International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 5, July-August 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Analyze Production Efficiency and Scale Efficiency of Rice Farming Households in Hau Giang Province

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ABSTRACT

Data Envelopment Analysis (DEA) was used in this study to evaluate the production efficiency of rice farming households in Hau Giang Province. Research data were collected from 250 rice farming households. DEA method was used in the studyto measure the cost-effectiveness based on aggregating the technical efficiency and allocative efficiency. Besides, the study estimated and compared the scale efficiency of rice farming households. The research results indicated that rice farmers in Hau Giang achieved technical efficiency at a pretty good level whereas the allocative efficiency was at a fairly goodlevel, and the cost efficiency was at an average level. The results also showed that the majority of rice farming households reached high scale efficiency, particularly, many households got the optimal scale efficiency.

KEYWORDS: *Technical efficiency, allocative efficiency, cost efficiency, scale efficiency, rice farming household*

How to cite this paper: Nguyen Quoc Nghi | La Nguyen Thuy Dung "Analyze Production Efficiency and Scale Efficiency of Rice Farming Households in Hau Giang Province" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-5, August 2020, pp.525-527, URL: www.ijtsrd.com/papers/ijtsrd31887.pdf

IJTSRD31887

1. INTRODUCTION

In recent years, as a province with plenty of advantages for agricultural development in the Mekong Delta, Hau Giang has been building many projects to restructure its agricultural industry. Agricultural land accounts for 80% of the total land. Rice is considered the key crop, playing an important role in the development of Hau Giang's agricultural industry. In 2018, Hau Giang Province has a large rice-growing area, equivalent to 80.000 ha. The annual rice-growing area is approximately 210.000 ha/3 crops. Rice is the major plant of the province, so the locality invest and apply technical advances into cultivation to increase productivity and quality. However, rice farmers in Hau Giang Province still face difficulties, especially the problem of investment costs and production efficiency. Most rice-producing households follow traditional farming, therefore, they do not pay attention to the technical efficiency and the input factors (seed, fertilizer, labor, etc.). Therefore, evaluating the production efficiency of rice farmers in Hau Giang Province is necessary. Based on the estimated result of technical efficiency, allocative efficiency, and cost efficiency, the research may help farmers adjust the input lines and the scale of their investments, save cost, and improve rice productivity.

2. RESEARCH METHODOLOGY

2.1. Research data

This study uses the data envelope analysis (DEA) method to analyze the technical efficiency (TE), allocative efficiency (AE), and cost efficiency (CE). Data used in the study were collected from 250 rice farmers in Phung Hiep, Long My, Chau Thanh, and Chau Thanh A Districts (Hau Giang Province) using stratified random sampling.

2.2. Production efficiency and scale efficiency analytical method

According to Coelli et al. (2005), production efficiency results from technical efficiency, allocative efficiency, and cost efficiency that can be measured using the Constant Returns to Scale input-oriented DEA Model (CRS-DEA Model). The analysis of TE, AE, and CE can be done by many different computer programs. However, it is convenient that the author used the DEAP software 2.1 to evaluate types of efficiency.

In recent decades, there have been many studies that have separated the technical efficiency (TE) achieved from Constant Returns to Scale (CRS) into two parts. The first part is “pure” technical inefficiency, and the second one is scale inefficiency. Therefore, the measurement of scale efficiency (SE) is used to determine the quantity by whichproductivity can be improved by adjusting the production scale according to a determined optimal scale. To measure SE using the DEA, it requires to estimate an additional production margin which isCRS-DEA. Then, the measurement of SE can be conducted for every household by comparing the TE obtained from the CRS-DEA with the TE obtained from the Variable Returns to Scale-DEA (VRS-DEA). If there is a difference in TE between CRS-DEA and VRS-DEA for each household, it can be concluded that there is a scale

inefficiency = 1 - SE. As reported by Coelli et al. (2005), SE can be measured using the Variable Returns to Scale input-oriented DEA Model.

3. RESEARCH RESULTS AND DISCUSSION

In this study, the DEAP software version 2.1 was used to estimate the technical efficiency, allocative efficiency, cost efficiency,and scale efficiency of rice farmers.The resultis presented in Table 1.

Table 1: Rice production efficiency of households in Hau Giang Province

Value	Technical efficiency		Allocative efficiency		Cost efficiency	
	Number of households	Percentage (%)	Number of households	Percentage (%)	Number of households	Percentage (%)
Winter-Spring crop						
1.000	102	40.8	1	0.4	1	0.4
0.900 – 0.999	76	30.4	3	1.2	3	1.2
0.800 – 0.899	54	21.6	22	8.8	11	4.4
0.700 – 0.799	16	6.4	109	43.6	61	24.4
0.600 – 0.699	2	0.8	86	34.4	107	42.8
0.500 – 0.599	0	0.0	25	10.0	57	22.8
0.400 – 0.499	0	0.0	4	1.6	9	3.6
0.300 – 0.399	0	0.0	0	0.0	1	0.4
0.200 – 0.299	0	0.0	0	0.0	0	0.0
< 0.199	0	0.0	0	0.0	0	0.0
Mean	0.936		0.701		0.656	
Spread	0.681 – 1.000		0.456 – 1.000		0.394 – 1.000	
Standard deviation	0.078		0.086		0.091	
Summer-Autumn crop						
1.000	75	30.0	1	0.4	1	0.4
0.900 – 0.999	69	27.6	0	0.0	0	0.0
0.800 – 0.899	61	24.4	13	5.2	5	2.0
0.700 – 0.799	35	14.0	48	19.2	28	11.2
0.600 – 0.699	10	4.0	125	50.0	63	25.2
0.500 – 0.599	0	0.0	47	18.8	98	39.2
0.400 – 0.499	0	0.0	15	6.0	47	18.8
0.300 – 0.399	0	0.0	1	0.4	8	3.2
0.200 – 0.299	0	0.0	0	0.0	0	0.0
< 0.199	0	0.0	0	0.0	0	0.0
Mean	0.900		0.649		0.583	
Spread	0.604 – 1.000		0.398 – 1.000		0.342 – 1.000	
Standard deviation	0.100		0.091		0.105	

3.1. Technical efficiency

The technical efficiency value according to the DEA model minimizes the input in case the scale does not affect the production result, and it receives the value in the range of 0 to 1. If the value is equal to 1, this means that the rice farming households reach the optimal technical efficiency. If it is less than 1, this shows that the households have not achieved the optimal technical efficiency. The result in Table 1suggests that rice farmers in Hau Giang Province have high technical efficiency with highTE (0.936 in Winter-Spring crop and 0.900 in Summer-Autumn crop). Most of the rice farming households have technical efficiency of more than 0.6, of which the number of households with optimal technical efficiency (TE = 1) accounts for 30% in the Summer-Autumn crop and 40.8% in the Winter-Spring crop. With the above finding, it is proved that rice farmers in Hau Giang Province use reasonable inputs. The fact that in recent years, Hau Giang's agricultural industry authority has actively implemented training programs, transferred technical advances to farmers towards sustainable development and consistent with the needs of farmers. In particular, advanced farming models such as "3 reductions 3 increases", "1 must- 5 reductions", etc. help farmers to properly use the fertilizer and pesticides; thereby avoiding input waste.

3.2. Allocative efficiency

The allocative efficiency of rice farming households in Hau Giang Province is at a fairly good level compared to the technical efficiency, with the values of 0.701 in the Winter-Spring crop and 0.649 in the Summer-Autumn crop. The allocative efficiency among farmers fluctuates from 0.500 to 0.799, accounting for over 70% in both Winter-Spring and Summer-Autumn crops. The percentage of households with high allocative efficiency is small. Also, the number of households reaching optimal allocative efficiency is rare (0.4% in both crops). The main causes is the ineffective allocation of the resources for production and the unstable price of inputs. The inconsistencies in purchase price and rental price of the input lines increases expenditures and reduce allocative efficiency.

3.3. Cost efficiency

The cost efficiency or general economic efficiency of rice farming households is measured based on the combination of technical efficiency and allocative efficiency. The result presented in Table 1 shows that the cost efficency of rice farmers in Hau

Giang Province is at an average level and highly dispersed with the CE and the spread values is 0.656 and 0.394-1.000, respectively, in the Winter-Spring crop; 0.583 and 0.342-1.000 in the Summer-Autumn crop. Although farmers reasonably use the inputs with high technical efficiency, the allocative efficiency is still limited. This results in low cost efficiency. The average investment cost for the inputs of every household is 50% higher than the cost of the highest productivity households. The main reason of the ineffective cost is the unreasonable inputs' price. The result also points out that, if a farmer with low cost efficiency achieve the same level of cost efficiency as the households having the highest efficiency, he or she may save 0.344 currency unit (1- [0.656/1.000]).

3.4. Scale efficiency

The analytical result in Table 2 suggests that the average value of scale efficiency of rice farming households in Hau Giang Province is quite high (over 90%) in both Winter-Spring and Summer-Autumn crops. This proves that the rice-producing households in the study area have reasonable production scales. In both Winter-Spring and Summer-Autumn crops, households are in the area of Increasing Returns to Scales (IRS) and the majority reach the optimal scale. The number of households that require the Decreasing Returns to Scale (DRS) to improve their production efficiency is low. In addition to this, the result indicates that rice farmers in Hau Giang Province have made good use of production resources. Farmers who wish to increase the scale efficiency should use more inputs on the available rice planting zone combined with a reasonable price allocation to increase productivity, thereby enhancing production efficiency. Households that are in DRS areas should reduce the inputs (fertilizer, pesticide, labor, etc.) to achieve optimal production efficiency.

Table 2: Scale efficiency of rice farming households

Scale efficiency	Winter-Spring crop		Summer-Autumn crop	
	Number of households	Percentage (%)	Number of households	Percentage (%)
Total number of households	250	100.0	250	100.0
Households with IRS	137	54.8	170	68.0
Households with DRS	11	4.4	3	1.2
Households with CRS	102	40.8	77	30.8
Mean SE	0.964		0.931	
Min	0.707		0.674	
Max	1.000		1.000	

4. CONCLUSION AND IMPLICATIONS

In general, the study has achieved the goals to evaluate the production efficiency and scale efficiency of rice farmers in Hau Giang Province. In case the scale does not affect the production performance, rice farming households in Hau Giang Province achieve high technical efficiency, good allocative efficiency, and average cost efficiency. This result is the evidence for the inappropriate allocation of resources and the unreasonable combination of these resources with the inputs' price. However, if the production efficiency depends on the production scale, most households achieve high scale efficiency, many households reach optimal scale efficiency. Also, the research result confirms that rice farming households can reduce production costs by regulating and allocating input resources. Rice farmers in Hau Giang Province may consider the input allocation proposed from the result of the DEA model below to improve production efficiency.

Table 3: Input allocation based on field surveys and results from the DEA model for rice farmers in Hau Giang Province

Input factor	Winter-Spring crop		Summer-Autumn crop	
	Reality	Proposals from the model	Reality	Proposals from the model
Seed (kg/ha)	154.34	136.73	182.68	102.17
URE fertilizer (Kg/ha)	114.84	34.34	127.53	40.20
DAP fertilizer (Kg/ha)	98.81	31.40	109.47	40.20
LAN fertilizer (Kg/ha)	7.04	3.18	7.40	3.42
KALI fertilizer (Kg/ha)	60.40	21.89	71.88	18.76
NPK fertilizer (Kg/ha)	52.57	209.16	53.55	217.60
Herbicide (Liter/ha)	680.84	593.92	639.46	619.37
Pesticide (Liter/ha)	3023.57	2449.68	3079.62	2082.94
Growth stimulant (Liter/ha)	701.71	571.17	689.05	497.92
Fuel (Liter/ha)	34.65	26.89	48.44	46.08
Labor (Day/ha)	15.27	12.51	14.80	9.79
Equipment (Hour/ha)	13.97	9.35	14.51	10.42

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