COMPARATIVE ANALYSIS OF RESOURCE USE EFFICIENCY BETWEEN ORGANIC RICE AND CONVENTIONAL RICE PRODUCTION IN MEKONG DELTA OF VIETNAM

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ABSTRACT

The efficiency with which farmers use available resources is very important in agricultural production. The study was conducted to measure and compare resource use efficiency and relative productivity of farming under Organic rice and Conventional rice production in Mekong Delta of Vietnam. One hundred twenty randomly selected farms, 60 from each system, were surveyed. The study explored differences in efficiency and productivity between production systems. Cobb-Douglas production function analysis was used to calibrate resource use efficiency. The results showed that the regression coefficients of expenditure on seed, organic manure and bio-fertilizers in Organic rice cultivation, and expenditure on herbicide and machine labour in Conventional rice cultivation were significant. The efficiency was greater than one for seed, organic manure, machine labour and bio-fertilizer for Organic rice production. In conventional rice production, herbicide and machine labour were underutilized resources. The results suggested that the quantity of these resources was used less than optimum and there exists further scope for increased use of these resources. Other resources were over utilized, such as human labour and bio-pesticide in organic rice production, and seed, chemical fertilizer, pesticide and human labour in conventional rice production.

Keywords: *resource use efficiency, organic rice, conventional rice production, cobb-douglas fuction.*

INTRODUCTION

Rice is a very important staple food in the diet of the estimated 90 million Vietnamese. It is consumed in various forms but the most popular is as grains. According to the General Statisitc Office of Vietnam, from 1986 to 2012 national paddy production increased 2.7 times, from 16.0 to more than 43.66 million tonnes. Area under production has increased rapidly from 5.7 to more than 7.75 million hectares, and productivity increased from 28.13 to 56.32 quintals per hectare. From a state of modest rice deficit, Vietnam has changed to a positive rice balance since the year of renovation, 1986. From 1990, the surplus has increased continuously to 39 per cent of “rice available” in 2010 (Steven *et al.*, 2011). For the last twenty five years, a national food deficit has shifted to that of a very large food surplus which accounts for 20-25% of total world exports of rice, in volume terms.

In Vietnam, irrigated rice civilization has been a tradition for four thousand years. In recent years, the area of rice production in Vietnam has beengrowing (Binh and Thang, 2012). However, ever-increasing levels of rice production and export are not indicative of high levels of efficiency. Nor have they been associated with high levels of profitability, at least not for the Mekong Delta’s 1.46 million rice producers (Steven *et al.*, 2011). In addition, the present government of Vietnam emphasized the assurance of a minimum profit of 30% in rice production in order to raise farmers’ incomes. Organic farming is one advantageous production system. In many countries, organic farming has proven to be more efficient and to gain a better income (Satish and Sowmya, 2007). In recent years, organic rice production has emerged as a particular option of rice farmers. Some studies from India, Philippines, Thailand, Pakistan, Indonesia, etc showed that organic rice farmers received higher profit than conventional rice farmers (Mendoza, 2004; Arpaphan and Ganesh, 2009; Mehmood *et al.*, 2011; Agus and Teddy, 2011).

It is difficult to estimate the efficiency of farmers without knowledge of the conditions under which production takes place. Efficiency of resource use, which can be defined as the ability to derive maximum output per unit of resource, is the key to effectively addressing the challenges of achieving rice productivity maximization without actually raising the input application (Ali and Chowdhury, 1991; Gaddi *et al.*, 2002). Raising productivity in agriculture will certainly lead to reduced rice production costs. An increase of output and decrease of cost could be obtained by using available technology in rice production (Khai and Mitsuyasu, 2011). Therefore, it is necessary to examine resource use efficiency among rice farmers and know the contribution of each resource to total output. Hence the present study has been undertaken with the overall objective of empirical analysis of resource use efficiency in Organic rice and Conventional rice cultivation.

METHODOLOGY

The study was carried out in Cuulong River Delta as it has a large area under rice cultivation. A multistage random sampling procedure was adopted for the selection of respondents. In Cuulong river delta, Travinh and Longan province are intensive organic rice producing provinces. A sample of 30 organic and 30 conventional rice farmers were selected randomly from each province. For evaluating the specific objectives of the study, requisite primary data pertaining to the season of Winter-spring in 2012-13 were collected from the sampled farmers by personal interview method with the help of a pre-tested and well-structured interview schedule. The data thus collected were processed using tabular analysis and multiple regression/ production function analysis. The Mann – Whitney U Test was used to test for significant differences between two groups when the scores are measured on an ordinal scale.

Production function

The Cobb-Douglas production function was employed to study the resource use efficiency of Organic rice vs Conventional rice production. The estimated regression coefficients indicate the production elasticity. The general form of Cobb-Douglas productionfunction used in the present study is as follows,

$$Y = aX1^{b1} + X22^{b2} + X3^{b3} + X4^{b4} + X5^{b5} + X6^{b6} + e^{u}$$

Where: Y is gross return of organic rice production or conventional rice production (1,000 VND)

β_o, β_1, β_2, β_3, β_4, β_5, β_6 are the parameters which are estimated

X_1 = Expenditure on seed (in 1,000 VND).

X_2 = Expenditure on machine labor (in 1,000 VND).

X_3 = Expenditure on human labour (in 1,000 VND).

X_4 = Expenditure on bio-pesticide in organic farming or expenditure on chemical pesticide in conventional farming (in 1,000 VND).

X_5 = Expenditure on organic manure in organic farming or expenditure on chemical fertilizer in conventional farming (in 1,000 VND).

X_6 = Expenditure on bio-fertilizer in organic farming or expenditure on chemical herbicide in conventional farming (in 1,000 VND).

e^u = Errorterm,

b_i's = Output elasticities of respective factor inputs (i=0,1,2,…,n) (n=6)

Measurement of resource use efficiency or allocative efficiency

Maximizing profit is the objective of a rational farmer, who needs to allocate resources consistent with their respective marginal contributions in monetary terms. The degree to which it was accomplished was measured by allocative efficiency.

Allocative efficiency (AE) was determined by calculating the ratio of the marginal value product (MVP) to the marginal factor cost (MFC), i.e.

AE = MVP/ MFC

$MVP = b_i * (\frac{\bar{Y}}{\bar{X}_i})$

where,

MVP = Marginal value product

MFC = Marginal factor cost of each variable input. As the MFC is price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder *et al*., 2009).

where,

b_i = Elasticity coefficient of the i[th] independent variable from the Cobb-Douglas production function.

$\bar{Y}$ = Geometric mean of the gross return in VND. 1,000, and

$\bar{X}_i$ = Geometric mean of expenditure on the i[th] input

If AE <1, it means the resource in question was over utilized and decreasing the quantity used of that resource would increase profit.

If AE > 1, it shows that the resource was being underutilized and increasing the rate of use will raise profit.

If AE = 1 it means resource was being efficiently utilized.

To obtain the suitable function, Cobb-Douglas production function was estimated by OLS method using Excel software.

RESULTS AND DISCUSSION

Table 1. Socio-economic profilenof the samplem

No.	Particulars	Unit	Organic rice	Conventional rice	Z statistic
			N = 60	N = 60	
1.	Age of farmers	years	50.40	47.35	-1.534
2.	Education level status				
	Illiterate	No.	1 (1.70)	3 (5.00)	
	Elementary	No.	33 (55.00)	25 (41.70)	
	Secondary	No.	16 (26.70)	27 (45.00)	
	High school	No.	9 (15.00)	5 (8.30)	
	College	No.	1 (1.70)	-	
3.	Family size	No.	3.82	4.10	-1.168
4.	No. of family members working in agriculture	No.	3.10	3.10	-0.101
5.	Average area under agricultural farming	ha	0.878	1.284	-2.68***
6.	Average area under rice farming	ha	0.731	0.982	-1.958**

*(i) ***, ** and * significance level at 0.01, 0.05 and 0.1 respectively. (ii) Figure in parentheses were percentage. (iii) Source: Survey*

The general characteristics of the sample farmers are summarized in Table 1. The age and education level of organic rice farmers was higher than those of conventional rice farmers. The average age of sampled paddy farmers cultivating organic rice was insignificantly higher (50.40 years) than that of conventional rice farmers (47.35 years). This also suggests that old age is not a limiting factor for changing to organic of farming. It was noticed that most of farmers were literate, 98.3 per cent in case of organic farmers and 95.0 per cent in case of conventional farmers. There was also no significant difference between two groups in average family size and number of family members working in agricultural sector. On an average, the paddy crop occupied 0.731 hectares of agricultural land on organic farms accounting for 83.25 per cent of the land holding. For conventional farms, the paddy crop area was 0.982 hectares and accounted for 76.48 per cent of total agricultural area. This difference in area is statistically significant. It is mainly because of the fact that organic paddy has been cultivated for only the last 5-6 years in Vietnam. The advantages of organic farmingare still unproven. Hence organic farming was just applied in small area.

Table 2 shows differences in the use of inputs between organic and conventional farms. Since only variable cost was important in the short-run in influencing the decision-making of the farmers, only these were considered for calculating profitability. The total variable cost of cultivation of organic rice amounted to VND 20,495,450 per hectare resulting in a total per hectare income of VND 35,564,720 giving a BC ratio of 1.48. In case of conventional rice, the total variable cost of cultivation amounted to VND 17,373,910 per hectare resulting in a total per hectare income of VND 29,295,090 giving a BC ratio of 1.40. Cost of human labour cost was the highest among 8 kinds of input used, 42.13 per cent and 36.46 per cent of total variable expenses respectively. Organic farming uses more hired labour than conventional farming in some activities such as weed removing, pruning, irrigating, and post harvesting. Following labor, expenses in decreasing order were for fertilizer (28.53% and 27.74%), machine labor (12.02% and 18.69%), seed (8.63% and 7.31%, respectively), bio-fertilizer, pesticide, chemical pesticide. All input expenses were significantly different between organic and conventional farms.

Table 2. Input use pattern in organic and conventional rice farms (VND 1,000 per ha)

Sl. No.	Particulars	Organic farms		Conventional farms		Z statistic for value
		Value	**(%)**	**Value**	**(%)**	
1.	Human labour	8,635.70	42.13	6,334.93	36.46	-1.818*
2.	Machine labour	2,463.63	12.02	3,247.46	18.69	-3.875***
3.	Seeds	1,769.04	8.63	1,269.53	7.31	-7.448***
4.	Bio-fertilizer	1,299.34	6.34	-	-	-
5.	Vermi-compost	5,847.66	28.53	-	-	-
6.	Bio-pesticide	480.08	2.34	-	-	-
7.	Chemical fertilizer	-	-	4,820.27	27.74	-
8.	Chemical pesticide	-	-	1,701.72	9.79	-
Total variable cost		20,495.45	100.00	17,373.91	100.00	-1.903*
Gross return		35,564.72	-	29,295.09	-	-3.248***
B:C ratio		1.48	-	1.40		

*(i) ***, ** and * significance level at 0.01, 0.05 and 0.1 respectively. (ii) Source: Survey*

The estimates of the production functions are presented in Table 3. The coefficients of multiple determination (R^2) of organic and conventional farms were 0.809 and 0.36, respectively. The significant F value indicated that the Cobb-Douglas production function could explain 80.9 and 36.0 per cent of the variation in paddy output due to variations in the resources included in the model for organic and conventional farms, respectively. The adjusted coefficients of multiple determination were found to be almost equal to coefficients of multiple determination indicating the goodness of fit. The decreasing return to scale was noticed in organic rice cultivation where $\sum b_i$ value was less than one, 0.791. This feature was also true for conventional rice, 0.426. These indicated that both rice farmers were producing in the second period of production

Table 3. Estimated regression coefficient of paddy production under organic and conventional farming, Dependent variable – Gross return (1,000 VND per ha)

Variables	Organic rice		Conventional rice	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	5.215***	0.484	6.76***	1.255
Expenditure on seed	0.104***	0.037	-0.133	0.124
Expenditure on che. fertilizer		-	0.061	0.118
Expenditure on herbicide		-	0.086***	0.029
Expenditure on pesticide		-	-0.027	0.023
Expenditure on machine labour	0.14	0.310	0.328**	0.138
Expenditure on human labour	0.03	0.041	0.111	0.146
Expenditure on bio- pesticide	0.001	0.021		-
Expenditure on vermi-compost	0.265***	0.081		-
Expenditure on bio- fertilizer	0.251***	0.089		-
R^2	0.809		0.36	
F	36.871***		5.022***	
Total elasticity	0.791		0.426	

****, ** and * significance level at 0.01, 0.05 and 0.1 respectively; Source: Survey*

For organic rice, the parameters of the Cobb-Douglas function were all positively signed. The coefficients of expenditure on seed (0.104), vermi-compost (0.265), and bio-fertilizer (0.251) showed that one per cent increase in expenditure of seed, vermi-compost, and bio-fertilizer would bring 0.104, 0.265 and 0.251 per cent increase in gross return. Other coefficients of expenditure on machine labour, human labour, and bio-pesticide were not significant. The magnitude of the output elasticities in case of vermi-compost and bio-fertilizer were considerably higher than that of other inputs.

For conventional rice production, the output elasticities of four inputs were positive. Among these inputs, coefficients of expenditure on herbicide, and machine labor were 0.086, and 0.328, respectively and both significant at one and five per cent probability level. Other coefficients of expenditure on chemical fertilizer, and human labour were positive, but insignificant. Coefficients of expenditure on seed and pesticide were negative and insignificant. It was well understood that the use of seed and chemical pesticide have negative effect on the yield of conventional rice. The magnitude of output elasticity in case of machine labour (0.328) showed that one per cent increase in expenditure of machine labour would bring 0.328 per cent increase in gross return. It was considerably higher than that of other inputs.

Table 4: Resource-use efficiency of organic and conventional farms

Sl. No.	Variables	Organic rice		Conventional rice	
		Geometric mean	MVP/MFC ratio	Geometric mean	MVP/MFC ratio
1	Expenditure on seed	1,365.97	2.587	1,186.93	-3.139
2	Chemical fertilizer expenditure	-	-	4,513.14	0.379
3	Expenditure on herbicide	-	-	334.77	7.321
4	Expenditure on pesticide	-	-	788.59	-0.969
5	Expenditure on machine labor	2,286.27	2.081	2791.90	3.291
6	Expenditure on human labor	8,260.41	0.123	6,631.65	0.469
7	Expenditure on bio- pesticides	746.50	0.045	-	-
8	Expenditure on vermi-compost	5,615.45	1.604	-	-
9	Expenditure on bio- fertilizer	1,259.45	6.772	-	-

Source: Survey

The ratio of marginal value product (MVP) to marginal factor cost (MFC) was computed for each of the factors of production to draw some inferences about the allocative efficiency (Table 4). It can be observed that the ratios of MVP to MFC for different resources were greater than unity for expenditure of seed (2.587), machine labour (2.081), vermin-compost (1.604) and bio-fertilizer (6.772) for organic rice production. It implied that farmers were found to use seed, machine labour, vermin-compost and bio-fertilizer below the optimal level. This suggested that there is a further scope to increase organic output by using more of these resources. The marginal return for the 1,366th VND spent on seed was 2.587, for the 5,616th VND spent on vermi-compost was 1.604, for the 1,260th VND spent on bio-fertilizer was 6.772, and the contribution of the 2,287th VND spent on machine labour was 2.081. The ratios of MVP to MFC were less than one for expenditure on human labour and bio-pesticide. This implies that farmers were using human labour and bio-pesticide over the optimal level and consequently that more use of these inputs would reduce gross return. This suggests that farmers should limit these inputs in production because the increase in gross return was lower than the increase in expenditure on these inputs.

Regarding conventional paddy production, the ratios of MVP to MFC for different resources are also shown in Table 4. The MVP/MFC ratios for conventional rice production indicate that the values of expenditure on herbicide and machine labour were greater than one, 7.321 and 3.291, respectively. This suggests that there is a further scope to increase gross return of conventional rice by using more of above two resources. The marginal return for the 335th VND spent on herbicide was 7.321, and the contribution of the 2,792th VND spent on machine labour was 3.291. Ratios of expenditure on chemical fertilizer and human labour were positive and smaller than unity, 0.379 and 0.469, respectively indicated that farmers should limit these inputs in their farm. The ratios of MVP to MFC for expenditure on seed (-3.139) and chemical pesticide (-0.969) were negative. This suggests that these resources were used uneconomically and overutilized. In other words every VND of an additional expenditure on seed and chemical pesticide will lead to reduced gross return. Hence it would be profitable to decrease the use of these factors.

CONCLUSION

The results show that the gross return of organic rice cultivation was higher than that of conventional rice cultivation though its production cost is also higher. Production functions revealed that expenditures on vermi-compost in organic rice cultivation and machine labour in conventional rice production contributed the most to gross return. Organic rice cultivation has been found much more profitable for the growers in study area.

The allocative efficiency analysis has indicated that one Vietnam dong spent on seed, machine labour, vermin-compost and bio-fertilizer would enhance the total returns of organic rice by VND 2.587, 2.081, 1.604 and 6.772, respectively. In conventional rice cultivation, increased spending on herbicide and machine labor woulr enhance gross returns. That the efficiency of expenditures on human labor is less than one in both Organic (0.123) and Conventional rice (0.469) cultivation implies excessive utilization of human labor. Farmers need to be educated to reduce the use of plant protection chemicals, seed and chemical fertilizers in conventional rice since any further increase in the use of the above resources would lead to financial loss and environmental damage.

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TÓM TẮT

Phân tích hiệu quả sử dụng nguồn lực giữa hệ thống sản xuất lúa hữu cơ và vô cơ ở khu vực Đồng bằng sông Cửu Long

Hiệu quả sử dụng các nguồn lực sẵn đóng vai trò quan trọng trong sản xuất nông nghiệp. Nghiên cứu này được xây dựng để tính toán và so sánh hiệu quả sử dụng các nguồn lực của hai hệ thống sản xuất lúa hữu cơ và vô cơ ở khu vực Đồng bằng sông Cửu Long. 120 hộ gia đình được khảo sát, 60 hộ gia đình được lựa chọn bằng phương pháp chọn mẫu ngẫu nhiên từ mỗi hệ thống sản xuất. Hàm sản xuất Cobb-Douglass được sử dụng để xác định hiệu quả sử dụng các nguồn lực. Kết quả cho thấy có sự khác nhau về hiệu quả và năng suất giữa hai hệ thống sản xuất lúa. Phân tích hồi quy cho thấy các biến độc lập, như chi phí giống lúa, phân hữu cơ, phân bón lá hữu cơ trong hệ thống sản xuất lúa hữu cơ, biến chi phí thuốc cỏ, thuê máy móc trong hệ thống sản xuất lúa vô cơ có ảnh hưởng đến năng suất lúa ở mức có ý nghĩa thống kê. Ở hệ thống sản xuất lúa hữu cơ, tỉ số giữa MVP và MFC lớn hơn 1 chỉ ra nông dân cần phải sử dụng thêm giống, phân hữu cơ, thuê máy móc và phân bón lá. Ở hệ thống sản xuất lúa vô cơ, nông dân cần sử dụng thêm thuốc trừ cỏ và sử dụng nhiều máy móc để thay thế lao động thủ công. Trong khi đó, nông dân nên giảm sử dụng lao động phổ thông và thuốc trừ sâu sinh học ở hệ thống sản xuất lúa hữu cơ, giảm sử dụng giống, phân vô cơ, thuốc trừ sâu bệnh và lao động ở hệ thống sản xuất lúa vô cơ nhằm nâng cao hiệu quả sản xuất.