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PROFITABILITY OF SOYMILK PROCESSING: IMPLICATIONS FOR UPSCALING AMONG SMALL SCALE ENTERPRISES

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ABSTRACT: *The profitability of soymilk processing with implications for scaling up among small-scale enterprises was investigated based on data which emanated from the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Apata Ibadan, Southwest Nigeria. Soymilk, a plant-based product, has gained popularity as a nutritious and sustainable substitute for dairy milk, prompting interest in its production in a commercialized way. In order to establish profitability and upscaling, an economic analysis of soymilk processed at the Institute was carried out on five (5) treatments using two (2) different methods. The partial budgetary and gross margin analysis were used to evaluate the profitability of the soymilk processed. The research outcome showed that treatment Mch2-3.0Syb-3cps was the best with the least cost. Treatment Mch2-3.0Syb-3cps had a positive net benefit of ₦4,090, an incremental net benefit of ₦435, an incremental cost of ₦915 and a marginal rate of returns of 47.54. This implies that compared to other treatments, the Mch2-3.0Syb-3cps method of soymilk processing would give an additional 45.54 litres of soymilk for every ₦1 spent in processing soymilk, which is the highest compared to other treatments. The findings suggest that soymilk processing holds promise as a profitable business if this treatment is adopted and upscaled.*

KEYWORDS: Soymilk, soymilk processing, partial budgeting, profitability, gross benefit analysis.

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INTRODUCTION

There is an increasing global consciousness of more sustainable and healthier dietary choices with an emphasis shifting towards plant-based foods such as soymilk ((Han *et al.*, 2021). It has emerged as a popular alternative to dairy milk due to its nutritional qualities and the lower environmental impact of its production processes (Food and Agriculture Organization-FAO, 2018). Derived from soybeans, soymilk has gained prominence due to its nutritional benefits and environmentally friendly profile (Ugbabe *et al.*, 2017). The nutritional value of soymilk, including protein content and the absence of cholesterol, makes it an appealing choice for health-conscious consumers (Han *et al.*, 2021). Market trends indicate a growing preference for plant-based milk alternatives, driven by factors such as intolerance to lactose, environmental concerns, and changing consumer habits (Afouda *et al.*, 2019). The surge in health consciousness among consumers and the increasing adoption of plant-based diets have fueled the demand for soymilk (Kohli *et al.*, 2017). Plant-based market globally, including soymilk is projected to reach $21.52 billion by 2024. This trend presents a significant opportunity for businesses engaged in soymilk processing. Understanding evolving consumer preferences, such as lactose intolerance and environmental concerns, market demand and profitability, is crucial for effective market target (Zhi-Sheng,2012; Nishanthini & Nimalathasan, 2014).

The growing importance of soymilk has therefore stimulated concerns on the suitability of processing techniques across different considerations bothering on food safety, drudgery, technologies, innovations and entrepreneurship potentials (Atuna *et al.*, 2022). Soymilk processing involves several techniques comprising soaking, grinding, milk extraction and homogenization (Han *et al.*, 2021). The entrepreneurial consideration in soymilk processing has underscored the critical importance of the cost efficiency and profitability of the processing techniques (Munezero, 2018). Consequently, factors such as the cost of raw materials (soybeans), labour, equipment, utilities, packaging, and distribution must be carefully considered in order to make informed economically viable decisions. Achieving efficiency in processing methods, including optimizing yields and minimizing waste, contributes to cost reduction. Therefore, introducing novel technologies, such as automated processing and energy-efficient equipment, can enhance production efficiency and improve profit margins (Olayemi, 2004; Olayide and Heady, 2006), borne on the scale of processing.

LITERATURE/THEORETICAL UNDERPINNING

Analyzing production costs is fundamental to assessing the profitability of soymilk processing (Yusuf and Shuaibu, 2022). Raw materials, labour, equipment, energy and packaging expenses all contribute to the overall cost structure. One advantage of upscaling is the potential for economies of scale, wherein the cost per unit of production decreases as output increases (Yusuf and Shuaibu, 2022). There is a growing interest in understanding the profitability of soymilk processing and the implications for scaling up production to meet rising demand as consumers' tastes change (Chanpura and Gupte, 2022). As the demand for plant-based products continues to increase, the profitability of soymilk processing presents an attractive enterprise for investment (Shea *et al.,* 2016) such that the final product meets consumers' expectations (Ferguson *et al.*, 2021).

One of the aims of the innovation system is to develop processing techniques that not only ensure cost efficiency but also assure food safety and quality standards (Shea *et al.*, 2016). This

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has been of great concern at cottage-level value-addition processes for agricultural commodities. The Institute of Agricultural Research and Training, out of its mandate for developing production and processing technologies for soybean has developed an automated processing line for soymilk production targeted at further enhancing entrepreneurship in the soybean value chain. Upscaling the technology requires adequate consideration of its economic potential relative to commonly practised manual production at the cottage level in line with the profit maximization concept of the farm/firm (Olayemi J.K., 2004; Olayide and Heady, 2006). This study therefore evaluates the profitability of the soymilk processing line developed by IAR&T as a measure of its entrepreneurial potential for upscaling.

METHODOLOGY

Data for this study was obtained from soymilk processing trials conducted at the Ibadan station (lat. 7 22`N, long. 3 50`E) of the Institute of Agricultural Research and Training (IAR&T), Moor Plantation. Two (2) soymilk processing methods were employed for this study, comprising the manual/traditional method of soymilk processing (control) and the newly developed automated processing line. The experiment was conducted at the Institute's Agricultural Value Addition laboratory. The manual method of Soymilk processing started with soaking soybeans overnight, milling and the addition of water while milling. This is followed by blanching or cooking for 10 minutes. The paste formed was sieved and the suspension was brought to boil for 10 minutes. Finally, salt (0.1 grams) and sugar (0.18kg) were added at varying levels for desired taste and allowed to cool before dispensing into bottles. The Automated Method of Soymilk processing followed the same stepwise procedure as the manual method, the difference however was the use of machines to carry out these processes instead of total dependence on humans for labor. Consequently, the following treatments were evaluated for economic potential.

Treatment 1: Machine +1.5soybeans+2cups of Sugar (Mch1-1.5syb2cpsug).

Treatment 2: Machine+3.0soybeans+3cups of Sugar (Mch2-3.0syb3cpsug),

Treatment 3: Machine+3.0soybeans +4cups of Sugar (Mch3-3.0syb4cpsug),

Treatment 4: Manual+1.5soybeans+2.5cups of Sugar (Mn1-1.5syb2.5cpsug),

Treatment 5: Manual+3.0soybeans+1.5cupsofSugar (Mn2-3.0syb1.5cpsug).

Data from the respective treatments were subjected to economic analyses using partial budgetary analysis, dominant analysis and Marginal Rate of Return (MRR) analyses. The net benefit from each treatment was determined as given by:

$$GM_t = P_{ot}Q_{ot} - C_t \qquad (1)$$

Where

$$C_t = \sum_{i=1}^{n} P_{it}\, Q_{it} + \sum_{j=1}^{k} W_{jt}C_{jt} \quad for\ i = (1,2,3,...,n),\ j = (1,2,3....k), t = (1,2,.....,s) \qquad (2)$$

Where

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GM_t = Gross Margin for treatment

P_{ot} = Price per unit of output of Soymilk under treatment t

Q_{ot} = Quantity of Soymilk produced under treatment t

C_t = Cost of production of soymilk under treatment t

P_{it} = Cost per unit of input i under treatment t

Q_{it} = Quantity of inputs for used under treatment t

W_{jt} = Manday of labour used for operation j under treatment t

C_{jt} = Cost per manday of labour used for operations j under treatment t

i = input i for i=(1,2,…..,n)

j = operation j for j = (1,2,3,…….k)

t = treatment t for t= (1,2,…….,s)

In this study, the dominant analysis was estimated from the outcomes of the partial budgetary analysis (Makinde *et al.*, 2007).

RESULTS/FINDINGS

Based on the data provided for the quantity of soymilk produced and the adjusted quantity processed under different treatments, Treatment 1: Mch1-1.5syb-2cpsug, Treatment 2: Mch2-3.0syb-3cpsug, Treatment 3: Mch3-3.0syb-4cpsug, Treatment 4: Mn1-1.5syb-2.5cpsug, Treatment 5: Mn2-3.0syb-1.5cpsug. The quantity of Soymilk Produced (litres) for Treatment 1 is 46 litres, Treatment 2 is 56 litres, Treatment 3 is 56 litres, Treatment 4 is 27 litres, and Treatment 5 is 24 litres. Adjusted Quantity of Soymilk Processed (litres) for Treatment 1: 41.4 litres, Treatment 2: 50.4 litres, Treatment 3: 50.4 litres, Treatment 4: 24.3 litres, Treatment 5: 21.6 litres.

Key Findings

Highest Production and Efficiency:

Treatment 2 and Treatment 3 produced the highest quantity of soymilk, both at 56 litres. After adjustment, both treatments also maintained the highest processed quantity at 50.4 litres each. This suggests that increasing the soybeans to 3.0 (syb) and using 3-4 cpsug in these treatments is optimal for higher yield and processing efficiency.

Moderate Production:

Treatment 1 produced a moderate amount of soymilk at 46 litres, with an adjusted processed quantity of 41.4 litres. This indicates that using 1.5 syb and 2 cpsug is less effective than higher soybean content but still reasonably efficient.

Lower Production:

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Treatment 4 and Treatment 5 resulted in the lowest quantities of soymilk, at 27 litres and 24 litres respectively. After adjustment, the processed quantities were 24.3 litres for Treatment 4 and 21.6 litres for Treatment 5. The lower soybean content (1.5-3.0 syb) combined with different cpsug levels (1.5-2.5 cpsug) in these treatments are less effective for soymilk production and processing efficiency.

DISCUSSION

Analysis of Soymilk produced

The quantity of soymilk obtained from the machine method in Treatments 1, 2 and 3, identified by Mach1-1.5syb2cpsug, Mach2-3.0syb3cpsug and Mach3-3.0syb4cpsug were 46, 56 and 56 litres respectively while soymilk quantity obtained from the manual methods represented as Treatments 4 and 5, which can also be identified as Mn1-1.5syb2.5cpsug and Mn2-3.0syb1.5cpsug were 27 and 24 litres, respectively (Table 1). The adjusted soymilk quantities for the machine method were 41.4, 50.4 and 50.4 litres, respectively while those of the manual method were 24.3 and 21.6 litres, respectively. The adjusted yield is incorporated to account for possible yield gaps between research stations and farmers' fields due to differentials in capabilities to abide by standard procedures. (Makinde *et al.,* 2007); (Saka *et al.,* 2007)

Partial Budget analysis of soymilk processed

The results of the partial budget analysis of the soymilk processed across treatments are presented in Table 2. The total variable costs (TVC) for treatments involving the use of a machine (Treatments 1, 2, and 3) were ₦3095.0, ₦4010.0 and ₦4190.0 respectively while that of the manual method (Treatments 4, and 5) were ₦3185.0 and ₦3740.0 respectively. The revenue from soymilk produced from treatments 1,2, and 3 was ₦6,210.0, ₦7,560.0 and ₦7,560.0, respectively, while revenue obtained from the manual method of processing (treatments 4 and 5) were ₦3,645.0 and ₦3,240.0, respectively (Table 2). Consequently, the gross margin (net benefit) from soymilk processing with the use of a machine (Treatments 1, 2 and 3) were ₦3,115.0, ₦3,550.0 and ₦3,370.0 respectively, while gross margin (net benefit) from manual processing (Treatments 4 and 5) were ₦460.0 and ₦-500.0 respectively. The study outcome showed that the gross margin (GM) for soymilk processed with the machine was higher for treatments 2, 3 and 1 at ₦3,550.0, ₦3,370.0 and ₦3,115.0, respectively than the gross margin outcome from treatments 4 and 5 at ₦460.00 and -₦500, respectively. These results therefore buttress the economic advantage of the use of machines over the manual processing of soymilk. Similarly, the highest GM was obtained from treatment 2 (₦3,550.0) and treatment 1 (₦3115.0) this is attributable to greater milk yield over the other treatments (3). However, the manual methods of soymilk processing (treatment 4 and 5) showed that the benefit relative to cost is very low at ₦460 and -₦500.0, respectively, with treatment 5 recording negative returns. This study outcome further shows that treatment 5 is a disincentive to investment because of the negative outcome obtained.

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Table 1: Analysis of soymilk produced

Soymilk Produced	Mch1-1.5syb-2cpsug (Treatment 1)	Mch2-3.0syb-3cpsug (Treatment 2)	Mch3-3.0syb-4cpsug (Treatment 3)	Mn1-1.5syb-2.5cpsug (Treatment 4)	Mn2-3.0syb-1.5cpsug (Treatment 5)
Quantity of Soymilk produced (litres)	46	56	56	27	24
Adjusted quantity of Soymilk processed	41.4	50.4	50.4	24.3	21.6

Source: Experimental data, 2023

Table 2: Partial Budget Analysis for Soymilk processing

	Mch1-1.5syb-2cpsug (Treatment 1)	Mch2-3.0syb-3cpsug (Treatment 2)	Mch3-3.0syb-4cpsug (Treatment 3)	Mn1-1.5syb-2.5cpsug (Treatment 4)	Mn2-3.0syb-1.5cpsug (Treatment 5)
Quantity of Soymilk produced	46	56	56	27	24
Adjusted quantity of Soymilk processed	41.4	50.4	50.4	24.3	21.6
Price	150	150	150	150	150
Revenue (₦)	**6,210**	**7,560**	**7,560**	**3,645**	**3,240**
Variable Cost					
Qty of Soybean	1.5	3	3	1.5	3
Cost of Soybean @ N490/kg	735	1470	1470	735	1470
Qty of sugar (cups)	2	3	4	2.5	1.5
Qty of sugar (kg) 1 cup = 0.18 kg	0.36	0.54	0.72	0.45	0.27
Cost of Sugar @ N1,000/kg	360	540	720	450	270
Material Cost	1095	2010	2190	1185	1740
Variable Input Cost (N)					
Cost of labor	2000	2000	2000	2000	2000
Total Variable Costs	**3095**	**4010**	**4190**	**3185**	**3740**
Gross Margin	3,115	3,550	3,370	460	-500

Source: Experimental data, 2023. * US$1= ₦1,000**

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Dominance and Marginal Rate of Returns Analysis

The dominant analysis rendered Treatments 4 and 5 unacceptable for investment. This implies that these treatments will return lower net benefits at higher costs. Treatments 1, 2, and 3 had higher net benefits and lower costs (Table 3). The result of the Marginal rate of return (MRR) analysis indicated that the cost implications for treatments 1 and 2 (Mch1-1.5syb-2cpsug and Mch2-3.0syb-3cpsug) were lower in their different treatment categories, hence they were the undominated treatments and can be referred to as the base lines for the different categories (manual and treatments). From table 3, we saw that Mch2-3.0syb-3cpsug had a benefit (8100) above Mn2-3.0syb-1.5cpsug, Mn1-1.5syb-2.5cpsug, Mch1-1.5syb-2cpsug and Mch3.3.0syb-4cpsug, respectively. Thus, Mch2-3.0syb-3cpsug had an incremental cost benefit of 43 over other methods, an incremental cost of 915 lower than other methods and a marginal rate of return of 47.54 better than other methods. This implies that a unit cost of variables used in producing soymilk processed using the Mch2-3.0syb-3cpsug method will produce 47.54 more units of soymilk than any other methods used. This makes Mch2-3.0syb-3cpsug processing method of soymilk the best out of the four considered in this study.

Table 3: Dominance and marginal rate of return analysis for treatments

Treatments	Cost (₦)	Benefit	Net Benefit	Dominance
Mch1-1.5syb-2cpsug	**3095**	**6210**	**3115**	**Undominated**
Mn1-1.5syb-2.5cpsug	3185	3645	460	Dominated
Mn2-3.0syb-1.5cpsug	3740	3240	-500	Dominated
Mch2-3.0syb-3cpsug	**4010**	**7560**	**3550**	**Undominated**
Mch3-3.0syb-4cpsug	4190	7560	3370	Dominated

Source: Experimental data, 2023

Marginal rate of Returns (MRR) analysis of the Undominated Treatments

The MRR analysis for the undominated treatments were captured in Table 4. The incremental net benefit for the two undominated Treatments 1 and 2, was ₦1.350 while the incremental cost was ₦915. The overall MRR was 1.48 which implies that for every naira spent in producing soymilk using treatment 2 (Mch2-3.0syb-3cpsug), processors were able to save an additional 0.48 litres of soymilk.

Table 4: Marginal rate of return (MRR) analysis of the Undominated Treatments

Treatments	Cost (₦)	Benefit	Net Benefit	Incremental Net Benefit	Incremental Cost	MRR
Mch1-1.5syb-2cpsug	3095	6210	3115			
Mch2-3.0syb-3cpsug	**4010**	**7560**	**3550**	**1350**	**915**	**1.48**

Source: Experimental data, 2023; * US$1= ₦1,000**

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IMPLICATION TO RESEARCH AND PRACTICE

The global shift towards healthier and more sustainable dietary choices has led to a growing demand for plant-based alternatives to traditional dairy products. Soymilk, derived from soybeans, has emerged as a popular and nutritious substitute for cow's milk. The profitability of soymilk processing has gained considerable attention in recent years, particularly as businesses consider the implications of upscaling their operations to meet the rising demand. This article delves into the key factors influencing the profitability of soymilk processing and explores the strategic implications for businesses looking to scale up their production.

CONCLUSION

Treatments that use higher soybean content (3.0 syb) combined with moderate to high cpsug (3-4 cpsug) yield the highest production and processing efficiency in soymilk processing. Conversely, treatments with lower soybean content and varying cpsug levels produce significantly less soymilk, indicating a direct relationship between the quantity of soybeans used and the efficiency of soymilk production. The outcome from the showcased treatments of soybeans implies that treatments 1 and 2 (Mch1-1.5syb-2cpsug and Mch2-3.0syb-3cpsug and were the best method of all the treatment employed in this study. It was the method with the least processing cost and highest incremental benefit. This implies that a unit cost of variables used in producing soymilk processed using treatments 1 and 2 produces 0.48 more litres of soymilk than other methods used. This makes these treatments the best of the five considered in this study. This study therefore recommends treatments 1 and 2 for soymilk processing upscale, as well as a viable technology to be introduced for uptake among the Institutes stakeholders interested in soymilk processing as a profitmaking venture. We also suggest investment in fabrication of locally made machines for cottage industry's use in processing soymilk, this will increase cost efficiency and the growth of smallholder processors will be ascertained.

FUTURE RESEARCH

Further analysis could explore cost analysis and profit/production efficiency (Technical, allocative and economic efficiencies, returns to scale and optimization of the soymilk production process).

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