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PROFITABILITY OF ORGANIC VERSUS CONVENTIONAL RICE PRODUCTION: AN EVIDENCE FROM SOUTH ASIA

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ABSTRACT

Rice, a staple and cash crop in South Asia, is vital for small-scale farmers, but concerns about the profitability of organic farming challenge its adoption despite its environmental benefits. The present study was conducted in the Rice-Wheat zone of three South Asian countries to make a comparison of profit efficiency in rice production under organic and conventional farming systems and to examine factors affecting profit efficiency. A multistage sampling technique was employed to collect cross-sectional data. Profit efficiency was determined by employing Cobb Douglas's functional form of stochastic profit frontier. Results show that the mean profit efficiency of organic rice growers is 0.89 less than conventional rice growers (0.910) in Pakistan. The mean profit efficiencies of organic growers are higher than conventional growers in Nepal and Bangladesh. Education and the role of the extension department are important factors in increasing the efficiency of organic and conventional farming while access to credit and experience in rice farming are significant in reducing inefficiencies in conventional rice farming. The study concludes that the education of farmers, the role of extension services, and easy credit access are key policy variables to improve profit efficiency.

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INTRODUCTION

Crop production is facing a multitude of challenges in the developing countries. Loss of biodiversity and soil fertility, water pollution, and rising health risks associated with chemicals have become huge challenges to the farming community (Pimentel 1996; Badgley et al., 2007; Singh, 2000; Schrama et al., 2018), particularly in Asia. Dependency on chemicals (fertilizers and pesticides) for increasing crop productivity has resulted in a decline in crop productivity over time in South Asia where small farms dominate. This is evident from the fact that the productivity of one kg of nitrogenous fertilizer has significantly declined from 20 kg to 8-10 kg of grains (Hossain et al., 2007), implying that the chemicals have caused long-term damage to crop production. Further, the intensive use of chemicals has led to mono-cropping systems in South Asia at the expense of loss of biodiversity. In addition to the higher use of chemicals, reduced soil fertility, and loss of biodiversity, the cost of production of high-yielding varieties decreases economic benefits to the farmers. Small farmers are highly vulnerable to these outcomes.

Organic agriculture is an alternative to conventional agriculture with a complete management system enhancing agro-ecosystem health by improving agro-diversity, soil biological activities, and other natural cycles (FAO, 2002). It is mainly the application of different agricultural practices by taking into account locally adapted systems and regional conditions. This production system combines innovation, tradition, and scientific information to benefit the environment with a promise of quality life for farmers and others associated with it. Farm resources, organic inputs, and biodiversity-based cropping patterns are employed in organic agriculture (IFOAM, 2005). So, organic agriculture is based on environment-friendly methods in the process of production, handling, processing, and packaging, resulting in the smooth functioning of the whole agriculture system (Pretty, 1995). However, there are concerns about whether organic agriculture is capable of meeting the feed requirement of the world in the absence of synthetic chemicals (De Ponti et al., 2012). Yield gaps between organic farming and conventional farming exist and these gaps are due to local conditions, characteristics of agriculture systems, and the management capacity of the farmers (Seufert et al., 2012; De Ponti et al., 2012). Similarly, Forster et al. (2013) argue that the productivity of organic crops is low but gross margins are higher due to low production costs compared to conventional crops. While considering the sustainability of the agriculture system, organic agriculture becomes more economically viable in the long run compared to conventional agriculture. Organic agriculture is also an effective strategy to mitigate the impacts of changing climate by building resilient soils that can perform better in extreme conditions (FAO, 2008; Scialabba and Müller-Lindenlauf, 2010).

Low productivity in organic agriculture can lead to low adoption as farmers are interested in maximizing profit. Rising demand for organic products in Europe and North America has resulted in an increase in the price of organic products. Availability of premium prices for organic products is the leading force for ever-increasing adoption of organic agriculture (Sheeder and Lynne, 2011; Musshoff and Hirschauer, 2008) in the world generally and Asia particularly. Considering South Asia, organic agriculture constitutes a very small percentage of total arable land, for example share of organic agriculture in total arable land is only 0.28% in India and 0.75% in Sri Lanka. The same is the case with other countries. Having a small percentage share of total arable land, we find that very little information is available on the productivity and profitability of organic farming (Charyulu and Biswas, 2010). In the present study, we estimate the profit efficiency of organic rice production in South Asian countries namely Pakistan, Bangladesh, and Nepal. We also compare the profit efficiency of organic rice production with conventional rice production. Rice is considered the cash and staple food crop in South Asia. All three countries considered in the study are important rice-producing countries with dominant small-scale organic and conventional farming systems. Thus, these countries seem important for our study site. The findings of the study are useful for policymakers to increase acreage under organic rice production.

The remaining research article has been arranged as follows. The next section describes materials and methods. Results and discussion are provided in the third section followed by conclusions and references.

METHODOLOGY

Analytical framework

Farmers choose a particular type of farming system with the aim of increasing profit. This decision leads to efficiency in resource usage. We employed a stochastic profit efficiency approach to examine whether farmers are getting profit efficiency in organic and conventional rice production. Profit efficiency is the combination of technical and allocative efficiencies. Technical efficiency is the firm or farm's ability to get a set level of output by using a minimum input bundle, while, allocative efficiency shows the firm or farm's ability to use the input mix in optimum proportions by taking into account prices of inputs and output and the production technology (Fried et al., 2008). To be technically efficient, profit maximizing firm produces maximum output from a given set of inputs and to be allocative efficient it uses the optimum mix of inputs and produces the right mix of outputs by keeping in view output and input prices (Kumbhaker and Lovell, 2000). Theory of production entails that farmers in their decisions prefer to maximize profit and choose different combinations of inputs and outputs. The profit function is thus basically the production decision based on the quantity of inputs and outputs and their respective prices (Sadoulet and Janvry, 1995).

If the technology is homogenous to all farms, the general form of stochastic profit frontier for jth farm is:

$$\Pi_j = f\left(P_{ij}.X_{kj}.D_{nj}\right).\exp(\varepsilon_j) \quad (1)$$

Where, Π_j denotes the normalized profit of *jth* farm measured by dividing the profit by farm specific price of output, P_{ij} refers to the normalized price of *ith* variable input estimated by dividing the input price by the output price, X_{kj} are the fixed factors, D_{nj} are the dummies representing the environmental factors, ε_j is the error term. It can be written as:

$$\varepsilon_j = \nu_j - \upsilon_j \quad (2)$$

ν_j is normally distributed $N(0,\sigma^2_v)$ two-sided error term associated with stochastic effects that are beyond the farmer's control, while, υ_j is associated with inefficiency effects and non-negative ($\upsilon_j \geq 0$). If $\upsilon_j = 0$, the farm is operating on frontier gaining maximum profit but if $\upsilon_j > 0$, the farm is experiencing inefficiencies and profit loss. The factors affecting inefficiency can be modeled as:

$$\upsilon_i = \omega_i\delta + \varsigma_i \quad (3)$$

Where, ω_i denotes the household characteristics and farmers managerial abilities that affect the level of efficiency of ith farm, δ is the parameter, while ς_i is the normally distributed error term as: $\varsigma_i \sim N(0,\sigma_\varsigma^2)$.

The equation for profit efficiency of *jth* farm can be written as:

$$EEF_j = E\,[\exp(-\upsilon_j)\,/\varepsilon_j] \quad (4)$$

Where, EEF_j is the profit efficiency of jth farm ranging from 0 to 1, while E shows the expectation operator. Equation 1 was estimated by the maximum likelihood method to estimate the industry's best-practice profit.

The likelihood function is:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \quad (5)$$

$$\gamma = \sigma_u^2 / \sigma^2 \quad (6)$$

σ^2 represents the total variation due to random shocks σ_v^2 and profit inefficiency σ_u^2. The value of γ lies between 0 and 1.

The Study Area

The study was carried out in the rice-wheat zone of South Asia which is called the bread basket of the region. It comprised of 13.5 million hectares of India, Pakistan, Bangladesh, and Nepal (Arshad and Ahmad, 2011). The study was confined to Nepal, Pakistan and Bangladesh. Data from India could not be collected due to the political situation between India and Pakistan. Sample farmers were selected through a multistage sampling technique. In the first stage, three districts were selected from rice-wheat zone of each country with the priority of the presence of organic farms. Districts Sheikhupura, Nankana Sahib and Gujranwala from Pakistan, districts Kathmandu, Bhaktapur, Lalitpur from Nepal, and districts Dhaka, Natore and Comilla from Bangladesh were selected for data collection. Secondly, fifty farmers were selected randomly from each district comprising of twenty-five conventional and twenty-five organic farmers. Only those organic farmers were selected who had completed three years of conversion period successfully from conventional to organic. This was the main reason for the low sample size from each district. These farmers were certified through the Participatory Guarantee System (PGS) well recognized by the International Federation of Organic Agriculture Movements (IFOAM). PGS is a locally adopted quality assurance system to certify organic products (IFOAM, 2017). The total sample size was 450 farmers comprising of 150 farmers (75 organic and 75 conventional) from each country. Data regarding inputs, output and socioeconomic characteristics of farmers was collected through a comprehensive questionnaire. The interviews were taken in the local language.

Empirical model

Literature shows many functional forms to estimate the production and profit efficiencies but Cobb Douglas is the most popular and widely used method to measure the efficiencies (Dawson and Lingard, 1991; Kalirajan and Obwona, 1994; Battese and Hassan, 1999). So, the study used Cobb Douglas model.

$$ln\Pi_j = \beta_o + \beta_1 lnP_{1J} + \beta_2 lnP_{2j} + \beta_3 lnP_{3j} + \beta_4 lnP_{4J} + \beta_5 lnZ_{1j} + \beta_6 D_{1j} + \beta_7 D_{2j} + (\nu_j - \upsilon_j) \quad (7)$$

Π_j is the normalized profit of ith farm computed by dividing profit with ith farm price of output (P_y), ln is the natural log, P_i are the normalized prices of variable inputs taken by dividing input prices by output price and it ranges from 1 to 4. P_1 is the normalized price of land preparation. P_2 is the normalized price of inputs (seed, composts/fertilizers, pesticides). P_3 is the normalized price of irrigation, while, P_4 shows the normalized price of labour employed at the farm. Z_k represents the fixed inputs and Z_1 is the capital utilized on farm j that includes light machinery and hand tools. D_q are the environmental factors that affect the efficiency.

D_1 is the dummy for soil fertility (if yes = 1 otherwise = 0) and D_2 is the dummy for pest breakout (if yes = 1 otherwise = 0). β's are the parameters. Error terms v_j and u_j have already been defined.

Inefficiency Model

Due to different socioeconomic factors and managerial abilities, it has been assumed that all farmers cannot produce on the frontier. It gives logic to the development of the inefficiency effects model to determine the factors responsible for the inefficiency. So, the socio-economic variables including rice growing experience of the farmers, education of farmers, experience, off-farm employment, access to credit, links with extension department and area are considered in the model.

The model can be written as:

$$\upsilon_j = \delta_0 + \sum_{d=1}^{6} \delta\, \omega_d + \varsigma_j \qquad (8)$$

υ_j are the inefficiency effects associated with the characteristics of the farmers. ς_j is the truncated random variable and δ_0 is the constant. ω_d are the variables that explain inefficiency effects.

RESULTS AND DISCUSSION

Summary Statistics

The socioeconomic characteristics of conventional and organic farmers are given in Table 1. The age of the household head for conventional and organic farmers is approximately the same in Pakistan.

The age of household head for conventional farmers in Nepal is higher than organic farmers. In Bangladesh, the age of organic farmers is 51 years and 49 years for conventional farmers.

The education of the household head plays an important role in the adoption of new technology. Results show that the education of conventional farmers in a number of schooling years is lower than organic farmers in all countries. The mean schooling years of organic farmers are 6, 5, and 5 years compared to 5, 3, and 4 years of conventional farmers in Pakistan, Nepal and Bangladesh, respectively. The experience of conventional and organic farmers in the study areas is almost the same.

Credit access and the role of extension services are quite important to make availability of on-time funding to purchase inputs and advice for good agricultural practices. The data shows conventional growers have less access to credit than organic growers in Pakistan and Nepal while in Bangladesh, conventional growers (42%) have better access to credit than organic growers (30%). Organic farmers in the study areas are found to have better linkages with extension services as compared to conventional farmers. This is due to the fact that organic farmers are regularly seeking advice from cooperatives, NGOs, and other farmer's organizations involved in the promotion of organic farming.

The analysis shows that the average landholding for organic growers in all countries is relatively less than the conventional growers. Organic matter contributes to increasing the water-holding capacity of soil to save irrigation costs. In Pakistan, organic farmers experience less cost of irrigation as compared to conventional farmers, while, Nepali and Bangladeshi farmers do not bear any cost of irrigation due to rainfed agriculture and Aman rice crop, respectively. Aman rice crop is cultivated in the Monsoon season in Bangladesh and totally depends on rain. In all countries under study, the cost of other inputs is higher for conventional farming as compared to organic farming. This is mainly due to the dependence of organic farmers on on-farm resources as they do not need to spend on chemical inputs. Organic farmers receive higher prices than conventional farmers for their organic produce. Conventional farmers receive more gross margin per acre in Pakistan (358.94 USD) compared to organic farming (340.31 USD). However, farmers engaged in organic farming in Nepal and Bangladesh receive a higher gross margin per acre than conventional farmers.

Table 1. Summary statistics.

Characteristics	Pakistan		Nepal		Bangladesh	
	Org	Con	Org	Con	Org	Con
Age (Years)	45.76	44.93	43.4	45.82	51.23	49.36
Education (Schooling Years)	5.84	4.77	4.66	3.05	4.97	4.02
Experience (Years)	23.70	24.09	20.29	18.41	24.09	26.40
Credit Access (%age)	52	46	40	34	30	42
Linkages with extension Services (%age)	72	52	54	37	53	36
Landholding (Acres)	5.32	6.05	1.56	1.63	1.73	1.86
Rice area (acres)	3.57	4.03	0.89	0.92	1.45	1.39
Land preparation (USD/acre)	36.63 (3608)	34.66 (3414)	44.72 (3908)	50.05 (4374)	41.01 (3191)	37.12 (2888)
Irrigation (USD/acre)	65.73 (6473)	79.46 (7826)	0	0	0	0
Labour (USD/acre)	41.40 (4078)	38.86 (3827)	48.83 (4267)	49.28 (4307)	51.39 (3999)	53.09 (4131)
Other inputs (USD/acre)	46.36 (4566)	73.69 (7257)	40.77 (3563)	44.91 (3924)	70.18 (5460)	79.93 (6219)
Yield (Kgs/acre)	1505.2	1686.8	1411.6	1380	1686	1691.2
Rice price (USD/Kg)	0.35 (34.7)	0.34 (34.2)	0.22 (19.42)	0.21 (18.95)	0.21 (16.85)	0.19 (15.95)
Gross Revenue (USD/acre)	530.43 (52242)	585.61 (57677)	313.72 (27417)	299.1 (26140)	365.16 (28409)	346.63 (26968)
Gross margin (USD/acre)	340.31 (33518)	358.94 (35352)	179.40 (15678)	154.88 (13535)	193.87 (15085)	176.46 (13731)
N	75		75		75	

Note: Figures in the parenthesis are the values in PKR for Pakistan, Taka for Bangladesh and NR for Nepal. Dollar Rates used in the study: 1USD= 98.49 PKR, 87.39 NPR, 77.80 BDT.

Tests of Hypotheses

Various restrictions in the model are tested by using Log Likelihood (LL) test statistics. In this regard, the first null hypothesis that all farms are efficient (operating on the frontier) and do not experience inefficiencies, is tested against the alternative. The second null hypothesis that variables in the inefficiency model do not affect the efficiency is tested against the alternative. The LL statistics is as under:

$$LL = -2\{log[LL(H_0)] - \log[LL(H_1)]\} \quad (9)$$

Where, $LL(H_0)$ is null hypothesis while (LL_R) represents restricted likelihood, while $LL(H_1)$ is the value for an alternative hypothesis that shows unrestricted likelihood (LL_U), while LL is the absolute value between LL_R and LL_U. Kodde and Palm's (1986) table is used for critical values to decide about the acceptance or rejection of hypotheses. The results show that all farmers are not efficient showing the presence of inefficiency and socioeconomic factors in the inefficiency model significantly affect the profit efficiency (Appendix A).

Frontier Profit Function

Table 2 shows the estimates of the stochastic frontier profit function. The first column shows the independent variables regressed against the dependent variable, the profit gained from rice output. The second, third and fourth columns show the results about Pakistan, Nepal and Bangladesh, respectively, subdivided further into sub-columns for organic and conventional farmers. The maximum likelihood (ML) estimates of Cobb Douglas model can be explained as elasticities of inputs.

The results of land preparation for organic rice in Pakistan, Nepal, and Bangladesh, are significant at 10, 1 and 5 percent level, respectively. The negative signs indicate that organic farmers are spending more than the requirement on land preparation in these countries. Bakhsh (2007) registered the same results about land preparation. The results were non-significant for conventional rice farmers in Pakistan and Nepal but significant at a 1 percent confidence level for Bangladesh conventional rice farmers.

The optimum quantities of other inputs (seed, composts/ fertilizers and bio-pesticides/pesticides) are important for farm efficiency. The results of other inputs are significant at 1 percent level for conventional rice farmers in all countries under study. The negative signs of the coefficients in this regard show that conventional farmers are overusing these inputs. Shaheen et al. (2017) and Abedullah et al. (2007) registered the same type of results about fertilizers. The results are also in line with Rahman (2003). The results for other inputs are non-significant for organic rice farmers in all countries.

The result of irrigation is significant at 10 percent level for Pakistani conventional rice farmers. The negative sign describes that irrigation minimizes profit. The prices of irrigation are ignored in the analysis for Nepal and Bangladesh because of rainfed agriculture in Nepal and the Aman rice crop in Bangladesh. Organic farming is considered more labour-intensive as compared to conventional as organic farmers mostly depend on labour-oriented activities like composting, mulching and hoeing etc. In case of Pakistan, the estimated coefficients of labor are significant at a 5 percent level of confidence for both farming systems. The negative signs of coefficients indicate that farmers are over-employing the labour that in turn lowers the profit. Vasanthi et al. (2017), Hyuha (2006) and Ali and Flinn (1989) had the same results. For Nepali organic farmers, the result for labour is positive with 10 percent significance level indicating that farmers can increase profit by employing more labour. The coefficients of labour are non-significant for Bangladeshi organic and conventional rice farmers.

The fixed capital is considered important for farm efficiency. The coefficients are significant for both farming systems in all countries. The positive signs of coefficients imply that farmers need to employ more capital to increase farm efficiencies. Koirala et al. (2016) registered the same type of results.

Table 2. Estimates of frontier profit function.

Variables	Pakistan		Nepal		Bangladesh	
	Org	Con	Org	Con	Org	Con
Constant	5.074*	6.816*	1.978***	2.160**	6.328*	8.691*
	(0.878)	(0.530)	(1.140)	(0.966)	(0.913)	(1.201)
lnP_1	-0.26***	0.051 ns	-1.047*	0.167 ns	-0.304**	-0.421*
	(0.186)	(0.059)	(0.278)	(0.181)	(0.128)	(0.082)
lnP_2	0.032 ns	-0.223*	-0.166 ns	-0.496*	-0.095 ns	-1.074*
	(0.047)	(0.074)	(0.249)	(0.192)	(0.116)	(0.307)
lnP_3	-0.013 ns	-0.18***				
	(0.196)	(0.130)				
lnP_4	-0.376**	-0.306**	0.403***	-0.079 ns	0.075 ns	0.145 ns
	(0.189)	(0.139)	(0.272)	(0.093)	(0.158)	(0.293)
lnZ_1	0.413*	0.180*	1.148*	0.809*	0.293*	0.351*
	(0.112)	(0.053)	(0.173)	(0.134)	(0.093)	(0.088)
D_1	0.024 ns	0.013 ns	0.240*	0.055***	0.045***	0.216*
	(0.024)	(0.024)	(0.036)	(0.032)	(0.029)	(0.014)
D_2	-0.093*	-0.053**	-0.316*	-0.093**	-0.05***	-0.001 ns
	(0.024)	(0.022)	(0.053)	(0.039)	(0.038)	(0.088)
Sigma Square	0.048*	0.002*	0.224*	0.219*	0.003*	0.055*
	(0.009)	(0.0003)	(0.058)	(0.050)	(0.001)	(0.008)
Gamma	0.986*	0.990*	0.956*	0.991*	0.999*	0.910*
	(0.009)	(0.026)	(0.019)	(0.005)	(0.054)	(0.116)
Log likelihood	90.107	133.248	29.173	53.937	110.299	29.374
Mean profit efficiency	0.892	0.910	0.874	0.857	0.748	0.657

Note: *, ** and *** shows the significance level at 1, 5 and 10 percent, respectively and ns means non-significant while standard errors are placed in the parentheses.

The results of dummy variables for soil fertility and pest breakouts show that soil fertility increases the profit and on the other hand pest breakout coefficients with negative signs show that it contributes to challenge the profit of the organic and conventional farmers. The results indicate that coefficients of soil fertility are significant at 1 and 10 percent for Nepali organic and conventional farmers, respectively and significant at 10 and 1 percent for Bangladeshi organic and conventional farmers, respectively. Hyuha (2006) and Rahman (2003) also registered the same type of results about soil fertility. The coefficients of soil fertility are not significant for Pakistani farmers. Pest breakouts directly affect farm efficiency by damaging crops and increasing the cost of production incurred by the management of pests. The coefficients of pest breakouts are significant at 1 and 5 percent level for organic and conventional growers, respectively in Pakistan and Nepal. It is significant at 10 percent level for Bangladeshi organic farmers. The negative signs of coefficients imply that pest breakouts contribute to lower profit significantly.

The values of variance parameters confirm that farms operate at different levels of frontier. The mean efficiency of conventional growers is better than organic growers in Pakistan. The mean efficiency score of conventional farmers is 0.91 as compared to the efficiency score of organic farmers (0.89). This minor difference is due to the better yield in conventional agriculture. Nepali and Bangladeshi organic farmers are better off as they have better efficiency scores than conventional farmers. The results are encouraging for organic farmers and can be the reason for more areas under organic production in the near future.

Determinants of farm-specific profit Inefficiency

The equation 8 is used to estimate the determinants of profit inefficiency. The dependent variable is inefficiency and explanatory variables include education, rice farming experience, rice crop area in acres, access to credit, links with the extension department, and off-farm employment. Table 3 shows the findings of the inefficiency models used in the study. Education increases farm efficiency by enhancing the management capacity of the farmers and the adoption of new technology. Negative and significant signs of coefficients of education variable in all three countries show that education is an important variable to improve profit efficiency. Koirala et al. (2016), Khai and Yabe (2011) and Yasin et al. (2014) reported the same results for education.

By increasing the proficiency in farming, rice farming experience is supposed to increase the efficiency but it is also considered the proxy of the age and older farmers are more strict in their practices and do not adopt new technology easily. The negative and significant coefficient of conventional rice in Pakistan implies that experience is contributing to increasing profit efficiency. The results indicate that experience is negatively affecting the profit inefficiencies in Nepal. In Bangladesh, rice farming experience is significantly contributing to lower profit inefficiencies for organic rice farming. Boubacar et al. (2016), Khai and Yabe (2011), Rahman (2003) and Ali and Byerlee (1991) registered similar results.

Timely availability of funds is important to the purchase and application of farm inputs. Access to credit in this regard, is a valuable source needed for farm practices. The results indicate that coefficients of credit access are significant for conventional rice farming in all countries while these are non-significant for organic rice farming. It confirms the self-sufficiency of organic farming that relies upon on-farm resources and does not require the purchase of external inputs. Results imply that access to credit is important in conventional farming to increase profit efficiency. Shaheen et al. (2017), Ali and Flinn (1989) and Hassan and Ahmad (2005) reported the negative impact of access to credit on farm inefficiencies.

Linkages with extension services enhance the managerial abilities of farmers and enable farmers to utilize resources efficiently. The results imply that links with extension services are important to increase the efficiency of organic farming in Pakistan, Nepal, and Bangladesh, as better management skills are needed to maintain organic systems. The coefficients for Nepali and Bangladeshi conventional growers are also significant with negative signs indicating the reduction in farm inefficiencies with linkages with extension services. Similar results have been reported by Shaheen et al. (2017) and Rahman (2003).

Off-farm employment is an extra source of income. It can provide more funds for the timely purchase of inputs. On the other hand, it can be the reason for farm inefficiencies by utilizing considerable time of farmers. The estimated coefficient is statistically significant for conventional rice in Bangladesh. It is non-significant for organic and conventional farming in Pakistan and Nepal and for organic rice farming in Bangladesh.

Table 3. Determinants of farm specific profit inefficiency.

Variables	Pakistan		Nepal		Bangladesh	
	Org	Con	Org	Con	Org	Con
Constant	0.254 ns (0.256)	0.502* (0.063)	1.196*** (0.629)	2.199* (0.571)	0.799* (0.075)	0.817* (0.317)
Education	-0.085* (0.025)	-0.006*** (0.003)	-0.160* (0.062)	-0.112** (0.052)	-0.009* (0.003)	-0.047* (0.007)
Rice farming experience	-0.002 ns (0.010)	-0.006* (0.001)	-0.04*** (0.022)	-0.038* (0.015)	-0.003* (0.001)	0.00029 ns (0.003)
Access to Credit	-0.044 ns (0.231)	-0.055** (0.027)	-0.282 ns (0.291)	-0.631** (0.418)	-0.016 ns (0.022)	-0.146* (0.045)
Links with extension Department	-0.81*** (0.564)	-0.041 ns (0.035)	-1.934** (0.817)	-0.546 *** (0.426)	-0.034*** (0.021)	-0.104*** (0.054)
Off-farm employment	0.0001 ns (0.155)	0.018 ns (0.019)	-0.093 ns (0.246)	0.263 ns (0.352)	0.043 ns (0.039)	0.141* (0.050)
Area	-0.012 ns (0.034)	-0.019*** (0.012)	-0.012 ns (0.508)	-2.120* (0.403)	-0.265* (0.033)	-0.057*** (0.032)

Note: *, ** and *** shows the significance level at 1, 5 and 10 percent, respectively and ns means non-significant while standard errors are placed in the parentheses.

The coefficient of area under rice crops is non-significant for organic growers in Pakistan and Nepal but significant for conventional rice farming in these countries. It is significant for organic and conventional rice farming in Bangladesh. The negative signs of the coefficients indicate that the efficiency of the farms increases with an increase in rice area. This result is in full agreement with Chang et al. (2017), Koirala et al. (2016), Kaur et al. (2010), and Abdulai and Huffman (2000).

Profit loss in rice production and key policy variables

This section explains the role of key policy variables in farm inefficiency in the form of profit loss. So, education of the household head, linkages with extension services, and credit access are considered for analysis. The variables like area under rice crop, off-farm income, and experience of the household head cannot be affected by direct policy interventions that's why ignored in the analysis.

Profit loss is the amount of profit lost due to inefficiencies at given input and output prices and fixed farm resources. It can be computed by multiplying the maximum possible profit by a term (1–PE), where, PE is the farm-specific profit efficiency. Maximum profit per acre is equal to farm-specific actual profit per acre divided by its efficiency score (Rahman, 2003). The results are presented in Table 4.

Farmers are divided into two categories to assess the difference between profit loss of farmers with education primary or above and farmers with education less than primary, farmers with and without access to credit, and farmers with and without linkages with extension services. Significant difference is found between the profit loss of farmers with education primary or above and farmers with education less than primary for both farming systems in all countries. This shows the importance of education in these countries where minor differences in education can contribute significantly to improving the efficiency of the farmers.

A significant difference in profit is observed between farmers who have access to credit and those with no access to credit for both farming systems in Pakistan and Bangladesh. Similarly, farmers who are seeking advice from extension services are getting more profit than the other farmers in both farming systems in all countries.

These results clearly indicate that the provision of credit and extension services are effective strategies to improve the profit efficiency in rice farming.

Table 4. Profit loss in rice production.

Selected Policy Variables	Pakistan				Nepal				Bangladesh			
	Org		Con		Org		Con		Org		Con	
	Mean				Mean				Mean			
	N	Profit Loss	N	Profit Loss	N	Profit Loss	N	Profit Loss	N	Profit Loss	N	Profit Loss
Education												
Above Primary	37	1707	32	593.8	26	911.3	20	931.9	30	1784	31	3900
Up to primary	38	5657	43	4904	49	2626	55	1658	45	3013	44	8938
t-ratio		-6.15		-11.9		-2.89		-2.81		-4.74		-10.15
Access to Credit												
Yes	39	1996	35	491.5	30	1760	26	1058	23	2021	32	3710
No	36	5563	40	5317	45	2212	49	1680	52	2742	43	9197
t-ratio		-5.56		-17.7		-0.65		-2.26		-2.21		-12.76
Linkages with extension services												
Yes	54	942.3	39	746.3	41	1065	28	802.3	40	1887	27	5748
No	21	4784	36	5577	34	3197	47	1859	35	3245	48	7478
t-ratio		-8.38		-17.7		-2.59		-4.13		-5.40		-2.09

Source: Survey data.

CONCLUSIONS AND RECOMMENDATIONS

Agriculture is the mainstay of South Asian countries where most of the farmers are small landholders. The profitability of the agriculture system is important for poverty alleviation in these countries. The present study focuses on comparing the profitability of organic rice farming with conventional rice farming by measuring the profit efficiency. Being both a cash and staple food crop, rice is an important cereal of the region occupying significant acreage in South Asia and central to meal patterns. The study concludes that conventional growers are more profit-efficient than organic farmers but the difference in efficiencies is very minute and organic farmers can improve efficiency with better management practices. In Nepal and Bangladesh, organic farmers are better off than conventional farmers with better efficiency scores concluding organic farming can occupy more acreage in these countries.

The study concludes that farmers in both farming systems do not use the optimum quantity of variable inputs which has always been a challenge for the farmers. It contributes to lowering the profit efficiency. So, it is suggested that judicious use of farm inputs by both organic and conventional farmers can improve farm efficiency. The role of extension services is important in this regard. Organic farmers in these countries employ more labor than conventional farmers in different farm practices. Proper and timely utilization of labor and use of plant protection measures are important to improve efficiency, especially for organic farmers.

The study concludes that profit inefficiency can be decreased by improving the education of the farmers and increasing farmers' access to credit and extension services. The role of extension departments is important to train farmers and diffusion of the latest technologies. Increasing education facilities in rural areas of these countries will capacitate farmers for better utilization of resources. Today, agriculture starts with a capital, so policies should be devised to provide quick, easy, and adequate credit.

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Appendix A. Hypotheses testing.

Hypotheses	Likelihood Values	Pakistan		Nepal		Bangladesh	
		Org	Con	Org	Con	Org	Con
$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_d = 0, \nabla_d$ Each farm is operating on profit frontier	LL_U	89.99	132.97	29.07	54.11	109.73	2.81
	LL_R	68.01	95.01	9.04	10.43	76.69	-12.29
	LL	43.96	77.06	41.10	87.31	64.88	31.29
	C.V	14.86	14.86	14.86	14.86	14.86	14.86
	Decision	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection o H_0
$H_0: \delta_0 = \delta_1 = \delta_2 = \delta_d = 0, \nabla_d$ Variables in the inefficiency model have no effect	LL_U	89.99	132.97	29.07	54.11	109.73	2.81
	LL_R	51.97	95.01	0.23	-15.02	75.13	-15.03
	LL	76.12	77.17	58.03	138.09	71.01	34.80
	C.V	13.40	13.40	13.40	13.40	13.40	13.40
	Decision	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection of H_0	Rejection o H_0

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