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Determinants and Productivity Analysis of Sugarcane Production in Bauko, Mountain Province

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Abstract

The study was conducted to assess the factors influencing sugarcane productivity in Bauko, Mountain Province. Data were collected from 70 sugarcane growers in selected barangays. Analysis using the Cobb-Douglas production function unveiled low sugarcane productivity in Bauko, averaging only 46%. This shortfall primarily stems from suboptimal farm management and input utilization. The Cobb-Douglas analysis identified key variables impacting productivity. Farm Yard Manure (FYM) and training showed high significance at a 1% level, while farm size and household size were significant at a 5% level. The adjusted multiple determinations coefficient (R^2) reached 0.78, signifying a well-fitted model that explains 78% of the variable's variation. Based on these findings, several recommendations are proposed to enhance sugarcane productivity in the region. These include improved ratoon management, cost-effective labor practices, FYM promotion, sugarcane variety enhancements, and the distribution of processing machinery for muscovado production. Additionally, seminars and training programs should address postharvest losses, sucrose content, pest and disease management, muscovado marketing, and organizational issues. Encouraging the formation and strengthening of sugarcane farmer associations will facilitate the adoption of new technologies. Furthermore, government and related entities should support intensification methods to assist small landholder farmers in overcoming their challenges. These measures collectively aim to boost sugarcane productivity in Bauko, Mountain Province.

Keywords: Sugarcane, Productivity, Cobb-Douglas, FYM, Training, Landholding Size

Introduction

Background of the Study

Sugar is one of the most widely consumed agricultural commodities globally. The Food and Agriculture Organization (2017) estimates that average global per capita sugar consumption is approximately 24 kg annually, reaching as high as 33.1 kg in industrialized countries. About 70% of the world's sugar supply comes from sugarcane, emphasizing its importance in global agricultural systems.

In the Philippines, sugarcane is a major commercial crop cultivated in 19 provinces and contributes substantially to the rural economy. According to the Sugar Regulatory Administration (2022), the industry generates around PHP 76 billion annually and provides livelihood to approximately 62,000 farmers and 600,000 farm workers. Despite this economic importance, the Philippine sugar industry remains relatively uncompetitive in the global market due to high production costs, inefficient input utilization, outdated technologies, weak infrastructure support, fragmented marketing systems, and declining farm labor availability.

Within the Cordillera Administrative Region (CAR), sugarcane ranked third in crop production during the first semester of 2018, accounting for 12.2% of total output. However, in Mountain Province, sugarcane contributes less than 8% of total crop production, despite favorable agro-climatic conditions and strong performance in other high-value crops (PSA, 2018). This discrepancy suggests the presence of structural, managerial, and productivity-related constraints affecting sugarcane production in the province. These are also attributed to inefficient input use, outdated production techniques, inadequate financial and infrastructure support, and declining availability of skilled farm labor as younger generations migrate to urban areas (PEF, 2016). Moreover, the absence of collective marketing among planters and cooperatives results in dependence on multiple layers of traders, increasing transaction costs and reducing farm-gate prices (Zabaleta, 1997).

In Bauko, sugarcane farming has long been practiced and is increasingly considered an alternative crop following disease outbreaks (e.g., Fusarium) that affected other agricultural commodities. Government interventions—such as community-based processing projects supported by the Department of Science and Technology (DOST) and livelihood initiatives under the Second Cordillera Highland Agricultural Resource Management Program (CHARM)—have aimed to revitalize sugarcane production and muscovado processing.

Despite these initiatives, overall productivity remains low, and in many cases, muscovado production is limited to household consumption rather than commercial-scale marketing. This situation raises a critical empirical question: Why does sugarcane productivity remain low in Bauko despite institutional support and long-standing cultivation practices?

Understanding this phenomenon requires systematic examination of farm-level productivity and the determinants influencing it. Extensive literature has analyzed sugarcane productivity in countries such as Ethiopia (Erifo et al., 2016), Fiji (Narayan, 2004), and South Africa (Townsend et al., 1998), frequently employing the Cobb-Douglas production function to estimate input-output relationships. These studies identify land, labor, fertilizer use, irrigation, farm size, and farmer experience as significant determinants of productivity and profitability.

However, three major gaps remain. These are the geographic gap, integrated determinants gap, and productivity measurement Gap. There is limited empirical research on smallholder sugarcane production in upland and highland regions of the Philippines, particularly in Mountain Province. Most Philippine studies focus on major sugar-producing regions such as Negros Island, leaving peripheral production areas underexamined. Existing local discussions emphasize agronomic practices but rarely integrate socio-economic characteristics (age, education, organizational membership, off-farm income) with

production inputs in a unified analytical framework. Moreover, there is insufficient empirical estimation of farm-level productivity using formal production function models in smallholder muscovado-based systems. Much of the available data are descriptive rather than econometric. Thus, there is a need for a rigorous empirical assessment of sugarcane productivity and its determinants in Bauko, Mountain Province, using a structured analytical framework.

This study contributes to the literature and policy discourse in several important ways. It provides localized empirical evidence on sugarcane productivity within an under-researched upland production system, thereby addressing the scarcity of data specific to smallholder producers in Mountain Province. Also, the study integrates socio-economic characteristics and farm-level production variables into a unified productivity model, allowing for a more comprehensive analysis of the factors influencing output. The study applies an econometric production framework, particularly the Cobb-Douglas production function, to estimate the determinants of muscovado output, thereby strengthening the methodological rigor of productivity analysis in the local context. It generates policy-relevant insights for local government units, farmer organizations, and development agencies by identifying leverage points to improve farm efficiency and profitability. Finally, the findings establish baseline empirical data that may guide future interventions aimed at enhancing the competitiveness and sustainability of smallholder sugarcane production systems.

By addressing both technical and socio-economic dimensions, the study moves beyond descriptive analysis and offers a structured explanation of productivity variation in smallholder sugarcane systems.

Conceptual Framework

Agricultural productivity and efficiency are at the center of many of the debates, policies, and measures concerning the farming sector. The emphasis placed by the Sustainable Development Goals on agricultural productivity underlines the many reasons why additional research on statistical frameworks for productivity and efficiency targeted to developing countries is necessary (FAO, 2017).

For years, the government and other organizations' interventions have been centered on on-farm productivity. However, smallholder sugarcane production is under-researched and underdeveloped with limited industrial links and support (Tena *et al*., 2016). Nationally and globally, there is very little empirical research on sugarcane production both in developed and developing countries (Reza *et al*., 2016).

Productivity of Sugarcane Production

The agricultural industry plays a critical role, particularly in developing countries. Agriculture productivity improvement is significant because it contributes to poverty reduction by improving food security and increasing farm income (FAO, 2017). Aside from food security, agriculture is a way of alleviating poverty by providing additional income sources for rural households (Musaba & Bwacha, 2014). The problem, however, is that agriculture is also faced with different issues. Some of these problems include (1) the degradation of resources, (2) the conversion and limitation of land resources, and (3) the

effects of global warming. Hence, to compensate for these problems, farmers must increase their output.

The productivity of crop agriculture is most often assessed by a measure of crop yield. These measures are expressed as product per unit of land, labor, fertilizer, seed, insecticide, tillage, and irrigation (Reza *et al*., 2016).

Studies on productivity involve analysis of the different factors affecting productivity. Analyzing the effect of these different factors contributes to improving productivity and would help farmers increase their income.

Sugarcane productivity is thought to be boosted through an increased number of inputs, training of farmers, and increased use of agro-organic and chemical applications. However, agro-inputs and farmers' training may not be the only factor responsible to increase sugarcane productivity but also intangible factors like farmers' socio-economic profile may augment productivity. Thus, the following socio-economic profile of farmers such as age, civil status, educational attainment, household size, training, and seminars attention on sugarcane production and membership in farmers' organizations are included in the study. Thus, makes the paradigm of the study as shown in Figure 1.

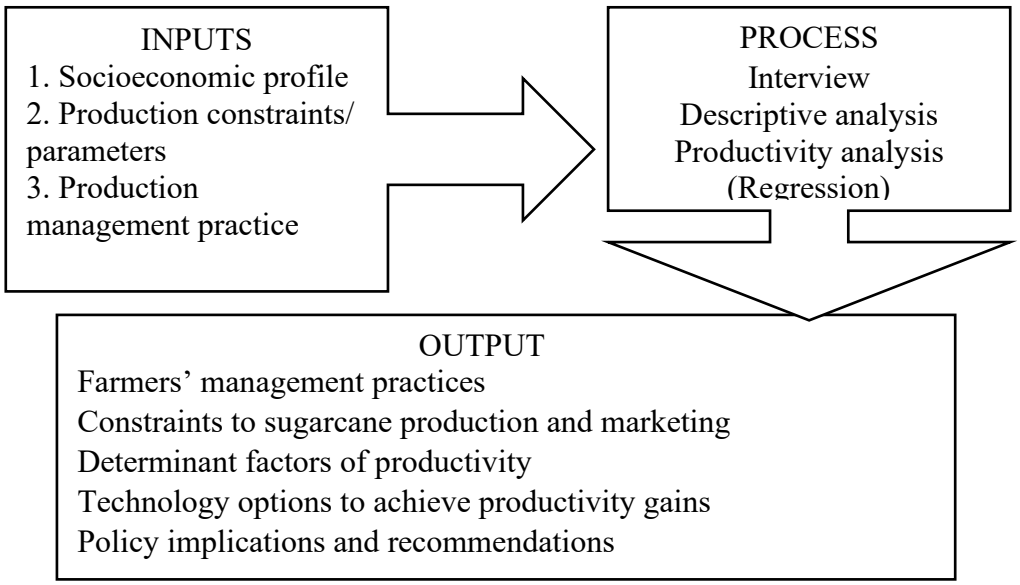

Figure 1. The paradigm of the study

Market of Sugarcane Production

Muscovado is a non-centrifugal sugar that is obtained from evaporating fresh cane juice of *Saccharum officinarum L.* until the desired consistency has been attained. The data from the Sugar Regulatory Administration (SRA), shows a bright opportunity for Philippine Muscovado farmers since a minimum capital and labor input is needed to produce Muscovado sugar (PNS, 2015).

Sugarcane growing has long been practiced in Bauko, Mountain Province. Sugarcane plantations can be seen when visiting the municipality's various isolated districts. Sugarcane, on the other hand, is often used only for muscovado manufacturing in the area. Sugarcanes

are sold as raw materials to sugar mills in other countries, according to some literature. In Bauko, the practice is different. Sugarcanes are gathered and transported to sugar mills for processing, after which the muscovado is sold in the market. The end product is Muscovado. An interview with one of the sugar mill owners stated that a certain kilogram of muscovado corresponds to certain kilograms of raw sugarcane. However, it is not a common practice for all and the estimates might vary in some areas. Thus, in this study, total muscovado will represent productivity output.

In a similar study of winegrowers in South Africa, Townsend *et al*. (1998), used wine production as the output, while the seven inputs were fertilizer, herbicides, pesticides, labor, machinery, vineyard enhancements, and land.

Determinant Factors of Sugarcane Productivity

Mountain province is one of the top producers of other crops in the Cordillera however doesn't top a high level of sugarcane production. Pieces of literature say that there are many factors affecting sugarcane production and constraints to its profitability. These include farm size, farmers' experience, fertilizer application and cost, labor, irrigation, distance to the mill, yield, etc.

Studies on productivity commonly identify the factors that affect productivity as well, since both are usually estimated consecutively. A new focus on the determinants is important because it gives a framework for developing policies and initiatives to increase farm efficiency. The factors to be tested were identified using various kinds of literature as a guide.

Farm inputs and management practices. Inputs and cultural management techniques are linked since practices almost always require the usage of inputs. Similarly, the sort of inputs used and their degree of use are determined by the farmers' management decisions. Azam and Khan (2010) found that various inputs, including land, labor, capital, seed, fertilizer, irrigation, and soil, have a significant impact on agricultural productivity. All the inputs are divided into three categories: land, labor, and capital, where land refers to the 12-month rental value of land and labor refers to paid and family labor.

In sugarcane production, there are different practices employed. For instance, the habit of rearing and planting daughter plants/emerging ratoons, this method affects the yield of the plant later. However, a different effect is seen when new planting materials are utilized instead of daughter plants or ratoons.

To optimize income, smallholder cane growers, according to Malaza and Myeni (2009), must raise yield and sucrose content. The timely and sufficient use of inputs throughout the crop's life cycle is the most important factor in sugarcane productivity. Lowering input usage will undoubtedly save money, but it will also diminish productivity. It is also said that ratoon age is inversely proportional to crop yield. If no new sugarcane is planted, productivity is expected to decline. Malaza and Myeni (2009) thus identified seed, fertilization, irrigation, transport costs, and ratoon management as the key elements to be managed for efficient production. The right varieties for the climate and soils need to be grown. The land has to be prepared to take into consideration the method of irrigation to be used and it should facilitate proper water movements.

Narayan (2004) also estimated a sugarcane production model of sugarcane production in Fiji and found that the area harvested and fertilizer, labor force, and prices paid to sugarcane farmers had a positive influence on sugarcane productivity and profitability in both the short- and long run.

A study by Reza *et al*. (2016) shows that farmers gain profit from sugarcane production, and the profit margin increases if the farmers grow inter-crop with sugarcane. It is also stated that fertilizer, seed, and pesticides significantly affect sugarcane production where the use of fertilizer and pesticides are positively and seed is negatively related to sugarcane production. In the case of sugarcane production with inter-crop, tilling and pesticides are positively and significant and human labor is significantly but negatively related to sugarcane production. Thus, the study recommends that to increase the production and profit level of sugarcane, farmers should be encouraged to inter-cropping.

Also, the study of Dlamini and Masuku (2013) indicated that variables such as farm size, farming experience, sucrose price, labor cost per hectare, and fertilizer cost per hectare significantly ($p<0.01$) influence the profitability of smallholder sugarcane farmers associations in their study area. The adjusted R^2 was 0.623, suggesting that about 62.3% of the variation in profit per hectare is explained by the explanatory variables. It is therefore recommended that good crop husbandry practices like timely weeding, fertilization, and irrigation should be adopted to produce a good crop that will enhance profitability.

Production levels and success of a sugarcane farm depend on the input use efficiency and the quality of decisions made by the smallholder farmer (Kalinga, 2014). Environmental factors can affect inputs, management techniques, and output in addition to inputs. The unstable climatic conditions in the country were influenced by global warming. Rainstorms and typhoons have been known to occur at random periods. Though sugarcane is believed to grow in any type of soil, weather conditions for planting and harvesting must be taken into account. Typhoons in the later months of the year damage the plant's flourishing capability and yield capacity before harvest due to climatic conditions. Because losses are unavoidable on some days, the volume of output may be lowered. Environmental influences are among the random errors in the stochastic approach.

Landholdings/ farm size. Sugarcane is one of the major crops of the Philippines. It is cultivated in 19 provinces across the country. From 2002 to 2006, sugarcane production contributed an average of P24.91 billion/per year to national agricultural production. Based on the latest statistical data, about 392,300 hectares are for sugarcane production which accounts for 7.43 percent of agricultural lands for major crops.

In terms of farm size, small farms comprised around 38.7%, medium-sized farms 30.3% and large farms occupied 31%. The greatest number of sugarcane farmers which was 26,188 farmers is in Negros Island where 87% are small farmers (with farms 10 hectares or less) considering that it has the biggest sugarcane area in the country. Table 1 shows the distribution of farmers and plantations in Luzon.

Table 1
Number of farmers by farm sizes, Luzon, CY 2009 – 2010 to 2011-2012

FARM SIZES	2011 -2012		2010 – 2011		2009 -2010	
	NO. OF FARMERS	FARM AREA (HAS)	NO. OF FARMERS	FARM AREA (HAS)	NO. OF FARMERS	FARM AREA (HAS)
Small (10 has and below)	12,590	27,532	12,291	25,711	12,244	26,215
Medium (10.01 has to 50.0 has)	986	21,382	963	20,758	970	20,824
Large (over 50 has)	183	16,936	143	15,191	161	16,921
Total Luzon	15,759	65,850	13,397	41,660	13,375	63,960

Note. Plantation size refers to the area planted with sugarcane, based on survey reports of SRA M&E District Officers
Reference: SRA Agricultural Extension Monitoring Reports

SRA (2015) wrote that small farms are generally less productive compared with medium-sized and large farms ranging from 48.47 to 57.31 tons of cane per hectare compared with large farms having productivity levels with a low of 62.72 TC/Ha to a high of 76.19 TC/Ha within the three-crop year period. Lack of economies of scale, no financial capability to procure the necessary farm inputs such as fertilizer and planting materials from cane high-yielding varieties, and poor farm practices are seen to influence the low yields of small farms.

A study conducted in Ethiopia shows that increase in land under sugarcane production results in a yield increase (Erifo *et al*., 2016; Masterson, 2007). However, a study by Townsend *et al*. (1998) shows an inverse relationship between farm size and both land and total productivity is weak and not consistent. In some cases, although not significant, it is positive.

Bauko is one of the municipalities in Mountain Province engaged in sugarcane farming. As of 2013, thirteen hectares of sugarcane plantation are recorded in the municipality-owned by smallholders. Though farmers are classified as small farmers, analyzing productivity will motivate them to improve and engage more in sugarcane farming.

Labor. Hired and family works are both types of labor. Most studies on household size agree that it has a beneficial impact on productivity. Fakayode (2009) found a positive and substantial association between family size and technical efficiency since larger households have better access to family labor. Furthermore, according to a study conducted in Nigeria, family work is more widespread in farms than hired labor. Douglas (2008) came to the same conclusion, stating that greater family work would allow them to perform better at their assigned jobs because farm chores would be dispersed to a larger number of people.

In considering family size as a determinant, Dao (2013) mentioned that the number of children present in the household should be taken into account. Family members can be considered as a labor source, however, if household members are mostly children, it may not apply.

Socio-economic and Production Characteristics

As stated earlier, socio-economic factors may also augment productivity. The following characteristics were included in the study.

Age. A study conducted by Erifo *et al*. (2016) about determinant factors of sugarcane productivity in Ethiopia found that most of their respondents were within the age group of 40-50 years. According to Haruna and Kushwaha (2003), as cited by Aina *et al*. (2015), this age group is considered a productive age group. The young farmers are more active in the adoption of new farming techniques and always willing to change for better than the older ones who are somehow conservative. Asumugha *et al*. (2000) also stressed that relatively young farmers assume greater risk in anticipation of high profits than older ones.

Years in farming. Long years in farming have traditionally been seen to boost output because it signifies greater producing experience. However, the outcomes of several investigations differed. Douglas (2008) and Shaheen *et al*. (2011), for example, found that extended years of farming had a favorable impact on technical efficiency. Because of the knowledge gained through the years of farming, more farming experience means stronger managerial abilities and decision-making on the farm.

Jaime and Salazar (2011), on the other hand, linked years of farming experience to age, because older farmers had greater experience. According to their findings, age has a negative relationship with technical efficiency since younger and new farmers are more open to embracing new technology, but older farmers are said to have less awareness of agricultural advancements.

Other sources of income. According to Haji (2006), as cited by Khaile (2012), having other sources of income positively affects productivity. Off-farm income would mean that farmers are more likely to have money to buy inputs and farm materials for farm operations on time, thus, increasing productivity. Also, the chances of reducing input use due to financial constraints are lessened. Contrary to the first study, the results of the study of Essilfie *et al*. (2011) revealed that having off-farm jobs results in a decline in technical efficiency. It was mentioned that having off-farm jobs could decrease the hours spent on the farm.

Membership in farming organizations. Participating in farming organizations is expected to boost productivity. Membership in groups facilitates interaction and sharing of innovations with other farmers, according to Okwir's research from 2009. Furthermore, affiliations' activities and seminars may aid in the development of their members' skills. In addition, government development plans are sometimes conducted first through partnerships with groups or organizations. Membership in an association, according to Nyanjong and Lagat (2012), supports a rise in human capital and is vital in improving farmers' efficiency.

Although this variable is thought to have a favorable impact on efficiency, there is evidence suggesting the contrary in the literature. For example, in Jaime and Salazar's (2011) study, participation in organizations was found to have a detrimental impact on technical efficiency. It was suggested that this could be because groups operated as more of a gathering

place for farmers rather than a place to learn more about farming. As a result, the goals of boosting productivity through technology sharing with other farmers have not been accomplished.

Seminars and training. Seminar and training attendance have been linked to increased productivity. Rajendran (2012) indicated that knowledge and farm innovations are the key and important contributions of training in his study, which included training as a variable. The same findings were found in research by Douglas (2008), whose primary goal was to examine the technical efficiency of farmers who participated in a government-sponsored training program. The technical efficiencies of the two groups were found to be significantly different, with trained farmers being more efficient.

Productivity Measures and Analysis

Productivity can be measured for a single entity (farm, commodity) or a group of farms, at any geographical scale. For example, a productivity measure for agriculture that is often cited is crop output per land area (commonly referred to as crop yield), with a higher yield corresponding to higher productivity. Land productivity measures can be calculated by dividing crop production by the amount of planted land, expressed in an area unit, such as hectares or acres. When expressed in terms of physical output, such as tons of maize, land productivity corresponds to crop yields (FAO, 2017).

For the analysis, the Cobb-Douglas production function is used by some researchers in measuring productivity in agricultural economics. Using the Cobb-Douglas production function, Erifo *et al*. (2016) reveal in their study that landholding size, costs of inputs for land preparation, DAP, and urea were highly significant at 1% level with positive coefficients 0.33, 1.86, 0.65, and 0.18, respectively. Education level and the cost of FYM were significant at a 5% level with coefficients of 0.24 and -0.04. The coefficient of adjusted multiple determinations R2 was 0.8624, which indicated that it is well fitted and 86% variation in the variables was explained by all the hypothesized explanatory variables.

Similarly, Nazir *et al*. (2013) as cited by Reza *et al*. (2016) found that the costs of inputs of sugarcane i.e., urea, FYM, land preparation, seed, and its application, weeding, and cost of irrigation were the important factors which influenced the returns of sugarcane growers. The effectiveness was examined by using the Cobb-Douglas production function, and MVP and allocative efficiency were also calculated. They also found that the high prices of inputs, low price of output, delay in payments, and lack of scientific knowledge were the major problems in sugarcane production.

Ogwang (2009) also employed the Cobb-Douglas production function to identify factors that affect sugarcane productivity, as well as gross margin analysis to assess sugarcane profitability. Sugarcane growers were receiving good gross margins from their sugarcane business, according to the findings. Sugarcane area (farm size), labor used, and distance from fields to the factory were all statistically significant, according to the Cobb- Douglas results.

Statement of the Problem

Agricultural development in Bauko, Mountain Province faces multiple constraints, including land degradation, crop disease outbreaks, limited capital, and market inefficiencies.

While sugarcane has emerged as a viable alternative crop and is traditionally cultivated in the area, its production remains low and largely subsistence-oriented.

Despite government-supported interventions to promote muscovado processing and farmer organization development, there is no clear empirical evidence explaining the persistently low productivity levels. Existing information does not adequately quantify production performance nor identify which farm-level, socio-economic, and management factors significantly influence productivity outcomes.

The absence of localized, econometric analysis has constrained evidence-based policy formulation and limited the ability of stakeholders to design targeted interventions for improving farm efficiency and profitability. Given these conditions, a systematic examination of sugarcane productivity and its determinants in Bauko was necessary to provide empirical insights into the performance of smallholder producers and the factors affecting their output.

Therefore, this study aims to determine the level of sugarcane productivity and identify its key determinants in Bauko, Mountain Province. Specifically, the study is guided by the following questions:

1. What are the socio-economic profile and production characteristics of sugarcane farmers in Bauko, Mountain Province?
2. What management practices are employed by sugarcane farmers?
3. What constraints do farmers perceive in sugarcane production and marketing?
4. What is the level of sugarcane productivity in terms of land productivity?
5. Which farm inputs, socio-economic characteristics, and management factors significantly determine sugarcane productivity?

Hypotheses of the Study

The study hypothesized that sugarcane farming in Bauko, Mountain Province is productive; and the following factors significantly affect sugarcane productivity: landholdings positively influence productivity; the use of farmyard manure positively influences productivity; labor cost negatively influences productivity; family size has a positive relationship with productivity; age has a positive relationship with productivity; long years of farming experience have a positive effect on productivity; the length of membership of farmers in an association has a positive relationship with productivity; the more the number of training and seminars attended by the farmer, related to sugarcane farming, the higher the productivity; and planting new sugarcane positively influences productivity.

Methodology

Research Design

The study used qualitative and quantitative research designs. A descriptive research design is appropriate to explain the farm practices employed by sugarcane farmers. The means and frequency counts are necessary to describe better the socio-economic and production characteristics of sugarcane farmers. On the other hand, a quantitative research design is used to explain the input-output relationship and the determinant factors of sugarcane productivity.

Population and Locale of the Study

The study covered the major producing area of sugarcane in Bauko, Mountain Province. Many barangays in the municipality are beneficiaries of DOST projects and assistance from different agencies to encourage sugarcane production. Five (5) barangays were included for sampling. These barangays are Banao, Bila, Guinzadan Sur, Lagawa and Tapapan. The selection of these barangays was strengthened by the owners of processing sites stating that these barangays are the active top-producing barangays in the municipality and even within the threat of the pandemic.

In Bauko, barangay associations engage in sugarcane farming and have a minimum of 15 members. Initially, at least fifteen respondents are to be randomly selected per barangay for a total of 75 farmers. A set criterion for respondents is that he/she must be/have been a member of the sugarcane association and have an experience in muscovado production. However, in the conduct of the study, it was found from the data taken at the office of the municipal agriculturists that they have no record of associations despite the associations existing at the barangay level. Thus, only the list of identified sugarcane growers was provided.

With the set criteria and list of sugarcane growers, a total of 78 who engage in sugarcane farming for 3 years or more were considered. The required number of samples uses a purposive random sampling technique so the target group of farmers can enter the sample. However, during the interview, it was found out that some of the identified farmers already passed away while some farmers never brought a harvest at the processing mill. Thus, only the data gathered from 70 respondents were utilized.

Data Collection Instruments

The study used an interview guided by a questionnaire. Improvements to the instrument were done after the pre-testing of the questionnaire.

Part of the questionnaire includes the profile of the respondents, farm inputs and farming management practices, constraints to sugarcane production, and problems encountered in marketing. Multiple responses to the problems encountered in sugarcane production and marketing were allowed.

Data Collection Procedure

Coordination with the Municipal Local Government Unit (MLGU) was undertaken before the data collection from farmers. Primary and secondary data were used in the study. Secondary data on the list of sugarcane growers of each barangay was obtained from the municipal agriculturist office. Primary data were obtained from the respondents through interviews guided by a questionnaire. The following information were gathered:
Socio-economic and farming characteristics of the sugarcane farmers;
The farmers practice in sugarcane production;
Inputs used and corresponding levels of usage;
Total output for sugarcane, methods of selling; and Problems encountered by the farmers in sugarcane production and marketing.

The socio-economic characteristics include age, sex, civil status, family size, educational attainment, and sources of income. On the other hand, farm and production

characteristics include farm size and the number of years in farming, years of membership in organizations, and training and seminars attended.

Treatment of Data

The data were analyzed using both descriptive and econometric analysis methods. Data were organized and tabulated in excel. Descriptive analysis was used to explain the farm practices employed by sugarcane farmers. The means and frequency counts are necessary to describe better the socio-economic and production characteristics of sugarcane farmers and their level of productivity. The production methods, the different inputs, and the problems encountered in production and marketing were discussed similarly.

The level of sugarcane productivity was computed in terms of land productivity and the computed value were categorized as low, medium, or high productivity. To determine the factors influencing sugarcane production, the Cobb-Douglas production function was employed and the parameter estimates were generated using JASP 0.16.3.0 software.

A multiple linear regression model was used to study the relationship between a dependent variable and one or more independent variables. The generic form for the linear regression model is

$$y = f(x1, x2, \dots, xk) + \varepsilon$$
$$= x1\,\beta 1 + x2\,\beta 2 + \cdots + xk\beta k + \varepsilon$$

Where y is the dependent or explained variable and x1, …, xk are the independent or explanatory variables. ε is the disturbance factor.

From the above equation, the Cobb-Douglas production function can be written as

$$\ln Y = \beta_o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_n lnX_n + \varepsilon$$

where;

Y is the dependent or explained variable, in this case, sugarcane Productivity, expressed as muscovado in kg per hectare. Since sugarcane farmers don't sell harvested raw sugarcanes, outputs in kg used the total amount of muscovado produced.

X_1, …, X_n are the independent or explanatory variables

ε is the disturbance factor.

The independent or explanatory variables expected to influence the dependent variable are

x_1 = Landholdings/ Farm size (ha)
x_2 = Farm Yard Manure (FYM) use (1=yes, 0=no)
x_3 = Labor cost/ha
x_4 = Family size (total family members)
x_5 = Age
x_6 = Farming experience (years in farming)
x_7 = Membership in a sugarcane organization (years of membership)
x_8 = Seminars attended (number of seminars or training attended)
x_9 = Mother plants used (percentage of mother plants used).

Initially, total investment was included as the tenth predictor, however, upon analysis, this was excluded as discussed in the results and discussion.

Results and Discussion

Socio-economic Profile

The respondents interviewed in the study came from the five barangays of Bauko municipality namely: Banao, Bila, Guinzadan Sur, Lagawa, and Tapapan. The socio-economic profile of the 70 farmer respondents is summarized in Table 2.

Among the 70 respondents, 22 are men, while 48 are women signifying the dominance of women in the sugarcane production industry in Bauko. In terms of ages, the farmers' ages ranged from 22 to 63 years. If classified according to age brackets, more than half of the farmers (42) were 51 to 63 years old and 40 percent (28) were younger of age. This implies that most of the sugarcane growers in Bauko, Mountain Province are adults whose ages range from 40 and above. This shows the same result as the study of Erifo *et al.* (2016) about determinant factors of sugarcane productivity in Ethiopia where they found out that most of their respondents are within the age group of 40-50 years. Though one study reveals most middle-aged (35-50 years) sugarcane farmers, a similar age bracket is seen in the study of Chauhan, Shanthy, and Senthamil (2021) comprising 41.67% of sugarcane farmers.

One of the many problems in agriculture is the low number of young entrants who will take over farms as they preferred non-farm jobs over engaging in agriculture. This case exactly holds true for sugarcane farming considering that there are more old farmers than young adult farmers. Roughly 83 percent of the respondents are married, with the remaining 17 percent, widowed. On the average, households of respondents have five members. The data gathered imply that family labor is generally the source of labor for sugarcane farming with the number of family members in each family. Some farmers explained that the reason for having a large family size seen in the data is due to the common practice of extended family living in one house.

On livelihood, more than 78 percent of the farmers said that their primary source of income is farming which includes vegetables, and rice. Sugarcane farming is an additional source of income. Around 70 percent of the respondents depend on farming alone, as it is their only source of income. However, none of the farmers engaged in sugarcane farming as their sole source of income. The remaining 30 percent have additional sources of income. Despite the higher number of respondents who graduated from college (27 percent), most of them still believe in and consider farming as their primary occupation.

Table 2
Distribution of respondents per socio-economic characteristic

CHARACTERISTICS	NUMBER					TOTAL	PERCENTAGE (%)
	Ba	Bi	G S	L	T		
Sex							
Male	3	2	7	4	6	22	31
Female	12	5	8	12	11	48	69
Age							
21-30	-	-	1	1	4	6	9
31-40	1	1	-	-	2	4	6
41-50	2	2	5	5	4	18	25
51-60	10	4	5	10	6	35	50
61 and above	2	-	4	-	1	7	10
Mean (Age)	54	50	54	52	44	51	
Civil Status							
Married	11	7	12	13	15	58	83
Widowed	4	0	3	3	2	12	17
Educational Attainment							
No formal Schooling	-	-	-	3	1	4	6
Elementary Graduate	-	1	3	5	6	15	22
Highschool Undergraduate	4	-	-	3	5	12	17
Highschool Graduate	1	3	1	2	-	7	10
Vocational	-	-	1	-	-	1	1
College Undergraduate	4	3	2	1	1	11	16
College Graduate	6	-	7	2	4	19	27
Post Graduate	-	-	1	-	-	1	1
Sources of Income							
Primary							
Farming	15	7	8	11	14	55	79
Self-Employment	-	-	5	2	-	7	10
Non-Farm Jobs	-	-	2	3	3	8	11
Secondary Source of Income							
Farming	-	-	5	3	3	11	16
Livestock Raising	-	-	2	2	-	4	6
Self-employment	2	-	-	-	-	2	3
Non-farm Jobs	1	2	-	-	-	3	4
None	12	5	8	11	14	50	71
Household Size							
1 – 3	1	1	4	7	2	15	22
4 – 6	10	5	5	5	8	33	47
7 – 9	4	1	6	4	7	22	31
Mean (Household size)	5	5	6	5	6	5	

Legend: Ba=Banao; Bi=Bila; GS=Guinzadan Sur; L=Lagawa; T=Tapapan

Off-farm jobs like driving, working in sari-sari stores, and being barangay workers are among the mentioned, typical additional sources of income. Some farmers raised hogs and chickens, but since it was a backyard farm, they did so only to increase their income. On the other hand, some people, like those who work in off-farm careers, do not view farming as

their primary source of income. Since sugarcane farming doesn't require much attention, sugarcane farming is an additional source of livelihood for them.

Among the common primary sources of income aside from farming are teaching, government employees, and farm supply business. Off-farm income would mean that farmers are more likely to have money to buy inputs and farm materials for farm operations on time, thus, increasing productivity (Haji, 2006). However, the study of Essilfie *et al*. (2011) states otherwise, as having off-farm jobs could decrease the hours spent on the farm, thereby, declining efficiency.

Production Characteristics

Other than the socio-economic profile of the respondents, farm and production characteristics such as farm size, tenure status, years of experience in sugarcane farming, involvement in organizations, and the number of seminars attended were also determined to describe the production system of sugarcane better. The following attributes are also essential in identifying the determinants of productivity. Found in Table 3 is the distribution of farmers for each type of characteristic.

Table 3
Distribution of respondents per production characteristic

CHARACTERISTIC	NUMBER					
	Ba	Bi	GS	L	T	TOTAL
Size of the farm (m^2)						
Less than 500	15	-	10	13	15	53
500 – 1000	-	4	5	3	2	14
1001 – 1500	-	3	-	-	-	3
Mean (Land Size)						356 m^2 (0.0356 Ha)
Tenure Status						
Owned	15	7	15	16	17	70
Years in sugarcane farming						
1 – 3	6	3	2	3	8	22
4 – 6	6	4	6	11	7	34
7 - 9	3	-	7	2	2	14
Mean (Number of years in sugarcane farming)						4.4
Years of Membership in Organizations						
1-3	14	6	5	16	15	56
4-6	1	1	7	-	2	11
6-9	-	-	3	-	-	3
Mean (Years of Membership)						1.6
Attended Seminars or Training						
Yes	9	4	10	7	3	33
Number of Seminars Attended	20	5	21	23	7	76
No	6	3	5	9	14	37
Mean (Number of seminars and training attended)						1.5

Legend: Ba=Banao; Bi=Bila; GS=Guinzadan Sur; L=Lagawa; T=Tapapan

Land utilization. All of the respondents claimed that they owned the farms and each farmer has less than 2 hectares as shown in Table 3. Only three of the respondents own a farm of more than 1000 m^2 (0.1 ha) while most of the farmers (53) have less than 500 m^2 farms. On average, each farmer is considered to have 356 m^2 of land utilized for sugarcane production. Thus, the study reveals that the farmers are identified as small farm holders (SRA, 2015).

Farming experience. Extended years of farming had a favorable impact on the farmers' performance because the knowledge gained through the years means stronger managerial abilities and decision-making on the farm (Douglas, 2008). Nearly 50 percent (34) of the farmers have more than 3 years of experience in planting sugarcane, of which, only 14 respondents have been planting sugarcane for 7 – 9 years. Twenty-two of the respondents are new to sugarcane farming with 3 years of farming experience. Results imply that sugarcane farming has long been done in Bauko, Mountain Province having Guinzadan Sur farmers as the earliest to cultivate such crop with an average experience of 8.27 years as shown by the survey from the respondents. Barangays Lagawa and Bila have the least average years of experience with 3.71 and 3.67 years respectively.

According to the farmer respondents, sugarcane was not given much importance in the past years. This is for the reason that the harvest in those times was few and was used primarily for consumption until such time that the farmers came to realize the impact of increasing production as they introduce the processing machines in their production and operation activities. This was the time that muscovado was traded in the market. This led to an increase in the number of sugarcane growers. However, in the later years, these machines became unfunctional so some farmers opted not to harvest their sugarcanes than to incur additional costs in bringing their harvest to available processing sites.

Seminars and training attended. Around 47 percent of the farmers have attended seminars and training related to sugarcane production, and nearly 80 percent of them are affiliated with sugarcane organizations within 1 to 3 years. A number of those who have attended seminars and training said that some of the seminars and training they attended are open to all, regardless of organizational affiliation. However, not all members of the sugarcane associations were able to attend. In some cases, new members of sugarcane associations acquired their seminars and training before they joined an organization.

The average number of seminars or training attended on sugarcane production is 2 and the highest is 5. Topics of seminars and training are centered mostly on production practices and muscovado processing. However, the respondents who attended muscovado processing said that they were not able to apply or conduct processing in their respective barangays since the provided machines became unfunctional after 2 years of using it. There are also other seminars not related to production like accounting and book-keeping. According to some respondents, seminars or training are not conducted yearly. Thus, some members were not given the opportunity to attend.

Membership in organizations. Participating in farmer organizations is expected to boost productivity. Membership facilitates interaction and sharing of innovations with other farmers (Okwir, 2009).

Results of the study show that out of the 70 farmers interviewed, some farmers are new to the sugarcane associations. Still, there are many sugarcane growers in the communities that are yet to join associations. Average years of membership show that Guinzadan Sur farmers have the longest years of membership in associations followed by farmers of Lagawa with 7.57 and 7.50 years respectively. The sugarcane farmers from Bila and Tapapan have a membership average of one year.

Some farmers explained that despite the existing associations and their years of experience in sugarcane farming, their names were not included in the list of members while some also explained that their names were late to be included in the list. This affects the average years of membership.

In barangay Tapapan, there are many sugarcane growers. However, during the interview, only two identified themselves to have joined the association for at least 3 years. This could be explained by the identified problems encountered by farmers which will be discussed in the succeeding part.

In the formation of the barangay sugarcane growers' associations, there should be at least 15 members to be recognized and registered. However, due to constraints in the processing of papers for the association to be registered, the associations remain at the barangay level. This explains why the OMAG only has the list of sugarcane growers without the names of associations and their respective members.

Management Practices

Farmers in Bauko, Mountain Province are adaptive and appreciative to different farming practices including new technologies introduced to them as long as it is not burdensome. However, in terms of sugarcane farming, the traditional way is still practiced. In terms of management practices, the farmers have a lot in common.

Production Schedule and Farm Activities

The cropping cycle of sugarcane can reach 10 to 12 months. Hence, sugarcane can only be planted once a year. Despite the common schedule of farming activities in Bauko, the time and length of the cropping cycle for sugarcane may still vary. This explains why some farmers opt to harvest their sugarcanes beyond 12 months after planting. The schedule of farm activities is presented in Figure 2.

FARM ACTIVITIES	MONTHS											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Land Preparation												
Planting/ Transplanting												
Weeding/ Trimming												
Harvesting and Processing												

Figure 2. Gantt chart of the schedule of farm operations in sugarcane production

The first step in land preparation is clearing. The activity is usually done in March or April. Clearing involves the removal of weeds, tree stumps, and others. When finished, the land is tilled through manual labor. At this stage, fertilizers (if available) like compost, cow, and chicken manure are cultivated into the soil. Farmers usually perform tillage and planting simultaneously.

As the sugarcane crop stands in the field for a year or more, it is necessary to do deep plowing. The farmers' scheduled time for plowing is immediately after the preceding crop is harvested or just after a good shower of rain is received. The best time for planting is at the beginning of the rainy season which is usually from March to May, provided the soil is moist enough to ensure a higher survival rate for the seedlings.

A mixed variety of sugarcanes is grown in Mountain Province. Given the limited knowledge and information on sugarcane varieties, the respondents identified their sugarcanes by their color such as green, violet/purple, brown, and yellow. Upon showing some pictures of different sugarcane varieties, farmers confirmed the varieties and these refer to Phil 2005 – 0483 (a), Phil 2000 – 2155 (b), Phil 99 – 0925 (c), and Phil 2003 – 1727 (d) (SRA, 2022) as shown in Figure 3.

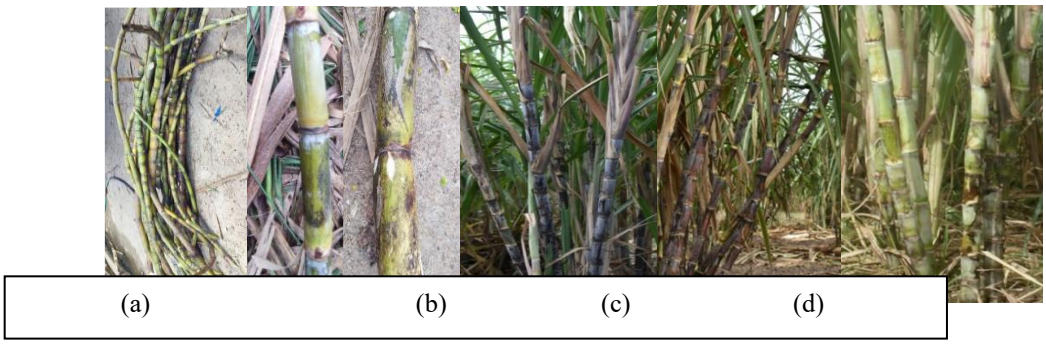

Figure 3. Sugarcane varieties cultivated in Bauko, Mountain Province

Among these varieties, green–colored variety is the variety most well-known and grown commercially in Bauko for muscovado processing. The farmers prefer the green variety based on their experience that this variety is suitable for the area. In comparison to the seedlings given by the Department of Agriculture years ago, the green variety is more productive.

The dry method of planting is followed. During planting, eye buds (sets) are placed in the soil and covered with a thin layer of soil. After which, the field is irrigated, otherwise, the farmers rely on the rain. Thus, the timing for planting is necessary. Single, two, and three eye bud methods of planting are practiced and only the upper half or two third cane is selected for planting.

Sugarcane growers of Bauko Mountain Province are not certain about planting distances. Farmers usually plant the seedlings randomly so long as they have space to perform weeding and other farming activities. Other countries like India recommend the 22.5 cm spacing per set. However, 2-3 ft x 2-3 ft plant spacing is recommended by experienced farmers to maximize the area of the farm and achieve its maximum yield with ease and convenience in the care and maintenance of the farm (PNS, 2015).

For the entire cropping cycle, several activities for the maintenance of the farms are done. Among the necessary activities are fertilizer and pesticide application (if available), and weeding and leaves trimming.

The application of organic manures for the maintenance of soil is essential. However, this practice is usually neglected by most sugarcane farmers as discussed in the succeeding part. Those whose farms are far from the community often neglect the application of organic fertilizers compared to those who grow sugarcane in their backyards or just near their homes.

Weeds compete with cane plants for nutrients, sunlight, and water. Most of the sugarcane growers perform weeding and leaves trimming once to twice in a cycle, while others do not until the harvesting period. These are all done manually.

In terms of pest and disease control, the sugarcane growers are not familiar with sugarcane diseases however all of them mentioned the problem of rodents. Their usual practice to address this problem is to apply rodenticides at the farms away from the community while others perform weeding whose farms are adjacent to the homes.

Harvesting sugarcane in Bauko starts in March and extends to April, sometimes, May. Manual harvesting is practiced due to slopy terrain and the non-availability of harvesting machines. The maturity index is known by the yellow color of the crop, swelling of eye buds, the metal sound of the cane, breaking of the cane at nodes, and instrument reading (Agri Farming, 2022).

Most farmers harvest their canes annually while some in every two years. The farmers believe that the canes are mature enough and can be harvested 12 months after planting. Before harvesting, the farmers withhold irrigation or make sure that it didn't rain for at least 3 days. The harvested canes are then brought to the processing site for muscovado processing. Agri Farming (2022) suggests that before harvesting, irrigation is not provided for 10 to 15 days.

Cropping System

A study by Reza *et al*. (2016) shows that profit margin increases if farmers grow intercrop with sugarcane. In Bauko, the sugarcane farmers are practicing monocropping. This is because most land areas utilized for sugarcane farming are not suitable for vegetable farming, especially for sloping terrains.

Management of Ratoon Crop

In managing ratoons, PNS (2015) states that: stubbles above the ground level need to be shaved within 10-15 days after harvest of plant crop; infected stubbles should be removed and burned; the hard and compact mass of soil near the root zone should be loosened by breaking the soil by plow near the root. In Bauko, the farmers said that the ratoons are left after the matured canes were harvested. Instead of burning trash after the harvest of the previous cane crop, it was left spread in between the ratoon crop. Gaps between ratoons are now filled with new sets to replace the harvested canes. These ratoons will then be harvested for the next cycle together with the matured canes.

Sugarcane is a perennial grass which means it doesn't need to be replanted every year. When harvested, is cut just above the root level so new sprouts will grow, ready to be harvested again in 10-12 months (AGMRC, 2022). However, the yield is lower compared to the previous cycle (Verheye, 2022). This agrees with the study of Malaza and Myeni (2009) stating that ratoon age is inversely proportional to crop yield. If no new sugarcane is planted, productivity is expected to decline.

Waste Management

In terms of waste disposal in the farms, the farmers' usual practice is to let it decompose or burned to turn it into fertilizer. However, at the processing site, the waste/bagasse is dried and used as fuel during the vaporization of the extracted sucrose. The number of farmers and their corresponding waste management practices are shown in Table 4.

The table shows that there are farmers who practice one method of waste disposal while some are practicing at least two. Aside from the usual practice like burning and composting, turning waste into fuel and animal feeds are also practiced.

Table 4
Distribution of respondents per waste disposal

WASTE DISPOSAL*	NUMBER				
	BANAO	BILA	GUIN. SUR	LAGAWA	TAPAPAN
Burning	6	7	7	5	7
Composting	5	-	8	14	10
Others:					
Fuel	7	-	-	-	3
Animal Feed	1	-	2	5	2
Total	19	7	17	24	22

Legend: * = Multiple Response

Capital Investment

In sugarcane production, a few types of machinery are used like tractors. For land preparation, since farms are small, not reaching hectares, sugarcane growers in Bauko don't use tractors for the following reasons: farm location and topography, cost of tractors, and frequency of use.

Other than tractors, vehicles are used, and similarly, not all farmers but a farmer from Banao own one. Cars are for easier access to farms since no public vehicles pass by the roads nearest to the farms. Moreover, it is convenient for transporting harvest to the processing site.

The tools and equipment used for clearing during land preparation are sickles, grab hoes, Japanese hoes, cultivators, trowels, and shovels. Farmers usually have these tools, although, some hired laborers also bring their own. On the other hand, bolos are used for manual harvesting of the canes.

Inputs

The production level and success of sugarcane farms depend on the input use efficiency and the quality of decisions made by the smallholder farmer (Kalinga, 2014). Inputs needed for sugarcane production are planting materials, fertilizers, and labor. The use of chemical fertilizers is not being practiced by the sugarcane farmers in Bauko, and the use of farm yard manures (FYM) and other compost are not measured but directly brought and used on the farm.

Though sugarcane is believed to grow in any type of soil, Dlamini and Masuku (2013) recommended that good crop husbandry practices like timely weeding, fertilization, and irrigation should be adopted to produce a good crop that will enhance profitability. The prices of inputs are discussed in parallel with the inputs. Found in Table 5 are the lowest and highest prices of the inputs as mentioned by the farmers.

Table 5
Lowest and highest prices of inputs used in sugarcane production

INPUT	UNIT/SIZE	PRICE	
		LOWEST	HIGHEST
Planting Material	Piece	2	3
Fertilizer		Not Measured	
Labor	Man-day	300	330

Planting Material. Though some farmers may avail of free planting materials from others, some new entrant farmers buy some of their planting materials from other farmers within their community, sometimes from other barangay at two or three pesos each. Instead of buying new plants every planting season, farmers use the ratoons. Although all the respondents do not completely use ratoons. Almost all of the respondents mix mother plants with ratoons as shown in Tables 6 and 7.

Table 6
Distribution of sugarcane farmers according to production characteristics on planting materials used

TYPE OF PLANTING MATERIAL	NUMBER
Ratoons	-
Mother plant	5
Mixed	65
Total	70

Presented in Table 7 are the combinations of mother plants and ratoon plants farmers use. The most common ratio of mother plants to ratoons is 60:40 (41.43%), while the least ratio practiced is 80:20 (1.43%). Only 5 farmers (7.14%) prefer new planting materials every cycle. Some farmers said that they only include old plants to serve as fillers when they failed to prepare the needed planting materials before the start of the planting season.

Table 7
Distribution of farmers according to the ratio of mother plants to ratoons used

RATIO OF MOTHER PLANTS TO RATOONS	FREQUENCY						PERCENTAGE (%)
	Ba	Bi	GS	L	T	TOTAL	
10:90	-	-	2	-	-	2	2.86
30:70	-	-	2	-	3	5	7.14
40:60	1	-	1	-	-	2	2.86
50:50	1	-	7	4	2	14	20.00
60:40	8	7	3	8	3	29	41.43
70:30	4	-	-	4	4	12	17.14
80:20	1	-	-	-	-	1	1.43
100:0	-	-	-	-	5	5	7.14
TOTAL	15	7	15	16	17	70	100

Legend: Ba=Banao; Bi=Bila; GS=Guinzadan Sur; L=Lagawa; T=Tapapan

Fertilizer. Fertilizer applications vary from one farmer to another in terms of their choice. The respondents were instructed to identify the type of fertilizer they used. The number of respondents that use FYM can be found in Table 8. Sugarcane farmers were also asked about their practice in terms of fertilizer application. Results show that the farmers stick to the usual practice of growing sugarcane where no chemical fertilizers were used.

Table 8
Distribution of respondents who uses Farm Yard Manure (FYM)

BARANGAY	NUMBER
	FYM
Banao	5
Bila	7
Guinzadan Sur	3
Lagawa	15
Tapapan	9
Total	39

As Table 8 further shows that farmers do practice the use of farm yard manures, it also shows that not all farmers are applying fertilizers to their farms. Out of 70 respondents, only 39 of them are applying fertilizer to their farms. Most of these farmers have sugarcane farms not too far from their homes. However, there is no specified amount/ measurement for farm yard manure that is applied. Farm yard manures are brought to the farm whenever available.

Labor. The average man-days needed for a cropping season of sugarcane given the average farm size of 356 m^2 is 13.2 as shown in Table 9. Most of the farmers are hands-on with their farms, but some of them hire laborers, especially during the harvesting period. The wages of these laborers range from Php 300 to 330 per day, making it one of the most expensive inputs in sugarcane farming.

For small farms, simple tasks like fertilizer application and leave trimming are usually done by farm owners. More strenuous tasks such as land preparation, planting, and hauling

on the other hand require more hands. Those farmers with few family members rely on hired laborers. Some farmers follow a contract scheme for land preparation and harvesting. Included in the contract are laborers, in charge of clearing up to incorporating FYM fertilizer (if available). The cost of these contracts usually ranges from Php 1500 to Php 3000 per 350 m^2 of land. The division of labor according to farm activities is listed in Table 9. The most laborious tasks on the farm are weeding and leave trimming, land grubbing and clearing (usually for new farms), and harvesting. These tasks have the highest number of man-days required. While harvesting is done once a year, more hand is required for the hauling of harvested canes.

Meanwhile, weeding and leaves trimming are both done – usually once to three times per cycle — for care and maintenance. However, most farmers indicated that weeding and leaves trimming is conducted once to two times, sometimes none, in a year. On the other hand, transplanting requires the least number of man-days. Transplanting is usually done within a day but usually requires numerous workers.

Table 9
Average labor usage per type of farm operation, per 356 m^2 area planted

FARM OPERATION	AVERAGE LABOR USAGE (DAYS)	PERCENTAGE (%)
Land Grubbing and Clearing	2.7	20.45
Land cultivation (and Fertilizer application)	2	15.15
(Hauling) and Transplanting	1.5	11.36
Weeding and Leaves trimming	4.7	35.61
Harvesting (and hauling)	2.3	17.42
Total	13.2	100

Production, Disposal, and Marketing of Sugarcane

The average yield of all the sugarcane farms is 82.03 kg for an average of 356 m^2 of land. The lowest output recorded was 7 kg, while the highest was 393 kg. Farmers indicated that their harvested sugarcanes are all subjected to milling. Since it is not the farmers' practice to weigh harvested cane before milling, postharvest losses in kg of fresh cane cannot be determined. Constraints in sugarcane production in the latter part discuss this further. Canes are then processed into muscovado. As seen in Table 10, muscovado is distributed differently after processing. The largest portion (66 percent) of the total output was sold. About 27 percent of muscovado was allotted for home consumption and 7 percent for gifts.

Table 10
Distribution of farmers per method of disposal and corresponding mean volume of muscovado disposed of, per 356 m^2 area planted

METHOD OF MUSCOVADO DISPOSAL	VOLUME	
	MEAN (kg/356 m^2)	PERCENTAGE (%)
Sold	54.23	66.11
Home Consumption	22.26	27.13
Given Away	5.54	6.76
Total	82.03	100.00

The farmers' common way of selling (Table 11) is either through wholesale (at the processing site) or retail (individually). Sometimes, however, bought by the organization or by middlemen. Most farmers, especially those from Lagawa, Banao, and Tapapan prefer to sell their products at the processing site. Thus, the owner of the processing site buys the muscovado at 95.00 to 110.00 pesos per kg as wholesale price and then retail these to other establishments like the Negosyo center. However, this doesn't guarantee that the price is better than those offered by the middleman.

There are also some organizations like Tapapan and Lagawa that would buy the muscovado of their co-member at a fixed rate of 115 pesos per kilo regardless of the season. Some mentioned however that when demand is high, they opt to sell their products individually for a higher gain. Those who wish to sell their products at a higher price from 120-150 pesos may sell their products individually.

In terms of prices, the money that farmers get from selling may vary depending on the method of disposal. The prices of sugarcane when sold in different methods as indicated by the respondents are presented in Table 11. To show the variations in the prices of sugarcane, the lowest and highest prices are also presented.

Table 11
Lowest and highest prices of muscovado per kilo by mode of selling

MODE OF SELLING	PRICE (Php/kilo)	
	LOWEST	HIGHEST
Middleman	100	115
Retail (individually)	120	150
Bought by the (their) Organization	-	115
Bought at the processing site	95	110

Constraints to Sugarcane Production and Marketing

Tables 12 and 13 present the list of possible problems encountered in sugarcane production and marketing of muscovado that the farmers identified and commented on. Of the identified problems in sugarcane production, most farmers believed that lack of government support and low sucrose content is the main problem they encountered followed by plant pests and diseases, low harvest, high cost of transportation, and lack of information on proper farm management which rank 1st to sixth respectively in Table 12.

Table 12
Distribution of respondents per problems encountered in sugarcane production

PROBLEMS ENCOUNTERED IN SUGARCANE PRODUCTION*	FREQUENCY					TOTAL	RANK
	Ba	Bi	GS	L	T		
High cost of inputs	-	-	-	-	21	2	12
Lack of government support	8	5	5	3	12	33	1
Natural calamities	1		1	11	5	8	7
Low harvest	2	5	7	1	3	28	4
Low sucrose content	5	6	8	8	5	32	2
Lack of information on proper farm management	2	3	4	5	10	24	6
Plant pests and diseases	6	3	3	4	4	30	3
Weather		1	2	1	1	5	9
Lack of capital	1				5	6	8
High cost of transportation	4	2	3	7	10	26	5
Others (please specify):							
Labor Cost	-	-	-	-	3	3	11
Lack of Muscovado Processing Machine	-	-	2	-	2	4	10

Legend: *=Multiple response; Ba=Banao; Bi=Bila; GS=Guinzadan Sur; L=Lagawa; T=Tapapan

Transportation is a problem because not all the farmers own cars or trucks for transportation and those trucks for hire charge them costly. Transportation cost ranges from 500 to 1500 depending on which processing site (Banao, Tadian, Cervantes) they would bring their harvest. Thus, sometimes farmers opt not to harvest their canes.

In terms of pests and diseases, rodents are a common problem experienced by farmers. Farmers said that canes were attacked by rodents even before maturity resulting in a lesser harvest.

Malaza and Myeni (2009) said that to optimize income, smallholder cane growers must raise yield and sucrose content. Most farmers in Bauko described that they could harvest more sugarcanes but turn out to have low sucrose content, resulting in less muscovado produced. These reflect postharvest losses in muscovado production. The farmers believe that this problem is influenced by the sugarcane variety they plant. They also identified a lack of information on proper farm management and a lack of government support as commonly experienced constraints to engage in sugarcane production since they only rely on their experience and traditional knowledge and practices which they believe to be a contributing factor to lower sucrose content of their produce. Some said that it would be helpful if the government could provide assistance such as the provision of inputs (like planting materials), processing machines, and training.

Farmers said that inputs, capital, and weather condition are not serious problems in sugarcane production in Bauko though some farmers identified these as problems that they encountered in sugarcane production. Input cost, being reflected as not a common constraint contradicts the study of Cockburn *et al*. (2014). Perhaps the reason for low productivity because the farmers prefer not to use fertilizers to minimize cost (Eweg, 2005). On the other hand, natural calamities were also identified as a problem experienced by a few of the farmers but they consider it as no big deal since it doesn't happen all the time.

In addition to the identified problems, the high cost of labor is a problem for some farmers especially those with farms that are far from the community. This is because the cost of labor sometimes outweighs their output. Though each barangay except Banao, has no processing machines, the muscovado processing machine/site is an identified problem in Guinzadan Sur and Tapapan. They need to have a processing machine to minimize the transportation cost incurred in transporting their produce to the processing sites in Banao, Tadian, or Cervantes.

Of all the possible problems presented in muscovado marketing (Table 13), lack of information on marketing strategies ranks first followed by lack of government support and no established market site which ranks second and third respectively. Lack of information on marketing strategies is the most identified problem in marketing muscovado. This is because the farmers' practice is to market their products individually if not all for home consumption and gifts.

Lack of government support ranks second since the farmers believed that with continuous government initiative, they could be able to improve their ways of marketing and be more than willing to bring their products to the market. However, some farmers opted to keep their products for home consumption, and as giveaways or donations to relatives and friends than bringing them to the market. It has long been practiced in some communities that muscovados are to be shared or sold at a lower price which could not compensate for the production cost. More so, some farmers also identified the lack of government support as one of their problems since there has been no follow-up and monitoring conducted after the turnover of muscovado processing machines and seedlings in 2013.

During the group discussion, some farmers were shocked to know that there is a high-income opportunity in muscovado production. Some are not aware of the Negosyo center in the municipality that could buy their products for retail.

In terms of market site/establishment, this is not a serious problem according to the farmers, because they can still sell their produce anywhere in the community. However, they still identified this as a problem they encountered because they believed that with established market sites, there shouldn't be a problem with where to bring their produce at a reasonable price. Also, they consider this as a problem because they believed that additional market sites should be established and they proposed to have one in each community.

Distance to the market site is associated with transportation costs. In addition to costly transport, time and money spent to bring the product to the market are considered a problem. The common market site of muscovado is at the Negosyo center in Abatan Bauko.

Those who are far from the place, opt to sell their produce at the processing site so the owner/ manager of the processing site will be the one to bring their product to the Negosyo center. The farmers believed that this is a disadvantage on their part, since their products can be bought at one time but at a lower price when in fact it has a higher market price.

The farmers said that for non-members and other organizations, there are also instances where buyers go to the them and offer their prices, a deal happens between the farmers and the buyer. Although seemingly favorable, other farmers mentioned this as a problem since these could make them earn less than what they could have earned when selling to the market. Competition is not a problem since a shortage in the supply of muscovado has been experienced. In some instances, the farmers tend to lower their prices for faster movement or disposal of their products.

In addition to the listed problems, seven farmers believe that they encountered a problem in organizational management due to some issues within the organization. Some farmers chose not to join and participate in the organization. This explains now why there are farmers who do not identify themselves as members of the organizations.

Table 13
Distribution of respondents per problems encountered in muscovado marketing

PROBLEMS ENCOUNTERED IN MUSCOVADO MARKETING*	FREQUENCY					TOTAL	RANK
	Ba	Bi	GS	L	T		
Distance to the market site	-	3	2	1	12	18	4
Lack of information on marketing strategies	3	4	2	8	13	30	1
No established market site/establishment	-	2	1	3	14	20	3
Lack of government support	2	5	2	5	10	24	2
Competition	-	-	-	-	5	5	6
Others (please specify):							
Organizational Management	-	-	2	5	-	7	5

Legend: *=Multiple Response Ba=Banao; Bi=Bila; GS=Guinzadan Sur; L=Lagawa; T=Tapapan

Sugarcane Productivity

Land productivity measures can be calculated by dividing crop production by the amount of planted land, expressed in an area unit, such as hectares or acres. When expressed in terms of physical output, such as tons of maize, land productivity corresponds to crop yields (FAO, 2017). As explained earlier, sugarcane productivity used in this study refers to kg of muscovado per ha, similar to the study conducted by Townsend *et al.* (1998) on wine production.

According to Verheye (2022), the average yield of sugarcane is around 90 - 100 tons/ ha for the first planting and between 40 and 60 tons/ha for the ratoon crops. If considering ratoon crops, may yield an average of 50 tons/ha (5kg/m^2) or 500kg/ 100m^2.

In India, the yield of sugarcane was estimated to be approximately 82 metric tons per hectare (Statista, 2022). In the Philippines, productivity in terms of tons of cane harvested per hectare – averaging at about 60 tons per hectare – and sugar produced per hectare at an

average of less than 6 tons, also tells a similar story (SRA, 2022). Based on this information, the level of productivity can be categorized as low, medium, and high, with medium representing the desirable productivity value, 50kg/100m^2 (5000kg/ha) as shown in Table 14.

Table 14
Frequency counts of farmers as per the level of productivity

LEVEL OF PRODUCTIVITY		FREQUENCY				
Range (kg/ha)	Category	Banao	Bila	Guin. Sur	Lagawa	Tapapan
4000 and below	Low	13	7	15	14	17
4001 – 6000	Medium	1	-	-	2	-
6001 and above	High	1	-	-	-	-
Total		15	7	15	16	17

Farmers with productivity values of 4000kg/ha and below are categorized under low productivity while those with productivity values higher than 6000 kg/ha are categorized under the high level of productivity. The frequency shows that only one farmer had achieved a high level of productivity, three farmers under a medium level of productivity, and the rest of the farmers have a low level of productivity.

In comparison to the results in Table 15 reflects that sugarcane productivity in Bauko is generally low since the computed value (23.06kg/0.01ha, 46%) is below the typical productivity. SRA (2015) states that small farms are generally less productive due to a lack of economies of scale, no financial capability to procure necessary farm inputs such as fertilizer and planting materials from high-yielding varieties, and poor farm practices.

Table 15 further presents that a total of 2.49 hectares of land utilized for sugarcane production in the five barangays of Bauko yields a total of 5742 kg of muscovado. Considering the number of respondents in each barangay (Table 15), Bila has the highest average output with 305 kg of muscovado produced from an average of 0.116 hectares of land followed by Lagawa, Banao, Guinzadan Sur, and Tapapan with 85.94kg (.029ha), 61.53kg (0.022ha), 47.73kg (0.035ha), and 34.76kg (0.022ha) respectively.

Table 15
Distribution of respondents per output and productivity

BRGY	N	FARM SIZE (ha)	MEAN FARM SIZE (ha)	TOTAL MUSCOVADO (kg)	MEAN OUTPUT (KG)	PRODUCTIVITY		LEVEL
						AVE-RAGE (kg/.01ha)	PERCENTAGE (%)	
Banao	15	0.325	0.022	923	61.53	28.40	57	Low
Bila	7	0.81	0.116	2137	305.29	26.38	53	Low
Guinzadan Sur	15	0.527	0.035	716	47.73	13.59	27	Low
Lagawa	16	0.46	0.029	1375	85.94	29.89	60	Low
Tapapan	17	0.369	0.022	591	34.76	16.02	32	Low
Total	70	2.491	0.036	5742	82.03	23.06	46	Low

Determinants and their Relationships to Sugarcane Productivity

Focus on the determinants and productivity relationships is important because it gives a framework for developing policies and initiatives to increase farm productivity and efficiency. The following factors were identified using various kinds of literature.

Before analyzing the results of the model, it was first subjected to diagnostic tests to test multicollinearity and heteroscedasticity. The results of the test show that the value of the Variance Inflation Factor (VIF) is small. The mean VIF of the variables is 2.25 suggesting that there is a low multicollinearity among the variables. Also, the result of Durbin-Watson statistics of 1.78 (typical values are between 1 to 3, or close to 2) reveals the independence of the variables. The presence of high multicollinearity implies redundancy among the data; hence, they may be representing the same information.

Results of the analysis also show the model was found to have no heteroscedasticity. This implies that the error term is similar across all values of the independent variable. The standard residual ranges from -3.1 to 2.3 (standard residual should be within the range of -3.29 to 3.29). In other words, biased parameter estimates are reduced thereby strengthening the proof of the good fit of the model.

With regards to the model itself, the statistically significant P-value indicates the reliability of the model since has a good fit. Therefore, the model is said to have explanatory power. Meanwhile, the adjusted R^2 denotes that 78 percent of the variation in productivity is explained by the variables.

To recall, muscovado per hectare represents productivity and the determinants considered in the study were (1) farm size, (2) use of FYM, (3) labor cost/ha, (4) household size, (5) age, (6) years in farming, (7) years of membership in organizations, (8) the number of seminars and training attended, (9) the percentage of mother plants used and (10) total investment. Total investment however was not included for discussion since it results in a higher value of residuals and VIF if included. A dummy variable was used for the second variable, the use of FYM. The estimates were run simultaneously with the Cobb Douglas production function using the software, JASP 0.16.3.0. Results can be found in Table 16.

Table 16
Parameter estimates of the Cobb Douglas production function

VARIABLES	COEFFICIENTS	STANDARD ERROR	t STAT	P-VALUE	
Constant	6.464	1.933	3.346	0.001	***
Farm Size	-0.261	0.13	-2.011	0.049	**
FYM	0.402	0.132	3.036	0.004	***
Labor cost	-0.112	0.178	-0.632	0.530	
Household Size	-0.284	0.138	-2.059	0.044	**
Age	0.452	0.271	1.666	0.101	
Experience	-0.132	0.238	-0.559	0.580	
Membership	-0.058	0.116	-0.5	0.619	
Seminars/Training	0.284	0.104	2.742	0.008	***
Planting Material	0.042	0.161	0.263	0.794	

Legend: ***, **= significant at 1%, and 5% respectively

Four out of the nine expected signs and relationships were found to hold true. Results show that the variables: labor cost, age, experience, years of membership to organizations, and planting material did not significantly affect productivity. Though insignificant, a negative relationship was found to exist between productivity and the variables, labor cost, farming experience, and years of membership in organizations.

On the other hand, the constant, FYM and seminars/training were found to be significant at a 1 percent level of significance. Likewise, the farm size and household size were also significant, but at 5 percent.

Farm Size

The result of the analysis shows a negative and significant relationship between the variables at a 5% level of significance. This indicates that a percentage increase in farm size would decrease output by 0.261 percent. This implies that an increase in farm area results in higher opportunity cost, thus, a decrease in productivity. This result agrees with the findings of the study conducted by Townsend *et al*. (1998) stating that for the case of smallholders, farm size and productivity shows an inverse relationship. This also agrees with the findings of Narayan (2004) in Fiji showing a significant relationship between farm size and productivity. However, this result is in contrast with the findings of Erifo *et al*. (2016), Ogwang (2009), and Masterson (2007) which show that an increase in land under sugarcane production results to increase in yield.

Use of Farm Yard Manure (FYM)

Inputs and cultural management techniques are linked since practices almost always require the use of inputs. Kalinga (2014) states that the production level and success of a sugarcane farm depend on the input use efficiency and the quality of decisions made by the stallholder farmer. Similarly, the sort of inputs used and their degree of use are determined by the farmers' management decisions. According to Malaza and Myeni (2009), the timely and sufficient use of inputs throughout the crop's life cycle is the most important factor in sugarcane productivity. Lowering input usage will undoubtedly save money, but it will also diminish productivity.

FYM is an important factor that influences the returns of sugarcane growers (Nazir, *et al*., 2013; Reza *et al*.,2016). The result of the analysis shows a positive and significant relationship between muscovado and the use of FYM at a 1% level of significance. This indicates that the use of FYM would increase productivity by 0.402, ceteris paribus. When cost is considered, the study of Erifo *et al.* (2016), shows a significant negative relationship between FYM and productivity at a 5% level of significance.

Seminars and Training

The number of seminars and training attended was also determined to have a direct relationship with productivity. Involvement in seminars helps in imparting knowledge in production to farmers. Furthermore, it is also a means of updating farmers with existing innovations to encourage them to use technologies (Rajendran, 2012 & Douglas, 2008). Table 3 presents the number of farmers who attended seminars and training in relation to sugarcane farming.

Results show that only 31 farmers out of the 70 respondents attended seminars/training. Most of the farmers who had training and seminars were members of associations, if not, barangay officers who took advantage of training/seminars conducted within the barangay while being a facilitator. Results of the analysis also imply that a percentage increase in seminars or training would increase productivity by 0.284 percent.

Household Size

The size of the family was hypothesized to affect productivity positively since it could be an additional source of labor through family labor. However, it was found to have an inverse relationship.

Most studies on household size agree that it has a beneficial impact on productivity. Results of the study, however, reveal that sugarcane productivity and household size were found to have a negative and significant relationship at a 5% level of significance. A percentage increase in household size results in a 0.284 percent decrease in productivity. This is for the reason that some of the family members have off-farm jobs. Thus, family labor is not maximized on the farm.

In considering family size as a determinant, Dao (2013) mentioned that the number of children present in the household should be taken into account. Family members can be considered as a labor source, however, if household members are mostly children, it may not apply.

Age

Farmers in different age groups are believed to perform differently. Data implies that most of the sugarcane growers in Bauko, Mountain Province are adults whose age ranges from 41-50 (18), 51-60 (35), and 61 and above (7).

This shows the same result as the study of Erifo *et al.* (2016) about determinant factors of sugarcane productivity in Ethiopia where they found out that most of their respondents are within the age group of 40-50 years. This age range of 40 – 50 is considered a positive age group (Aina *et al*.,2015).

Results of the analysis, however, reveal that there is no significant, though with a positive relationship, between productivity and the farmers' age. Regardless of age doesn't guarantee a significant effect on output. Jaime and Salazar (2011) however revealed in their study a negative relationship between age and productivity.

Labor Cost

Various inputs, which include labor, impact agricultural productivity (Azam & Khan, 2010). Though sugarcane farming doesn't require intensive attention compared to other farming, the cost of labor in the case of sugarcane farming in Bauko turns out to be one of the farmers' problems.

As mentioned in the hypothesis, results revealed that productivity and labor cost per hectare has a negative relationship, though insignificant. This is in contrast to the study of Dlamini and Masuku (2013) revealing a significant influence of labor cost/hectare on productivity. On the other hand, the result of this study agrees with the study results of Reza *et al.* (2016) revealing

that labor is negatively related to sugarcane production. The results of this study may be due to the low productivity of the sugarcane that outweighs the farmers' income, especially with high labor costs.

Farming Experience

Long years in farming have been traditionally seen to boost output because it signifies greater producing experience. However, the outcomes of several investigations differed (Douglas, 2008; Shaheen *et al*., 2011; Jaime & Salazar, 2011).

Data gathered shows that sugarcane farming has long been done in Bauko, Mountain Province, especially in Guinzadan Sur with 8.27 average years of experience. Barangay Lagawa and Bila have the least average years of experience with 3.71 and 3.67 years respectively.

Previously, farmers indicated that sugarcanes were not given much importance and muscovado processing was not prevalent until the processing machinery was introduced to them. The introduction of this machinery led to an increase in the number of sugarcane growers. However, as time went on, these machines lost their functionality, and some farmers chose to forgo harvesting their sugarcane rather than incur additional costs transporting it to the processing facilities.

This experience of farmers would reflect in the result of the analysis which reveals that productivity and farming experience has a negative relationship, though insignificant. This agrees with the findings of Jaime and Salazar (2011) linking farming experience to age revealing a negative relationship.

Membership in Farming Organization

Participating in farming organizations is expected to boost productivity. Membership in groups facilitates interaction and sharing of innovations with other farmers according to Okwir's research in 2009.

Results of this study show that though insignificant, productivity and years of membership in organizations have a negative relationship. This is in agreement with Jaime and Salazar (2011) suggesting that this could be because groups operated as more of a gathering place for farmers rather than a place to learn more about farming. As a result, the goals of boosting productivity through technology sharing with other farmers have not been accomplished. This may be due to farmers' experience in joining associations, that despite being enrolled as members, farmers' potential was not fully realized.

Planting Material

A higher percentage of mother plants just like the age is expected to increase output. However, the variable though having a positive relationship was found to be insignificant. This may be due to improper care and maintenance of the canes after planting despite planting new canes, it doesn't guarantee a significant increase in output. Cockburn *et al*. (2014) cited that if planting materials are not taken care of properly, may eventually contribute to reduced yield.

Summary

Associated with the declining yield of sugarcane are the different factors affecting productivity. Therefore, the study aimed to investigate the productivity of sugarcane along with its determinants, in the five sugarcane-producing communities in Bauko namely: Banao, Bila, Guinzadan Sur, Lagawa, and Tapapan. These were chosen as the place of study since the majority of the active sugarcane farmers in the municipality are from these barangays. The specific objectives of the study are: (1) to describe the sugarcane farmers' socio-economic profile and sugarcane production characteristics; (2) to describe the farm management practices of sugarcane farmers; (3) to identify the problems encountered by sugarcane farmers in production and marketing; (4) to describe sugarcane production in terms of land productivity; and (5) to identify the determinants and describe their relationship to productivity.

For the study, 70 respondents were interviewed. A purposive random sampling approach was used since participating farmers had to meet specified criteria: one must be a member of an association and have been active in muscovado production for at least 3 years.

The characteristics of the sugarcane growers, farm management techniques, inputs, and constraints with production and marketing were all explained using descriptive analysis. The method utilized for estimating productivity was the Cobb-Douglas and the parameter estimates were generated using the JASP 0.16.3.0 software. The regression analysis was used in explaining the determinants of sugarcane productivity. Diagnostic tests were also carried out to analyze the model.

On the average, each farmer allocates 356 m^2 of land for sugarcane production. When planting, the common cropping system done by sugarcane farmers is monocropping. Some have done intercropping with chayote and Camote but that was before muscovado production was encouraged in the community. Moreover, around 14 man-days are needed for farm activities for an average farm area of 356 m^2. The mean output of all the farms is 82.03 kg and most of the muscovado is sold to middlemen or at the processing facility.

The study also revealed that 5 respondents completely use the mother plant, and there were 65 who prefer a mix of ratoons and mother plants. The mostly practiced ratio between new planting materials to ratoons was 60:40.

As for the fertilizers, there were only 39 farmers who uses FYM on their farms, while none of them applies any other kind of fertilizer. For labor, the most labor-intensive tasks in the farm are weeding and leave trimming (4.7 average man-days), land grubbing (2.7 average man-days), and harvesting (2.3 average man-days) given an average land area of 356m^2.

Respondents mentioned numerous problems in sugarcane production and marketing. Lack of government support, low sucrose content, and rodents are the top three problems of the respondents in farming. Lower sucrose content results in a lower amount of muscovado. In addition, problems raised by the farmers include high costs of labor, lack of processing machines, difficulties in selling outputs, and lack of information on marketing strategies and even organizational management.

Sugarcane productivity in Bauko is generally low. The average output of 82.03 kg per 356 m^2 reflects low productivity. Maximized and well-managed farms have an output of at least 50 kg per 100 m^2. On the average, the productivity of farmers is only 23 kg (46 percent). Thereby indicating the need to increase output by at least 27 kg (54 percent). To address low productivity, key factors that affect productivity were identified. Aside from the size of the farm, among the contributing factors to productivity is the use of fertilizers like FYM. The use of FYM could increase productivity by 0.402 percent. Moreover, planting new canes could increase productivity by 0.284 percent but not that significant based on the result of the analysis. Therefore, farmers could replace their planting materials, if not propagate the ratoons every after-cropping cycle.

The study also reveals the importance of up-to-date information on production practices in improving productivity. Participation in seminars and training related to sugarcane farming can increase productivity by 0.284 percent. These findings indicate that seminars and training provided by the government and private institutions were effective as they positively affected sugarcane productivity.

Since the study examined the relationship between productivity and its determinants, findings suggest that productivity can be improved regardless of the planting materials used, farmers could maximize their output by proper management of the farm, enhancing their knowledge by attending training and seminars and applying them, and maximizing output by minimizing labor cost. Overall, the study reveals the existence of a technological gap as well as a yield gap in sugarcane that leads to reduced productivity.

Conclusions and Recommendations

Conclusions

Analyzing the productivity of sugarcane production in Bauko, Mountain Province leads to the following conclusions:

1. The farmers' 82.03 kg average output per 356m^2 of farm reveals low sugarcane productivity in Bauko, Mountain Province. This rejects the first hypothesis stating that sugarcane production in Bauko, Mountain is productive.
2. Sugarcane productivity is determined by the different factors affecting it. Use of Farm Yard Manure (FYM), and the number of seminars and training positively and significantly affect sugarcane productivity at one percent level of significance. This accepts the hypothesis that these variables positively influence productivity. Likewise, landholdings/farm size, and household size significantly but negatively affects productivity at a five percent level of significance. Thus, rejects the hypotheses stating that farm size and household size positively influence productivity.

Age and planting materials, though insignificant, have a positive relationship to productivity accepting the hypotheses stating that these variables positively influence productivity. On the other hand, labor cost per hectare, years of farming experience, and years of membership in organizations have no significant effect but have a negative relationship to productivity. Thus, it fails to reject the hypothesis stating a negative relationship between labor cost and productivity. On the other hand, results reject the hypotheses stating positive relationships between years of farming experience and years of membership to organizations to productivity.

Recommendations

Analysis of the productivity of sugarcane presents an overview of sugarcane production in Bauko, Mountain Province. Based on the farmers' outputs, productivity is low. Results reveal that on average, productivity has the potential to increase by 54 percent by improving farm management and maximizing farmers' potential. In pursuing this goal, the study recommends a few feasible suggestions.

Policy Implications and Recommendations

Formation of institutions. There are several farming organizations in line with sugarcane production. Sugarcane associations still exist though at a barangay level and at least two of the identified affiliations are still in the process of registration. However, the results of the study indicate that organizations do not affect productivity. These findings were linked to the fact that farmers are not participative in their organizations' activities or that the group has no activities related to farming, to begin with. For these reasons, it is suggested that farming institutions must meet different criteria to be formally classified as one. The organization must be able to conduct seminars and training for its members annually. It should also be able to monitor the farm performance of its members. With this in consideration, organizations are focused on activities in line with improving the farm performances of its members. In the same manner, farmers are encouraged to participate in their groups. Coherently, farming organizations could be used by government institutions as a medium for disseminating information, conducting programs, and extending government assistance should there be any.

The Sugar Regulatory Administration, known to monitor the sugarcane industry in the country requires more participation from the local communities. Therefore, boosting existing organizations could be a way to continually create projects and effectively monitor the progress of programs. These could also be the coordinators if ever the DA decides to formulate projects for the crop. Furthermore, if ever a budget allocation can be given to the organization, money for purchasing imported planting materials could be shouldered.

Dissemination of information. Proper knowledge of sugarcane production is also a factor in improving output. Therefore, the dissemination of information must be a priority of both private and government groups. Accredited sugarcane organizations could be organizers of seminars and training, as mentioned in the first recommendation. Another option is for them to coordinate with other farming organizations. The study shows the importance of seminars and training in the technical know-how of sugarcane farmers. Possible points of interest in seminars and training are the: (1) importance of new planting materials and varieties and strategies on managing sufficient ratoons; (2) proper planting practices like proper spacing, with proper care and the maintenance thereof; (3) biological knowledge on pests and diseases and corresponding pest management information; (4) proper postharvest practices; and (5) introduction of technologies that are not yet widely adapted (e.g. use of bio-fertilizers, and different planting methods). The introduction of technologies could potentially increase the levels of productivity and awareness campaigns before planting helps the farmers to be well-equipped with information on the latest sugarcane production technologies.

In addition, the conduct of seminars could also be a platform for disseminating information to encourage more farmers to engage more in muscovado production. This will also help them realize the income potential that lies behind muscovado production.

Technological improvements. Planting materials possibly determine the quality and quantity of output. It is also among the variables, though not significant, that was proven to have a favorable influence on the output. Results of several pieces of research reveal that there are different sugarcane varieties with potential for muscovado production in other places. In 2013, an introduction and adaption of a variety in Bauko expected to somehow encourage an increase in the farmers' output, only lasted for a short time, and resulted in the loss of some of the potential varieties, according to the farmers. Thus, the introduction of potential varieties is encouraged.

The Office of the Municipal Agriculturist's most recent record on sugarcane growers and the status of their production was in 2017, but in reality, muscovado processing is still ongoing in the local communities, and the farmers are actively seeking out new varieties and processing equipment to increase their output. It is strongly recommended that an allotment of funds would be given to the project seeing that the total sugarcane production of Bauko has been declining despite the increasing demand for muscovado based on the record of the Negosyo Center in Bauko, Mountain Province, and the recently conducted feasibility study on muscovado production. It is encouraged that for at most every five years, a new type of planting material is released to minimize the vulnerability of the crop to diseases.

Recommendation for Further Research

It can be said that the ultimate goal of a farmer is to increase his or her profit. For the same reason, a farmer wants to boost productivity. Therefore, it is recommended that research be done on economic analysis of other areas of sugarcane production. At present, farmers follow a monocropping system (purely sugarcane, but different varieties). Future research may compare the profitability and productivity of various cropping systems. It might also address how much money farmers make based on the kinds of crops they plant.

In line with the goal of increasing income, a study on the economic efficiency of sugarcane can be pursued as well. Specifically, looking into the allocative efficiency of farmers suggest how farmers could minimize their spending and yet attain high output levels. Furthermore, it is suggested that determinants of efficiency are also tackled. The model to be used should consider more variables than this study since findings suggest that the variables only explain 78 percent of the productivity.

Another possible subject of interest in line with sugarcane is minimizing postharvest losses. At least 32 farmers experienced low sucrose content in their harvest. Failing to process the canes within 24 hours after harvesting causes postharvest losses. Hence, it is important to have literature on proper postharvest practices for sugarcane.

Another area of interest is marketing. At least 30 farmers experienced difficulties in selling their products. It is recommended that a study on the marketing system of sugarcane will be done. This could suggest ways to decrease the chances of farmers selling at extremely low prices because of failing to find buyers or identified establishments to bring them to. The

study may also discuss resources for the trading present in the area, for example, the Negosyo Center, and the ongoing building of a trading center near the Municipal Hall for future trading activities. Moreover, the results of such a study may help in lowering the differences in the price of sugarcane among the markets.

The grounds of this study were limited to the productivity of sugarcane and its determinants. It is suggested that processing sugarcane into other products and utilization and management of by-products should be researched as well since some farmers restricted their harvest for muscovado and by-products are usually treated as waste, though some feed it to animals. Although, sugarcane remains not to be the crop prioritized by farmers, the analysis of productivity and profitability could be a strategy to boost farm output, and eventually, income.

Lastly, research on the different constraints faced by farmers in adopting sugarcane technologies, and new varieties might as well be conducted to address the technological and yield gaps of sugarcane in the municipality.

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