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Profitability and Profit Efficiency of Sugarcane Block Farming in Balayan, Batangas, the Philippines: An Empirical Study

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Abstract: This study aimed at determining the profitability and profit efficiency of sugarcane block farming in Balayan, Batangas, Philippines. Farm-level data obtained from 157 block farm members in Crop Years (CY) 2018-19 and 2019-20 were used and analyzed using a Cobb-Douglas stochastic frontier profit function model. Empirical results show that the block farm mean profitability is higher in CY 2019-20 than in CY 2018-19 by 27% in both gross margin and profit while only 5% for Revenue/Cost ratio. While the mean profit efficiency scores increased from 0.57 in CY 2018-19 to 0.77 in CY 2019-20. Although around 96% of the sample farms were inefficient in CY 2018-19, this became 100% in the succeeding year. With efficiency score of 0.77 for the current year, there is still opportunities to increase profit efficiency by 23% through the adoption of the best farm practices in the study area. The factors that influenced profit efficiency were the costs of power, man-animal, fertilizer, planting materials, labor, and fixed cost. Also, the number of trainings, number of planting materials, and frequency of weeding positively influenced efficiency. The sole constraint to efficiency was the use of N fertilizer (kg). Block farming had played its part in increasing farmers' profit efficiency through technology diffusion and adoption as various training, technical advisory and production support embedded in the program were provided to the members. Therefore, the Sugar Regulatory Administration (SRA) should continue organizing small farmers unto block. It should also organize service providers in the district to serve as a hub in providing production support services making productivity inputs (high yielding varieties and farm machinery) accessible in the area. Furthermore, SRA should expand the coverage of its Socialized Credit Program to enable farmers to modernize their farm operations and enhance their farm income and profit.

Keywords: Block Farming, Block Farms, Profitability, Profit Efficiency, Stochastic Frontier Approach, Sugarcane Farmers

1. Background of the Problem

Sugar is one of the Philippines' export commodities and its largest importer is the United States. In 2019, total production was $700 million, making sugar the fifth-largest agricultural crop product by value after rice, bananas, corn, and coconut. The industry contributes Php 76 billion annually to the national economy [19]. For Crop Year 2020-21, the industry produced 25.14 million MT of cane, 2. 13 million MT of raw sugar, and 746,090 MT of refined sugar. Domestic consumption of raw sugar (based on the volume of withdrawal from sugar mills) was around 1,752,746 metric tons, of which 50% was allotted for industrial users, 32% households, and 18% institutions such as restaurants, bakeshops, hospitals, and others. Around 65,000 farmers and 700,000 farm workers depend on the industry for livelihood and income.

Sugarcane is the main source of centrifugal or refined sugar in the country, however its total area declined from 421,358 hectares in CY 2016-17 to 398,478 hectares in CY 2020-21, of which, 80% are small-scaled farms, less than five hectares in size with an average productivity of 47.96 tons cane per hectare (TC/HA); 65.56 TC/HA for the bigger-scaled ones. For Luzon and Mindanao, the average area per farm size is 1.79 for the less than 5-hectare farm size class [21]. Expectedly, the farm size will decrease more due to the continuous implementation of the country's Comprehensive Agrarian Reform Program (CARP), rapid population growth, and death of farm owner-beneficiaries, which cause the already small farm size to be subdivided among multiple heirs.

Sugarcane is a plantation crop where economies of scale are important. Padilla-Fernandez and Nuthall [17] showed that the average optimum land size for sugarcane production is around 41 hectares, and further reported that this was lower than the optimum size (50 hectares) stated in the 1997 report of the Presidential Task Force on the Sugar Industry. Generally, plantation crops are high valued intended for export. To be competitive in the world market, crop production should be on a large scale to achieve economies of operation by labor-saving machinery. The land fragmentation caused by CARP especially has disturbed the plantation economy of the crop [7]. Fragmentation of sugar farms led to some 140,000 hectares being held by about 74,800 small farmers or holders of less than 5 hectares of farmland. These farmers generally have marginal capability to cultivate these lands [14].

De los Santos and Mendoza [5] proved this argument when they surveyed 304 Agrarian Reform Beneficiaries (ARBs) growing sugarcane during crop years 1994–1997. They learned that their per-hectare yield was 31 percent lower than that of non-ARB planters in the district. Evidently, small farmers could not raise the productivity of their land and therefore remain subsistence in farming.

With small sugarcane farm productivity hardly improving, the Department of Agrarian Reform (DAR) together with the Department of Agriculture (DA) through the Sugar Regulatory Administration (SRA) launched the Sugarcane Block Farming (SBF) program in 2011 to improve the technical and agribusiness entrepreneurial skills of CARP beneficiaries and their organizations, sugarcane farms owned/operated by members of agrarian reform beneficiary organizations (ARBOs), including cooperatives and farmers' associations under the Agrarian Reform Community Connectivity Economic and Support Services (ARCCESS). The goals were to reduce cost of production and increase farm productivity to 75 TC/HA. Under the SBF program, small farmers were organized by SRA unto block farms to become bigger to bring about economies of scale in sugarcane farming. Given the mechanization requirement of the crop, organizing, and consolidating the planting, harvesting, hauling and marketing of sugarcane will improve the farm-based income of CARP beneficiaries. Further, cheaper farm inputs, especially fertilizer, through bulk purchasing and labor contracting, will also increase farm profit.

Initial interventions were given to these block farms in the form of capacity-building, technical assistance, farm budgeting and planning and farm management support. From these interventions, the twelve (12) pilot block farms formed in 2012 were reported to have increased their productivity by 7.47% to 100% (average of 29%). The average increase in productivity would translate to an estimated average increase of farmers' income by Php 39,815.00 per hectare, at 1.96 LKG/TC and a composite price of P1,400 per LKG-bag of raw sugar, the SRA said. The sources of this wide and varying productivity and farm income have not been empirically established, likewise with farm profitability.

There is a concern among policymakers over the profitability and profit efficiency of the block farm members, especially now that the industry is experiencing market distortions, i.e. decreasing demand for sugar as the production of sugar-based products become limited due to the COVID-19 pandemic and even before it struck. At the same time, the continuous increasing cost of labor due to its shortage makes the cost of sugarcane production high. Also, the proliferation of artificial sweeteners, sugar substitutes and the practice of the government to import sugar to bring down its local price. All of these have consequences to sugarcane production hence the supply of sugar which eventually affects its price. One may ask, "Did the SBF program provide small farmers with improved income or sufficient protection from incurring losses due to price fluctuations brought about by market distortions?" Are the block farms' profitability and efficiency good enough to manage such situations?"

2. Objectives of the Study

The Sugarcane Block Farming program has been implemented since 2012 in sugarcane farms. However, since the program started, there had been no empirical evidence on its effect on farm net income and productivity as most literature merely provides descriptions and data. Therefore, the aim of the study is to evaluate whether the existing block farming production system is profitable and profit efficient to advocate change in the block farming systems to make the program more sustainable. Specifically:

1) To measure the profitability and profit efficiency of block farms in the Balayan mill district;
2) To identify the factors affecting profit inefficiency; and
3) To formulate policy options for enhancing the profitability of sugarcane production hence, competitiveness at the farm level.

3. Conceptual Framework

Profit efficiency measurement has received considerable attention in production economic literature e.g. rice (Rahman [20], maize (Ogunniyi [16]), coffee (Hailemichael [8]), cassava (Ogunleye et al., [15]) and of late, sugarcane (Munir et al., [13]). Profit efficiency within a profit function context is defined as the ability of a farm to achieve the highest possible profit, given the prices and levels of fixed factors of that farm. Meanwhile, profit inefficiency is defined as profit loss from not operating on the profit frontier given farm specific prices and resource base [1].

Following Ali and Flinn [1], Figure 1 traces a profit frontier for a sample of farms; each dot corresponds to the actual outcome in terms of profit per unit for a specific farm; points on the stochastic frontier curve (estimated by maximum likelihood methods and labeled MLE) are fully efficient farms (on the frontier), and all points below are inefficient farms in terms of their specific resources at prevailing input prices.

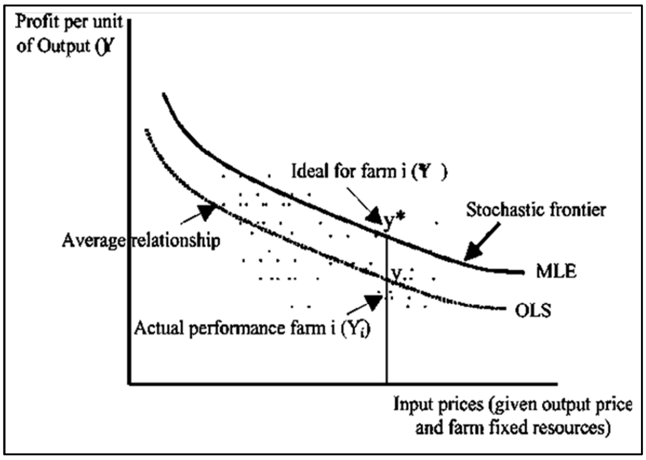

Figure 1. *Frontier (MLE) stochastic profit function for a sample of farms.*

Farm-specific profit efficiency (deviations below the frontier) is measured as the ratio of actual profit per unit (Yi in figure 1 for a farm i) and ideal profit (Y*). Note that the curve denoting average profit for any given level of resources (shown as the locus of points Y in Figure 1)-estimated by Ordinary Least Squares Regression (OLS)--is less than ideal profit. The measure of farm efficiency embodied in Yi/Y* is bounded by 1 (best-on the frontier) and worst 0, no profit. Farm-specific inefficiency is the distance below the frontier, (Y* - Yi).

All farms that fall below the frontier are not attaining optimal profit given the prevailing input and output prices in the product and the input markets. In agriculture, a farmer must pay attention to relative prices of the inputs. If that is not done, economic efficiency will not be achieved. This inefficiency could arise from several sources, including access to appropriate information in a timely manner or a lack of skills to take advantage of modern agricultural inputs. Besides, the farmer's inability to make optimal decisions may be due to external factors. These include untimely input supply, bad weather, and other random shocks such as floods, pests and diseases, droughts, and statistical errors.

Munir et al., [13] estimated the production efficiency of sugarcane production using profit in Punjab, Pakistan and applied the stochastic production frontier approach. They showed that farmers were relatively efficient, but still there are opportunities to increase profit efficiency in their farming activities. The 7.0% efficiency gap from optimum 100% is yet to be achieved by sugarcane farmers. The findings exposed that the farmers' level of education, farming experience, family size, extension services and mill development activities significantly influenced the efficiency of farmers. Results suggested that efficiency of sugarcane farmers can be increased through improvements in rural education, effective extension programs and enhancement in mill development activities.

Mohapatra [12] did profit efficiency in sugarcane production but related it with farmers' education in Orissa. Using a stochastic frontier profit function approach, the role that education of the effective head of the farm household, education of the family of the farm household and their experience plays, in addition to the primary inputs, in improving the profit efficiency of the farm household has been empirically tested. The results suggest that the 93% differences in the efficiency levels are due to profit inefficiency, and profit inefficiency reduces significantly with higher education. The mean efficiency is 79% and more than 80% of the farmers achieve 70-99% profit efficiency. A grassroots level farming practice awareness program both by government and private agencies and the reorientation of the formal education curriculum toward farm-oriented curriculum are highly recommended.

4. Methodology

4.1. Study Area

Balayan is a lowland town, located at the center of western Batangas. It falls under the first type of climate: Dry season from November to April and Wet season from May to October [9]. The month with the most rain in Balayan is August, with an average rainfall of 11.8 inches. The month with the least rain in Balayan is March, with an average rainfall of 0.9 inches. [10].

According to the Philippine Statistics Authority [18], the municipality has a land area of 108.73 square kilometers (41.98 sq mi) constituting 3.49% of the 3,119.75-square-kilometre- (1,204.54 sq mi) total area of Batangas. It is bounded on the north by Tuy, west by Calatagan and Lian, east by Calaca, and south by the Balayan Bay. It is politically subdivided into 48 barangays. The five block farms are in the following barangays: Makina, Pooc Ibaba, Calan, Pook Ilaya and Tanggoy.

4.2. Data Collection

The farm-level cross sectional survey data under the Block Farm Program in the Balayan Mill District gathered face-to-face in Crop Years 2018-19 and 2019-20 were used in this study. All members of the five block farms were included. The survey collected detailed information on costs and returns on sugarcane production to include variable and fixed cost (interest on capital and land tax). The socio-economic factors such as the farmers' age, sex, number of household members, level of education, farming experience and number of training/seminars attended were also used to determine the causes of profit inefficiency. Some production inputs used by the farmers such as the number of lacsa (planting materials= 10,000 canepoints), number of Nitrogen fertilizer, frequency of weeding, and family labor were also included in the analysis as possible causes of profit inefficiency.

4.3. Measuring Profitability

To measure farm profitability, gross margins and profit are the indicators that were used in this study. Gross margins (GM) provide a simple method for comparing the performance of farms that have similar requirements for capital and labor. A gross margin refers to the total income derived less the variable costs incurred of a given crop for a given period of time (usually per year or per cropping season).

Farm profit from sugarcane is measured in terms of gross margin (GM) which is the difference between the total revenue (TR) and total variable cost (TVC) and is given by:

$$GM = TR - TVC;$$

$$Л = GM - TFC,$$

Where,
GM= Gross Margin,
Л= profit,
TR= Total Revenue,
TVC= Total Variable Cost,
TFC= Total Fixed Cost.

The Return Cost Ratio (RCR) analysis is employed to determine whether sugarcane production is economically feasible or not. A RCR attempts to identify the relationship between the benefits and cost observed in the study area and is given by:

$$R/C\text{-Ratio} = \pi/TC$$

Decision rule:
if $R/C > 1$ farming is profitable;
if $R/C \leq 1$ farming is not profitable;
if $R/C = 1$ farming is breakeven.

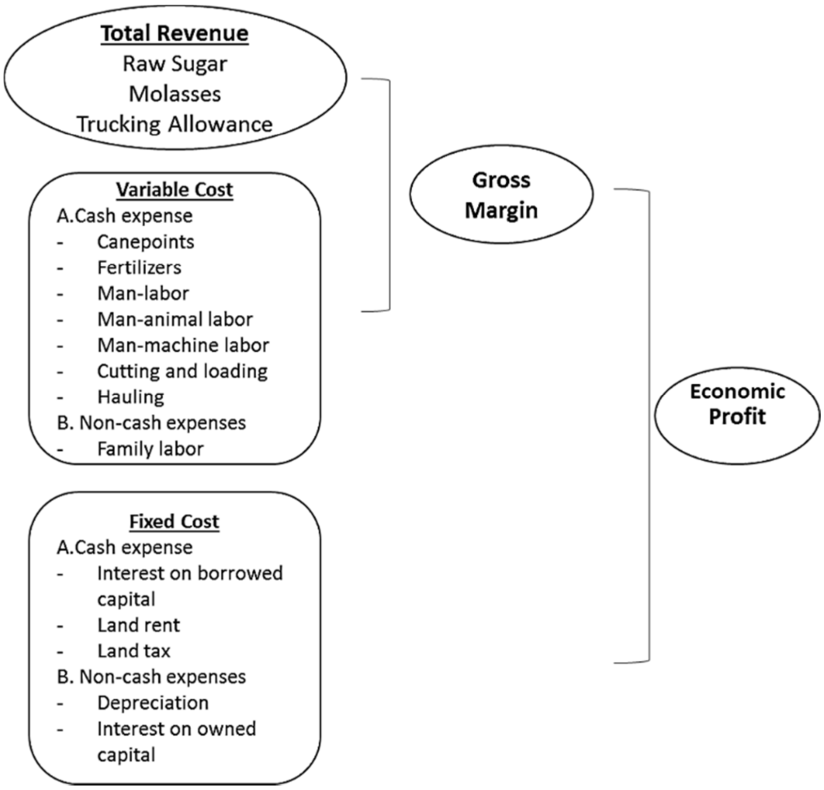

Figure 2. *Total Revenue, Variable and Fixed Cost, Gross Margin and Economic Profit in Sugarcane Production.*

4.4. Measuring Profit Efficiency

The Cobb-Douglas stochastic frontier profit function model was used to examine the profit efficiency in both CY 2018-19 and CY 2019-20. Following Battese and Coelli's [2] framework 1, the stochastic frontier profit function in the double log (Cobb-Douglass functional form) is specified as:

$$\ln\pi_i = \ln\beta_0 + \ln\beta_1 P_{1i} + \ldots + \ln\beta_8 P_{8i} + (V_i - U_i)$$

Where:

π_i = normalized gross margin computed for the jth farm which is defined as total revenue less total variable cost divided by farm specific output price P_y;

ln = Natural log;

P_i = Price of variable inputs normalized by price of output where (for i =1, 2, 3 and 4).

So that:

P_1 = cost of planting materials (lacsa) normalized by price

1 Battese and Coelli (1995) extended the stochastic production frontier model by suggesting that inefficiency effects can be expressed as a linear function of explanatory variables. The advantage of this model is that it allows for the estimation of farm specific efficiency scores and factors explaining efficiency differentials among farmers in a single stage estimation procedure.

of output;

P_2 = cost of fertilizer normalized by price of output;

P_3 = cost of labor normalized by price of output;

P_4 = cost of man-animal normalized by price of output;

P_5 = cost of power normalized by price of output;

P_6 = cost of hauling normalized by price of output;

P_7 = cost of family labor normalized by price of output;

P_8 = cost of fixed cost normalized by price of output;

$\beta_o, \beta_1, \beta_2,.. \beta_9$ are parameters to be estimated and expected to have negative signs.

V_i represents statistical disturbance error term and U_i represents farmer specific characteristics related to profit efficiency.

The inefficiency model (U_i) is defined as:

$$U_i = \delta_0 + \delta_1 W_{1i} + \delta_2 W_{2i} + \ldots + \delta_{13} W_{13i} + e_i$$

Where:

U_i = Profit inefficiency of i-th farmer;

W_i = farm-specific managerial and household characteristics explaining inefficiency effects.

$W_1, W_2, \ldots W_{14}$ will represent age, sex, marital status, years of farming experience, years in school, primary occupation, number of households, farm size, number of training attended, number of planting materials planted per hectare (lacsa), kilogram of Nitrogen applied per hectare, and frequency of weeding.

The δ_i are parameters to be estimated. The e_i is an error term that follows a truncated normal distribution.

The parameter estimates of the stochastic profit frontier and inefficiency effect models will be simultaneously obtained using STATA 15 software FRONTIER 4.1 [4].

5. Results and Discussion

5.1. Brief Overview of the Characteristics of Sample Farms

Majority (75%) of the respondents were men. This distribution of sex in our sample farms may be explained by the socio-cultural pattern in the Philippine sugarcane industry where men dominated the production of sugarcane while women are more involved in rice and corn production, domestic and household chores, and some trading activities to support their family. Majority (82%) were married. Table 1 shows the mean statistics of the respondents by group (block farm). Total mean age of the respondents was around 59 years with respondents from Pook Ibaba having the highest, followed by Pook Ilaya. Both, together with Makina were above the total mean age. Calan, the lowest, was below the total mean age.

Table 1. *Mean statistics of sample farms by block farms, CY 2019-20.*

	Calan (26)	Makina (47)	Pook Ibaba (25)	Pook Ilaya (27)	Tanggoy (32)	Total (157)
Age	53.88	59.55	61.92	61.74	56.13	58.67
No. of schooling (years)	8.69	7.49	8.56	9.11	7.63	8.17
Farming Experience (years)	17.62	26.21	24.40	24.85	20.63	23.13
No. of training attended	5.58	3.77	6.24	5.56	4.72	4.96
Household size	3.88	4.09	3.32	4.26	3.56	3.85
Area owned/operated	1.48	1.37	1.33	1.41	1.69	1.46
Nitrogen (kg)/ha	240.49	213.87	247.29	242.15	230.86	231.93
Lacsa=10,000 seeds /ha	3.077	2.426	2.600	2.037	2.078	2.424
Frequency of weeding/ha	1.423	1.340	1.280	1.556	1.781	1.471
Family labor (cost/md)/CY	4,821.99	6,066.91	5,097.90	5,129.93	6,562.54	5,646.32

Around 50% and 30% of the respondents obtained elementary and high school education, respectively and around 17% reached college while the remaining 3% had no formal education at all. The total mean years in school of the respondents was 8.17 meaning, they have reached high school so they are functionally literate which may impact on their ability to adopt improved farming practices and comprehend new farming information. Across block farms, the mean age of Makina and Tanggoy fell below the total mean while the rest, above with Pook Ilaya, having the highest mean age. For the number of farming experience, the total mean was 23.13, Makina with the highest while Calan, the lowest. The number of training received by all respondents showed a mean of around 5. Pook Ibaba received the highest number of trainings, followed by Calan and Pook Ilaya, all of which were above the total mean. Tanggoy received the least and together with Calan, their means were below the total mean number of trainings. When it comes to the total household size, the mean was around 4. Pook Ilaya had the highest mean, followed by Makina and Calan, all of which were above the total mean value. Both Pook Ibaba and Tanggoy's mean values were below the total mean household size. For the area owned or operated, the total mean was 1.46 with Tanggoy, being the highest, followed by Calan. The rest have mean areas below the total area mean.

Looking at the input used by the sample farms, the nitrogen per hectare applied ranged from as low as 91 to 336 kg. Except for Makina and Tanggoy, the rest were above the total mean nitrogen applied per hectare. In terms of lacsa planted per hectare, there was a wide disparity from 1 to 8 lacsas per hectare because apart from the cane seeds, replanting materials were also included in the data. Some farmers may have not been practicing gap filling. Calan had the highest and together with Pook Ibaba, were above the total mean lacsa planted per hectare, while the rest were below. Frequency of weeding ranged from 1 to 3 with Tanggoy and Pook Ilaya having more frequencies. The family labor was priced during the survey. The computation was based on the hours spent in the farm and prevailing rate for agricultural labor and this ranged from Php800.00 to Php

25,010.00 per year. The cost of family labor was high and even above the total mean for Makina and Tanggoy which shows that farmers spent more time in the farm compared to the rest of the block farms.

5.2. Profitability of Sugarcane Production of the Sample Farms

Table 2 shows the costs and returns in sugarcane production by the sample farms on a per hectare basis. For the two crop years, cost structures showed that the cost of (hired) labor occupied the largest share, around 40-44%, followed by the cost of fertilizer. Hauling is an integral input cost and usually occupies huge amount of cost however, in this particular case, since all block farms have been receiving trucking subsidy, the cost was very much lesser.

Looking at the profit and profitability of the sample farms, both gross margins and profits increased by around 27% from CY 2018-19 to CY 2019-20. For the profitability which was measured in R/C ratio, it also increased by around 6%. Results of the Two-sample t-test for R/C Ratio revealed that there is a statistical difference in the ratios of the two crop years which is significantly different from 0 at 10% level of significance (Table 3). All sample farms' R/C ratios were greater than 1 hence, all farms were economically profitable.

***Table 2.** Mean costs and returns per hectare in sugarcane production of the sample farms.*

	CY 2018-19	Cost structure	CY 2019-20	Cost structure
Total Revenue	95,305.76		114,394.50	
Sugar	80,615.84		93,533.61	
Molasses	14,689.92		20,860.88	
Variable cost	46,700.72		52,576.90	
Seeds & replanting materials	862.72	1.67%	968.54	1.64%
Fertilizers	10,857.66	21.04%	11,026.50	18.70%
Labor	20,925.47	40.54%	26,196.45	44.44%
Man-animal	3,292.52	6.38%	3,300.41	5.60%
Power	1,662.35	3.22%	1,161.32	1.97%
Hauling	2,444.75	4.74%	2,667.26	4.52%
Family labor	4,135.83	8.01%	5,646.33	9.58%
Fixed cost	4,913.75		6,376.94	
Interest on borrowed capital	4,733.75	9.17%	6,196.94	10.51%
Land Tax	180.00	0.35%	180.00	0.31%
Total cost	51,614.47	100.00%	58,953.84	100.00%
Gross margin (Total Revenue-Variable cost)	48,605.04		61,817.60	27.18%
Profit (Gross margin-fixed cost)	43,691.29		55,440.66	26.89%
R/C Ratio	1.85		1.94	5.09%

***Table 3.** Two-sample t-test wih equal variances, CY 2018-2019 and CY 2019-2020.*

GROUP	MEAN	STANDARD ERROR	STANDARD DEVIATION
CY 2018-2019	1.9100	0.03577	0.4481
CY 2019-2020	1.9900	0.03294	0.4127
Combined	1.9500	0.02439	0.4323
Difference	-0.0856*	0.04862	

*Note: *, **, ***, represent level of significance at 10, 5, and 1 percent, respectively.*

Across block farms, gross margin and profit per hectare varied and showed interesting results (Table 4). In CY 2018-19, Pook Ibaba obtained the highest gross margin followed by Makina and Tanggoy, then by Pook Ilaya and the lowest, Calan. The latter, in the following crop year, obtained the highest gross margin, followed by Pook Ilaya and Tanggoy, then by Makina and the lowest, Pooc Ibaba. Calan's recovery from having the lowest in the previous year to the highest gross margin and profit was due to the adoption of Phil 99-1793, a high yielding variety with a potential yield of about 170 TC/HA and the reduction in the cost of power for land preparation as most of its crops were ratooned in the next crop year.

Calan, Pook Ilaya and Tanggoy's performance improved as gross margins, profits and R/C ratio increased in CY 2019-20. However, Makina although it increased its gross margin and profit, its R/C ratio decreased substantially hence, showed negative value. Makina was not able to maintain its profitability due to increase in the costs of labor, family labor and interest on capital in the following year. Pooc Ibaba's poor performance resulted to a decrease in gross margin, profit and R/C ratio. This could be attributed to the decline in the revenue from sugar and increase in variable costs (seeds, hired labor, use of machines and family labor). The decrease in fixed costs was not compensated as the increase in variable costs was higher. Nevertheless, R/C ratios obtained were greater than 1, thus farms were economically profitable.

Table 2 also showed that total mean R/C ratio increased by about 5%. The result of R/C ratio indicated that Calan ranked first, followed by Makina and Pook Ilaya, and then Tanggoy, and Pooc Ibaba. Adjustments in the input factors could lead to improved profit of different block farms. More specific, the inputs that were important in determining output for Calan were the hiring of more labor and increased borrowed capital which enabled them to apply the proper farm cultural practices, for Makina, the hiring of more or higher productive labor, engagement of family labor and increased borrowed capital. In the case of Pook Ilaya, the adoption of improved variety, increased family labor and hired labor for proper cultivation. Likewise, for Pook Ibaba, the adoption of improved variety and together with Tanggoy, increased labor used.

Table 4. *Costs and returns per hectare in sugarcane production by block farms.*

	Makina			Pooc Ibaba		
	CY 2018-19	CY 2019-20		CY 2018-19	CY 2019-20	
Revenue	86,592.30	105,044.97		120,260.16	98,366.39	
Sugar	73,319.26	87,500.64		103,321.24	72,631.09	
Molasses	13,273.04	17,544.33		16,938.92	25,735.29	
Variable cost	39,178.23	46,151.64		51,754.78	56,627.42	
Seeds & replanting mat	378.16	828.09	1.62%	658.71	1,120.53	1.88%
Fertilizers	10,252.62	10,184.24	19.87%	11,789.05	11,775.71	19.71%
Labor	18,219.04	22,613.50	44.12%	24,147.47	27,371.68	45.82%
Man-animal	2,900.06	2,900.06	5.66%	3,639.43	3,699.43	6.19%
Power	718.09	550.53	1.07%	1,098.00	2,002.50	3.35%
Hauling	2,108.21	2,355.01	4.59%	2,969.00	2,920.00	4.89%
Family labor	3,472.39	6,066.91	11.84%	4,698.92	5,097.90	8.53%
Fixed cost	2,929.29	5,100.10		7,490.00	3,113.33	
Interest on borrowed capital	2,749.29	4,920.10	9.60%	7,310.00	2,933.33	4.91%
Land Tax	180.00	180.00	0.35%	180.00	180.00	0.30%
Total cost	42,107.52	51,251.74	100.00%	59,244.78	59,740.75	100.00%
Gross margin (Total Revenue-Variable cost)	47,414.07	58,893.33	24.21%	68,505.38	41,738.97	-39.07%
Profit (Gross margin-fixed cost)	44,484.78	53,793.23	20.93%	61,015.38	38,625.64	-36.70%
R/C Ratio	2.06	2.05	-0.33%	2.03	1.65	-18.88%

Table 4. *Continued.*

	Calan			Pook Ilaya			Tanggoy		
	CY 2018-19	CY 2019-20		CY 2018-19	CY 2019-20		CY 2018-19	CY 2019-20	
Revenue	93,590.68	123,428.63		92,927.12	129,969.28		92,008.51	120,167.12	
Sugar	77,153.93	103,299.05		79,214.75	106,894.60		77,589.10	99,516.89	
Molasses	16,436.75	20,129.58		13,712.37	23,074.68		14,419.42	20,650.23	
Variable cost	53,710.69	53,579.87		50,836.82	60,804.28		44,615.46	51,092.75	
Seeds & replanting mat	1,696.03	979.87	1.66%	850.79	1,739.68	2.62%	1,066.82	396.25	0.63%
Fertilizers	11,331.46	11,345.20	19.17%	11,105.84	11,531.10	17.38%	10,424.30	10,993.55	17.39%
Labor	21,735.91	27,000.51	45.63%	22,574.32	30,606.02	46.13%	20,333.66	26,166.86	41.38%
Man-animal	2,934.18	2,934.18	4.96%	3,556.35	3,546.71	5.35%	3,666.46	3,666.46	5.80%
Power	3,628.23	970.47	1.64%	2,384.34	2,589.17	3.90%	1,283.68	351.56	0.56%
Hauling	2,459.68	2,720.92	4.60%	2,675.97	3,072.09	4.63%	2,322.24	2,543.26	4.02%
Family labor	4,855.54	4,821.99	8.15%	4,243.89	5,129.93	7.73%	3,994.41	6,562.55	10.38%
Fixed cost	2,956.50	5,587.97		3,617.04	5,549.75		8,500.10	12,140.99	
Interest on borrowed capital	2,776.50	5,407.97	9.14%	3,437.04	5,369.75	8.09%	8,320.10	11,960.99	18.92%
Land Tax	180.00	180.00	0.30%	180.00	180.00	0.27%	180.00	180.00	0.28%
Total cost	56,667.19	59,167.84	100.00%	54,453.86	66,354.04	100.00%	53,115.56	63,233.74	100.00%
Gross margin (Total Revenue-Variable cost)	39,879.99	69,848.76	75.15%	42,090.30	69,164.99	64.33%	47,393.06	69,074.37	45.75%
Profit (Gross margin-fixed cost)	36,923.49	64,260.79	74.04%	38,473.26	63,615.24	65.35%	38,892.95	56,933.38	46.38%
R/C Ratio	1.65	2.09	26.31%	1.71	1.96	14.78%	1.73	1.90	9.71%

5.3. Profit Efficiency Distribution

Tables 5 and Table 6 show the distribution of the profit efficiency scores of the sample farms for CY 2018-19 and CY 2019-20, respectively.

Table 5. *Distribution of the profit efficiency score of the block farms in Balayan, Batangas, CY 2018-2019.*

PROFIT EFFICIENCY SCORE	BLOCK FARM											
	Makina	%	Pooc Ibaba	%	Calan	%	Pook Ilaya	%	Tanggay	%	Total	%
1.00	3.00	6.38	3.00	12.00	0.00	0.00	0.00	0.00	1.00	3.13	7.00	4.46
0.90-0.99	2.00	4.26	2.00	8.00	1.00	3.85	0.00	0.00	1.00	3.13	6.00	3.82
0.80-0.89	5.00	10.64	3.00	12.00	0.00	0.00	0.00	0.00	2.00	6.25	10.00	6.37
0.70-0.79	4.00	8.51	2.00	8.00	3.00	11.54	1.00	3.70	3.00	9.38	13.00	8.28
0.60-0.69	15.00	31.91	4.00	16.00	2.00	7.69	3.00	11.11	6.00	18.75	30.00	19.11
0.50-0.59	10.00	21.28	7.00	28.00	5.00	19.23	6.00	22.22	8.00	25.00	36.00	22.93
0.40-0.49	5.00	10.64	3.00	12.00	9.00	34.62	7.00	25.93	4.00	12.50	28.00	17.83

PROFIT EFFICIENCY SCORE	BLOCK FARM											
	Makina	%	Pooc Ibaba	%	Calan	%	Pook Ilaya	%	Tanggay	%	Total	%
0.30-0.39	2.00	4.26	0.00	0.00	2.00	7.69	5.00	18.52	3.00	9.38	12.00	7.64
Below 0.30	1.00	2.13	1.00	4.00	4.00	15.38	5.00	18.52	4.00	12.50	15.00	9.55
Total	47.00	100.00	25.00	100.00	26.00	100.00	27.00	100.00	32.00	100.00	157.00	100.00
Mean	0.64		0.67		0.49		0.45		0.55		0.57	
Minimum	0.29		0.29		0.07		0.17		0.17		0.07	
Maximum	1.00		1.00		0.94		0.77		1.00		1.00	
Std. Dev.	0.17		0.21		0.19		0.14		0.20		0.20	

Table 6. *Distribution of the profit efficiency score of the block farms in Balayan, Batangas, CY 2019-2020.*

PROFIT EFFICIENCY SCORE	BLOCK FARM											
	Makina	%	Pooc Ibaba	%	Calan	%	Pook Ilaya	%	Tanggay	%	Total	%
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.90-0.99	14.00	29.79	1.00	4.00	8.00	30.77	6.00	22.22	8.00	25.00	37.00	23.57
0.80-0.89	16.00	34.04	1.00	4.00	13.00	50.00	7.00	25.93	11.00	34.38	48.00	30.57
0.70-0.79	10.00	21.28	4.00	16.00	3.00	11.54	7.00	25.93	8.00	25.00	32.00	20.38
0.60-0.69	4.00	8.51	4.00	16.00	1.00	3.85	4.00	14.81	4.00	12.50	17.00	10.83
0.50-0.59	2.00	4.26	8.00	32.00	1.00	3.85	2.00	7.41	0.00	0.00	13.00	8.28
0.40-0.49	1.00	2.13	6.00	24.00	0.00	0.00	1.00	3.70	1.00	3.13	9.00	5.73
0.30-0.39	0.00	0.00	1.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.64
Below 0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	47.00	100.00	25.00	100.00	26.00	100.00	27.00	100.00	32.00	100.00	157.00	100.00
Mean	0.80		0.58		0.84		0.76		0.80		0.77	
Minimum	0.46		0.34		0.58		0.44		0.42		0.34	
Maximum	0.95		0.92		0.95		0.96		0.94		0.96	
Std. Dev.	0.12		0.14		0.08		0.14		0.12		0.15	

Of the 157 farms, seven were identified as profit efficient in CY 2018-19 while none in the following year. These seven farms (around 4% of the sample farms) defined the efficient frontier and represent the best practice farms for combining the various cost inputs (labor, planting materials, fertilizers, man-animal, power and fixed costs, to produce maximum sugar revenue. As expected, the efficient farms achieved higher returns than the inefficient ones. Conversely, around 96% of the sample farms were inefficient and this became 100% in the succeeding year. However, looking at the mean profit efficiency levels from CY 2018-19 to CY 2019-20, there was an improvement as it increased from 0.57 to 0.77. The latter is close to the results obtained by Carambas [3] which showed an average profit efficiency score of 0.787 for the Batangas mill district. The peak proportion which was represented by around 23% of the farmers with 0.50 - 0.59 profit efficiency level in CY 2018-19 raised to efficiency level of 0.80 – 0.89 (31% of the farmers) the year after. Results of the Two-sample t-test for profit efficiency revealed that there is a statistical difference in the efficiency scores of the two crop years which is significantly different from 0 at 1% level of significance (Table 7).

Table 7. *Two-sample t-test wih equal variances, CY 2018-2019 and CY 2019-2020.*

GROUP	MEAN	STANDARD ERROR	STANDARD DEVIATION
CY 2018-2019	0.5667	0.01584	0.1985
CY 2019-2020	0.7679	0.01167	0.1463
Combined	0.6673	0.01135	0.2011
Difference	-0.2012***	0.01968	

Note: *, **, ***, represent level of significance at 10, 5, and 1 percent, respectively.

The mean efficiency score of 0.57 implies that 43% of the maximum profit was lost in CY 2019-20 due to economic inefficiency at the given input prices and technology. The result indicated that farmers could increase their profits by 43% by improving their economic efficiency. However, only 20% was achieved as reflected in the mean profit efficiency in the following year. Mean efficiency score achieved was 0.77 which implies that farmers could increase maximum profit by 23% through the adoption of best farm practices that have allocative efficiency to strengthen their competitiveness (in the short run).

Across block farms, in CY 2018-19, Pook Ibaba obtained the highest profit efficiency, followed by Makina. This is in consistent with the trend in the computed R/C ratio presented earlier where the efficient farms were located in both block farms. Their mean values were above total mean. The rest namely, Tanggoy, Calan and Pook Ilaya (the lowest) have mean values below the total mean. Some improvements happened in the following year. Calan now achieved the highest mean profit efficiency, followed by Makina and Tanggoy. The latter's efficiency was above the total mean. Pook Ilaya's performance was still below the total mean efficiency, together with Pook Ibaba, being the lowest. The variation in the profit efficiency levels across block farms could be attributed to the variation in the inputs employed. The high efficiency score obtained by Calan was due to farmers' hiring of more labor using borrowed capital to apply proper farm cultural practices which resulted to higher yield and profit. In the case of Pook Ilaya, the improved mean efficiency score obtained was due to the adoption of improved variety, increased family labor and hired labor as well as proper cultivation. Pook Ibaba also adopted improved variety and together with Tanggoy, increased labor used.

5.4. Estimates of the Profit Frontier Model

Maximum likelihood estimates (MLE) of the parameters in the Cobb-Douglas (log form) stochastic profit function were obtained using Frontier 4.1. The unknown parameters of the stochastic profit function and inefficiency were estimated simultaneously. Table 8 shows the MLE estimates of normalized frontier profit function. All sigma squares were significant at 10% level. According to Aigner et al. (1997), statistical significance of the variance-parameter (σ2) is an indication of a good fit for the model and confirmation of distribution assumption of the composite error term.

The estimated gamma parameter (γ) of MLE model of 34.98 in the CY 2019-20 data was highly significant at 1% level. This implies that about 35% of the differences between the observed and frontier profits were due to existing differences in efficiency levels among the block farm members while the rest, due to random variability. However, this does not apply to the CY 2018-19 data, as estimated gamma parameter significantly revealed that differences were due largely to random errors.

Nevertheless, it would be interesting to analyze the behavior of the parameters with profit efficiency in CY 2018-19 and compare the same with CY 2019-20. Positive coefficients lead to an increase in the normalized profit realized from the production of sugarcane and vice-versa. Further, in the stochastic profit frontier model, these coefficients indicate the percentage change in the rate of revenue of a sugarcane farm household with respect to a percentage change in output, selling price, and costs of variable or fixed inputs [11].

Table 8. *Maximum likelihood estimates of stochastic profit frontier function, Balayan, Batangas.*

Variables	Parameters	Cropy Year 2018-19			Crop Year 2019-20		
		Coefficients	T-ratio		Coefficients	T-ratio	
No. of observations: 157							
Profit Function							
Constant	βo	1.6122	-5.50E+04	***	0.4502	2.0800	**
Cost of manpower-machine	β1	-0.0006	-247.38	***	-0.0001	-0.73	
Cost of man-animal	β2	-0.0016	-1.60E+04	***	-0.2853	-3.76E+00	***
Cost of fertilizer	β3	-0.1061	2.70E+04	***	-0.0475	-3.70E-01	
Cost of planting materials	β4	0.1267	1.90E+04	***	-0.0922	-3.44E+00	**
Fixed costs	β5	0.0348	5.30E+04	***	-0.0276	-2.50E+00	**
Labor cost	β6	0.8274	4.70E+04	***	1.2636	9.65E+00	***
Variance parameters							
Log-likelihood estimate		-55.6138			6.8375		
Sigma squared		4.80E-09	4.44E-03	*	0.128	4.892	*
Gamma		-7.98E+09	9.32E-01	*	-34.9813	-10.34	***
Mean profit efficiency score: 0.57				Mean profit efficiency score: 0.77			
t-test (T > t): 0.000							

Note: *, **, ***, represent level of significance at 10, 5, and 1 percent, respectively.

Results showed that the coefficients of the estimated parameters of the normalized profit function were positive except the costs of power, man-animal and fertilizer. The following year, all parameters became negative except cost of labor. The price paid for labor positively influenced profit efficiency. With a significant positive value of 1.2636 means that for a 10% increase in the price incurred through hiring of labor, the profit obtained from the sugarcane production will increase by about 12.64%. Therefore, additional investment in labor can increase profit so long as farmer pay farm workers lower than its true price. Marginal value productivity of labor should be greater than its price.

While the negative coefficients of the cost of power and man-animal tends to reduce profit, the latter being highly significant. This implies that farmers paid higher amount to these inputs than the true price especially if only few farmers availed of the tractor services which in that case commands a higher rate or maybe, mechanizing land preparation and increased frequency of cultivation were not properly applied by the farmers.

The cost of planting materials and fixed cost positively influenced profit efficiency. The high cost of improved planting materials and high interest on borrowed capital (fixed cost) increased profit because their marginal value contributions to sugarcane production were higher than their price. The adoption of improved planting materials gave high yield thus increase profit. However, although significant, the relation became negative and weak the following year as the crops were ratooned where farmers customarily give less importance to its maintenance thus less profit. Likewise, the cost of fertilizer inversely influence profit with a weak relationship. Farmers may have paid competitive price for fertilizer input.

5.5. Determinants of Profit Inefficiency

Estimating inefficiency model determines the relationship between profit efficiency and farm characteristics. The signs and significance of the estimated coefficients have important implications on the profit efficiency of sugarcane block farms. The sign of the parameter estimate has the opposite meaning. A positive coefficient on δs signifies profit inefficiency because the value of u would be higher when the farm is further away below the profit frontier [6]. The results from the inefficiency model were presented in Table 9.

The input used (nitrogen applied, number of canepoints (lacsa) planted, frequency of weeding) and the cost of family labor (which showed multicollinearity in estimating profit function while a good determinant of profit inefficiency) were included to further determine their influence on profit inefficiency. Surprisingly, only few factors were captured that significantly explain the variation in efficiency among farmers in both crop years. This may be an indication that farmer characteristics are fairly homogeneous. For technology input used, mixed results on the signs and significance of the estimated coefficients were also obtained which suggest that the relationship changes over time.

Number of trainings in sugarcane production significantly decreased profit inefficiency as indicated in Table 9. This was due to the ability of more trained farmers to adopt the best farm practices through a continuous learning process to produce the frontier output using the least cost combination of the productive inputs available. Many training/seminars were provided during the organization and operationalization of the block farms that helped enhance farmers' knowledge and skills in farm management. With regards to input used, the number of nitrogen (kg) applied significantly increased profit inefficiency. This may be due to the efficiency of fertilizer as affected by rate/methods of application, etc. Overuse and underuse of fertilizer can lead to a waste in the former and low production in the latter. Therefore, efficiency of fertilizer nitrogen can be increased, and losses reduced, by matching supply with crop demand.

Table 9. *Maximum likelihood estimates of profit inefficiency model, Balayan, Batangas.*

Inefficiency Model							
Constant	δo	-5.4645	-1.70		0.4502	-3.15	**
Farming experience	δ1	-0.0123	-1.19		0.0142	0.90	
Trainings	δ2	-0.1336	-1.67	*	-0.0344	0.52	
Nitrogen application	δ3	0.9660	1.40		2.6315	2.73	**
Number of lacsa	δ4	-1.2430	-2.69	**	-0.2594	-0.33	
Weeding application	δ5	0.1682	2.01	**	-0.0050	-0.06	
Cost of family labor	δ6	0.7954	1.41		-2.3294	-3.92	***

Note: *, **, ***, represent level of significance at 10, 5, and 1 percent, respectively.

The number of planting materials in terms of "lacsa" used by the farmers significantly decreased profit inefficiency. This shows that higher planting density have increased farm profit apart from the effect of high yielding variety of farm productivity. However, its influence became insignificant the following year. Plant crops were ratooned where farmers customarily give less importance to its maintenance especially on non-replanting of missing hills, thus less profit. Moreover, the high frequency of weeding significantly increased profit inefficiency. Perhaps farmers may not have applied proper weeding thus positive effect of such technology on productivity was not realized. It was only in the following year, although not significant, that the positive effect of an increase in the frequency of weeding on profit efficiency was realized. The cost of family labor significantly increased profit inefficiency. This may be due to the adoption of improved technology that entails more family labor to properly apply the necessary cultural practices for the said technology.

6. Conclusion and Recommendations

Block farm profitability in terms of gross margin, profit and R/C ratio was higher in CY 2019-20 than in CY 2018-19. Adjustments in the input factors could lead to improved profit. More specific in this study was the cost of labor and planting materials. To increase profitability of the farms and reduce production cost, farmers could hire lesser but competent farm workers to make farm operations more cost-efficient. Further, subsidy on HYV canepoints and tractor services could make the cost of planting materials and tillage lower therefore, since block farms were already provided with nursery farms and farm tractors/equipment, planting materials and tractor services, these should be given to members at subsidized cost.

The study concludes that the profit efficiency scores for the sample farms increased from a mean score of 0.57 in CY 2018-19 to 0.77 in CY 2019-20. This suggests that with the current efficiency score, there are still opportunities to increase profit efficiency in their farming activities. Therefore, farmers should adopt the technology and techniques used by the best–practicing sugarcane farmers in the study area to increase maximum profit by 23%.

Analysis on the influence of cost of HYV planting materials on profitability changes over time as plant cane usually produced higher yield than ratoons (next crop cycle). Therefore, to maximize the full potential of the HYV planting materials, farmers must be taught on how to manage their ratoon crops. Ratooning, if properly managed could generate more profit since the cost in planting material, land preparation, labor and time are eliminated. While the influence of labor cost on profitability was consistent and positively significant. Again, the competency of the hired labor must be taken into consideration as sugarcane production is labor intensive since most farm operations are done manually from planting and maintenance activities. The cost of fertilizer also influenced profit efficiency. Farmers may have paid competitive price for fertilizer input and therefore, timing and bulk procurement of fertilizer must be continued. Moreover, farm mechanization is proposed but synchronization in the operation is a must in block farming to maximize its efficiency and cost. Further, credit should be made available to enable farmers modernize and improve their farm operations.

This study concludes that the number of trainings, plant density as reflected in the number of planting materials used, frequency of weeding and cost of family labor positively influenced profit efficiency. The sole constraint to profit efficiency was the use of N fertilizer (kg). Therefore, it is recommended that the SRA or extension agents should conduct series of training/seminars on improved planting techniques, weeding management and the proper use of fertilizer with emphasis on the timing of N fertilizer application. It is generally known that sugarcane production relies heavily on the use of N fertilizer. A proper amount of N-fertilizer can remarkably increase tillering and thus results in an early population with high yield, which can increase output.

The endowment of the SRA interventions which was included in the block farm program had helped farmer-members perform better and became more profit efficient. Block farming which is particularly aimed at diffusing and adopting new technology, experience, knowledge, and skills to small sugarcane farmers, seemed to play its part in increasing farmers profit efficiency. Therefore, block farming should be advocated to reach all small sugarcane farmers in the country. The various training/seminars and technical assistance embedded in the program should be continued with emphasis laid on new technologies that would help farmers boost their current levels of efficiency. Moreover, service providers should be organized in the block farm area to serve as a hub in the multiplication and distribution of high yielding variety planting materials and farm machinery/equipment services thus, making these technologies available and accessible. Furthermore, access to credit should be continued as it enabled farmers to modernize their farm operations and improve their farm income and profit.

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