labor per 100 sqm)
X_{11} = young labor (man-hour labor per 100 sqm)
X_{12} = animal-labor (man-animal-hour labor per 100 sqm)
X_{13} = machine-labor (man-machine-hour labor per 100 sqm)
X_{14} = seed variety adoption (1=introduced HYVs; 0=traditional)
ln = natural logarithm
β = parameters to be estimated
E = composite error term, defined as $(v_j - u_j)$ in Equation (1)

$$U_j = \delta_0 + \sum_{i=1}^{13} \delta_i Z_{ij} + e_j \qquad \text{Equation 2}$$

where:
U_j = technical inefficiency of the j[th] rice parcel
Z_1 = age of farmer (year)
Z_2 = household size (number)
Z_3 = education (year)
Z_4 = rice parcel management experience (year)
Z_5 = source of management (1: male; 0: female)
Z_6 = access to information such as trainings and seminars (1: access; 0: no access)
Z_7 = access to credit (1: access; 0: no access)
Z_8 = deviation from agricultural calendar (day)
Z_9 = *ubaya* violations (number)
Z_{10} = tenure (1: owned; 0: borrowed)
Z_{11} = number of co-managed parcels (number)
Z_{12} = distance of the rice parcel from seedbed (hours travelled)
Z_{13} = distance of the rice parcel from irrigation outlet (hour travelled)
δ = parameters to be estimated
e = error term

RESULTS AND DISCUSSION

Study area. Sagada has a total land area of 9,969 hectares with 2,223.8 hectares devoted to agriculture, 431.5 hectares of which are planted with rice. The town has a mountainous terrain of gentle to very steep slopes. It is a tributary of the Chico River, where two major river systems in Pidlisan are connected, one running through the Bumod-ok Falls in Fidelisan and the other located in Bangaan. The Mabileng Irrigation, the largest irrigation system in Northern Sagada is sourced from the Bomayeng Falls in Aguid and irrigates the rice fields in Pidlisan (Sagada MAO, 2015). Sagada has Type 1 climate, with the wet season running from May to October and dry season from November to April. It has a mean precipitation of 204.97 mm and temperature of 20.71˚C. The soil is acidic with a pH range of 4.55 to 5.0 and is deficient in Phosphorus and Nitrogen. Potassium, however, is adequate and organic matter is medium. The soil has shallow depth, low water-retention capacity and prone to erosion (CSC-UPB, 1999 as cited by NCIP, 2004). The common sources of income are farming, mining, tour guiding, backyard animal raising, logging and carpentry. Most are Christians, but elders considered themselves as pagan, performing rituals for farming and other community activities (PITO, 2014).

Rice production practices. In Sagada, the single cropping agricultural calendar is based on the appearances of different kinds of birds such as *kiling*. Community rituals are observed by the farmers such as *begnas*, *pakde*, and *ubaya*. The calendar synchronizes activities to facilitate labor exchange and pest management. The "new year" is celebrated in August with the first sowing of seeds. However, with the introduction of HYVs, sowing of seeds is done starting December until January. Clearing of weeds in the stone walls is done in November, followed by plowing and harrowing. The removed weeds and wild sunflower plants are mixed into the soil during plowing to serve as fertilizer. The fields are flooded before plowing to ease the work. These are done with hand tools made of wood and metal such as hand trowel and plough, while others ease their work with the aid of carabao. Putting of mud around paddies is done to prevent seepage.

Originally, transplanting is done in November to December; however, with HYVs, transplanting is performed in January to March. The fields are flooded before pulling the seedlings from seedbed and transplanting. When dry season starts, people usually go to irrigation outlet to divert water to their rice fields. In the previous years, there were water distributors or *lampisa* who disperse water from Mabileng irrigation to the rice fields. Come harvest time, the *lampisa* were given a small portion of the harvest of the rice fields assigned to them. However, since 2014, there were no *lampisa* volunteers anymore. Weeding is done during late March to April when grasses have already grown. At the same time, damaged rice plants are replaced. Weeds, stems and leaves of pine trees are used to cover rat tunnels in the stone walls. Rats eat up the palay grains, so they need to be prevented from entry or driven them away as early as possible. Driving away birds is known as *buwew*. A small hut equipped with boiled resin of a shrub and constructed in an area where birds stay most is used to catch birds. Those who helped in the construction of the hut, usually young males, were given palay during harvesting. Harvesting is done in May. In the past, farmers used to cut palay at about 7 to 8 inches from the panicle using a hand reaper known as *lakem*, then bundled them with the use of *bika* or rattan strips. Palay bundles were transported using bamboo stick or *assiw*. After threshing palay with the use of *saplitan*, an improvised thresher made of wood, grains were transported with the use of woven basket known as *gimata*. However, with HYVs, people are now using hand sickle known as *kompay* in harvesting. The use of manual thresher is commonly done, and grains are transported in sacks using a tram line.

The grains are dried under the sun for at least 2 to 3 days after which they are winnowed by women with the use of woven rattan or *i-gao*. Before, people used to hand pound palay using *lusong* and *pat-o* or mortar and pestle made of stone and wood, respectively. At present, rice mills are being used, but hand pounding is still done to red and black rice and *dikit* or glutinous rice. The exchange of free labor among members of a group or *ub-ubbo* is commonly adopted. It involves completion of farm works for each of the member in rotation until all members shall have been served. This is commonly practiced during transplanting and harvesting.

Rice parcel heads. Results shown in Table 1 reveal that women-farmers (51 years) are younger than men who had an average age of 56 years. Similarly, women had lower mean household size (5) than men-farmers (6). Women had higher average formal schooling (8.05 years) than men (7.64 years). Men did not continue education after elementary and worked in mining and logging instead. Since women were younger than men, they had lesser experience in rice parcel management (23 years) than men (26 years). Before, children are required to help in rice farming to learn their culture and tradition. However, fewer children are participating in rice farming nowadays due in part to the growing issue of child labor. In addition, more women (89) had access to information such as trainings and seminars than men (74). Most are members of the Pidlisan Tribe Organization (PITO) which promotes the use of indigenous micro-organisms to produce organic fertilizer. There are members of cultural leadership institutions, *dap-ay* for men who are responsible for their farming calendar and *balikatan* for women for the collection of fines for *ubaya* violations. There were seminars attended on organic fertilizers and integrated pest management (IPM) organized by PITO, DA and Cordillera Highland Agricultural Resource Management Program (CHARMP). Also, more women (23) had acquired credit for rice farming than males (10) particularly because they had to pay for hired labor, fertilizers and pesticides. More women had higher paid hired laborers since they had fewer source of family labor.

Table 1. Means and mean differences in the socio-economic and rice parcel characteristics, by sex, 278 rice parcels, Sagada, Mountain Province, 2015.

Variable	Mean		Mean Difference		Standard Error
	Male	Female			
Socio-economic Characteristics					
Age (year)	55.92	50.5	-5.42	***	1.65
Household size (number)	6.06	5.16	-0.79	***	0.33
Education (year)	7.64	8.05	0.40		0.41
Parcel management experience (year)	26.24	22.82	-3.41	**	1.67
Access to information[a]	74	89			
Access to credit[a]	10	23			
Rice Parcel Characteristics					
Tenure[a]	111	104			
No. of co-managed parcels (number)	2.04	2.04	0.00		0.18
Distance from seedbed (walking hour)	0.14	0.32	0.19		0.03
Distance from irrigation (walking hour)	0.25	0.28	0.04		0.03
Cultural Factors					
Deviation from agricultural calendar (day)	24.95	25.73	0.26		0.35
Ubaya violation (number)	0.97	0.93	-0.04		0.12

*, ** and ***significant at 10%, 5% and 1% level of probability, respectively; [a]dummy variable where 1=with access to information and credit and owned parcel; and 0 otherwise

Women managed lower number of owned rice parcels (104) than men (111). Borrowing of rice parcels is common, since there are many idle parcels due to lack of water and labor. These parcels are more prone to destruction of stone walls and erosion. Most of the rice farming households in Pidlisan have been managing more than one rice parcel, usually of different locations (mean of 2 rice parcels each). In reality, parcel heads found difficulty overseeing or managing parcels all at the same time, for every farming activity. This affected their observance of agricultural calendar and utilization of inputs.

Rice parcels. The rice fields are commonly terraced, supported by century age stone walls or *agabat*, with height ranging from less than a meter to greater than one meter. The rice paddies or *sinkong* have irregular shapes and different sizes ranging from few square meters to less than half a hectare. A rice parcel is a piece of land composed of one or more adjacent rice paddies. Rice parcels differ in bio-physical factors such as source of irrigation water, soil fertility, temperature, and distance from seedbed. The average walking distances between rice parcels and seedbed (0.3 hours or 18 minutes) and irrigation facility (0.28 hours or 16.8 minutes) were higher among female-headed parcels than those male-headed (0.14 hours or 8.4 min, 0.25 hours or 15 minutes, respectively). Seedbeds are commonly put up directly on the rice parcels to be planted, on rice parcels with good fertility and lesser pests, or on rice parcels near their houses. However, more women had seedbeds on rice parcels near their houses to enable them to maintain the seedlings while doing household chores. The Mabileng irrigation is the common source of irrigation water for the rice parcels. Other sources of irrigation are the Balikwey irrigation, Bumod-ok Falls, Bellang and Lenang Lakes. The distance of the rice parcels from irrigation negatively affected the schedule of farming activities.

Cultural practices/traditions. Women (26) had slightly higher average number of days of deviation from the agricultural calendar than males (25). Deviations were observed mostly during land and seedbed preparation. Rice field should be flooded before land preparation, but female-headed parcels were irrigated later due to farther distance from the irrigation facility. On the other hand, *ubaya*, a community ritual, was more frequently violated by men (0.97) than females (0.93). This runs counter to the higher deviation from agricultural calendar by women. The main reason is the fact that *ubaya* is not limited to farming but include also rituals for sickness and death of villagers. Moreover, women had higher awareness of these declarations because they are responsible for the collection of fees for the violation of the *ubaya*, unlike the agricultural calendar which is male determined.

The results of t-tests of two means show that age, household size and management experience had significant mean differences between genders (Table 1). Hence, women are significantly younger, had significantly lower household size and had lesser management experience than men.

Factors affecting production. Table 2 shows the different factors that could possibly affect rice production between genders. The t-test of two means revealed that rice parcel area, seed, adult and middle-aged male labor and machine labor had significant mean difference between genders (Table 2). That is, women had significantly lower rice parcel area, use less seed, and employ fewer adult and middle-aged male and machine labor. This is because women had lower average rice parcel area (410 sqm) than men (460 sqm). The size of rice parcel influenced the use of seeds, fertilizers, pesticides and labor. Consequently, the average amount of seed used was lower among women (2.43 kg/100 sqm) than men (3.15 kg/100 sqm). More women (97) had also the higher tendency to adopt HYVs than men (95). Elder respondents who are mostly males strictly follow their agricultural calendar, which is usually adopted when traditional varieties are used. On the other hand, land preparation of most women started late, hence, more females adopted HYVs to cope up with the observance of the agricultural calendar. HYVs used were *Bordagol*, *C-1*, *Daswan* and *Taiwan* which are planted in February to March. Meanwhile, traditional varieties used were *Apolog*, *Pokpoklo*, *Senyor*, red and black rice which are planted in January to February.

Table 2. Means and mean differences in factors that could possibly affect production by sex, 278 rice parcels, Sagada, Mountain Province, 2015.

Variable	Mean		Mean Difference		Standard Error
	Male	Female			
Area of parcel (100 sqm)	4.6	4.10	0.50	**	0.43
Seed (kg)	3.15	2.43	0.72	**	0.36
HYV Adoption[a]	95	97			
Nitrogen (kg)	0.47	0.73	-0.26		0.13
Phosphorous (kg)	0.25	0.34	-0.09		0.08
Rodenticide (L)	0.09	0.15	-0.06		0.04
Pesticide (kg)	0.03	0.07	-0.04		0.02
Adult male labor (man-hour)	185.35	88.55	96.80	***	11.96
Adult female labor (man-hour)	130.29	199.51	-69.22		11.28
Middle-aged male labor (man-hour)	104.48	56.54	47.94	***	10.39
Middle-aged female labor (man-hour)	76.22	131.22	-55.00		10.73
Young labor (man-hour)	11.78	26.91	-15.13		6.24
Animal-labor (man-animal-hour)	3.51	2.71	0.80		0.69
Machine-labor (man-machine-hour)	3.81	3.15	0.66	**	0.36

*, ** and ***significant at 10%, 5% and 1% level of probability, respectively

[a]dummy variable where 1=male; those with access to information and credit; owned parcel; and 0 otherwise

Man-labor is vital in rice farming in Pidlisan since activities are mostly done manually. Middle-aged laborers are aged between 18 to 59 years. Males at these ages are active in mining and logging. The mean middle-aged male and female labor employed among male-headed parcels constituted 104.48 and 76.22 man-hours/100 sqm, respectively. Meanwhile, the mean middle-aged male and female labor employed among female-headed constituted 56.54 and 131.22 man-hours/100 sqm, respectively. Adult labor classification was for those who are at least 60 years, majority of whom are working primarily in the farms. The average adult male and female labor employed among male-headed parcels were 185.35 and 130.29 man-hours/100 sqm, respectively. Meanwhile, the average adult male and female labor employed among female-headed were found to be 88.55 and 199.51 man-hours/100 sqm, respectively. Moreover, machine-labor was also employed but it was more frequent during milling of majority of harvest. On the average, females employed lower (3.15 man-machine-hour labor/100 sqm) than males (3.81 man-machine-hour labor/100 sqm). Black, red, brown and glutinous rice were hand-pounded since the grains would be broken if milled using their available rice mills.

Production and technical efficiency analysis. TE is the deviation of the average production function from the frontier production function, suggesting the need to estimate these two production functions. The Ordinary Least Squares (OLS) was used in the parameter estimation for the average production function, while the Maximum Likelihood Estimation (MLE) was employed for the frontier production function. The presence of technical inefficiency was determined using the t-test of gamma and the generalized likelihood ratio (GLR) test.

Table 3 reveals that the t-test of gamma (0.06953) was not significant but the sigma squared was found to be significant at 10 percent level of probability, implying the correctness of the specified assumption for the distribution of the error term. It had a coefficient of 0.006 indicating that the values in the distribution were dispersed from the mean by 0.60 percent. On the other hand, GLR statistic (96.98) was greater than the chi-square value (24.38) with degrees of freedom of 15 at 5 percent level of probability. Furthermore, the log likelihood value for the MLE model was higher than the OLS model. Thus, technical inefficiency existed and the MLE model better fitted the data.

Table 3. Ordinary least squares and maximum likelihood estimates of the stochastic production frontier, production function, 278 rice parcels, Sagada, Mountain Province, 2015.

Variable	OLS Coefficient		T-Ratio	MLE Coefficient		T-Ratio
Constant	1.39034	***	38.25761	1.47247	***	36.54923
Land	0.84099	***	37.20774	0.80274	***	36.08609
Seed	0.11193	***	4.85553	0.05931	***	2.75611
Seed Variety Adoption	0.02338	*	1.78031	0.03350	**	2.59002
Nitrogen	0.00001		0.55887	-0.00002		-1.11645
Phosphorous	0.00001		0.30345	0.00000		0.25212
Rodenticide	0.00001		0.39044	0.00004	**	2.54778
Pesticide	-0.00001		-0.58711	-0.00002		-0.85632
Adult male labor	0.00004	**	2.06051	-0.00002		-1.16446
Adult female labor	-0.00001		-0.47023	0.00002		1.40260
Middle-aged male labor	-0.00003	*	-1.71490	-0.00005	***	-2.93065
Middle-aged female labor	0.00000		-0.06323	0.00002		1.16580
Young labor	0.00000		-0.15183	-0.00002		-1.46147
Animal-labor	-0.00001		-0.45573	0.00001		0.84856
Machine-labor	0.00000		0.08080	0.00000		-0.22965
Sigma-squared	0.00823			0.00593	***	7.38587
Gamma	0.05000			0.06953		1.00392
Log-likelihood value			277.16381			325.65176
GLR test statistic						96.97592***

*, ** and *** significant at 10%, 5% and 1% level of probability, respectively

Coefficients implied that land, at 1 percent level of probability significantly and positively affected production, suggesting that every 1 percent increase in land area, holding other things constant, would result to 1.47 percent increase in production. As expected, increasing land utilization would increase production. Moreover, rodenticide, at 5 percent level of probability significantly and positively affected production, suggesting that every 1 percent increase in the amount of rodenticide used, *ceteris paribus*, would result in 0.00004 percent increase in output. Furthermore, seed at 1 percent level of probability significantly and positively affected production, indicating that every 1 percent increase in seed used, other things held constant, would result to 0.06 percent increase in production. Also, seed variety adoption, at 5 percent level of probability significantly and positively affected production, signifying that the use of HYVs, ceteris paribus, would result in 0.03 percent increase in output.

Meanwhile, middle-aged male labor was significantly but negatively related to production at 1 percent level of probability, which implies that every 1 percent increase in employment of middle-aged male labor, *ceteris paribus*, would decrease output by 0.00005 percent. One possible reason for this is that middle-aged males used to juggle their time and effort between mining or logging and rice farming, both of which require strength, and this could have negatively affected the quality of labor devoted to rice farming.

Women had significantly smaller parcel area and seed utilization, which were significantly and positively related to production. Moreover. They had significantly lower utilization of middle-aged male labor, which was significantly but negatively related to production. However, its MLE coefficient was nearly close to zero (0.00004), hence, the effect can be considered negligible. Results revealed that men (98.16%) were significantly more technically efficient than women (89.72%) at 5 percent level of probability (Table 4). This means that production of male-headed parcels could only be improved by 2.12 percent, but the female-headed ones could improve production by 10.67 percent.

Table 4. Means and mean differences in technical efficiency and production by sex, 278 rice parcels, Sagada, Mountain Province, 2015

Measure	Male		Female
Technical Efficiency			
Mean (%)	98.16		89.72
Mean difference (%)		8.44***	
Standard error		0.47	
Production			
Mean (kg)	104.04		83.96
Mean difference (kg)		20.08**	
Standard error		8.76	

***significant at 1% level of probability; ** significant at 5% level of probability

Also, it can be seen in Table 5 that household size positively influenced TE, that is, as household size increases, TE also increases. This is to be expected since family labor is vital in laborious and manual activities of rice farming. Likewise, access to information directly affected TE at one percent level of probability, suggesting that as more information and skills are acquired, TE improves. Skills may be about composting, organic farming, and integrated pest management (IPM). However, in the case of women, this could have been negated by the fact that they have significantly lower rice parcel area, seeding rate, adult and middle-aged male and machine labor. On the other hand, level of formal education negatively affected TE, at five percent level of probability, implying that farmers with higher educational attainment were more technically inefficient. Those with higher level of education have the higher tendency to have employment other than rice farming such that not enough attention is being given to rice farming. This is bolstered by the finding that deviation from agricultural calendar negatively affected TE at one percent level of probability. This is because the agricultural calendar helps in pest management and labor exchange, hence, as farmer deviates from this calendar, pest infestation becomes more likely. Those farmers with regular employment tended to have more deviations from the agricultural calendar. Similarly, the number of co-parcels (other parcels simultaneously managed by the same farmer) negatively affected TE at one percent level of probability since parcels are located far apart and have different bio-physical characteristics, making simultaneous management more difficult.

Table 5. Maximum Likelihood Estimates of the stochastic production frontier, technical inefficiency function, 278 rice parcels, Sagada, Mountain Province, 2015

Variable	MLE Coefficient		T-Ratio
Constant	-0.15882		-0.89706
Age	0.10726		0.88248
Household size	-0.11062	***	-3.06715
Education	0.00008	*	1.91816
Parcel management experience	0.00377		0.09650
Sex	-0.14014	***	-7.71583
Access to information	-0.04455	***	-2.89693
Access to credit	-0.03112		-1.19789
Tenure	-0.00507		-0.25947
No. of co-managed parcels	0.11162	***	2.97838
Distance from seedbed	-0.00002		-1.01962
Distance from irrigation	0.02564		1.45010
Deviation from agricultural calendar	0.17075	***	3.54180
Ubaya violation	-0.00002		-1.35961

*, ** and *** significant at 10%, 5% and 1% level of probability, respectively

Problems encountered in indigenous rice production. There had been rivalry in irrigation water due to lack of *lampisa* to manage the Mabileng irrigation facility and which was made even more difficult with the occurrence of El Niño. Also, loggers use irrigation canals to transport timber from the mountains. As a practice they block irrigation outlets for greater volume of water to carry the timber along the stream. In addition, some irrigation canals had been damaged due to landslides caused by typhoons. More women had problems on lack of water for their rice fields partly due to longer distance of their rice parcels from the irrigation facility and their greater time constraint (due to household chores) that prohibits them to oversee the channeling of water to their irrigation outlet. This results to them having more problem on *saktoto* (worms associated with lack of water) and them applying more pesticide to control the spread of these worms. Problems on rats, rice birds, and golden snails were also more frequently encountered.

Also, more women had problems on soil fertility as this is associated with their use of inorganic fertilizers. Application of inorganic fertilizers had also been inevitable in fields which were irrigated with water that contain chemical wastes from the mines. Similarly, more females faced physical constraints such as small area of rice paddies and high stonewalls which were more laborious to work on. More of them had difficulty in transporting seedlings (from near their households) and harvest due to lack of stone pathways, long distance and difficult terrain going to fields. Stone pathways going to some fields were dilapidated by landslides. Miners had also added damages to these pathways due to heavy loads they transport. Other problems faced were typhoons which caused damages to palay and irrigation canals; and limited and immobile rice mills, hence, palay had to be transported and the cost of milling was relatively high. Some traditional varieties are hand-pounded since the available rice mills are not suitable for milling these varieties.

CONCLUSION AND RECOMMENDATIONS

Based on the results of the study it can therefore be concluded that female-headed parcels were more technically inefficient (89.72%) than male-headed ones (98.16%) and this has been the result of the disadvantages the women are faced with, both bio-physical and cultural which negated their technical advantage. These disadvantages include: non-participation of women in the dap-ay; inadequacy of man-labor; small size of rice parcels; inadequate logistical and infrastructure support to address their dilapidated state of the terraces and pathways; lack of irrigation water; and lack of organic inputs for rice production. The following are therefore recommended:

Inclusion of women in the dap-ay especially in determining the agricultural calendar and declaration of ubaya. The *dap-ay* system promotes cultural traditions and customary laws which encourage sustainable management of resources by determining the agricultural calendar and declaring *ubaya*. While the agricultural calendar is generally based on bird sightings and other natural occurrences, still this may be based on subjective perceptions of those included in the *dap-ay,* all of whom are male. It is being argued that, at present, in their decision-making, the *dap-ay* is not considering the situation of women who more often cannot follow the agricultural calendar simply because of their other responsibilities in the household. It is hoped that with the inclusion of women in the *dap-ay*, these may likewise be considered so that they will not be frequently violating the agricultural calendar. This is particularly important for female farmers because they are the ones who encountered pest infestation more often due to their frequent deviation from agricultural calendar.

Encourage the continued practice of the ub-ubbo. *Ub-ubbo* is the practice of exchange of labor among the different farms, generally in rotation until all who are engaged in this have been served. This is favorable for smaller households with limited family labor. It can be recalled that women-farmers had significantly lower household size. Household size positively related to TE.

Expansion of rice parcel area should be fostered for adjacent ones. Borrowing of rice parcels is very common among *Kankanaeys* as this is an important practice for them to prevent rodent infestation in untended plots. Meanwhile, increasing parcel area can be beneficial to women who have difficulties manually doing land and seedbed preparation because animal-labor is inappropriate in small parcels. It would therefore be ideal if borrowing of adjacent rice paddies can be promoted or more permanently, exchange of parcels can be encouraged.

Provision of logistical and infrastructure support for indigenous rice farming. Results revealed that more women had difficulty transporting seedlings (from near their households) and harvest due to lack of stone pathways, long distance and difficult terrain going to fields. Furthermore, existing stone pathways were dilapidated by landslides and frequent use of miners. It is therefore suggested that pathways going to rice fields be improved using part of the community income from the Sagada tourism industry. Irrigation systems should be rehabilitated and maintained through collective participation in community maintenance to establish a sense of ownership.

Revival of the lampisa system. The *lampisa* (irrigation water distributors) should be revived and maintained by institutionalizing their compensation instead of them doing volunteer work and given only a small portion of the harvest of the rice fields assigned to them. Efficient water distribution is critical also because leaving the land without irrigation and idle increases the occurrence of rat infestation, soil degradation, stone wall destruction and erosion. The lack of *lampisa* also disenfranchises the female-headed parcels because women have less time ensuring that enough water is diverted into their parcels. A regular *lampisa,* may also deter the loggers from blocking the water gates and pathways to effect better streamflow.

Provision of institutional support to organic rice farming. Traditionally, *Kankanaey* rice farmers are used to practicing organic rice farming. However, the low soil fertility in rice fields close to the mining sites and irrigated by the river in Fidelisan, where processing of gold ore is being done caused many farmers to resort to greater use of inorganic fertilizer that through time further degrades the soil. According to them, producing organic fertilizers such as composted wild sunflower plants normally found within the communities take a long time, as well as being more laborious. A welcome development, however, is that the Tebtebba (Indigenous Peoples International Center for Policy Research and Education, Inc) and PITO are currently working on the use of indigenous microorganisms (IMO) and manual shredder to decrease the period of decomposition of organic matter. The use of this technology should be promoted among the rice farmers through a series of technical training. It is also highly possible that production of organic fertilizer and pesticides can be institutionalized by assigning certain farmer groups to take charge of their production for sale to or exchange with other farmers. The use of traditional soil management practices such as planting of nitrogen-fixing plants like beans and peanuts on the fields should also be employed.

ACKNOWLEDGEMENT

The authors would like to acknowledge the financial support from the UPLB Gender Center and the Association of Fellows, Scholars, Trainees and Residents of International Rice Research Institute (AFSTRI). The logistical support and the data provided by the NCIP are highly appreciated along with the full cooperation of the farmer-respondents and the *Kankanaey* community.

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