The Effect of Rainmaking Service on Maize, Cassava and Sugarcane Yields in Lamtakhong River Basin, Nakhon Ratchasima Province, Thailand

Nongnooch Poramacom
Department of Agricultural and Resource Economics
Faculty of Economics
Kasetsart University
Bangkok 10900, Thailand

Abstract

The aim of the research was to analyze the cost of rainmaking services on maize, cassava and sugarcane in the Lamtakhong River Basin in Nakhon Ratchasima Province, Thailand. The results will assist the Bureau of Royal Rainmaking and Agricultural Aviation to decrease rainmaking service expenditure and increase the effectiveness of the service in the future. Data were collected on costs and returns of maize, cassava and sugarcane grown in the 2006/2007 crop year in Sungnun district. Data were collected through interviews with 30 maize, 30 cassava and 30 sugarcane farmers receiving rainmaking services and with the same number of both types of farmers not receiving rainmaking services. Regression analysis and t-test analysis were then made. The results showed that rainmaking expenditure can be reduced by conducting rainmaking operations only from March to October. The quantity of rainfall affected statistically the maize yields.

Keywords: Cobb-Douglas production function, cost of rainmaking service, Lamtakhong River Basin

Introduction

Since 1971, the Royal Rainmaking Project created by King Bhumiphol, the King of Thailand, has endeavored to alleviate these drought problems throughout the country. The Lamtakhong River Basin, which is the major river basin in Nakhon Ratchasima province in north-eastern Thailand, faces drought problems and has received rainmaking services for several years. This research evaluated the output levels and net incomes of farms growing maize, cassava and sugarcane that were receiving rainmaking services. The results provide input to enable the Bureau of Royal Rainmaking and Agricultural Aviation to improve its services. The purposes of the research were to: analyze the costs of rainmaking services in the Lamtakhong River Basin, Nakhon Ratchasima province; analyze the costs and returns of crop production; and increase the effectiveness of rainmaking services. Data on costs and returns for maize, cassava and sugarcane grown in the 2006/2007 crop year were collected in Sungnun, Dankumtod and Kong districts of Nakhon Ratchasima province. Maize farms in Sungnun district, which received rainmaking services, were compared with maize farms in Dankuntod district, which did not receive rainmaking services; while cassava farms in Sungnun district, which received rainmaking services, were compared with cassava farms in Kong district, which did not receive rainmaking services**;** while sugarcane farms in Sungnun district, which received rainmaking services, were compared with sugarcane farms in Kong district, which did not receive rainmaking services**.**

Objectives

The objectives of this study were to:

1) identify farmers' perception regarding water needs and rainmaking services
2) analyze the costs and returns of maize, cassava and sugarcane production
3) analyze factors affecting maize, cassava and sugarcane yields

Literature Review

Knut Wicksell (1851–1926) proposed Cobb-Douglas production function, and the function was tested against statistical evidence by Charles Cobb and Paul Douglas during the period from 1900 to 1928. Just and Pope (1979) employed a Cobb-Douglas production form and estimated the standard deviation of the output.

Doll and Orazem (1984) also applied the Cobb-Douglas production function and suggested independent variables, such as land, labor, and capital. Felipe and Adams (2005) proposed the estimation of the Cobb-Douglas production: a retrospective. Independent variables were labor and capital. Muro (2013) derived a three sector Cobb-Douglas GDP function including three goods (agriculture, manufacturing and services) and three sectors (capital, labor and land).

The Cobb-Douglas production function has been applied by several economists, including Poramacom (2011), and Hossasim, Majamder and Besak (2012). Poramacom(2011) applied Cobb-Douglas production function for farmers in Sa Kaeo province in Thailand. Data were collected through interviews with 30 maize and 30 cassava farmers receiving rainmaking services and with the same number of both types of farmers not receiving rainmaking services. Comparisons of maize and cassava farming with and without rainmaking services were then made using regression analysis. Hossasim, Majamder and Besak (2012) analyzed 16 manufacturing industries in Bangladesh. Their research considered Cobb-Douglas production function with additive error and multiplicative error term. They found that the Cobb-Douglas production function with additive error performed better for the selected manufacturing industries based on the survey data. There are economies of scale in the manufacturing for example of Drug, Furnirure, Iron, etc.

Based on Doll and Orazem(1984), Poramacom (2011) and Hossasim, Majamder and Besak (2012), the present study also applied the Cobb-Douglas production function; in addition, labor, use of seed or shoots, chemical fertilizers, chemical pesticides and herbicides, and the numbers of rainfall days were included as independent variables.

Methodology

Data

The primary data on costs and returns for the 2006/2007 crop year were collected by interviewing farmers selected using a purposive sampling technique. Through interviews with rainmaking service officers, it was found that the district of Sungnun had received rainmaking services and the district of Dankuntod and Kong had not. Samples of 30 maize farmers in Sungnun district and 30 in Dankuntod district, 30 cassava farmers in Sungnun district and 30 in Kong district and 30 sugarcane farmers in Sungnun district and 30 in Kong district were interviewed.

Analysis

The costs and returns for each cash crop were analyzed and the fixed and variable costs were calculated. A comparison of farming with and without rainmaking services was used to explain the output of the rainmaking service. A comparison of the number of rainfall days and rainmaking service days was taken to indicate the effectiveness of the rainmaking service.

Model

The Cobb-Douglas production function was applied to analyze factors affecting maize, cassava and sugarcane yields, with and without rainmaking services. The model was composed of factors affecting the output level, including the quantity of rainfall as a factor of the rainmaking service (Equations 1 and 2):

$$Y_i = a_i X_{i1}^{b_i} X_{i2}^{c_i} X_{i3}^{f_i} X_{i4}^{g_i} X_{i5}^{h_i} e^{U} \qquad (1)$$

$$\ln Y_i = \ln a_i + b_i \ln X_{i1} + c_i \ln X_{i2} + f_i \ln X_{i3} + g_i \ln X_{i4} + h_i \ln X_{i5} + U_i \qquad (2)$$

Where, y_i = yield (kg ha^{-1})

x_{i1} = seed used (kg ha^{-1})

x_{i2} = chemical fertilizer used (kg ha^{-1})

x_{i3} = chemical pesticides used (kg ha^{-1})

x_{i4} = labor used (workers ha^{-1})

x_{i5} = numbers of rainfall day (mm)

i = 1 maize, i = 2 cassava, i = 3 sugarcane

Results and Discussion

Maize production

Of the 60 maize farmers with rainmaking services, 25 (41.67%) claimed that they had adequate water for their maize during the 2006/2007 crop year. The major sources of information were local officers and the television. All farmers believed that the rainmaking services were still inadequate. Farmers wanted rainmaking services during the period from July to October.

Cassava production

Of the 60 cassava farmers with rainmaking services, 15 (25.00%) claimed that they had adequate water for their cassava during the 2006/2007 crop year. The major sources of information were radio and the television. All farmers believed that the rainmaking services were still inadequate. Farmers wanted rainmaking services during the period from March to October.

Sugarcane production

A small proportion (28.33%) of the sugarcane farmers receiving rainmaking services claimed that they had inadequate water for their sugarcane during the 2006/2007 crop year. Their major sources of information were television and the radio. Most farmers believed that the rainmaking services were still inadequate. Sugarcane farmers wanted rainmaking services during the period from February to October.

Cost and return analysis

The total cost per kilogram of maize, cassava and sugarcane were USD 0.13, 0.02 and 0.02, and the returns on these crops were 0.18, 0.03 and 0.02, respectively. Maize farmers received net returns of USD 0.05 per kilogram and cassava farmers received USD 0.01 per kilogram. Table 1 shows that net return per hectare of maize was higher than cassava farms and sugarcane farms, USD 101.03, 55.92 and -76/05, respectively.

Table 1 Costs and returns of cash crops in the 2006/2007 crop year, in Sungnun district. Unless indicated otherwise, all data are in USD ha^{-1}

Items	Maize	Cassava	Sugarcane
Variable cost	515.92	483.09	1,147.12
1. Labor cost	257.55	347.66	433.6
1.1 Labor cost	111.51	185.51	208.94
1.2 Machine rent cost	146.04	161.78	225.17
2. Material cost (seed, fertilizer, etc.)	258.36	110.19	713.51
3. Opportunity cost of labor and material cost	35.99	22.2	86.03
Fixed cost	99.87	83.18	105.55
1. Land rent	69.96	48.64	69.98
2. Depreciation cost of machine	29.91	34.53	35.57
Cost per hectare	615.79	566.28	1,252.67
Yield per hectare (kg)	4,495.87	19,184.63	53,747.06
Yield per hectare		622.2	
Net return per hectare	806.82		1,176.62
		55.92	-76.05
	191.03		
Return (USD kg^{-1})	0.18	0.03	0.02
Total cost (USD kg^{-1})	0.13	0.02	0.02
Net return (USD kg^{-1})	0.04	0.01	0.00
Number of farm (units)	36	43	52

Note: (USD 1 = 37 baht in Thai currency)

Results of production function

Table 2 presents the regression results. For maize production with rainmaking services, the factors of rainfall, labor and chemical fertilizer had statistically significant effects on maize yield at the .05, .05 and .01 level, respectively, indicating that these factors were positively related to maize yield. For cassava production with rainmaking services, the factors of chemical fertilizer, chemical, shoot and capital had statistically significant effects on cassava yield at the .1, .1, .05 and .05 level, respectively, indicating that these factors were positively related to cassava yield. The rainfall coefficient for maize farming with rainmaking services was 0.131.

For sugarcane growing in Sungnun district, which received rainmaking services, labor and the root type used had statistically significant effects on sugarcane yield at the .1 and .01 level, respectively. However, the Cobb-Douglas model has some limitations, since the model does not take into account input interaction effects, which affect somewhat the significance in yield. This study assumed all other factors, besides rainmaking services, were the same. In reality, there are other factors that affect productivity, such as the quality of land, types of chemical pesticides and herbicides or fertilizer used, and farmer practice, but these were not included in the model.

Table 2 Estimated coefficients of crop production of maize, cassava and sugarcane in Nakhon Ratchasima province, 2006/2007 crop year

Independent variable	Maize	Cassava	Sugarcane
Constant	3.976 (9.797)	2.734 (-1.662)	5.814 (6.539)
Chemical fertilizer	0.088 (5.292)***	0.209 (1.757)*	0
Chemical	0	0.249 (1.695)*	0
Numbers of rainfall day	0.131 (2.671)**	0.122 (1.053)	-0.153 (-2.673)
Seed, root, or shoot	0	0.450 (3.310)**	0.520 (4.199)***
Capital	0	0.107 (2.181)**	0
Labor	0.114 (2.403)**	0	0.079 (1.821)*
Adjusted R	59.05%	25.20%	45.42%
F-value	14.459	1.898	8.490
n	36	43	52

* = $p < .1$
** = $p < .05$
*** = $p < .01$

Comparison of yields with rainmaking service and no rainmaking service

Table 3 presents a comparison of the yield and the rainfall for maize, cassava and sugarcane using the t-test. There were statistically significant differences at the .10 level and .05 level for the rainfall and for maize and cassava farms between the areas with and without rainmaking services, respectively. In the areas with rainmaking services, however, the greater quantities of rainfall might not produce higher levels of yield than those in areas without rainmaking service. Even so, rainmaking services were effective in increasing the rainfall. Nevertheless, it should be pointed out that natural rain cannot be separated from artificial rain (the product of rainmaking), and so the rainfall in this study would be composed of part natural rain and part artificial rain. Rainmaking operations meet with success only if the appropriate conditions for cloud, temperature, and moisture exist; if they do not, no rain will fall. A comparison of the areas with rainmaking services with those without rainmaking services explained the output of the rainmaking service.

Table 3 Comparison of rainmaking target area and other area

	Maize		Cassava		Sugarcane	
	Sungnun district	Dankun tod district	Sungnun district	Kong District	Sungnun district	Kong District
t-test	0.274		1.410		0.290	
Yield (kg ha^{-1})	4,495.87	4,605.50	19,184.63	23,217.06	53,747.06	52,226.81
t-test	2.715**		2.212*		0.339	
Numbers of rainfall day (days)	26.41	15.14	32.28	20.93	24.80	23.63

** = p < .05
* = p < .10

Rainmaking service expenditure

The number of days with rain (93 d) accounted for 104.49 percent of the total rainmaking services (Table 4). The rainmaking services in October were less effective than that in any other months; during the 22 d of service, there were only 11 d of rainfall. The rainfall in Nakhon Ratchasima province was 1,150.90 mm from October 2006 to September 2007 (2007 fiscal budget year). The rainmaking cost per millimeter of rain was USD 256.47.

Table 4 Rainmaking service expenditure in Nakhon Ratchasima province, from October 2006 to September 2007 (USD)

Month and years of service	Number of service days (d)	Variable cost-chemical, wage and gas	Fixed cost-depreciation of airplanes	Numbers of rainfall days (d)	Rainfall in Nakhon Ratchasima Province (mm)
2006-October	22	43,667.16		11	255.4
2006- November	9	15,552.24		2	3.5
2007-March	2	2,676.54		8	44.3
2007-May	16	22,017.86		19	254.3
2007-June	8	10,578.89		11	106.3
2007-July	6	7,934.16		10	132.2
2007-Aug	13	80,348.68		17	157
2007-Sept	13	71,584.59		15	147.9
Total	89	254,360.10	40,816	***93***	***1150.9***
Total expenditure		***295,176.10***			
Percentage of rainfall days (%)	***104.49***				

Source: Bureau of Royal Rainmaking and Agricultural Aviation and Office of Thai Meteorological Department and Nakhon Ratchasima Meteorological Office.

Conclusion and Recommendations

The following conclusions can be drawn from the study:

1. Maize farmers needed rainmaking services from July to October. Cassava farmers needed rainmaking services from March to October. Sugarcane production needed rainmaking services from March to October. To reduce rainmaking service expenditure, the Bureau of Royal Rainmaking and Agricultural Aviation could provide services when farmers need them. However, whether there is rainfall depends on clouds and other atmospheric conditions. Local officers, television and the radio were the major sources of information for farmers and therefore, the Bureau of Royal Rainmaking and Agricultural Aviation should convey their information through these means.
2. Maize and cassava farms gained a positive net return per kilogram. Besides rainfall, the yield might be dependent on other factors excluded from the study, such as land quality.
3. Based on the Cobb-Douglas production function, the numbers of rainfall day affected the maize yield. In addition, it was also found that the quantities of rainfall were significantly different for both maize and cassava farms when the areas with and without rainmaking services were compared. Therefore, the Bureau of Royal Rainmaking and Agricultural Aviation should provide sufficient rainmaking services to these farms.
4. In order to improve the effectiveness of the rainmaking service, the Bureau of Royal Rainmaking and Agricultural Aviation should adjust the service based on the possibility of rain, since there were 11 d with rain in October after 22 d of rainmaking operations.

Research Limitations

The rainmaking service can be successful only if the necessary operational environmental parameters of cloud, temperature and moisture are present; in their absence, no rain will fall. Moreover, it is not possible to exclude natural rain from the artificial rain (rainmaking service). The rainfall in the study would be composed of part natural and part artificial rain.

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