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Marte, Winston E
Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University : Instituto Dominicano de Investigaciones Agropecuarias y Forestales-IDIAF

Nanseki, Teruaki
Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

Takeuchi, Shigeyoshi
Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

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Towards Farm Management Strategies on Dominican Rice Farming under DR–CAFTA: A Case Study of Monte Cristi Province

Winston E. MARTE[1], Teruaki NANSEKI[2]* and Shigeyoshi TAKEUCHI[2]

Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University, Fukuoka 812–8581, Japan
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Rice is the main staple food crop in the Dominican Republic (DR). Although 45% of the rice farmers hold less than 4 ha, rice plays a significant role in food security and provision of employments. However, the process of trade liberalisation given by the Dominican Republic, Central America and the United States of America free trade agreement (DR–CAFTA) questions the viability of Dominican rice farming. Besides, the US rice farmers have larger farms, better access to technology and credit and higher yield compared to those in the DR. This calls for sound management strategies and policies to overcome some of the forthcoming effects of the DR–CAFTA on the Dominican rice farming. Thus, this study identifies and evaluates the Dominican rice farmers' agronomic and economic strategies on this FTA. The analysis used cross–sectional survey data collected from 93 rice farmers in Monte Cristi province. The results indicate that to reduce rice–production costs, self–financing, and expanding farmland size were the main agronomic strategies. While land levelling, buying certified seeds, and increasing yield were the main economic strategies. The evaluation of these strategies revealed that fertilizer, machinery service costs and paid interest on operating capital were key components to reduce rice–production costs. Further, results indicate increasing returns to scale for rice farmers. To undertake such strategies, the transformation of farmers' association to a cooperative is a promising strategy from farmers' side.

Key words: Dominican Republic, DR–CAFTA, farm management strategies, rice farming

INTRODUCTION

Rice is the most important staple food crop in the Dominican Republic (DR), accounting for 0.5% of the country's GDP and providing close to 250,000 direct and indirect employments in 2009 (Central Bank of the Dominican Republic, 2010). There are over 30,000 farmers growing rice and nearly 45% of them are holding farms of less than 4 ha, on average (Ministry of Agriculture of the Dominican Republic, 1999). This indicates that rice production mainly takes place on small holding farms. Therefore, small farms play an important role in food security, poverty alleviation, and employment provision. Under such circumstances, the ongoing process of trade liberalisation provided by the Dominican Republic, Central America and the United States of America Free Trade Agreement' (DR–CAFTA) questions the viability of rice farming in the DR. This agreement has been seen as the most transcendental policy change in the nation, which may bring new opportunities, challenges, and issues, not only for the agricultural sector but also for the whole economy as well. It is well known that increased free trade can improve social welfare and facilitate more efficient resource allocation (Cramer *et al.*, 1993). Furthermore, free trade could substantially contribute to price stabilisation since price movements are magnified when large sectors of the world economy are effectively protected from changing conditions in the world economy (Shei and Thompson, 2001). Thus, DR–CAFTA is expected to increase production and export of vegetables and tropical fruits from the DR to the USA. In a country such as the DR, on the other hand, tariffs and nontariff trade barriers have been preventing world market price signals to be reflected in staple food crops such as rice, beans, potatoes, poultry meat, and milk, cutting down the link between world market and domestic prices. This isolation from world market prices may cause domestic farmers to produce commodities at a higher cost than those countries that do permit the linkage between international and domestic prices. Findings in the literature suggest that this is because rice and other staple food market liberalisation would have a profound impact on producer welfare as well as on government budget.

Another factor that causes rice farmers to fear the effects of this FTA is the great differences among Dominican and the US rice sectors. For instance, the average size of a rice farm in the DR is approximately 4.3 ha, while the US rice farm is approximately 160 ha (over 30 times larger than Dominican rice farms). In addition, the US rice farmers' yield is 5.16 t/ha, while the Dominican rice farmers' yield is 3.11 t/ha (Kyushu University, 2011). This indicates a yield gap in favour of

[1] Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University; Instituto Dominicano de Investigaciones Agropecuarias y Forestales–IDIAF, 10147, Dominican Republic

[2] Laboratory of Agricultural and Farm Management, Division of International Agricultural Resource Economics and Business Administration, Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

* Corresponding author (nanseki@agr.kyushu–u.ac.jp)

the US rice farmers greater than 2 t/ha compared to the Dominican rice farmers' yield. Also, the changes in trade policy introduced by this FTA have been raising concerns among players of this sector, such as rice millers, input suppliers, and moneylenders.

According to Marte *et al*. (2009), in an estimation of the impacts of the DR–CAFTA on Dominican rice farming, this FTA will have significant effects on rice farmers, greater than USD300 million per year, eventually leaving many of them out of the rice sector. Considering the effects that this FTA would have on the Dominican rice sector, farm management strategies constitute a key factor to approach some of the challenges given by this FTA.

Thus, the objectives of this study are to identify and evaluate rice farmers' agronomic and economic strategies on DR–CAFTA and to seek farm management strategies aiming to overcome some of the forthcoming outcomes of this FTA. This study provides useful information on determining alternative strategies and policies, since it is the first of its kind to report on this issue in the DR.

DATA AND METHODOLOGY

Study area and survey method

The Ministry of Agriculture of the Dominican Republic (MADR) has established eight agricultural regions. These regions are composed of provinces. Rice production mainly takes place in seven agricultural regions with a total area under rice cultivation of 155,915 ha as for 2008. The largest rice producing region is the northeast region, which shared 41% (64,711 ha) of total rice production area, followed by the northwest region which shared 29% (45,463 ha) of the total area under rice production (MADR, 2010). The study site of this research corresponds to Monte Cristi province, which is located in the northwest region. In this sense, Monte Cristi province shared 17% (26,000 ha) of the country's total area under rice production. Therefore, the results of this study would be useful for other rice producing areas across the country. In this province, agriculture is the most important economic activity, mainly producing rice, bananas, and plantains; as well as raising sheep, goats, and cows, but less intensively. Rice production is at the cornerstone of the residents' livelihood since it is the main source of employment, followed by banana production. In addition, rice farmers believe that this is one of the most efficient rice producing areas in the DR.

The data used in this study is derived from a cross–sectional survey conducted between March and April 2008 on over 93 rice farmers in Monte Cristi province. Data was collected through a face–to–face interview using a structured questionnaire. The questionnaires were administered to the respondents by three enumerators and the first author, who also administered the process of the questionnaires to the farmers. The interviewed farmers were randomly selected from the San Fernando de Monte Cristi, Castañuelas, Las Matas de Santa Cruz, and Villa Vasquez municipalities, where rice production is mostly concentrated. It is worth stating that the agro–climatic conditions in the DR allow rice farmers to grow rice during the whole year, having two cultivation seasons per year.

Data was collected on farm area, costs of production and output. Farmers were also interviewed on sources of credit, marketing, economic and agronomic strategies to overcome DR–CAFTA outcomes and producers' specific characteristics. Information obtained from the farmers included amounts and types of improved and owned inputs used, and amounts and types of labour used in rice farming.

Testing the returns to scale

Since most of the farmers in the study site would like to expand farmland size as one of the main economic strategies to deal with the DR–CAFTA and the total area under rice production has been increasing over time, the return to scale is tested under the farmers' current situation. To find out about returns to scale in agriculture, a Cobb–Douglas production function type is typically used. In a production function approach, differences in output across farms are explained by differences in the levels of inputs, both conventional (e.g. land, labour, machinery and improved inputs) and non–conventional (e.g. land quality, physical infrastructure, research, government policies and farmer idiosyncratic factors). The Cobb–Douglas production function is used here because of its ease of manipulation and interpretation. It is also worth stating that this functional form has been widely used in economies of scale analysis in both developed and developing countries. Therefore, in order to examine the contribution of three conventional inputs to rice yield, namely machinery service costs, fertilizer input costs and labour input costs, the Cobb–Douglas production function is estimated, and its specification is as follows:

$$Y = AX_1^{\beta 1}X_2^{\beta 2}\ldots + X_n^{\beta n} \quad (1)$$

Usually for ease of computation, the power function is transformed into a linear function by taking the natural logarithm of the dependent and independent variables, as illustrated below.

$$\mathrm{Ln}Y = \mathrm{Ln}A + \beta_1\mathrm{Ln}(X_1) + \beta_2\mathrm{Ln}(X_2) + \beta_3\mathrm{Ln}(X_3) + e \quad (2)$$

Where Y is yield expressed in *fanega*[1]/ha, A is the constant term, X_1 is machinery service cost in Dominican Republic's peso (RD$[2])/ha, X_2 is fertilizer input cost in RD$/ha, X_3 is labour input cost in RD$/ha, β_i is the coefficient (elasticity) of input X_i, and e is the error term. The estimation was done based on 89 sample–farmers who do not possess any type of agricultural machinery and using the Ordinary Least Square (OLS) method. The

[1] One fanega is approximately 100 kg of rough rice

[2] As for April 2008, one USD = RD$34

sum of the estimated coefficients will provide information on returns to scale, that is to say, the response of output to a proportionate change in the inputs: i.e. if $\beta_1+\beta_2\ldots+\beta_n = 1$, then there are constant returns to scale; if $\beta_1+\beta_2\ldots+\beta_n < 1$, then there are decreasing returns to scale; if $\beta_1+\beta_2\ldots+\beta_n > 1$, there are increasing returns to scale.

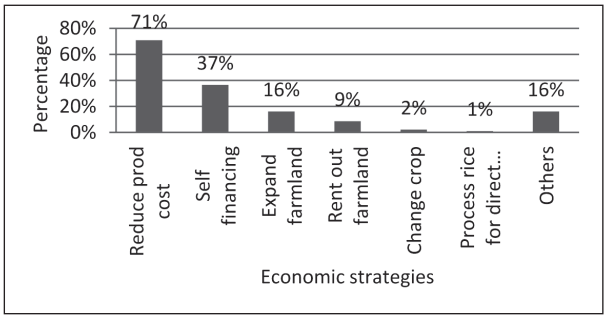
RESULTS AND DISCUSSION

Survey results

The Dominican Republic, Central America, and the United States of America Free Trade Agreement (DR–CAFTA) awareness and strategies

The data suggests that 27% of the sample rice farmers have no knowledge at all on this FTA, and 26% of them know almost nothing at all; in turn, 34% said to have little knowledge, and only 8% of them said to possess much knowledge regarding DR–CAFTA. This indicates that over 50% of the sample–farmers were almost completely unaware of anything regarding this FTA.

To improve rice farming competitiveness in light of DR–CAFTA circumstances, the farmers' economic and agronomic strategies are important. Figure 1 shows the main economic and agronomic strategies chosen by sample–farmers. In this regard, survey data indicates that 71% of the sample–farmers have chosen reducing rice–production costs, self–financing (37%), and expanding farmland size (16%) as the main economic strategies. The set of economic strategies is completed by others (16%), renting out farmland (9%), changing crops (2%) and processing (milling) rice for direct selling (1%). Regarding agronomic strategies, about 61% of the farmers have chosen land levelling as the main agronomic strategy followed by purchasing certified seeds (32%), and increasing rice yield (31%). The rest of the agronomic strategies included changing rice variety (29%), changing rice planting systems (introduction of mechanized planting system) (28%), others (10%), and hiring consultation services (3%). This reveals that land levelling, along with quality of the rice seeds and increasing rice yield constituted the main agronomic strategies of rice farmers in the survey site.



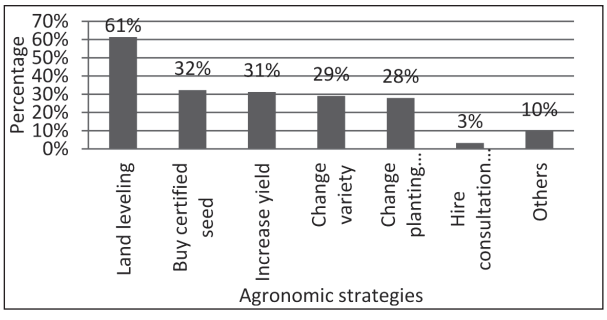


Fig. 1. Sample–farmers' economic and agronomic strategies.

Socio–economic characteristics and cost structure

This section provides information on sample–farmers' land size, sources of land, cost structure by farm categories on average per ha, average yield, sale price and revenue. Information regarding farmers' assets, credit sources and farmers' association structures are also provided. The operational holding in the study site ranged from 0.5 to 100 ha. The sample–farmers hold 6.2 ha on average, which is greater than the national average (4.3 ha). Over 42% of farmers hold farms between 2–4 ha and about 19% between 1–2 ha.

Approximately 7% of the surveyed farmers hold farms of less than 1 ha, while 8.5% had farms between 4–6 ha and 7.4% farmed areas larger than 20 ha. This indicates that most of the farmers in the survey site relied on medium (2–4 ha) to small (1–2 ha) holding farms to grow rice. Regarding sources of land, the government allocation programme shared 70% of the sample–farmers, followed by purchased land (11.7%), inherited land from parents or relatives (9.5%), and rented–in factors (8.5%). This suggests that the government allocation programme, agrarian reform, was the predominant source of land acquisition. According to the agrarian reform law, granted farms are managed by individual farm families that only have the right to grow crops on those lands, that is to say, they do not own the lands.

Since 71% of the sample–farmers have pointed out to reduce rice–production costs as one of the economic strategies to deal with DR–CAFTA's outcomes, the cost structure of rice production by farm categories along with rice yield, sale price, and revenue is examined. Total cost figures in table 1 indicate that as long as farmers expand land size up to 6 ha, average costs per ha decrease. This suggests that farmers could increase farmland size up to 6 ha or close to that size. When examining the cost structure components, fertilizer input represented the higher cost, followed by machinery service costs (land preparation, harvesting, and precision land levelling), paid interest on operating capital (credit) and labour input costs for all farm categories. These four cost items decreased up to 6 ha and then increased for farmers holding areas greater than 6 ha (large and very large categories). This implies that fertilizer costs, machinery service costs, paid interest on operating capital and labour costs constitute the key items to reduce rice–production costs.

Regarding rice yield, expressed in *fanega* per ha, survey data shows that farmers holding very small and small farms have higher yields than those holding larger farms. It seemed that the sample–farmers' rice yield decreases along with farm size. In the economic literature, this issue has been defined as an inverse relationship between productivity and farm size. Several explanations have been given to this puzzle in the literature on developing coun-

try agriculture. Benjamin (1995) and Lamb (2003) have pointed out that the inverse relationship could be due to unobservable land quality differences that are not adequately controlled in the regression analysis. More recently, Assuncao and Braido (2007) found out that unobserved farm attributes play an important role in explaining the puzzle rather than farmers' characteristics. In addition, this inverse relationship might occur because decision making is more complex for larger farm operations. Likewise, labour market failures have been suggested as another cause of the inverse relationship. Factors such as land and credit market failures, land fertility, differences in the intensity of land use, farm attributes and managerial factors may also play an important role in explaining the issue.

With regard to farmers' assets, 99% of farmers did not have any kinds of buildings or facilities devoted to rice farming, such as warehouses or milling processing facilities. In addition, 96% of rice producers did not have any type of agricultural machinery, and only 4% of them hold one type of machinery, which is the tractor. This indicates that most of the rice farmers relied on hired machinery services to carry out farm activities, such as land preparation, precision land levelling and harvesting.

Credit is an indispensable resource to produce rice in the study site since 98% of the surveyed farmers relied on credit to grow rice. Survey data indicates that rice sector moneylenders provided 48% of the overall credit for growing rice, this being the dominant source of credit for rice farming, followed by the Government Agricultural Bank (23%), commercial banks (9%), and others (18%), which include cooperatives, family or relative sources.

The data suggests that rice sector moneylenders charged the highest interest rate per crop season (19.6%) to rice farmers, followed by commercial banks (16.6%), others (14.8%), and the Government Agricultural Bank, which charges the lower interest rate (6.0%). Regardless of the credit source, all borrower farmers must repay the loans at harvest. Furthermore, 61% of the farmers had to repay the loans in kind while 39% in cash. Although, rice sector moneylenders charged the highest interest rate on rice production financing, they were the main source of financing resources. This may be not only because rice sector moneylenders required fewer prerequisites and credit seems to be more readily available compared to other sources but also due to the fact that commercial banks are reluctant to provide credit to agricultural businesses because they have to make higher provisions on agricultural loans, which are still considered high risk loans.

An interesting finding on the survey site is the rice farmers' association structure. Nonetheless, every rice farmer belongs to a farmers group or association (*Junta de Regantes* in Spanish), they are neither oriented to purchase inputs nor to get services through these groups and/or associations. In turn, these farmers groups are only oriented to manage water services and drainage canals maintenance. That is, rice farmers purchase inputs and get machinery services from credit provider sources, especially rice sector moneylenders. In addition, farmers who borrow money from rice sector moneylenders must purchase inputs and get machinery services from this credit source. Furthermore, close to 98% of the sample–farmers depended on loans with relatively high interest rates to produce rice, which have to be paidback at harvest, and they cannot use their lands as collateral to take loans from commercial banks that offer a lower interest rate on loans. Hence, farmers have very little (if

Table 1. Cost structure by farm categories on average per ha

Item	Very Small (<1 ha)	Small (1–2 ha)	Medium (2–4 ha)	Large Medium (4–6 ha)	Large (6–20 ha)	Very Large (>20 ha)
Number of farmers and %	7 (7.4%)	18 (19.1%)	40 (42.5%)	8 (8.5%)	14 (14.8%)	7 (7.4%)
Irrigation water cost	1,476	1,439	1,440	1,352	1,339	1,476
Herbicide cost	3,791	3,646	3,547	4,131	3,723	3,223
Pesticides cost	9,568	8,951	8,928	8,839	8,558	12,826
Fertilizer cost	28,639	20,923	19,971	19,346	23,433	24,168
Seed cost	7,631	5,806	7,160	5,517	6,077	6,695
Labour cost	12,094	11,225	11,032	10,996	11,003	10,856
Machinery services cost	16,559	16,487	16,018	15,605	15,913	15,221
Paid interest on operating capital	14,943	12,002	10,034	8,836	11,059	8,267
Fix cost (tractor)	0.0	0.0	0.0	3,021.8	2,021.7	674.7
Total cost	94,700.9	80,479.3	78,130.1	77,644.0	83,126.5	83,406.3
Cost (RD$[1] per *fanega*[2])	1,053.4	944.8	1,019.9	1,090.5	1,035.1	1,196.6
Yield (*fanega* per ha)	89.9	85.2	76.6	71.2	80.3	69.7
Sale price (RD$ per *fanega*)	1,296.4	1,310.8	1,267.8	1,305.0	1,317.8	1,334.2
Av Revenue per ha	109,605.0	109,382.9	96,804.0	92,199.0	104,730.6	92,248.3

Source: Survey data 2008.

[1]As of April 2008, one USD = RD$34; [2] One *fanega* is approximately 100 kg of rough rice

any) bargaining power even purchasing large amounts of inputs or hiring more machinery services. This is the case for pesticides, fertilizers, seed and hired machinery services costs shown in table 1, where the average expenditure per ha on these three inputs and hired machinery services increased for large and very large farm categories.

Crop enterprises available in the study site

Although only 2% of the sample–farmers have chosen to change their crop as one of the economic strategies, the crop enterprises available in the study site are analysed through a comparison. This analysis evaluates crops' profitability and crops' returns on labour cost input. These two indexes are important indicators to consider when changing crop. To do the analysis, survey results on rice–production costs, yield, selling prices, total revenue, gross margin–free–of–labour costs, labour costs, gross margin and a ratio of gross margin and labour costs are compared with other crop enterprises in the study site. The ratio of gross margin and labour costs provides information about returns on labour costs input. The comparison includes crop enterprises such as rice, whose national level aggregate data is compared to our survey data, banana, banana for export, paste tomato and taro. Although taro is not a traditional crop in the study site, it was included in the comparison based on its capability to be grown in rice fields and its potential to be exported. The details of this comparison are shown in table 2. The comparison indicates that paste tomato had the largest gross margin, followed by banana for export, taro, rice (survey data), etc. in the survey site. Although paste tomato had the higher labour costs, this enterprise had the largest return on labour cost input. This indicates that paste tomato is both the most labour intensive and the most profitable enterprise among the crops. Rice farmers in the study site had higher gross margins per ha compared to the national level aggregated data.

At the same time, sample–rice farmers had bigger return on labour cost input compared to national level aggregated data. This suggests that rice farmers in the study site were performing better compared to their national counterparts. Considering both gross margin and return on labour cost input, paste tomato was the most promising enterprise to change from rice production. Nonetheless, knowledge of paste tomato growing techniques in addition to pest and disease management is required. Likewise, this crop is likely to be more risky compared to rice and banana enterprises. For instance, four to five days of continue rainfall can easily stimulate a severe attack of diseases on paste tomato, while for rice and banana production this may not be a serious issue. Therefore, such crop management techniques and risk factors should be considered when shifting from rice farming to paste tomato.

Results on testing the returns to scale

The estimated results on testing the returns to scale of rice farmers in Monte Cristi are shown in table 3. The coefficient of determination for adjusted degree of freedom is 0.62, suggesting that the inputs included in the model explain approximately 62% of the variation in rice yield. The estimated coefficient on machinery service costs was highly statistically significant at 1% level. While the estimated coefficients on labour input costs and fertilizers input costs were not statistically significant. The estimated coefficient on machinery service costs was 2.06, indicating that the marginal product of this input increases with an increase of its utilisation. That is, a 1% increase in machinery service costs leads to 2.06% increase of rice yield. This result is not surprising since 61% of the sample–farmers have chosen land levelling as one of the agronomic strategies to overcome some of the effects of the DR–CAFTA on the rice sector. As noted above, machinery service costs are composed of land preparation (typically including plowing and harrowing), rice harvesting and precision land levelling. Since land preparation costs increase along with land size and harvesting costs rise proportionally to harvested amount, precision land levelling seems to be the component of machinery service costs that have greater impact on rice yield.

It is well known that a well–levelled rice field is a prerequisite for good water and crop management. An efficient land levelling will ensure more uniform distribution of the water in the field, reduce the time and amount of

Table 2. Comparison among crop enterprises in the study site, 2008

Crops	Cost (RD$[‡]/ha)	Yield (QQ[‡‡]/ha)	Price (RD$/QQ)	Total Revenue (RD$/ha)	Gross Margin–Free–of–Labour Cost (RD$/ha)	Labour cost (RD$/ha)	Gross Margin (RD$/ha)	Gross Margin/Labour cost
Rice survey[1]	69,981	160	1,294	207,040	137,059	11,201	125,858	11
Rice national[2]	68,400	138	1,353	186,173	117,773	26,496	91,277	3
Banana[2]	42,415	1680	94	157,920	115,505	25,008	90,497	4
Banana for export[2]	43,200	777	433	336,441	293,241	25,600	267,641	10
Paste tomato[2]	44,128	640	1,200	768,000	723,872	41,648	682,224	16
Taro[2]	52,304	178	1,478	263,202	210,898	37,328	173,570	5

[‡] As for April 2008, one USD = RD$34.00; [‡‡]One Quintal (QQ) = 45.45 kg

Source: [1] Survey data, 2008 (this is the average cost of the data provided in Table 1); [2] Ministry of Agriculture of the Dominican Republic, 2010

Table 3. Results of the Cobb–Douglas production function and returns to scale

	Constant term	Labour input cost (RD$/ha)	Fertilizer input cost (RD$/ha)	Machinery service cost (RD$/ha)	*R*–Squared	Adjusted *R*–Squared	Returns to scale
Output	−15.75***	0.37ns	0.07ns	2.06***	0.63	0.62	2.52
t–value	(–8.68)	(1.47)	(1.29)	(10.91)			

Source: Survey data 2008. ***, **, and * stand for statistically significant at 1%, 5%, and 10%, respectively; ns denotes not statistically significant

water to irrigate the field and improve crop establishment and management. On the other hand, when a rice field is not well–levelled water may get stagnated in the depressions and higher parts of the field may not get enough water. This causes uneven crop emergence and uneven early growth, emergence of additional weeds and uneven fertilizer distribution. This highlights the importance of a well–levelled field for rice production. In this sense, farmers who have good access to technology and credit may be able to take advantages of expanding farmland size. That is, because farmers would be able to afford the costs of introducing and/or adopting technologies such as precision land levelling to adapt new lands into rice production.

Table 3 shows that the sum of the estimated coefficients is greater than one (2.52), indicating that the sample rice farmers' agriculture is characterized by increasing returns to scale. This suggests that production was in stage one and thus indicates that farmers were not yet operating at the rational level. At the same time, this implies that an increase in inputs would lead to a greater increase in rice yield, proportionally. Further, the results on testing the returns to scale indicate that expanding farmland size would be a prospect to cope with some of the impacts of this FTA on the rice sector in the short term. Nonetheless, agriculture economics literature indicates that findings on returns to scale are mixed. Berry and Cline (1979) have reported constant returns to scale for developing countries' agriculture. However, several studies have found out decreasing returns to scale on rice farming though including capital factors as an independent variable in the models. Some of these studies include Appleton and Balihuta (1996) in Uganda, Weir and Knight (2004) in Ethiopia, and Asadullah and Rahman (2009) in Bangladesh. While Shehu and Mshelia (2007) and Omotesho *et al*. (2010) reported increasing returns to scale for rice farming in Nigeria. In this study, over 70% of the surveyed farmers have obtained their land throughout the government allocation programme. Generally speaking, most of the government allocated lands have good fertility, shape, relief and drainage capability, are located in suitable areas for growing rice with good access to water sources and are conveniently near roadsides. This implies that most of the good lands for rice cropping are already allocated and therefore farmers may face some land constraint when considering expanding farmland size. A significant feature of the agricultural land allocation programme is that beneficiary farmers are granted less than 4 ha on average because the government does not allocate larger farm sizes and beneficiary farmers have only the right to use that land for growing crop purposes, that is to say, grantee farmers are not allowed to sell the land legally or to use the land as collateral to borrow money. This suggests that when rice farmers decide to expand farm size, they would have to choose land areas that are considered marginal, since most of the good quality lands are already allocated. Table 1 also shows that these limitations on land quality, essentially land fertility, parcel relief and deficient irrigation infrastructure, may cause rice farmers that belong to large (6–20 ha) and very large (>20 ha) categories to apply larger amount of fertilizers, seeds and pesticides per ha than those who hold farms between 1 and 6 ha. Further, it is worthy to point out that the US rice farmers have larger farms, higher yield, better access to technology and credit, pay lower interest rates on loans for rice cropping and have more suitable agro–climatic conditions for rice cropping compared to the Dominican rice farmers. This points out the great differences among Dominican and US rice farmers.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study has identified and evaluated rice farmers' agronomic and economic strategies on DR–CAFTA and sought farm management strategies to overcome some of the forthcoming outcomes of this FTA on rice farming. Table 4 shows the set of agronomic and economic strategies with the corresponding alternatives and/or policies to undertake each one of the strategies. Land levelling, along with quality of rice seeds and increasing rice yield constituted the main agronomic strategies, while reducing rice–production costs, financing resources (credit) and expanding farm land size were the main economic strategies to rice farmers in the study site. Therefore, limited subsidies targeted to small farms on the adoption of new technologies, such as precision land levelling to help farmers to improve irrigation water–use efficiency, are needed. In addition, public investment addressed to the development of physical infrastructures such as road, transportation, irrigation and drainage canal must be increased.

The cost structure of sample–farmers has been examined. Expenditures on fertilizers, machinery services, interest on operating capital and labour costs constituted the key components of rice–production costs. Among the credit sources available in the study site, rice sector

Table 4. Set of strategies and corresponding alternatives and/or policies

	Alternative and policies		
Farmers' strategies	Coop	Education and training	Subsidies
Economic strategies			
Reduce rice–production cost	o	o	
Self–financing	o		
Expand farmland	o	o	
Rent out farmland	o		
Change crop		o	
Process rice for direct selling	o		
Agronomic strategies			
Land levelling	o		o
Buy rice certified seeds	o		
Increase rice yield	o	o	
Change rice variety	o	o	
Change planting system	o		o

moneylenders charged the highest interest rate on loans for rice production. At the same time, rice sector moneylenders constituted the main source of credit for farmers.

Although every farmer belonged to an association, they were neither oriented to purchase inputs nor to hire services. Therefore, the reorientation of the farmers' association to a different organisation structure such as a cooperative may help farmers to have lower interest rate on credits, better technical assistance service, cheaper inputs (fertilizers, pesticides, etc.), machinery services and better marketing strategies. Access to credit at low interest rates would facilitate the undertaking of precision land levelling and other technologies allowing rice farmers to reduce production costs and therefore improve efficiency. In this sense, cooperatives not only play an important role in gathering financial resources that can be lent to farmers at low interest rates but also in providing machinery services at a lower cost to their members compared to market prices. At the same time, cooperatives can help farmers to market products much more efficiently by upgrading quality and developing new markets for products. Through a cooperative, farmers could establish rice milling facilities to process rice for direct selling in the market, thus increasing farmers' profits. The provision of these services by the farmers' cooperative may contribute to significantly decreasing rice–production costs and also to develop own brands.

The crop enterprises available in the study site have been compared. Rice (survey data) was found to be the fourth profitable crop from the gross margin perspective, while from the returns on labour input point of view, rice was ranked as the second best enterprise. Likewise, banana for export was performing relatively well since it had the second highest gross margin and the third largest returns on labour costs input. Meanwhile, paste tomato was found to be the most profitable enterprise from both points of view, gross margin and returns on labour cost input. Nonetheless, knowledge on paste tomato growing techniques and pest and disease management is necessary when considering shifting from rice farming to paste tomato. Therefore, policies addressed to promote the development of high–value commodities such as paste tomato and banana for export are required. In this sense, education and training on crop, pest, and disease management and good agricultural practices are needed before and during the transition process.

Considering that most of the sample–farmers identified expanding farmland size as one of the main economic strategies to cope with some of the effects of DR–CAFTA, the returns to scale on rice farming in Monte Cristi province has been tested using a Cobb–Douglas production function approach. The results indicate that the sample–farms were characterised by increasing returns to scale. The undertaking of this strategy calls for investment on precision land levelling technology since this is the most promising input to increase rice yield in the study site. Nonetheless, the US rice farmers are far above compared with the Dominican rice farmers regarding farm levelling, farm size, yield, access to credit and technology and interest paid on loans for rice cropping. In addition, Dominican rice farmers may face land constraints when expanding farm size since most of the good lands are already allocated. Therefore, simply expanding farm size may not be enough to compete with the US rice farmers. Thus, perspectives on the small scale rice farmers' viability under the ongoing process of trade liberalisation are highly questionable.

To improve rice farmers' viability, strategies from the sector stakeholders (i.e. farmers and farmers' association, research institutions, extension service provider) are required. In this sense, a promising strategy from the farmers' side is the transformation of their associations to cooperatives. This process of transformation requires guidance and training from the Dominican Institute for Cooperative Development (IDECOOP) and the Ministry of Agriculture of the Dominican Republic (extension service). Training and education are at the cornerstone when considering the transformation of farmers' associations to cooperatives and the transition from rice farming to paste tomato and/or banana for export crop enterprises in the research site. This is even more important since Marte *et al.* (2011) have reported that farmers with 6 or more years of formal education tend to be more efficient when producing rice in Monte Cristi province. In addition, they found out that extension services were not properly being disseminated in the study site, calling to the need for stressing the importance of training and education for developing agriculture in this area. These policy options might help small scale farmers to overcome some of the DR–CAFTA's outcomes. Therefore, implementation by rice sector stakeholders should not be neglected. Further research, nonetheless, is required to analyse the implementation strategy of the suggested policies.

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