Research article

Assessment of Economics and Water Productivity of Four Crops Grown after Wet Season Rice under Differing Water Availability Conditions in Northeast Thailand

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Abstract The economic profitability and water use productivity of four crops grown after rice harvest were assessed in two sub-districts, Dong Klang (DK) with limited water availability for irrigation, and Tung Pra (TP) with greater water availability, in Kornsarn District, Chaiyapoom Province, Northeast Thailand. Three households growing dry season rice, soybean, chili and field corn were purposively selected for each crop in each area. Higher crop yields were found in TP than DK for dry season rice, soybean and field corn (5000 vs 5513 kg/ha, 1646 vs 1971 kg/ha, 3633 vs 4563 kg/ha, respectively), while chili yield was higher in DK (14917 vs. 9083 kg/ha). Fertilizer cost was the main cost for dry season rice in both areas (39-42% of total production cost), followed by labor (27-38%), but irrigation cost was higher in DK than TP (21% and 9%). Seed cost was the main cost for soybean production in DK (43%), but combined harvester was highest in TP (41%). Labor for fruit picking was the main cost for chili in both areas (80-81%), and fertilizer was the main cost for field corn (36-53%). Net returns in both areas followed a similar pattern, chili> dry season rice > soybean ≥ field corn (18,838>1,880>827>598 USD/ha in DK; 15,462>1,512>540≈ 585 in TP), with higher net returns in TP due to lower costs. The benefit-cost ratio was highest for dry season rice in both areas; 4.06 and 4.86 in DK and TP, respectively. However, water productivity on a yield basis was lowest for rice in both areas (0.68 and 0.75 kg/m^3 in DK and TP, respectively), and highest for field corn (0.98 and 1.23 kg/m^3 in DK and TP, respectively). Measures to reduce water use for rice, and reduce costs and improve market access of other crops could improve water productivity and farmer income.

Keywords dry season rice, soybean, chili, field corn, benefit-cost ratio, water productivity

INTRODUCTION

Rice is the main economic crop in Northeast Thailand. It contributes one third of the total national rice planted area and production. However, dry season rice production in the northeast region covered only 19% of total dry season rice area and contributed only 13% of dry season rice production nationally in 2011 (Office of Agricultural Economics, 2012). Dry season rice is typically cultivated with water supplied from large or medium scale reservoirs. Lower rainfall during the wet season leaves less water in these reservoirs, leading to low yields, crop failures, and reduced income for farmers. Due to the drought in the 2012 wet season, the Office of Agricultural Economics (2012) has predicted that the harvested area of dry season rice in the Northeast will be reduced by 50%, resulting in 43% lower yield, in contrast with relatively stable dry season production in other regions. In years with low levels water in reservoirs, the Royal Irrigation Department (RID) warns farmers that it may not have sufficient water for late-planted dry season rice. The Department of Agriculture has promoted change to non-rice crops with lower water requirements, but many farmers continue to grow dry season rice. However, the reasons why farmers continue growing dry season rice have not been reported. In this paper, we focus on economic returns and water use productivity of rice compared to the most important non-rice crops as possible key factors in farmer crop choice decision-making. Assessment of these two factors may suggest possible ways to improve the profitability of non-rice crops.

OBJECTIVE

To compare the economics and water use productivity of 4 different crops grown after wet season rice under different water availability conditions.

METHODOLOGY

Four crops (dry season rice, soybean, chili and field corn) grown under irrigation after wet season rice harvesting were assessed based on household surveys in 2 sub-districts, Dongklang (DK) and Tungpra (TP), Kornsarn District, Chaiyaphum Province, Northeast Thailand, during 2013. These sub-districts were selected based on their higher diversity of crops grown after main season rice in a preliminary field survey of 4 sub-districts.

DK was located at a higher elevation and had limited access to irrigation water from small streams. TP was situated near the Chern River, one of the main rivers in the Northeast. Irrigation was provided by publicly-financed electric pumps along the river. Soil is finer in TP (Sandy loamy) than DK (Loamy sand). Rice is the main crop grown in the dry season in both areas.

Three households growing dry season rice, soybean, chili or field corn were purposively selected for each crop in each area, 12 farmers per sub-district and 24 farmers total. Structured questionnaires were employed to interview each farmer regarding the farmer’s age and education level, types of dry season crops grown, cultural practices, yields, production costs, prices, markets, and reasons for crop selection. Group interviews with key informants (village headman, village committee members, and leading farmers) were done to obtain general village information. Descriptive statistics were calculated using the statistical package SPSS Ver.13.0 (SPSS Inc.). Spreadsheet software (Microsoft EXCEL) was used for percent analysis.

Water use productivity was expressed on two bases: monetary value per unit cost, shown in Eq. (1), and yield per quantity of water used, shown in Eq. (2), according to Pereira (2007), as follows:

$$\text{Water cost productivity} = \frac{\text{Value of crops}}{\text{Irrigation cost}} \qquad (1)$$

$$\text{Water use productivity} = \frac{\text{Crop yield}}{\text{Total seasonal water use crop}} \qquad (2)$$

Water requirements for rice (http://www.rid.go.th/attatch_branch/qrice.html) and field corn (http://www.rid.go.th/attatch_branch/qcorn.html) were obtained from the Royal Irrigation Department, while the water requirement for soybean was taken from the Agricultural Research Development Agency (http://www.arda.or.th/kasetinfo/north/plant/soy_water.html).

RESULTS AND DISCUSSION

Farmer Characteristics

Farmer's average ages were similar in both areas (46 years in DK and 48 years in TP). Fifty-eight percent of respondents in DK had finished elementary school, considerably less than 83% in TP. The average number of household laborers was 2.33 and 2.00 persons/household in DK and TP, respectively. These numbers are lower than average number of farm laborers per household of the province (2.86) and nationally (2.88) (Office of Agricultural Economics, n.d.).

Table 1 Planted area and yield of crops grown after wet season rice under irrigation in Dongklang (DK) and Tungpra (TP) sub-districts, Kornsarn Distict, Chaiyaphum Province, Northeast Thailand

Crops		Dongklang		Tungpra	
		Planted area (ha/household)	Yield (kg/ha)	Planted area (ha/household)	Yield (kg/ha)
Dry season rice	Average	0.91	5,000	0.85	5,513
	SD	0.24	1,875	0.49	642
	C.V.(%)	27	38	57	12
Soybean	Average	1.97	1,646	0.96	1,971
	SD	1.40	377	0.32	104
	C.V.(%)	71	23	33	5
Chili	Average	0.45	14,917	0.32	9,083
	SD	0.05	2,097	0.00	1706
	C.V.(%)	10	14	0.00	19
Field corn	Average	0.61	3,633	0.97	4,563
	SD	0.36	1,670	0.26	1,013
	C.V.(%)	59	46	27	22

Source: Field survey, 2013.

Yields and Planted Area of Crops Grown after Wet Season Rice

Higher planted areas per household of each crop except field corn were found in DK compared to TP (Table 1). This may be due to more labor availability, or because less favorable conditions in DK leads farmers to expand planted area in order to get more total production despite lower yields.

Yields of dry season rice, soybean and field corn were 10%, 20%, and 26% higher, respectively, in TP than DK (Table 1). This may be due to more favorable conditions in TP than DK. However, chili yield was 39% higher in DK than in TP. This is partly due to the longer harvest period of chili in DK due to its higher elevation. Farmers start growing chili soon after wet season rice and continue harvesting until rice planting in July for the next wet season in DK, while in TP farmer's have to stop harvesting chili in June due to excess soil moisture at its lower elevation.

Production Cost of Crops Grown after Wet Season Rice

Both sub-districts had similar patterns of production costs for all four crops. In both sub-districts, chili production cost was approximately 10 times or more higher than other crops, followed by field corn and dry season rice, and lowest in soybean (Tables 2 and 3). The fact that the production cost of soybean was lowest of the four crops contradicted farmer's stated expectations. A higher share of costs at the start of the season may influence farmer perceptions more than costs later in the season.

The factors contributing most to production costs differed among the four crops, but the patterns for each crop were similar between the two sub-districts. Fertilizer was the most important production cost for rice (42% of total cost in DK, 36% in TP) and field corn (36% in DK, 53% in TP). The greater proportion of cost allocated to fertilizer in TP indicated that field corn production was more intensive in TP than in DK, likely reflecting greater water availability in TP. Seed costs and land preparation were second and third in importance for field corn. More farmers indicated that good land preparation is crucial for seed germination. However, combined harvester was second in importance in contribution to rice production costs (27% in both DK and TP) (Tables 2 and 3).

Table 2 Production cost of crops grown after wet season rice under irrigation in Dongklang (DK) Sub-district, Kornsarn Distict, Chaiyaphum Province, Northeast Thailand, 2013

List	Dry season rice		Soybean		Chili		Field corn	
	Cost (USD/ha)	%	Cost (USD/ha)	%	Cost (USD/ha)	%	Cost (USD/ha)	%
Land preparation	36	7.3	1	0.3	208	2.9	102	19.7
Seed	-	-	177	43.5	239	3.3	104	20.1
Fertilizer	208	42.1	28	6.8	526	7.3	187	36.1
Fungicide/insecticide	-	-	-	-	218	3.0	-	-
Crop stimulants	-	-	-	-	82	1.1	1	0.1
Herbicide	8	1.7	-	-	6	0.1	14	2.6
Labor	-	-	-	-	5,775	80.0	32	6.3
Combined harvester	134	27.0	153	37.5	-	-	-	-
Irrigation	2	21.5	5	10.7	-	2.4	23	10.5
Transportation to market	106	0.5	44	1.2	169	-	54	4.4
Cost of production	495	100.0	407	100.0	7,223	100.0	517	100.0

**Production costs excluding family labor cost. Crop stimulants include plant growth regulators and liquid fertilizer. USD=US dollars*

Table 3 Production costs of crops grown after wet season rice under irrigated area at Tung pra (TP) Sub-district, Kornsarn Distict, Chaiyaphum Province, Northeast Thailand, 2013

List	Dry season rice		Soybean		Chili		Field corn	
	Cost (USD/ha)	%	Cost (USD/ha)	%	Cost (USD/ha)	%	Cost (USD/ha)	%
Land preparation	64	13.2	6	2.3	149	2.9	64	11.7
Seed	21	4.4	61	23.2	233	4.5	96	17.6
Fertilizer	190	39.1	4	1.6	297	5.7	290	52.9
Fungicide/insecticide	2	0.3	6	2.1	132	2.5	-	-
Crop stimulants	-	-	6	2.3	7	0.1	-	-
Herbicide	10	2.1	4	1.6	19	0.4	-	-
Labor	-	-	21	7.9	4,194	80.6	54	9.8
Combined harvester	132	27.1	88	33.1	-	-	-	-
Irrigation	24	9.1	11	21.8	-	3.3	7	6.8
Transportation to market	44	4.9	58	4.2	172	0.0	37	1.3
Cost of production	487	100.0	265	100.0	5,203	100.0	548	100.0

**Production costs excluding family labor cost. Crop stimulants include plant growth regulators and liquid fertilizer. USD=US dollars*

For soybean, seed and combined harvester costs were the two most important costs, with seed costs higher in DK but combined harvester higher in TP. In DK, farmers did not keep their own seed for next season, but in TP, one farmer used his own seed produced in an upland area. This indicates by saving their own seed farmers can lower production costs for soybean. Hired labor cost comprised approximately 80% of the cost of chili production in both sub-districts (Tables 2 and 3).

The sub-districts differed in the relative importance of irrigation water costs. In DK, with less water availability, the highest proportion of production cost spent for irrigation was for rice (21%). In TP, with greater water availability, the highest proportion spent for irrigation was for soybean (22%) (Tables 2 and 3). Higher water use for soybean in TP was reflected in higher yields (Table 1). This indicated that improved access to irrigation water can make non-rice crops more viable..

Returns of Crops Grown after Rice

In both locations, net returns was 10-fold or higher in chili (15,462-18,838 USD/ha), followed by dry season rice (1,512-1,880 USD/ha). In TP soybean was ranked third (827 USD/ha) followed by and higher yield per area. The high returns of chili were due to its high price (Fig. 1). Nevertheless, using price as the major criteria for crop selection may not be appropriate, due to its greater price fluctuation as seen in Fig. 1. This may be the reason why farmers did not grow chili as their secondary crop, or grew chili as one of 2 or 3 crops.

The benefit-cost ratio (BCR) was highest for dry season rice in both areas, 4.06 and 4.86 in DK and TP, respectively. This was higher than chili despite its much greater net returns, reflecting the much lower production cost of rice. Nevertheless, all 4 crops had BCR values higher than 1, indicating that all crops were profitable for farmers.

However, among the 4 crops chili had the highest water cost productivity, with similar values in both areas (Table 4). Water cost productivities of the same crop differed between the two sub-districts, reflecting different costs of water. For example, with limited access to water and resulting higher cost (DK), rice had the lowest value (18.9) of the 4 crops. However, where water costs were less (TP), water cost productivity was higher (53.5). However, when the cost of water is disregarded and only the amount of water used is considered, water yield productivity was highest for field corn, followed by soybean, and lowest for rice in both areas. This finding confirms that dry season rice uses more water than other crops. Unfortunately, in the absence of data on the water requirements of chili, we cannot compare chili water yield productivity.

Table 4 Partial budgeting (USD/ha) of crops grown after wet season rice under irrigated area at Dongklang (DK) and Tungpra (TP) sub-district, Kornsarn distict, Chaiyaphum province, northeast Thailand

List	Dongklang				Tungpra			
	Dry season rice	Soybean	Chili	Field corn	Dry season rice	Soybean	Chili	Field corn
Total cost	495	407	7,223	517	487	265	5,203	548
Gross return	2,007	946	22,685	1,102	2,367	1,093	24,028	1,147
Net return	1,512	540	15,462	585	1,88	827	18,838	598
BCR	4.06	2.33	3.14	2.13	4.86	4.12	4.62	2.09
Water cost productivity	18.91	21.72	133.88	20.25	53.46	15.73	139.80	30.59
Water yield productivity	0.68	0.78	NA	0.98	0.75	0.94	NA	1.23

BCR= Benefit-cost ratio, water cost productivity =yield value (USD)/water yield productivity (USD), water use= crop yield (kg/area)/total water use (m^3/area), NA= not available and USD=US dollars

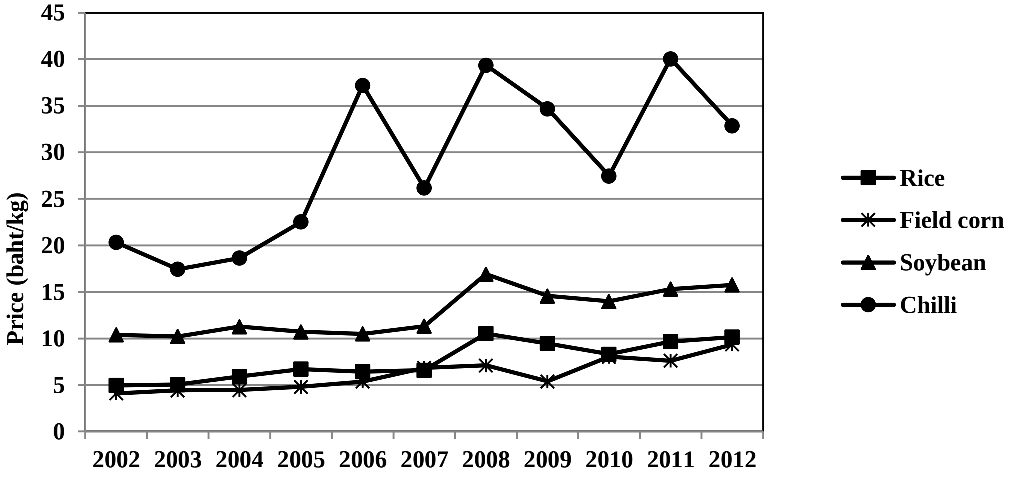

Fig. 1 Farm gate price of crops in this study in Thailand during 2002-2012
Source: Office of Agricultural Economic (n.d.)

CONCLUSION

In the introduction to this paper, we indicated that this study sought to answer the question, why do farmers continue to grow dry season rice despite the problems they faces due to insufficient water resulting from frequent droughts in the Northeast. Many factors may affect farmer's decisions to continuing growing rice. As a first step in identifying which factors are most important in crop choices, we assessed four dry season crops following wet season rice, dry season rice, soybean, chili, and field corn, using four measures: net returns, BCR, water cost and water use productivity. Net returns analysis indicated that chili was the most profitable, while dry season rice was second in net returns, exceeding soybean and field corn in both areas. However, BCR was highest in dry season rice in both areas compared to chili. The high BCR of rice thus may be the reason why farmers continue to grow dry season rice. However, in terms of water use efficiency, dry season rice is not the most efficient crop, and its water cost productivity is poorest when water costs are high. Measures to reduce water use in dry season rice in areas with poor water availability, and reduction of production and market constraints for other crops, may enable farmers to obtain higher water productivity and greater net returns from dry season second crop production. The effect of these measures should be assessed in relation to differences among farmer's in levels of education and household labor availability, those two factors which this study did not evaluate. Development of a decision-tree model based on BCR, water availability, and other potential factors could be a useful tool for extension and farmer group leaders.

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