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# The Efficiency of Technical and Economic Utilization of Cagayan Valley Green Dairy Technologies

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**Abstract** The Philippine dairy business, worth Php100 billion, has a far way toward meeting the country's dairy demands. Local dairy farmers fulfill 1% of the need, despite yearly imports of $800 million in dairy goods. Dairy is the third most imported agricultural item, with 85 percent of the country importing it in powder form, which is subsequently processed into a liquid for household usage. Milk manufacturing has a number of environmental consequences. Dairy cows and their dung create greenhouse gases including methane, nitrous oxide, and carbon dioxide, which contribute to climate change. The study assessed the technical and economic efficiency of green dairy technology utilization in the Cagayan Valley. Specifically, it analyzed the determinants that affect dairy farmers' technical and economic efficiency by utilizing green technologies. It gathered data and information via a semi-structured questionnaire. The data were processed using descriptive statistics and stochastic frontier analysis. The majority of the 11 dairy farmers surveyed were male, older farmers, with greater household size, who obtained their 9 years of school and had a lower monthly income of Php13,863.91. The productivity model reveals that the material costs that contributed to increasing milk productivity are significant. The lower cost of materials was due to the adoption of green technologies like silage making, vermiculture/composting, and recycling of farm wastes. The number of dairy animals, pre/post-harvest labor costs, and investment were all negative coefficients that did not affect milk productivity. Furthermore, age, household size, and agricultural years were among the technical inefficiencies that had a substantial impact. Dairy producers' technical inefficiency is aggravated by their age and years of farming. These farmers are getting older, starting at an age of 55.54, deteriorating their technical efficiency performance attributed to physical strength to perform dairying activities, while years of farming experience of 23.32 and above dairy farmers are attributed to their resistance to adopting green technologies. A household with four or fewer family members has fewer technical inefficiencies. The number of workers is usually drawn from the family members that contribute to better technical efficiency performance.

**Keywords** Green Dairy Technologies, Stochastic Frontier Analysis, Technical Efficiency, Economic Utilization

## 1. Introduction

Milk production takes place all over the world. Population growth, economic growth, urban growth, and the westernization of cuisines in countries like China and India are all driving up global dairy consumption. Natural resources such as freshwater and soil are being strained as the demand for dairy grows. Milk is produced by around 270 million dairy cows maintained by millions of farmers across the world. Milk production has a number of

environmental consequences, the severity of which is determined by the activities of dairy farmers and feed producers.

The dairy industry contributes to the financial well-being of rural families in a variety of ways. The rearing of animals has a significant impact on income and labor value, as well as the reduction of neediness in provincial areas. Dairy is an important part of agricultural growth, as well as a potential source of trade revenue [8]. Dairy cows and their manure produce greenhouse gas emissions such as methane, nitrous oxide, and carbon dioxide which contribute to climate change. Feed production, enteric fermentation, and manure management are the most significant sources of these emissions in milk production in the United States. Ammonia emissions in the air have the potential to harm downstream habitats, resulting in a loss of species diversity. On-farm activities can produce particulate matter and odor, which can have a negative influence on air quality. To cultivate feed, water cows, manage dung, and process products, dairy businesses can need a lot of water. Dairy farm runoff can also damage water resources with manure and fertilizer. Increased nutrients in local waterways encourage the growth of algae, which limits the amount of oxygen available to aquatic plants and animals. Over two-thirds of the world's agricultural land is currently utilized to raise livestock, such as beef and dairy cows. Desertification affects one-third of the world's land, owing to deforestation, overgrazing, and bad farming methods. Dairy cows can help to maintain healthy environments in some cases by using well-managed grazing.

The country's dairy sector will need at least another 50 years to cover a fraction of the country's dairy requirements, according to studies cited in the NDA Corporate Planning and Management Services Department's study [4]. The countries that export - dairy "needed at least 100 years to efficiently build their dairy sector," according to the World Bank, while the Philippines is still in its "teen years." Dairy producers and farm owners, on the other hand, are advised to examine the industry's worth. According to NDA statistics, the country has 2.8 million cows and buffalos, but only 45,439 are used for dairy production. In 2016, these animals generated 21.16 million liters of milk, accounting for less than 1% of the country's total milk consumption [3].

Dairy output increased by 4% between 2015 and 2016, according to the government. Due to continued dairy animal production and strong demand for milk and milk products, they are optimistic that these trends will continue. Dairy farmers should focus more on the quality of their milk output while expanding the number of dairy cows. To help the dairy sector accomplish its medium-term development objective, the NDA is implementing "Dairy Herd Build-up," an enterprise enhancement program, a milk feeding program for children using locally produced milk, and a safety and quality assurance program. Filipinos, contrary to popular belief, drink a lot of milk, mostly in powder form [4].

The Philippine-New Zealand Development Program (PNZDP) is a five-year programme with a $3.71 million fund. The initiative aims to boost the productivity of local milk producers via commencing training on animal nutrition and introducing novel feed grasses and legume combinations. To combat climate change, the government is mapping a route to expand its dairy industry. Dairy farms are cropping up all throughout the country to support the industry's expansion. With the arrival of grasses more suitable for dairy production, the current pastures technique needs to be re-invented [4].

The Department of Agriculture (DA) in Cagayan Valley will be initiating the modernization of a cooperative-owned dairy processing facility in Mallig, Isabela, through its business development component (I-REAP) through World Bank-assisted Philippine Rural Development Project (PRDP). Isabela Dairy Enterprise, a Php32 million I-REAP sub-project, will expand milk production, processing, and marketing and milk-based products such as raw milk, pasteurized milk, flavored milk, yogurt, and milk-o-gel. A wide array of its surrounding towns with more than 2,400 homes in Mallig are projected to benefit from the effort [11].

During a stakeholders' consultation of the Luzon, a Cluster leg of the First World Bank Implementation Support Mission to the PRDP, Edwin Respicio of the Cagayan Valley Maunlad Cattle and Dairy Cooperative stated that the project will provide a secure market for dairy farmers in Mallig and its surrounding municipalities. Increase women's earnings and empowerment so that even small farmers may participate in project activities such as milk collecting and fodder sales. The firm will pay dairy farmers with a daily cash inflow of approximately Php184 per bovine head for raw milk production. This will also encourage kids to drink milk, which will aid in the fight against malnutrition. Due to its vast expanses of land suitable for rearing dairy cows, Isabela has selected dairy as its top priority product under its Provincial Commodity Investment Plan (PCIP). The dairy enterprise sub-project will be expanded to include a farm-to-market road (FMR) sub-project [11].

Specifically, San Augustine, Isabela, where the upgraded swamp carabao buffaloes were utilized for milk production for their dairy processing products. The San Augustin Dairy Cooperative (SADACO) had produced 90 to 110 liters a day from the 2% of their members' lactating carabaos. According to the Philippine Carabao Center (PCC), they have an estimated 3,000 heads of upgraded swamp buffaloes ready for milking. However, the farmers have used them for hauling and plowing their fields. Since the Dairy, Philippine Rural Development Program (PRDP) was implemented in the Cagayan Valley, which provides comprehensive support to dairy farmers, and San Agustin is one of the recipients of this program, it is hoped that more farmers will be encouraged to go into dairying to increase milk production [12].

Dairy farmers can improve productivity while also preserving and protecting the environment using Green Dairy technologies. Assessing the technical and economic effectiveness of using green dairy technology in the Cagayan Valley will provide a better understanding of the technical and economic issues affecting everyday operations, particularly milk production, processing, and marketing.

Generally, the study assessed the technical and economic efficiency of the utilization of green dairy technologies in the Cagayan Valley. Specifically, it aims to: determine the green dairy technologies utilized by farmers in the Cagayan Valley; evaluate the productivity of the dairy farmers who are adopters of green technologies in their operations; and assess the determinants that affect the technical and economic efficiency of the dairy farmers by utilizing green technologies in the Cagayan Valley.

## 2. Research Methods

The study employed descriptive and inferential research design. Data were treated using descriptive statistical analysis to describe the data. Inferential analysis was used on the core information and data of the study to determine the inferences of the variables involved in the study. The respondents of the study were dairy farmers who are users of green technologies on farms. They were carabao and cattle dairy raisers in the provinces of Cagayan Valley such as Quirino, Nueva Vizcaya, Isabela and Cagayan. The primary data was gathered from the dairy farmers (users and non-users of green technologies) in the Cagayan Valley. They were asked for their demographic profile, dairy operations, yield, and income through the use of a semi-structured and pre-tested questionnaire. The secondary data was collected from the government and non-government agencies that are involved in dairy operations in the region. To describe the data, these descriptive statistics were used. The dairy farmers' productivity and technical efficiency performance were analyzed using Stochastic Frontier Analysis (SFA) and Front 4.1 software [7].

The Stochastic Frontier Regression

This tool will analyze the influence of uncontrolled factors and existing inputs on dairy producers' efficiency. The implications are given in a linear manner below, with the premise that farmers optimize output (yield) while lowering input consumption. As a consequence of their efficiency with their inputs, farms are in the finest possible condition for dairy production. As a consequence, the following equation emerges:

$$y = x_i b + e_i$$

where: y = yield of milk per head, $x_i$ = columns of inputs:

$X_1$ – Number of Dairy Animal (head)

$X_2$ -Material Prices

$X_3$ -Pre and Post-harvest Labor

$X_4$ –Investment Cost

b = is a sequence of parameters to be tested at 1, 5, and 10% levels.

$e_i$ = the "stochastic random error expressing the effect of other factors or unpredictability of human action that cannot be foreseen" as argued [9].

Slack (unused usage of dairy inputs, as observed in slack) prohibited farms from optimizing at the frontier (waste utilization of dairy inputs) (waste utilization of dairy inputs). As a result, they were unable to attain efficiency. As a result, the equation is written as (modeled after Battese and Coelli's Model 2 [5].

$$Y = x_i\beta + (V_i - U_i) , i = 1,...,5$$

Where:

*Y* = is the yield of milk per head in Ln

$X_i$'s in Ln are:

$X_1$ – Number of Dairy Animals (head)

$X_2$ – Material Costs

$X_3$ - Pre and Postharvest Labor

$X_4$ – Cost of Investment

*$\beta_i$ = parameters to be estimated and tested at 5% and 1% level*

$V_i$ = random noise

"$V_i$ is a set of random variables that are assumed to be independent and identically distributed (iid) truncated normal with zero mean and variance [N(0,sV2)], and independent of technical inefficiency (Ui),"[4], commonly known as ei in classical econometrics or the "stochastic random error representing the impact of other factors or randomness of human behavior that cannot be d" [9].

"$U_{it}$," which are non-negative random variables that are believed to be independently distributed (iid) as truncations at zero of the N (MIT, sU2) distribution and are thought to account for technological inefficiency in dairy farmers' activities;"[6].

Where: $U_{it} = b_i D_{it}$, i = 1..., N t = 1..., 2

*$D_{it}$ is dummy variables that may influence the farming efficiency of dairy farmers, expressed as:*

$d_1$ - Gender

$d_2$ - Age

$d_3$ – Household Size

$d_4$ - Years in School

$d_5$ – Years in Farming

$d_6$ - Household Income

$d_7$ - Climate Change Awareness

$d_8$ – Adoption of Green Technologies

$d_9$ – Silage/Haylage Making

$d_{10}$ - Use of solar panel for irrigation

$d_{11}$ - Adopt to use solar for irrigation

$d_{12}$ - Vermi-culture and composting

$d_{13}$ - Years in Dairy Production

bi= are parameters to be estimated and tested at 5% and 1% level

*Y/ Y* = maximum potential dairy yield of farmers in Cagayan Valley*

*Where:*

*Y* = estimated yield of dairy of farmers in Cagayan Valley (frontier)*

*Y = actual yield of dairy of farmers in Cagayan Valley*

*$\sigma^2$ = sigma squared > 0, dairy production efficiency are not all 100% efficient*

*γ = gamma > 0, the deviation from the frontier is attributed to technical inefficiency*

The yield of dairy products will be examined in relation to several parameters. Bi's for Regressor and di's for technical efficiencies variables are not equal to zero, according to the study's general premise.

## 3. Conceptual Framework

Increased yield and income, and improved technical efficiency performance of the dairy farmers will be dependent on the influence of interventions that have been provided to them and the background of the dairy farmers. Farmers with a good foundation in dairying and a positive outlook on the interventions might prove that they can have better performance in dairy production.

The Green dairy technologies are the interventions introduced to farmers. It includes not only Good Animal Husbandry Practices (GAHP) for dairy, but also some technologies that are prone to mitigating and adapting climate. These are green corn silaging, solar panels as a source of energy for light and water pumps for the irrigation of forage, electronic vehicles for transportation, vermicompost, and bio-digester. Adopting these technologies will help reduce the cost of operations in the long run and become profitable. The operation will be sustained and eco-friendly, which is beneficial to humans, animals, and mother earth.

Effort must be exerted, particularly by those farmers with resistance to change, to adopt eco-friendly technologies to increase the adoption rate and several farmers practicing sustainably throughout dairy production. These can be done by assessing the background of the farmers through their demographic characteristics and experiences in dairy production. Those with insufficient knowledge and skills in green technologies will be capacitated through seminars and training on this aspect (Figure 1).

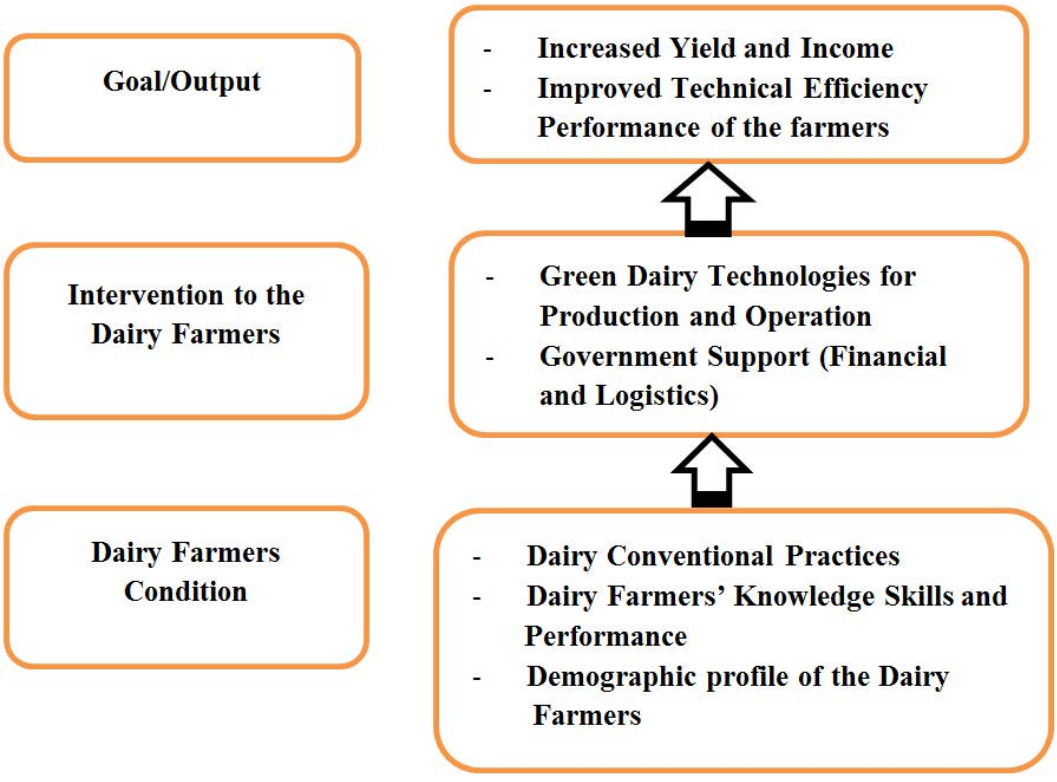


**Figure 1.** Conceptual framework of the study

**Table 1.** Demographic profile of the respondents

| Particular | Frequency (n=11) | Percent (%) |
|---|---|---|
| **1. Sex** | | |
| Male | 7 | 63.64 |
| Female | 4 | 36.36 |
| **2. Age** | | |
| 45–53 | 4 | 36.36 |
| 54–62 | 6 | 54.55 |
| 63–71 | 1 | 9.09 |
| Mean | 55.54 | |
| **3. Ethnicity** | | |
| a.Ilocano | 10 | 90.91 |
| b.Tagalog | 1 | 9.09 |
| **4. Household Size** | | |
| 2 member | 2 | 18.18 |
| 3 member | 1 | 9.09 |
| 4 member | 3 | 27.27 |
| 5 member | 2 | 18.18 |
| 6 member | 3 | 27.27 |
| Mean | 4 | |
| **5. Years in School** | | |
| 3 | 1 | 9.09 |
| 8 | 2 | 18.18 |
| 9 | 4 | 36.36 |
| 10 | 1 | 9.09 |
| 12 | 2 | 18.18 |
| 14 | 1 | 9.09 |
| Mean | 9 | |
| **6. Years in Farming** | | |
| 5 – 22 | 6 | 54.55 |
| 23 – 40 | 4 | 36.36 |
| 41 – 58 | 1 | 9.09 |
| Mean | 23.32 | |
| **7. Monthly Household Income** | | |
| Below 5000 | 6 | 54.55 |
| 10,000 - 15,000 | 2 | 18.18 |
| 35,000 - 40,000 | 3 | 27.27 |
| Mean | 13,863.91 | |
| **8. Seminar Attended** | | |
| Silage Making | 3 | 27.27 |
| TMR Making | 3 | 27.27 |
| None | 5 | 45.45 |
| **9. Provide the Seminar** | | |
| ISU | 2 | 18.18 |
| PCIC | 1 | 9.09 |
| PCC | 3 | 27.27 |
| None | 5 | 45.45 |

# 4. Results and Discussions

### A. The Respondents' Demographic Profile

Table 1 describes the demographic profile of the eleven (11) dairy farmers as respondents with their socio-economic condition, their ethnicity, and religion, including their household size, farming experience, and training or seminars they attended and who conducted them.

The results show that 7 or 63.64%, are male, while 4, or 36.36%, are female. The age also shows that the majority of the respondents, 6 or 54.55%, belong to the 54 to 62 age range, with a mean of 55.54 years. Their ethnicity was mostly Ilocano, with 10 or 90.91%, while 1 or 9.09% was Tagalog. The household size is overwhelming since 3 or 27.27% has 6 members of the family followed by 3 or 27.27% having 4 members of the family with a mean of 4. Their experience in farming is a manifestation of their years in farming. Most of the respondents had an average of 5 to 22 years of farming with 6 or 54.55%, while others had 4 or 36.36, and 1 or 9.09% with a mean of 23.32 years. Results also revealed that farmers having more experience were more efficient than those having comparatively less or no experience. The respondent's monthly income shows that 6 or 54.55% have an income below Php5000.00/month while 3 or 27.27%, 2 or 18.18% have Php35,000 to Php40,000 and Php10,000 to Php15,000 per month, respectively. For their educational attainment, the respondents attended school from 3 to 14 years, with most of them having a year in school. Regarding the training/seminar attended, most of the respondents attended seminars on silage making and TMR making, 3 or 27.27%, while 5 or 45.45% had not attended any seminars or training. The training and seminars of farmers have a positive effect on their technical efficiency. With regards to the seminar provided by the Philippine Carabao Center, there were 3 or 27.27% conducted, 2 or 18.18% were conducted by ISU, while 1 or 9.09% were conducted by PCIC.

### B. Production Information

Table 2 shows the length of time or years of engagement of every dairy farmer. As shown in the result, the highest length of years in dairy farming is only 2 years with 6 or 54.55%, 3 years with 3 or 27.27%, while 1 year and 10 years in farming, with 1 or 9.09% respectively. The result simply revealed that farmers having more years of experience does not guarantee their efficiency; rather, their exposure to seminars and training can be an attribute to their technical efficiency. According to the study [1], Option 4 (produce corn, treat it as fresh feed sources, and feed it as silage to 3 heads dairy Carabao) provides a net revenue of Php71,184.63 per year. With the shortest payback period of 0.82 years, the largest net present value of Php459, 634.71, and the highest internal rate of return of 124.21 percent, Option 3 is the most viable option.

**Table 2.** Length of time of farmers in dairy farming

| Years in Dairy | Frequency (n=11) | Percent (%) |
|---|---|---|
| 1 | 1 | 9.09 |
| 2 | 6 | 54.55 |
| 3 | 3 | 27.27 |
| 10 | 1 | 9.09 |

As shown in the results in Table 3, with regards to the animals raised by the dairy farmers. It was discovered that carabao is the most common dairy animal among farmers, with 7 or 63.64%, while 4 or 36.36% are cattle. Mostly, dairy farmers in the region have invested more in carabao raising than in cattle. As part of the result in the study conducted in the same region [2], most of the respondents have carabao as their main dairy farm animal, with a numerical value of 7 respondents, or 63.64 percent, while cattle are represented by 36.36 percent or 4 households. Some farmers have both cattle and carabao as their dairy animals.

**Table 3.** Animal raised by the dairy farmers

| Animal Raised | Frequency (n=11) | Percent (%) |
|---|---|---|
| Carabao | 7 | 63.64 |
| Cattle | 4 | 36.36 |

Table 4 represents the heads of the dairy animals raised by the farmer for their production. As shown in the table, there were 2 or 18.18% who raised 7 heads of dairy farm animals, 3 or 27.27% who had 4 heads, and 3 or 27.27% who raised 1 head, while 1 or 9.09% raised 2 heads, 5 heads, or 6 heads of farm animals, respectively. The average head of animals raised by the farmer was 4.

**Table 4.** Number of heads of animals raised by the dairy farmers

| Heads of Animals | Frequency (n=11) | Percent (%) |
|---|---|---|
| 1 | 3 | 27.27 |
| 2 | 1 | 9.09 |
| 4 | 3 | 27.27 |
| 5 | 1 | 9.09 |
| 6 | 1 | 9.09 |
| 7 | 2 | 18.18 |
| Mean | 4 | |

**Table 5.** Amount of investment of dairy farmers

| Investment (Php) | Frequency(n=11) | Percent (%) |
|---|---|---|
| Php 30,000 - 86,667 | 6 | 54.55 |
| Php 86,668 - 143,335 | 2 | 18.18 |
| Php 143,336 - 200,003 | 3 | 27.27 |
| Mean | Php 99,546.59 | |

Table 5 represents the amount of investment by the dairy farmers in their operations. As shown in the table, 6 or 54.55% has a total investment of Php 30,000 to Php86,667, 3 or 27.27% has a total investment of Php143,336 to

Php200,003, and 2 or 18.18% has a total investment of Php86,668 to Php143,335.The average farm investment they have incurred was Php99,546.59.

As shown in Table 6, the total number of heads of milking animals taken care of by dairy farmers, there were 4 or 36.36% with 2 milking heads, 3 or 27.27% with 3 milking heads, and 1 head in each, while 1 or 9.09% with 4 milking heads. The average milking animal head is 2. This means that for the total number of respondents, there were at least 2 milking heads for every farmer.

**Table 6.** Number of heads of milking animals taken cared by the dairy farmers

| Milking Animals | Frequency (n=11) | Percent (%) |
|---|---|---|
| 1 | 3 | 27.27 |
| 2 | 4 | 36.36 |
| 3 | 3 | 27.27 |
| 4 | 1 | 9.09 |
| Mean | 2 | |

Table 7 reveals the average number of milking days within a year for dairy animals. As shown, there is an age of 42 to 150 milking days as experienced by the 7 or 63.64% of the respondents. While there were 2 or 18.18% for 151 to 259 and 260 to 368 milking days, in each. The average number of milking days for dairy animals is 155.

**Table 7.** The average number of milking days in a year of animals of dairy farmers

| Milking Days | Frequency (n=11) | Percent (%) |
|---|---|---|
| 42 – 150 | 7 | 63.64 |
| 151 – 259 | 2 | 18.18 |
| 260 – 368 | 2 | 18.18 |
| Mean | 155 | |

As shown in Table 8, the result reveals the average daily production of milk harvested by dairy farmers. There are 3 or 27.27% for 5 harvested liters 2 or 18.18% for 8 liters, 4 liters, and 2 liters, respectively. While there was 1 or 9.09% for harvested dairy milk for 1 liter and 0.5 liters. The average amount of milk obtained per farmer per day is 4.04 liters.

**Table 8.** Average daily production of milk harvested by the dairy farmers

| Harvested Milk (lit) | Frequency (n=11) | Percent (%) |
|---|---|---|
| 0.5 | 1 | 9.09 |
| 1 | 1 | 9.09 |
| 2 | 2 | 18.18 |
| 4 | 2 | 18.18 |
| 5 | 3 | 27.27 |
| 8 | 2 | 18.18 |
| Mean | 4.04 | |

**Table 9.** Average monthly cost and return on the dairy operation of farmers

| Particular | Average Costs (Php) | |
|---|---|---|
| **a. Direct Labor** | | |
| 1. Care and maintenance | 1,040.91 | |
| 2. Feeding | 272.73 | |
| 3. Milk Collection | 89.55 | |
| Sub-Total | | 1,403.18 |
| **b. Direct Materials** | | |
| 1. Feed Concentrates | 690.91 | |
| 2. Silage | 220.00 | |
| 3. Forage | 581.82 | |
| 4. Medicine | 684.09 | |
| 5. Vaccine | 500.00 | |
| 6. Vitamins | 327.27 | |
| Sub-Total | | 3,004.09 |
| **c. Others** | | |
| 1. Salary/wages | 5,400.00 | |
| Sub-Total | | 5,400.00 |
| Total Costs | | 9,807.27 |
| **d. Marketing of products** | | |
| 1. Fresh milk produce | 102.70 | |
| Sold @ 180/lit | | 18,486.29 |
| Net Profit | | 8,679.02 |
| ROI (%) | | |

Table 9 displays the average monthly cost and return in dairy production and farmer operations. As shown in the table, the direct cost of labor, which includes care and maintenance, feeding, and milk collection, has amounted to Php1,403.18. Direct materials include feed concentrates, silage, forage, medicine, vaccines, and vitamins with a total cost of Php3,004.09. Salary and wages of Php5,400.00 while the expected cost for marketing and promotion of milk products is Php18,486.29 with an expected net profit of Php8,679.01. The return on investment (ROI) in the dairy operation is about 88.50%, which is a considerable ROI as compared to current lending of 18% per annum.

### C. Analysis of Productivity and Technical and Economic Efficiency

The Stochastic Frontier Analysis was used to calculate the productivity and technical and economic efficiency analysis, which determines the effects of regressor factors (Xs) (for productivity) and inefficiency (Ds) variables (for technical efficiency) as independent variables of the dependent variable (Y1). The $Y_1$ is the production of milk of the dairy farmers, while there are 4 regressor and 13 inefficiency effects variables are shown in Table 10. The productivity stochastic model for repressor's effect is shown below:

$$Y_1 = \text{Constant} + (V_i\text{-}U_i) + b_1 (X_1) + b_2 (X_2) + b_3 (X_3) + b_4 (X_4)$$

$$Y_1 = 7.85^{**} - 0.078^{ns} (X_1) + 0.43^{*} (X_2) - 0.025^{ns} (X_3) - 0.001^{ns} (X_4)$$

If the productivity variables are set to zero, the model predicts that milk productivity for dairy farmers will be around 7.85. The material cost ($X_2$) with a coefficient value of 0.34 has significantly ($p < 0.05$) contributed to the increase in milk productivity of dairy farmers. This is attributed to the lower cost of materials incurred by the dairy farmers due to measures that they implemented like silage making, vermiculture/composting, and recycling of farm waste products, which may have contributed to reducing the cost of the operation. The other variables like the several dairy animals ($X_1$), pre/post-harvest labor cost ($X_3$), and investment ($X_4$) were negative coefficient values with-0.781,-0.255, and-0.012, respectively, but insignificantly ($p > 0.05$) affecting milk productivity.

On the other hand, the model of inefficiencies effects evaluation that measures the technical efficiency performance of dairy farmers is shown below:

$$Y_1 = \text{Constant} + b_1 (D_1) + b_2 (D_2) + b_3 (D_3) + \ldots\ldots\ldots\ldots + b_n (X_n) + (V_i\text{-}U_i)$$

$$Y_1 = -0.08^{ns} - 0.043^{ns} (D_1) + 0.07^{*} (D_2) - 0.55^{*} (D_3) + 0.07^{ns} (D_4) + 0.06^{**} (D_5) + 0.00^{ns} (D_6) - 10.10^{ns} (D_7) - 0.16^{ns} (D_8) - 0.16^{ns} (D_9) - 0.16^{ns} (D_{10}) - 0.21^{ns} (D_{11}) - 0.49^{ns} (D_{12}) - 0.08^{ns} (D_{13})$$

Note: **Significant at 1% level;*Significant at 5% level; ns - not significant

**Table 10.** Technical efficiency analysis of the dairy operation of farmers in Cagayan Valley

| Variable | Name of Variables | Coefficient | t-ratio |
|---|---|---|---|
| **1. Regressor's Effects** | | | |
| $X_0$ | Constant | 7.848** | 7.95 |
| $X_1$ | Number dairy | $-0.781^{ns}$ | -1.35 |
| $X_2$ | Material Costs | 0.343* | 2.34 |
| $X_3$ | Pre/Post Harvest Labor Cost | $-0.255^{ns}$ | -0.66 |
| $X_4$ | Investment | $-0.012^{ns}$ | -0.10 |
| **2. Inefficiencies Effects** | | | |
| $D_o$ | Constant | $-0.084^{ns}$ | -0.09 |
| $D_1$ | Gender | $-0.341^{ns}$ | -0.45 |
| $D_2$ | Age | 0.075* | 2.15 |
| $D_3$ | Household Size | -0.555* | -2.74 |
| $D_4$ | Years in School | $0.067^{ns}$ | 0.67 |
| $D_5$ | Years in Farming | 0.062** | 3.07 |
| $D_6$ | Household Income | $0.000^{ns}$ | -0.60 |
| $D_7$ | Climate Change Awareness | $-0.101^{ns}$ | -0.34 |
| $D_8$ | Adoption of Green Technologies | $-0.159^{ns}$ | -0.19 |
| $D_9$ | Silage/Haylage Making | $-0.258^{ns}$ | -0.32 |
| $D_{10}$ | Use of Solar Panel for Irrigation | $-0.259^{ns}$ | -0.32 |
| $D_{11}$ | Adopt to use solar panels for irrigation | $-0.214^{ns}$ | -0.28 |
| $D_{12}$ | Vermi-Culture and Composting | $-0.488^{ns}$ | -0.71 |
| $D_{13}$ | Years in Dairy Production | $-0.083^{ns}$ | -0.74 |
| Sigma Squared | | $0.039^{ns}$ | 1.74 |
| Gamma | | 1.00** | 3.10 |

Significant Level: 0.01 = -3.14; 0.05 = -1.94

**Significant level at 1%; *Significant level at 5% ; ns - not significant

Table 10 reveals insignificant ($p > 0.05$) with less technical inefficiency effects based on the constant value of -0.08 if other factors will not positively or negatively influence the behavior of dairy farmers, meaning these 13 variables are set to zero. Age, family size, and years in farming exhibited significantly ($p < 0.05$) influences on the technical and economic efficiency performance of dairy producers, with coefficient values of 0.75, 0.55, and 0.06, respectively. Age and years of farming have positive coefficients, which implies that these variables contributed to greater technical inefficiency among dairy farmers.

This implies further that while farmers are getting older, at an average age of 55.54 years, their technical efficiency performance is deteriorating, which can be attributed to physical strength to perform dairying activities. Dairy farmers have experienced the same trend with age for years. This can be attributed to the resistance of farmers to adopting new technologies like green technologies because they are already content with what they have. Farmers' technical inefficiencies have been less affected by households with four or fewer people. Household sizes have decreased as a result of improved technical performance. Several workers are frequently chosen from among the family. The remaining variables had no significant ($P > 0.05$) impact on the farmers' technical efficiency performance.

Since the Sigma Squared value (0.039) is not zero, it indicates that the whole model has shown technical inefficiency effects but they are not significant.

### D. Problems Encountered by the Dairy Farmers

The result in this Table 11 shows some of the problems encountered by dairy farmers. The most important reason is the availability of equipment supplies in the area. With 8 or 47.06%, 4 or 23.53% of the respondents said that for dairy farmers, greening technologies are highly technical for them, 3 or 17.65% responded that it is very costly and they cannot afford it, while 2 or 11.76% responded that no government and non-government agencies provide capital for the acquisition of dairy greening technologies equipment.

**Table 11.** Problems encountered by the dairy farmers

| Problems | Frequency (n=11) | Percent (%) |
|---|---|---|
| a. Highly technical for us the dairy greening technologies | 4 | 23.53 |
| b. High costs and we cannot afford to have it | 3 | 17.65 |
| c. No available supply of that equipment in the locality | 8 | 47.06 |
| d. No government and non-government agencies that will provide capital for the acquisition of dairy greening technologies equipment | 2 | 11.76 |

* Multiple responses

## 5. Conclusions

Based on the findings, the following conclusions are drawn. The majority of dairy farmers are men, with an average age range from 54 to 62 years old and a mean age of 55.54 years old, according to the respondents' socio-economic profile. their ethnicity was mostly Ilocano; their dairy household size consisted of 6 members of the family with an average monthly income of Php13,863.91; their average years in farming is 23.32, and most of them attended seminars and training sponsored by the ISU and other government agencies. Farmers' technical efficiency improves as a result of their training and seminars. With regards to the seminar provided by the Philippine Carabao Center, there were 3 or 27.27% conducted, 2 or 18.18% were conducted by ISU, while 1 or 9.09% were conducted by PCIC.

As to the production information for the average milking days of dairy animals, there is an average of 155 milking days with a maximum of 5 liters of harvested milk. The average milking animal head is 2. This means that for the total number of respondents, there were at least 2 milking heads for every farmer. The average monthly production cost is Php1,403.18 with an expected net profit of Php8,679.01 and a return on investment (ROI) of 88.50%. While the length of time or years of engagement of every dairy farmer has only 2 years with 6 or 54.55% utmost, which indicate that farmers having more years of experience does not guarantee their efficiency; rather, their exposure to seminars and training can be an attributed to their technical efficiency. The average farm investment they have incurred was Php99,546.59.

In dairy production and farmer operations, the average monthly cost and return. The direct labor cost is Php1,403.18, which includes care and maintenance, feeding, and milk collection. Direct materials include feed concentrates, silage, forage, medicine, vaccines, and vitamins with a total cost of Php3,004.09. Salary and wages of Php5,400.00 while the expected cost for marketing and promotion of milk products is Php18,486.29 with an expected net profit of Php8,679.01. The return on investment (ROI) in the dairy operation is about 88.50%, which is a considerable ROI as compared to current lending of 18% per annum.

On the technical efficiency performance of the dairy farmers, the material cost regressor variable is shown to be significant ($p < 0.05$), while the rest are insignificant. For technical inefficiency effects variables, the dairy farmer's age, household size, and years in farming have indicated significant ($p < 0.05$). Dairy farmers have had fewer technical inefficiencies as a result of household size, but they have experienced more technical inefficiencies as a result of age and household size. The presence of technical inefficiencies in the model is shown by the Sigma squared and Gamma values.

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