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Paddy rice farming practices and profitability in northwest Cambodia

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Abstract

Rice (*Oryza sativa* L.) is a staple food and major crop in Cambodia. Improving rice cropping practices and production systems are required to enable a sustainable increase in rice profitability. Granular fertilizers are typically applied but often above the recommended application rate. There are increasing economic and environmental costs of this input-dependent approach without reference to yield responses. This study aims to estimate rice farming profitability and identify factors correlated with, and influencing rice production in Battambang province in northwest Cambodia. Data were collected in a survey of 135 rice growers in Thmakoul, Banan, Sankae and Battambang districts. Individual farm land area ranged from 0.50 to 12 ha. Sixteen rice varieties were grown across the study area and choice of variety was district-dependent. Seed broadcasting was the predominant sowing method, about 96%. Hand broadcasting is the predominant seeding method in northwest Cambodia and transplanting is largely confined to seed production and smaller scale farms. Average rice yield was 2.48 ± 0.08 tonnes per ha. Average direct cost was US$309.65 ± 4.59 per ha and gross margins of 513.29 ± 26.42 per ha can be obtained. Managing fertilizer application (i.e. types and amount), weeds, pests, diseases and water supply were the main factors influencing the profitability of rice farming in northwest Cambodia.

Keywords: Battambang, constraint, profit, rice farming, rice yield.

Introduction

Rice (*Oryza sativa* L.) is the most important crop in Cambodia and is the staple food for Cambodians. Battambang, a province, located in the northwest of the country, is known as the "Rice Bowl" of Cambodia. The rice cultivated area increased from 100,000 ha in 1988 to 300,000 ha in 2010 (26 % of the total land area). Since fertile soil covers most of the land area of the province, it supports a very strong agricultural sector (SCW, 2006). Rice is mainly cultivated during the wet season; in the 2010 rainy season 269,498 ha of rice growing areas produced 756,458 tonnes of paddy. This is 11.27% of the total rice growing areas in Cambodia and accounts for 11.55% of the country's rice production (MAFF, 2011).

However, rice farming practices are applied traditionally, yield has increased from year to year due to more availability of inputs (e.g. fertilizers). Fertilizers and irrigation are potential inputs for intensification of rice production in this country (Yu and Fan 2011). Granular fertilizers have been typically applied and often used above the recommended dose rate, with increasing economic and environmental costs of this input-dependent approach without tailoring fertiliser application to expected yields. Dalgliesh et al., 2016) have explored options to tailor cropping strategies and inputs to the potential yield under specific seasonal conditions in southwest Cambodia. Improving rice cropping practices and production systems have also been suggested for rice production improvement (Kassam et al., 2011). This study aims to estimate rice farming profitability and correlated factors influencing rice production in Battambang.

Methods

Study areas and data collection

One hundred thirty-five (135) rice growers were randomly selected from Sangkae (19), Banan (20), Thmakoul (20) and Battambang (76) districts of Battambang province, located in the northwest of the country (Fig. 1). Farmers were interviewed to collect data on rice farming practices, direct cost and yield per ha by using structured interviews. The interviews were conducted in March 2011 and the data related to rice production in the rainy season of 2010. Monthly climate

characteristics such as rainfall, temperature, evaporation and wind speed in 2010 are presented in Table 1.

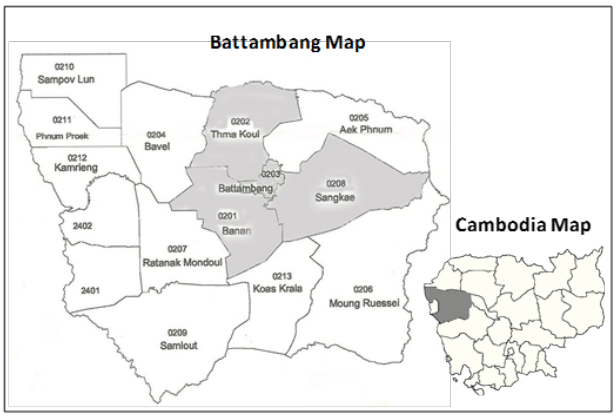

Fig.1: Map of study areas indicated as grey highlight.

Tab.1: Annual variability of climate characteristics: monthly total rainfall, temperature, wind speed and humidity in 2010.

Month	Rainfall (mm)	Evaporation (mm/d)	Max. temp (°C)	Min. temp (°C)	Wind speed (m/s)	Humidity (%)
Jan	2.77	3.93	32.20	22.38	2.48	68.71
Feb	4.00	3.80	35.30	24.91	2.50	68.32
Mar	8.40	4.21	35.66	25.15	2.61	59.39
Apr	9.99	4.30	37.09	26.95	2.77	68.53
May	7.73	4.31	36.32	27.24	3.94	71.03
Jun	7.13	4.43	34.28	26.34	3.10	77.60
Jul	12.10	4.41	33.12	25.57	3.35	80.81
Aug	10.83	4.61	32.30	25.42	3.45	83.10
Sep	10.17	4.48	31.90	25.53	2.48	84.20
Oct	14.78	5.13	30.47	23.75	2.77	84.16
Nov	8.10	4.11	30.60	22.97	2.63	75.83
Dec	0.40	4.03	31.09	21.68	2.30	73.29

Source: Meteorology Station of Veal Bek Chan, Battambang (2010).
Note: Min.: minimum, Max.: maximum, Temp: temperature.

Soil and climate conditions

The soils of the study areas were classified by White *et al*. (1997) as Toul Samrong soil group or Brown Hydromorphic soil group by Crocker (1962) having pH 5.3 (Soil : Water; 1:5), organic carbon 1.24%, total nitrogen 0.084%, available P 83 ppm (Olsen), exchangeable K 1.19 (meq/100 g soil), exchangeable Ca 5.75 (meq/100 g soil), exchangeable Mg 5.00 (meq/100 g soil), exchangeable Na 0.65 (meq/100 g soil), and particle size: 49.75% of clay, 17.10% of fine silt, 9.87% of coarse silt, 20.70% of fine sand, and 2.12% of coarse sand. The soil characteristics are based on the results of soil analyses of top soil to a depth of 20 cm in a rice field at the Research and Training Farm of the University of Battambang in 2006, located in Srah Keo village, Kampong Preah commune, Sankae district, Battambang province (12°59'46" N; 103°19'04" E).

Data analysis

To explore rice varieties and cultivation methods applied in the study areas, a Chi-square test was used for categorical data. To estimated profitability of rice farming per ha, gross margin was calculated by subtracting direct cost per ha from revenue per ha, and the direct cost per ha includes fertilizers, seed, labor, land preparation, irrigation, and threshing. Prices of rice, $335 for fragrant, $255 for mixed and $270 for IRR66/non fragrant (data in December, 2010; CRF 2010). To visualize correlations between all pairwise combinations of rice farming practices and profitability variables, bivariate relationships were analyzed using Pearson's correlation coefficient for numerical variables by performing correlation matrix using scatter plots in the package 'PerformanceAnalytics' (Carl and Peterson 2010). Correlation between gross margin and rice productivity was performed. All statistical analyses were performed using R software of version 3.3.1 (R Core Team, 2016).

Results

Rice cultivation

Land used for rice farming ranged from 0.5 to 12 ha or an average of 3.12 ± 2.24 (SD) ha per household, and rice varieties such as Senpidao, Senkra Ob, Somaly, Phkaromdol, Rang Chey, Neang Leak, Phka Malis, IR-54 and mixed varieties were observed in the study areas. These rice varieties were found to vary significantly in frequency between locations (χ^2 = 157.06, df = 36, P < 0.001; Fig. 2).

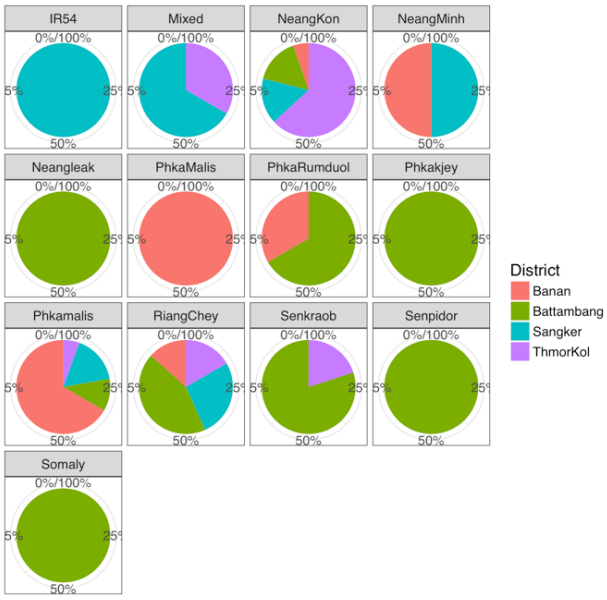

Fig. 2: Proportion of rice varieties cultivated in the study areas.

Broadcast seeding method (96%) was applied by most of the farmers, while a minority used the transplanting method for seed production. Farmers reported that the lack of an adequate labour force and relatively large farm size are the reasons that farmers have chosen the broadcast seeding method. The average seeding rate was 128 ± 42 (SD) kg/ha, with a minimum of 50 kg/ha and a maximum of 200 kg/ha. Famers begin land preparation from late April to June in the rainy season rice, depending on water availability in the rice field. Rainfall is the main water source for paddy rice during the rainy season in this region.

Rice yield ranged from 1.0 to 5.7 tonnes per ha (Fig. 3) and average yield was significantly different between locations ($P < 0.001$). The highest yields were in Thmakoul following by Sangkae, Banan and Battambang districts.

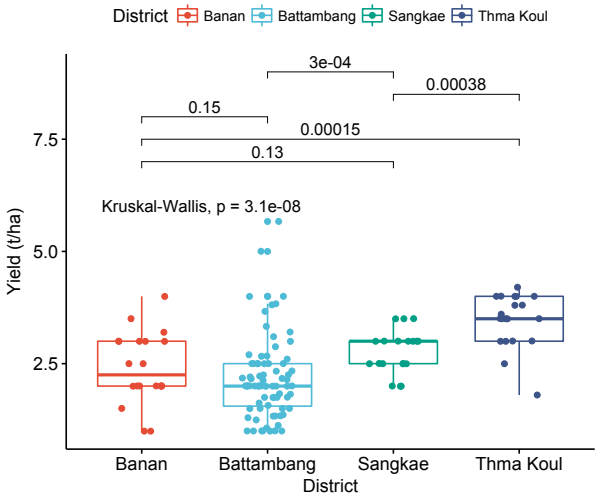

Fig. 3: Boxplot of rice yield for each variety cultivated in Banan, Sangkae, Thma Koul, and Battambang districts of Battambang province.

Rice farming practices and profitability

Fertilizers such as urea and ammonium phosphate (AP) were mainly used as soil applied fertilizers in these areas, whereas di-ammonium phosphate (DAP), 15:15:15 fertilizer, and organic fertilizer were used by the minority (Fig. 4). Amounts of fertilizer combination were frequently less than 200 kg per ha.

Correlations between all pairwise combinations of rice farming practices and profitability variables are given in Fig. 4. Farming experience of rice growers and amount of seed usage were positively correlated with the rice yield, indicating that farmers who had longer experience experienced less constraints than those who hade less experience. Amount of seed usage also increased with rice yield, suggesting that seed quality (e.g. purification, germination) should be improved, because farmers usually used the seeds from previous harvests. However, gross margin was negatively correlated with direct cost or chemical fertilizers used, but it was positively associated with grain yield. The grain yield was the main indicator to estimate gross margin for paddy rice production, in which higher yield was associated with greater profitability. Suprisingly, cultivated area was not significantly correlated with any variables.

Discusion

Cost and profit

The gross margin (US$/ha) ranged from 324.42 to 728.39 and was obtained by fifty percent of the farmers. Rice productivity is a main factor influencing the gross margin. The gross margin of rice farming in Khon Kaen (Thailand) was greater than in Battambang due to higher rice price and yield. This low productivity was relative to lack of access to inputs, e.g. fertilizers and good seed (Yu & Fan, 2011). See comapring the direct costs of rice farming per ha in Khon Kaen and Battambang in Table 2, and profitabilty of rice farming in both provinces in Table 3.

Table 2: Average cost of rice farming in Khon Kaen in 2009 and Battambang in 2010 (unit: US$/ha).

Types of direct cost	*Khon Kaen* [(a)]	*Battambang* [(b)]
Seed	42.40	25.53
Fertilizer	54.60	99.86
Pesticide	30.50	11.85
Labor	335.30	88.75
Land preparation	n.a	52.00
Irrigation	n.a	6.86
Threshing	n.a	24.80
Other	32.40	n.a
Total direct cost	***495.20***	***309.65***

Source: [(a)] Kawasaki and Herath (2011); and [(b)] Survey data in 2011.

Tab. 3: Average profitability of rice farming in Khon Kaen in 2009 and Battambang in 2010.

Items	*Khon Kaen* [(a)]	*Battambang* [(b)] (±SE)
1. Rice yield (t/ha)	3.79	2.48 (±0.08)
2. Rice price (US$/t)	310.00	255.00 – 335.00
3.Total revenue (US$/ha)	1173.66	822.93 (±26.41)
4. Total direct cost (US$/ha)	495.20	309.65 (±4.59)
5. Gross margin: (3. – 4.)	678.46	513.29 (±26.42)
6. Benefit and cost ratio: 5./4.	1.37	1.66

Source: [(a)] Kawasaki and Herath (2011); and [(b)] Survey data in 2011.

Chemical fertilizers and labour were major costs for rice farming in Battambang. Urea and AP were commonly combined for fertilization, with average amounts of 79.10 kg/ha urea and 63.51 kg/ha AP. Fertilizers were applied over a wide range below and above the recommended dose for the Toul Samrong soil group (White *et al*., 1997). However, in Khon Kaen, the

profitability was US$575 per ha in the rainy season or US$811 per ha in the dry season of 2009 (Kawasaki and Herath, 2011), which was more profitable than rice farming in Battambang.

Overall, the broadcast seeding method predominated for 12 varieties in rice farming areas in Battambang, with yield varying depending on varieties and locations. Costs of chemical fertilizers and labor are the main direct cost for rice farming in this region. Profitability could be obtained in US$513.29±26.42 per ha. Fertilizer application (i.e. types and amount), pests, diseases, weed and water supply are considered as the main factors influencing the profitability of rice farming in northwest Cambodia.

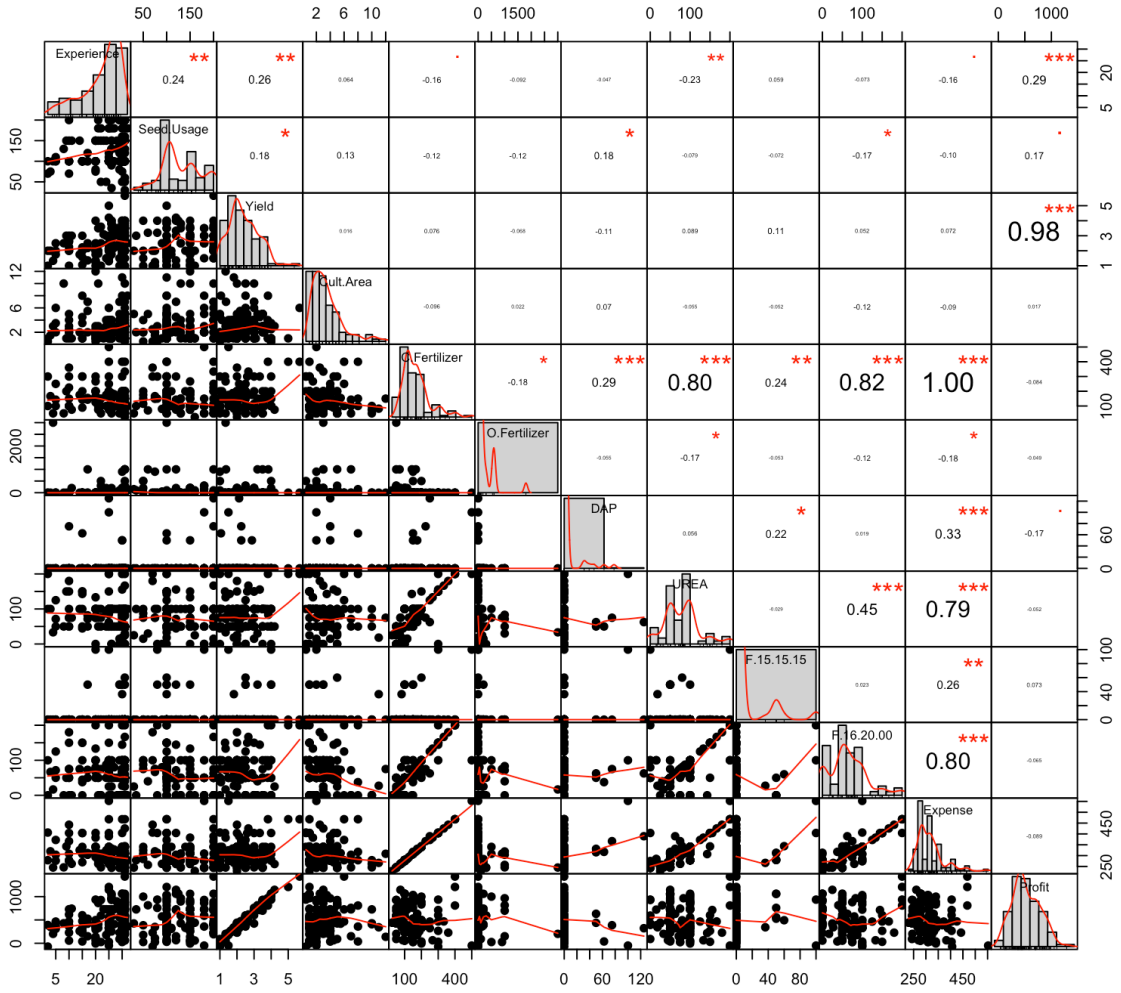

Fig. 4: Plot of correlation matrix for variables of rice farming practices and profitability. Note: ***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$, ˙: $P < 0.1$; C.Fertilizer: chemical fertilizer (kg/ha); Cult_Area: cultivated area (ha); DAP: di-ammonium phosphate (kg/ha); Expense: direct cost per ha (US$); F.15.15.15: 15% N:15% P:15% K fertilizer (kg/ha); F.16.20.00: ammonium phosphate (kg/ha); Experience: experience of rice farming (year); O.Fertilizer: organic fertilizer (kg/ha); Profit: profit per ha (US$); UREA: urea fertilizer (kg/ha); Seed_Usage: amount of rice seed used (kg/ha); and Yield: rice yield (tonne/ha).

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