The hidden vulnerabilities behind financial sustainability: a case study of a sugarcane farm business in Pemalang City, Central Java, Indonesia

As vulnerabilidades ocultas por trás da sustentabilidade financeira: um estudo de caso de uma fazenda de cana-de-açúcar na cidade de Pemalang, Java Central, Indonésia

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ABSTRACT

This study assesses the financial viability of a 4-hectare sugarcane farming enterprise operated by Perhutani, an Indonesian State-Owned Enterprise. The farm is situated in the geographical limits of Pemalang City, which is located in the Central Java Province of Indonesia. This study employs a financial feasibility analysis approach that involves the computation of key financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Pay Back Period (PBP), Benefit Cost Ratio (BCR), and the application of sensitivity analysis. Overall, the assessment of the viability of a 4-hectare sugarcane farming enterprise indicates that it is financially feasible and has the potential to operate as a sustainable business. This conclusion is drawn from the positive numerical values obtained through various financial analysis techniques. Nevertheless, it is evident from the conducted sensitivity analysis that sugarcane farming is a highly susceptible business to fluctuations in prevailing conditions. When molasses production experienced reductions of 10% and 15%, most financial feasibility analysis estimates yielded negative values. The issue of production vulnerability extending beyond economic feasibility has been rendered inconspicuous by many reasons, including climate change.

Keywords: Vulnerability. Climate Change. Financial. Feasible Study. Sugarcane. Farm Business.

RESUMO

O objetivo deste estudo é avaliar a viabilidade financeira de uma empresa agrícola de cana-de-açúcar de quatro hectares operada pela Perhutani, uma empresa estatal da Indonésia. A fazenda está situada nos limites geográficos da cidade de Pemalang, localizada na província de Java Central, na Indonésia. O estudo emprega uma abordagem de análise de viabilidade financeira que envolve o cálculo dos principais indicadores financeiros, como Valor Presente Líquido (VPL), Taxa Interna de Retorno (TIR), Período de Retorno (PBP), Relação Custo-Benefício (BCR) e a aplicação de análise de sensibilidade. No geral, a avaliação da viabilidade de um empreendimento agrícola de cana-de-açúcar de quatro hectares indicou que é financeiramente viável e tem potencial para funcionar como um negócio sustentável. Essa conclusão é tirada dos valores numéricos positivos obtidos por meio de diversas técnicas de análise financeira. No entanto, é evidente, a partir da análise de sensibilidade realizada, que o cultivo da cana-de-açúcar é um negócio altamente suscetível a flutuações nas condições prevalecentes. Quando a produção de melaço sofreu reduções de 10% e 15%, a maioria das estimativas de análises de viabilidade financeira produziu valores negativos. A questão da vulnerabilidade da produção, que vai além da viabilidade econômica, tornou-se imperceptível por uma série de razões, incluindo as alterações climáticas.

Palavras-chave: Vulnerabilidade. Mudanças Climáticas. Financeiro. Estudo de Viabilidade. Cana-de-Açúcar. Negócios Agrícolas.

1 INTRODUCTION

Sugar is a globally consumed commodity, with notable consumption levels observed in Indonesia. The notable surge in sugar consumption in Indonesia has correspondingly led to an escalation in the volume of sugar imports from diverse nations to meet domestic demands. According to the data from the Indonesia Bureau of Statistics in 2022, there has been a notable increase of 971,044.8 tons in the volume of imported sugar between 2017 and 2021. One potential measure that might be undertaken in this case is to augment sugar output to fulfil domestic demands. Indonesia's State-owned enterprise, Perhutani, engages in the agricultural sector. Perhutani division of Pemalang City, located in the Central Java Province, possesses a 4-hectare plot of land dedicated to cultivating sugarcane crops. The extension of sugarcane crop territory is associated with both good and negative impacts (Machado *et al.*, 2014). We conducted a financial viability assessment to determine the feasibility of maintaining operations for a four-hectare sugarcane plantation. A sensitivity analysis was conducted to assess the susceptibility of the four-hectare plant to future alterations. This study reveals that the sugar cane industry exhibits considerable financial profitability over an extended period of 11 years. The time range for conducting financial profitability analysis was selected to align with the duration of sugar cane's life cycle before replanting with fresh seeds. According to Verheye (2010), the duration of effective sugarcane planting typically spans four years in cases of highly intensive and mechanised cropping or 10 to 12 years in the setting of large agricultural or smallholder farming. However, the outcomes of the sensitivity analysis yielded.

The cultivation of a 4-hectare canopy is highly susceptible to ongoing changes, specifically the decrease in productivity. There exist various factors that can contribute to the occurrence of this phenomenon, with climate change being identified as one of them. The sugarcane production is highly susceptible to excessive rainfall since water overflow in the soil can hinder crop nutrient uptake, impeding the plants' optimal growth. The issue of climate change is a significant challenge in the context of sugarcane agriculture since it can lead to the occurrence of extreme heat events and heavy precipitation (Santos *et al.*, 2020). These climatic disturbances can potentially affect crops' growth and reduce their productivity. Drought has emerged as a significant contributing factor to the susceptibility of industrial production (Roy *et al.*, 2022). The physiological processes involved in sugarcane growth, which necessitate increased water intake during periods of limited precipitation, might be negatively impacted by extreme heat. The alteration in meteorological conditions leads to a decrease in sugarcane production, resulting in a corresponding decline in the revenue generated by the industry. The study by Cristina *et al.* (2021) on Reunion Island provides further empirical proof that climate change has substantially influenced worldwide agricultural output, as demonstrated by the 20-year decrease in sugarcane yields. The sensitivity analysis conducted on the decline in sugarcane production provides empirical support for the presence of an underlying issue pertaining to the substantial profitability and favourable financial feasibility of the sugarcane plantation occupying a 4-hectare tract of land. The existence of these imperceptible vulnerabilities might serve as a point of consideration for all stakeholders engaged in decision-making processes, as well as for the implementation of precautionary or mitigating strategies. This is crucial to ensure the sustainability and financial resilience of sugarcane production.

2 MATERIALS AND METHODS

2.1 DATA COLLECTION

The research was conducted at Pemalang, a city in the Central Java Province of Indonesia. The sugarcane cultivation area in this region spans 4 hectares and is managed by Perhutani, an Indonesian State-owned enterprise agency.

2.2 DATA ANALYSIS

- Production Performance Analysis

The calculation of total receipts involves determining the discrepancy between the sales revenue generated from the sale of sugarcane and the combined costs of variable and fixed expenses. The analysis of farm business is conducted for a single agricultural season.

- Financial Feasibility Analysis

The financial feasibility analysis is a comprehensive evaluation of the financial viability of a project or investment. Financial viability analysis encompasses various calculations, such as the Net Present Value (NPV), Benefit Cost Ratio (BCR), Internal Rate of Return (IRR), Pay Back Period (PBP), and sensitivity analysis. Financial sustainability refers to the situation where a business is considered viable due to its ability to provide suitable earnings and survive potential fluctuations in environmental and economic circumstances. This resilience allows the business to yield returns beyond the initial investment. An assessment of financial sustainability was conducted over a span of 11 years, employing a 7% interest rate. In June 2023, the exchange rate between the United States Dollar (US$) and the Indonesian Rupiah (IDR) was 1 US$ = 14,980 IDR. The formulas used to calculate NPV, BCR, PBP, and IRR are as follows:

- Present Value Net (NPV)

The concept of Net Present Value (NPV) refers to a financial metric used to evaluate the profitability of an investment by calculating the difference between the present value of cash inflows and outflows over a given time. The Net Present Value (NPV) is the present value of the net cash flows expected to be generated in the future. The Net Present Value (NPV) is computed using the following mathematical equation:

$$NPV = \sum_{n}^{t=11} \frac{(Bt - Ct)}{(1+i)^t}$$

Bt = Profit per annum

Ct = Total annual expenditure

N = Quantity of years

R = Discount Rate

t = year

- Benefit-to-Cost Ratio (BCR)

The benefit-to-cost ratio is a comparison between a positive and negative NPV. If the comparison result is greater than 1, it can be concluded that the NPV merits execution. Calculate BCR using the following formula:

$$\mathbf{BCR} = \frac{\sum_{t=11}^{n} \frac{(Bt-Ct)}{(1+i)^t}}{\sum_{t=11}^{n} \frac{(Ct-Bt)}{(1+i)^t}}$$

- Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is derived as the interest rate at which an investment's Net Present Value (NPV) becomes equal. In order to deem a business worthwhile, the internal rate of return (IRR) must exceed the interest rate. The computation of the internal rate of return (IRR) is conducted in the following manner:

$$\textbf{IRR} = i + \frac{NPV}{(NPV' - NPV'')} x(i' - i'')$$

i' = the interest rate at the time when NPV is positive

i'' = interest rates at the time of negative net present value

NPV' = Negative NPV

NPV'' =Positive NPV

- Pay Back Period (PBP)

The Pay Back Period (PBP) is a financial metric used to evaluate the time required for an investment to generate sufficient cash flows to recover the initial investment cost. The Pay Back Period (PBP) is a quantitative measure used to estimate the time required for a significant investment to generate sufficient returns to recoup the initial investment. A smaller payback period (PBP) number is preferable as it indicates a faster capital return time. The calculation of Payback Period (PBP) is determined using the following formula:

$$\textbf{PBP} = t' + \frac{Rv''}{Rv'}$$

t' = The year preceding the occurrence of positive income.

Rv' = The most recent instance of negative income.

Rv'' = Positive income.

- Sensitivity Analysis

Sensitivity analysis is a quantitative technique used to assess the impact of changes in input variables on the output of a mathematical model or system. Following the completion of the financial viability calculations, a sensitivity analysis was conducted to ascertain the potential financial vulnerability of the farm business. The present section provides an overview of the results obtained in this study, followed by a discussion of their implications and potential limitations. A comparative analysis was conducted to assess the financial feasibility of the farm business by implementing a reduction of 10% and 15% in sugarcane production. The percentages of 10% and 15% were selected as the reduction in sugar cane crops based on the findings of (Saunders, 1983), which suggests that little changes in a financial data analyst approach can yield significant variations in the outcomes. An initial sensitivity analysis was conducted, focusing on minimum reductions, to assess the feasibility vulnerability resulting from little variations in the quantity of sugarcane harvested. Sensitivity analysis is a technique applied to inform investment decisions by considering the potential impact of uncertain input values, such as revenue, cost, and investment value (Khan *et al.*, 2017; Peter, 2020)while assuming an annualised interest rate

of 7%. The Central Bank of Indonesia determines the interest rate in September 2023, with a range of 5.75% - 6.5% (Indonesian Central Bank, 2023). The interest rate applied as a benchmark is 7%, representing the most possible escalation in the interest rate employed in Indonesia.

3 RESULTS AND DISCUSSION

In the context of State-Owned Corporate Entities, the cultivation of a four-hectare sugarcane plantation represents a substantial land allocation. Compared to the average agricultural land ownership in Indonesia, which is approximately 0.95 hectares, the land in consideration can be characterised as a substantial expanse of land ownership. Additionally, it is noteworthy that the average annual income derived from farming activities in Indonesia is reported to be $333.5 (Indonesia Central Bureau of Statistics, 2021). It is anticipated that the utilisation of land by sugarcane will result in optimal agricultural productivity. Nevertheless, there exists a disparity between the assertions made by Aragón *et al.* (2022) and Gautam and Ahmed (2019) regarding the inability of economic outcomes to directly elucidate the positive correlation between land area and productivity. Additional examination of the financial sustainability of the sugarcane industry pertains to the generation of sugarcane yields and the expenses incurred in the annual production of sugarcane. The primary component of spending in this farm business is the acquisition of agricultural equipment, encompassing both fixed and variable costs. Variable costs encompass various expenses, including land preparation, planting, fertilisers, seasoning, and other miscellaneous charges. The expenditure on agricultural equipment represents an initial investment in the firm, the entirety of which is not depleted throughout the course of output. According to Araya and Asafu-Adjaye (1999), the level of operational costs is directly influenced by the degree of risk associated with the operations being conducted.

Table 1 | Operational Cost Structure of Sugarcane Farming in 1 Year

Cost		*US$*
Fixed Cost	Farm Equipment	$ 2,517
Total Fixed Cost		**$ 2,517**
Variable Cost	Land Preparation	$ 1,175
	Plantation	$ 1,623
	Pesticides, Fertiliser	$ 4,711
	General Fees	$ 1,308
Total Variable Cost		**$ 8,817**
Total Cost		**$ 11,334**

The aggregate fixed cost amounts to $2,517. The subsequent expense incurred within the sugarcane farm business is classified as a variable cost. The variable cost is subject to the effect of the manufacturing process associated with the input and the resulting output. The sum of the variable cost component amounts to $8,817. The aggregate expenditure of establishing 4 hectares of sugarcane farm business amounts to $11,334. Upon examination, it is observed that the aggregate fixed cost accounts for 22% of the whole, while the collective variable cost constitutes 78%. Based on the findings of Kumar *et al.* (2020), it has been shown that variable costs in typical businesses exhibit a range of 79% to 87%, with variable costs being much higher than fixed costs, which range from 13% to 21%. In a study conducted by Diatin *et al.* (2021), it was found that the variable cost accounted for the highest proportion of effort. In sugarcane production, fertilisers and pesticides are the most significant expense. This is because these inputs are crucial for promoting higher yields of sugarcane. In contemporary times, agriculture relies significantly on the supplementation of foreign nutrients via fertilisation Moshkin *et al.* (2023).

Consequently, this practice contributes to an escalation in the variable cost associated with planting. However, an alternative perspective is presented in a study conducted by Liverpool-Tasi (2017), which

posits that the heightened use of fertilisers does not necessarily guarantee the instant augmentation of earnings for farmers. This is due to the presence of various other factors that exert influence on farmers' income levels.

Table 2 | The Annual Profit for Sugarcane Farming

Items	*Amount*
Yield Molasses (tonnes)	850
Price Molasses (US$)/ton	$40,7
Total Revenue (4ha)	$13.842
Total Cost	$11.334
Profit	$2.509

The sugarcane farm business has the potential to undergo two harvests annually, so indicating the existence of two distinct growing seasons, each spanning a duration of six months. The annual sugarcane harvest on a 4-hectare plot of land yields a total of 85 tonnes of molasses, which are then sold at $40,7 per ton. The annual net profit resulting from the sale of a molasses, which generated a total income of $13,842, amounts to $2,509.

Table 3 | Financial Feasibility Analysis of Sugarcane Farming

Items	*US$*
Total Cost	$11,334
Total Revenue	$13,842
Profit	$2,509
NPV (i=7%)	$7,477
BCR	1.66
IRR	19%
PBP	5.1

Farming is an integral component of the broader business landscape, necessitating a comprehensive financial analysis framework for effective management and operation. The financial analysis estimates for this sugarcane farm business are presented in Table 3. Upon acquiring a business profit calculation of $2,509, the initial step in the financial analysis involved computing the net present value utilising a 7% interest rate. The net present value (NPV) estimate was derived from the cumulative profit over an 11-year period, resulting in a positive figure. This positive value signifies the viability and profitability of the business.

The following analysis examines the comparison between positive net present value (NPV) and negative NPV, with the Business Cost Ratio (BCR) serving as the metric. If the BCR number exceeds 1, it indicates that the farm business is considered financially viable.

The Internal Rate of Return (IRR) is a financial metric representing the interest rate at which an investment's Net Present Value (NPV) becomes zero. In order to evaluate if the capital invested in beet cultivation yields a higher profit than the bank interest, the internal rate of return (IRR) must exceed the discount rate employed in the net present value (NPV) calculation. It is evident that the Internal Rate of Return (IRR) is 19%, surpassing the interest rate (i) by 7%.

The subsequent computation involves the Pay Back Period calculation, which assesses the duration required for the initial capital invested in the business to be recovered and for the business to commence generating profits. The duration of the farm business capital returns is five years and one month. Based

on the elapsed duration of 5 years and 1 month, it may be inferred that the sugarcane farm business capital will be restored, leading to the commencement of profitable operations for the business.

Table 4 | Sensitivity Analysis in Sugarcane Farming

Molasses Production Decreased (%)	*NPV*	*BCR*	*IRR*	*PBP*
10%	-$2,903	0.74	-4%	10.1
15%	-$8,092	0.29	-70%	26.3

The sensitivity analysis regarding the utilisation of sugarcane is evident through the observed reduction in the volume of molasses generated. The decrease in the production of molasses has a direct and significant impact on the outcomes of the financial viability study of the farm business.

The prevailing interest rate remains at 7%, which is a significant concern for the sugarcane farm business due to the fluctuating yields. This issue has emerged as a prominent factor affecting the business's sensitivity. Vulnerability refers to a state in which an entity is directly exposed to risk and stress resulting from environmental and social changes, accompanied by an inability to effectively adjust (Adger, 2006). Based on the data presented in Table 4, it can be observed that when business income decreases to 10% and 15% of the financial analysis calculations employing the Net Present Value (NPV) and Internal Rate of Return (IRR) metrics yield a value below zero. This means that the venture lacks viability and is not feasible. The assertion that an endeavour with a high net present value (NPV) is inherently worthwhile cannot be made without careful consideration of several factors. Additionally, if the investment is currently unfeasible, it may be prudent to delay it for a period of around three years because the implementation of the site-specific crop management (SSCM) program demonstrated a numerical simulation indicating that a positive net present value (NPV) required a delay in investment of three years until the average soil quality reached a high level, alongside substantial variability in soil quality and fertility (Khanna *et al.*, 2000). Similarly, while calculating the Benefit-Cost Ratio (BCR), if the reduction in molasses results in a decrease of 10% and 15 of the BCR values are lower than that, it suggests that the undertaking of the business is not economically viable.

The PBP approach was employed to calculate the return on capital for a business that experienced a 10% decline in production. The analysis revealed that the business's capital would take 10 years to recover before generating a profit. Based on the sensitivity calculation, it is evident that the financial challenges faced by the sugarcane farming industry are becoming increasingly apparent, indicating a certain level of susceptibility to changing conditions, albeit not significantly so. It is evident that a reduction in output by a mere 10% might render the evaluation of the viability of the sugarcane enterprise unfavourable and unviable.

Indeed, the computation of farm business analytics, when conducted under standard settings, ensures the certain profitability and sustainability of farm business. The occurrence of sugarcane farm business in this particular scenario strongly correlates with the ongoing climate change phenomenon. The vulnerability of farm businesses has been observed to escalate due to climate change (Bernal *et al.*, 2022; Dungumaro; Hyden, 2010). One contributing factor to this vulnerability is the persistent utilisation of inorganic inputs, which can result in various issues, including diminished fertility and degradation of soil, the heightened prevalence of pests and diseases, and additional social and cultural challenges. According to a recent study conducted by Etongo *et al.* (2022), progress has been seen in enhancing farmers' agricultural vulnerability in three dimensions: exposure, sensitivity, and adaptive capacity, over a span of 10 to 20 years.

Sugarcane growth is primarily vulnerable to climate change, with an emphasis on the impact of rising carbon dioxide levels that contribute to elevated air temperatures and humidity (Baez-Gonzalez *et al.*, 2018; Linnenluecke *et al.*, 2018; Zhao; Li, 2015). Sugarcane crops require high water levels; therefore, the increase in temperature and CO2 due to climate change might enhance the vulnerability and sensitivity

of sugarcane crop yields. According to a study conducted by Flack-Prain *et al.* (2021), the elevation of carbon dioxide (CO2) and other greenhouse gases in the atmosphere of the Earth can raise the Earth's surface temperature, thereby instigating climate change. This phenomenon, in turn, leads to natural calamities and has a disruptive influence on economic endeavours. The issue under consideration is not expected to assume significant prominence in the immediate future, but it is anticipated to become a matter of substantial gravity in the foreseeable future. This phenomenon is evident in our conducted sensitivity analysis, which reveals that even a minor decrease in molasses production has the potential to significantly undermine the overall profitability and sustainability of the enterprise. One potential strategy for addressing the impacts of climate change is the implementation of mitigation and appropriate adaptation measures (Verma *et al.*, 2018). The primary objective of mitigation technology is to diminish the release of greenhouse gas emissions emerging from agricultural land by using strategies such as cultivating low-emission crop types and using water and land management techniques. Various adaptation technologies can be implemented to address the challenges caused by climate change. These technologies involve altering planting schedules, utilising advanced drought-resistant crop types, and advancing water management techniques.

4 CONCLUSION

Generally, the financial viability analysis of the sugarcane farm business indicates that it is economically feasible and has the potential to operate as a sustainable venture. This conclusion is drawn from the good results obtained through various financial analysis methods. Nevertheless, it is evident that the sugarcane farm business exhibits a high degree of vulnerability to fluctuations in circumstances, as indicated by the conducted sensitivity analysis. When molasses production decreased to 10% and 15%, the financial viability study indicated predominantly negative statistics across the board. The potential benefits of the sugarcane farm business for farmers may not be readily apparent at first (Gambelli *et al.*, 2014; Khanna *et al.*, 2000). However, it is crucial to emphasise and promote farm business as a valuable social asset for advancing sustainable agriculture in the coming years. The study determines that the degree of tolerance towards susceptibility to alterations in farming is significantly elevated and necessitates proactive anticipation and mature planning. According to Akinyi *et al.* (2021), crop management, land management, water management, risk management, and livestock management are the five areas that encompass climate change adaptation. Another essential aspect to consider is the necessity of establishing effective collaboration between the forestry company and local farmers, considering that the forestry business is still predominantly managed by the latter. Enhancing farmers' understanding of contemporary climate change (Conceição *et al.*, 2019; Lebel *et al.*, 2015) is imperative to enhance the efficacy of agriculture management practices. Potential collaboration may encompass targeted climate-related management and mitigation efforts, as exemplified by the expansion of media accessibility to pertinent information (Antwi-Agyei; Stringer, 2021; Mendes *et al.*, 2022), the implementation of cutting-edge technological applications (Vasquez-Arroyo *et al.*, 2021) can be employed to alleviate the adverse effects on the food industry, social dynamics, and climate change. Furthermore, fostering transparency among farmers and stakeholders within the sugarcane farm business is crucial.

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