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Economic Profitability of Shea Butter Production under Different Production Systems in the 2KP Districts in the Northern Part of Benin

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ABSTRACT

The production and marketing of shea butter provide enough benefit to the rural population, especially women. However, its production varies depending on the production systems used: traditional, semi-mechanized, and mechanized. Each system has specific characteristics that influence the economic performance of the processors. This article aims to evaluate the economic profitability of shea butter production according to the different production systems adopted by women processors of the 2KP and identify the socio-economic and technical factors that influence this economic profitability. To this end, empirical data were collected from 200 women butter producers in Kérou, Kouandé, and Péhunco in the northern part of Benin.

The processing of shea nuts into butter is economically profitable in the production areas from the point of view of processors' profit. In addition, the Average Labour Productivity showed a trend equal to the values of the net margin. Therefore, shea butter production is very economically profitable from the point of view of labor remuneration, but only for women who have used modern and semi-modern systems. Furthermore, the factors influencing the economic profitability of this activity for women include, among others, the age, experience of the processor, her level of formal education, the type of system adopted, the distance traveled to access equipment, etc.

Keywords (05 words): Shea Butter, Marketing, Production Systems, Economic Profitability, Mechanized System.

JEL Codes : Q13, M31, L23, D24, Q18

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1. INTRODUCTION

In Benin, the population consumes 162 species of forest resources, especially the rural ones, for their roots, barks, fruits, leaves, seeds, etc. (Codjia et al., 2003). Shea, scientifically called Vitellaria paradoxa, is among these species. According to (N' Danikou et al., 2011), V. paradoxa is a native species from Sub-Saharan Africa with high nutritional, ecological, economic, and medicinal importance for local communities in this region. The fruits/nuts of the shea tree are used to produce several consumer products, including shea butter, which is a source of income diversification for rural women. Internationally, almonds and butter from shea nuts are the subject of a flourishing trade, bringing considerable foreign currency to the producing countries (Singbo & Lansink, 2010). It should be noted that in Benin, V. paradoxa ranks fourth in export products and generated an income of nearly FCFA 26.4 billion in 2020 (INStad, 2021). However, despite its economic potential, the production and marketing of Shea butter face several challenges. These include logistical constraints (the obsolescence and non-renewal of processing equipment provided to processors) (Hinnou et al.., 2021); price fluctuations on local and international markets, the variable quality of the product, as well as issues relating to the organization of value chains. These factors are likely to influence the profitability of local Shea butter production operations, thus raising questions about the real profitability of this activity.

This essay examines the economic profitability of Shea butter production in an analysis of each stage of the value chain, from the collection of nuts to the marketing of the finished product. It also focuses on the challenges producers face, such as price fluctuations, logistical constraints, and quality standards imposed by international markets. The final objective is to determine the conditions under which Shea butter production can be maximized in terms of profitability while ensuring a fair distribution of benefits for the local communities involved and highlighting the factors influencing this profitability.

1.1. Statement of Problem

Traditionally, shea kernels are crushed manually in mortars and then stone ground. This muscular work is often very difficult and requires much labor. Thus, following the diagnostic survey on the processing of oilseed products in Benin, the mechanization of certain stages of the shea transformation process was identified as a priority need that could reduce the arduousness of the work and increase yield (Yabi. et al., 2021). Cushing and grinding are the two most restrictive operations in the shea butter production process. According to (Yabi et al., 2021), this must be added to producers' exposure to heat and smoke for hours during roasting for a low yield (10 kg/hour on average per person).

Introducing semi-mechanization technologies for transforming shea kernels into butter could increase the income of rural producers and provide added value to the promotion of the Shea sector. In addition, this surplus income could allow producers to invest more in their children's education. Given these advantages, the main research question comes to mind: "What is the economic performance of Shea butter production factors in the Northern part of Benin?"

1.2.Objective of the Study

This thesis analyzes the economic efficiency of shea butter production and marketing in the 2KP in the Northern part of Benin. From this general objective, the following specific objectives arise:

- Evaluating the determinants of the economic efficiency of the main players in the shea butter value chain in the Northern part of Benin;
- Evaluating the economic profitability of Shea butter marketing;

1.3.Research Questions

- Which of these systems is most efficient in terms of allocating available resources?
- Is Shea butter marketing economically profitable?

1.4.Research hypotheses

H_{01}: The processing system used, the number of years of experience, contact with a project leader or NGO, and access to credit determine the economic efficiency of women shea butter producers.

H_{02}: The types of actors determine the financial and economic profitability of shea butter marketing.

2. LITERATURE REVIEW

2.1.Conceptual framework

2.1.1. Economic and financial profitability

Far from dwelling on the multiple theoretical foundations to which the concepts of profitability, break-even point, and direct costing refer, we are trying to establish their link with this work. Indeed, according to (Dègla,, 2021), profitability is the ratio between the income achieved or expected and the resources committed to obtain it, and perceived as an indicator of the economic performance of an operation or any company or activity. It measures the capacity of this company or activity to generate profits or gains from the resources invested. (Arouna, A et al., 2021) profitability is "the capacity of a capital to obtain an income." In his conception of profitability, especially economic profitability, he compares the income obtained by the company to the capital committed to production regardless of its origin: equity or debt. Several authors have also tried to define profitability, but for the most part, these definitions converge with that of (Arouna et al., 2021): "capacity of an economic activity to produce results". (Bio Timperegou et al., 2024) Perceives profitability as the evaluation of the performance of invested capital. The author believes that it (profitability) can also measure the efficiency of a company's management and, therefore, finds that its analysis is essential in a liberal economy. Following him (Zallé A. et al. (2018) define profitability as the ratio between the income obtained or expected and the resources used to obtain it. For (Gnanglè et al., 2012), the profitability calculation diverges according to economic, commercial, and financial aspects. In literature, the analysis of the profitability of an activity refers to the evaluation of economic and financial performance (Dègla. et al., 2022). This essay focuses on economic profitability to evaluate women's performance in processing shea butter.

Economic profitability is an indicator of the economic performance of an operation or a production unit that uses all this capital. As such, after defining profitability as the ratio between earnings and funds committed to an economic operation, (Yabi et al., 2021) consider that economic profitability measures the ability of an economic operation to produce a flow of discounted income higher than the expenses incurred. This measure of economic profitability can also be understood through several methods, including direct costing. Economic profitability is "the performance measurement of the implementation of assets (capital)

regardless of their method of financing." For (Dègla. et al., 2021), the firm is independent of any capital financing and manages to express the capacity of the invested capital to generate a given level of income before paying interest and taxes. In other words, the ratio of the profit obtained (a flow) to the capital invested (a stock) makes it possible to calculate a profit rate.

On the other hand, financial profitability is only interested in the ratio of the capacity of equity to generate income (Dègla. et al., 2021). Profitability is the indicator of performance that relates to observed income and costs, reflecting the market price that processors, producers, or traders can receive. It is also the difference between the value and the cost of production determined based on prices observed on the market (Bio Timperegou et al.., 2024).

2.1.2. Performance

❖ **Economic performance**

- **Productivity**

Productivity is a performance indicator that specifies the relationship between the output level and the level of use of inputs from the production function, considering that all inputs except one are constant. The literature identifies three types of productivity: total, marginal, and average.

The average productivity of an input (PM) is defined as the ratio between the inputs' total productivity and the input's used productivity. It determines the number of output units **y** produced per input unit used. We can, therefore, write the average production of a factor $\mathbf{X_1}$ as follows.

$$\mathbf{PM} = \frac{\mathbf{y}}{\mathbf{x_1}} \qquad \mathbf{(01)}$$

The marginal productivity noted Pm, also called the marginal product of a production factor noted $X_{1,}$ is the increase in total productivity a firm can obtain from an additional unit of this factor while maintaining the other factors constant. Its formula is by (Dègla. et al., 2021) as follows:

$$\boldsymbol{\alpha_1 y / x_1 = \frac{\Delta y/y}{\Delta x_1/x_1} = \frac{\partial y x_1}{\partial x_1 y} = \frac{Pm}{PM}} \textbf{Hence:} \qquad \mathbf{(02)}$$

$$\mathbf{Pm = \alpha_1 . PM}$$

With α_1: elasticity and PM, the average productivity

As described by neoclassical economic theory, the producer/processor aims at maximizing his/her profit or profitability through a better efficient combination of allocative factors of production. The profit or profitability of an operation of any production system represents, according to (Dègla. et al., 2022), the performance indicator of this operation or production or processing unit. Two determination approaches in the literature are used to assess the economic profitability of an operation to determine this profitability or profit. These are the margin and operating results approaches (Sodjinou et al., 2015).

This research draws on this margin approach to assess the economic performance of women processing shea butter in the 2KP.

❖ **Margin approach:**

Well known in rural economics under the name of "business budget" or "gross margin methods", the margin method is an analysis technique that involves the allocation of operating expenses to the various activities of the company (Sodjinou, et al., 2015). Relatively simple and inexpensive, the margin method is only conceived in the short term. It indicates the

determination of gross product, expenses or costs, and margins for a product or a company on a given reference (Cordonnier, et al., 2023). Therefore, two types of expenses or costs are distinguished in these conditions: variable and fixed expenses.

❖ **Gross product**

The gross product corresponds to the total value of the products resulting from a production process. It includes internal flows, in this case, self-consumed production (shea butter in our case) and unsold productions that can be multiplied at market prices, i.e., at the price the producer could sell her production on the market.

❖ **Charges**

Charges or costs represent the expenses related to production factors. They are grouped into two categories: fixed charges and variable charges. Thus, variable charges or variable costs, also known as operating costs, are costs invested in production that change with the quantity of outputs produced but are not necessarily proportional. As an example of a cost in the context of this research, we can have a supply of shea almonds and occasional labor (for crushing, grinding, shelling, etc.) (Dègla et al., 2021). As for fixed costs, they are, according to (Arouna et al., 2021), structural costs corresponding to costs varying slightly in a short period following the variation of the activity. They are independent of the nature, size, and intensity of the activities carried out within the company during the reference period. These expenses include, in particular, the salaries of the permanent labor, maintenance, and repair costs of equipment, the cost of the processing premises, and the costs of small equipment used (basins, pallets, etc.). For this equipment with a multi-year lifespan, depreciation, i.e., their loss in value, is determined. Then, it will be necessary to calculate the number, lifespan, and unit price of each piece of equipment used in production.

❖ **Gross margin and net margin**

According to (Dègla., et al., 2021) and (Sodjinou et al., 2015), the gross margin or margin on operating expenses is an element of comparison between operations or groups of operations. It equals the difference between the gross product in value and the variable expenses. On the other hand, the net margin or profit is equal to the difference between the gross product and the production costs or between the gross margin and the fixed expenses. Indeed, the degrees of acceptability of the net margin are linked to (MN> 0) and (MN< 0). Thus, when (MN> 0), this means that the gross product manages to cover all the expenses (variable + fixed) and that the production of shea butter is economically profitable. On the other hand, if the net margin is negative (MN<0), then the gross production is unable to cover all the expenses, and the production of shea butter is, therefore, not economically profitable (Yabi et al., 2021). This latter case may occur when the variable and fixed production costs are very high, and the gross product remains low to the point of not covering them. It should be noted that in a production unit where several activities are carried out, the total net margin is the sum of the net margins of the results of each activity. Within the framework of this research, only the activity of transforming Shea into butter is considered.

2.2. Theoretical approaches

2.2.1. Theory on performance indicators: economic profitability and income of processors

Performance indicators, including economic profitability and processors' income, are two measures used to assess the efficiency and sustainability of processing activities, in this case in

small and medium-sized enterprises, cooperatives, or community or individual enterprises, such as those of processing enterprises in the agri-food sectors (processing of Shea nuts into butter). For these enterprises, whether collective or individual, to survive sustainably, they must optimize the factors of production and derive surpluses and benefits from them. Therefore, profitability is the first necessary condition. Profitability is considered a key performance indicator measuring the ability of a company or activity to generate profits from the costs incurred. It is generally expressed as the profitability ratio, such as return on investment (ROI) or profit margin.

- **ROI (Return on Investment)** measures profitability compared to investments made. It is an indicator of the effectiveness of investments in the transformation process.
- **Profit Margin**: This is the percentage of sales after deducting production costs, management fees, and other expenses. It is an indicator of the company's ability to generate profits from sales.

So, profitability represents a performance indicator that enables evaluating the performance of the resources invested in the Shea butter production activity. However, the decision of the investor to use a technology/equipment is linked to the advantage that it can provide in terms of cost-benefit ratio. To this end, measuring the impact of a technology equipment or process on the profitability of a company that adopts it is an important criterion to predict ex-ante or justify ex-post its acceptance by potential adopters. Thus, two levels of observation can be the subject of an evaluation of the profitability of a new technology/equipment or a process: the individual level (sole proprietorship) and the collective level. From the point of view of the individual processing unit or individual processor, the analysis of the profitability carried out is a financial one. It thus makes it possible to determine the processor's profit to assess the competitiveness of her activity. On the other hand, profitability analysis at the collective level is economical since it uses prices and costs that reflect the objectives, resources, and constraints related to the production or business environment. Unlike financial analysis, economic analysis considers the effects of policies on the production environment, individuals, and the local economy, as well as investors' secondary and indirect effects.

Regarding income, (profitability) refers to the net financial gains obtained by those involved in the transformation process after deducting operational costs and other expenses. It is then an essential indicator for assessing the economic sustainability of their activities. In this case, we can identify two types of income: net income and average income. In the context of an activity related to processing Shea nut into butter, net income refers to total income minus direct and indirect costs. This amount reflects what the processors can use for their personal needs, to reinvest in their business, or to save. On the other hand, average income will be the division of total income by the number of processors, this indicator allows us to see the average economic performance per individual or group.

This research then uses these indicators (economic profitability and processors' income) to evaluate the performance and sustainability of activities related to processing shea nuts into butter, directly impacting processors' economic security and local economic development.

2.2.2. Rural economy and neoclassical theory

Rural economics and neoclassical theory are two important fields in economics that interact to explain economic dynamics in rural areas, particularly in agricultural and rural

development contexts. It is noted in rural economics that the analysis of the profitability of production systems does not closely match the neoclassical theory postulating that the producer seeks to maximize his/her profit. This is reflected in other considerations such as self-consumption, prestige, mutual aid, etc., observed in rural areas considered revitalizing the rural economy. On the other hand, in the neoclassical model, the producer is a rational economic agent. According to this theory, individuals and firms make optimal decisions based on the information they have to maximize their utility (for consumers) or their profits (for producers). Otherwise, the economic agent seeks to minimize his/her fixed and variable costs and maximize his/her profit subject to the constraint of his/her costs. However, the producer's first objective is to obtain the greatest net income to minimize costs. However, achieving this objective is linked to factors entering into production (labor force, capital, inputs, etc.), considering marginal revenues equal marginal costs. It should be noted by (Yabi et al., 2021) that only the production conditions and the availability of resources are considered when women choose and implement their processing system. However, there are also considerations related to the economic and social environment that constrain their decision-making. Given these different factors, several indicators have been considered and defined to analyze the profitability of production systems in rural areas. However, the relevant and commonly considered in the literature are the net margin (MN) or profit, the internal rate of return or average labor productivity (TRI), marginal labor productivity (PML), and the benefit/cost ratio (RBC).

2.2.3. Production function

The production function determines the quantity of output produced related to the factors or elements used for this production. It is then represented as a curve, a table, or a mathematical equation that indicates the maximum production level that can be obtained from the specified set of production factors for a given technology or production system. Thus, according to (Arouna et al.., 2021), the theory of production will seek to analyze how the producer or entrepreneur combines different factors of production to obtain a property efficiently. Therefore, assuming that the quantity of output obtained by the woman processing Shea butter is noted **y** under the combination of several factors (Shea almond, firewood, labor, cost of equipment used, etc.), which are designated respectively by $\mathbf{x_1}, \mathbf{x_2}, \mathbf{x_3}, \mathbf{x_4}$, then the production function of these women is noted:

$$\mathbf{y = f(x_1, x_2, x_3, x_4)} \qquad \textbf{(03)}$$

It should, therefore, be noted that the quantity of Shea butter produced **y** is the result of the combinations of factors that these processors have brought into the production, which varies (variable factors $\mathbf{X_1 X_2 X_3 X_4}$) depending on the production level.

3. METHODOLOGY

3.1. Data collection

Empirical data were collected from women butter producers in the 2KP areas (Kérou, Kouandé, Péhonco) in the northern part of Benin. The data collected include information on the quantities of almonds processed during a year, the income of processors, volumes of butter, production costs, and other relevant variables to assess the performance of women processors according to the systems adopted by the latter. Also, variables relating to the socioeconomic

characteristics of producers made it possible to identify the factors that determine the economic performance of Shea butter producers using the Seemingly Unrelated Regression Model (SUR) (Labiyi et al., 2019).

3.2. Data analysis

To assess the economic performance of women shea butter producers in the 2KP and to determine the determinants of this performance, the margin approach and the Seemingly Unreleated Regression Model were respectively exploited.

3.2.1. Approach to assessing the economic profitability of shea butter production

To assess the economic profitability of shea butter production, indicators such as gross margin (MB), net margin (MN), Profit-Cost Ratio (RBC), average labor productivity (PLM), and break-even point will be calculated.

- **MB: gross margin**

The gross margin is obtained by deducting from the gross product in value (PBV) the variable costs or charges (CV) of shea butter production. Mathematically, it is established as follows:

$$\mathbf{MB = PBv - Cv\ In\ FCFA/kg\ of\ almonds} \qquad \mathbf{(04)}$$

- **MN: Net margin**

The net margin is obtained by deducting from the gross product in value (PBV) the total production costs or by deducting from the gross margin (MB) the fixed costs (Yabi et al., 2021). Otherwise, the net margin refers to the difference between the gross product (PBV) value and the fixed and variable costs generated by the production activity. Also called net profit or profit, it is obtained using the following mathematical formula:

$$\mathbf{MN = PBv - [Cv + CF]\ Or\ MN = MB - CF\ in\ FCFA/Kg\ of\ nuts} \qquad \mathbf{(05)}$$

- **Labor productivity (PML)**

Referred to as the Average Labor Remuneration Rate (TMRL), Labor Productivity is the net margin per unit of family labor used for production.

It is expressed as follows:

$$\mathbf{PML = \frac{MN}{\overline{MOF}}\ In\ FCFA/MAN\text{-}DAY} \qquad \mathbf{(06)}$$

With:

- **MN:** The Net Margin of shea butter production (in FCFA/kg of nuts);
- **MOF:** the total quantity of family labor exploited in person-day per kg of nuts (person-day/kg).

- **Benefit-Cost Ratio (RBC)**

It is obtained by dividing the gross productivity in value (PBV) by the total cost of production. Its formula is written as follows:

$$\mathbf{RBC = \frac{PBv}{CT}} \qquad \mathbf{(07)}$$

3.2.2. Seemingly Unrelated Regression (SUR) Model

According to (Labiyi et al., 2019), the Seemingly Unrelated Regression Model (SUR) is a model for determining the factors influencing the economic performance of a production activity. Indeed, mathematically, the models that express the relationship between the technical performance (P) of the processor and the factors that she combines and which are likely to determine them are in the form of a function:

$$\mathbf{P_{iJ} = f(x_{ij})} \qquad \textbf{(08)}$$

With:

- The index j, representing the type of performance, can take the values 1, 2, 3 (j=1, 2, 3) when considering three performance indicators: the net margin, the benefit-cost ratio, and the average labour productivity.
- The index i represents the processor

We will therefore define P_{ij}as as the type j performance of processor i and x_{ij} represent the explanatory variables related to processor i and are supposed to explain the differences in levels of type j performance of the processors surveyed. Thus, the factors affecting the profitability indicator j are determined from the coefficients of x_{ij} considering their signs. Then, assuming that the nature of the Shea almonds used, the type of equipment used, and the type of labor used are the factors influencing the economic profitability of Shea butter production, and also taking into account the specification, the previous equation becomes:

$$\begin{cases} P_1 = \propto_1 + (\beta_{11}Z_1 + \beta_{12}Z_2 + \beta_{13}Z_3) + (\varphi_{11}Q_1 + \varphi_{12}Q_2 + \varphi_{13}Q_3 + \cdots + \varphi_{1n}Q_n) + \mu_1 \\ P_2 = \propto_2 + (\beta_{21}Z_1 + \beta_{22}Z_2 + \beta_{23}Z_3) + (\varphi_{21}Q_1 + \varphi_{22}Q_2 + \varphi_{23}Q_3 + \cdots + \varphi_{2n}Q_n) + \mu_2 \\ P_3 = \propto_3 + (\beta_{31}Z_1 + \beta_{32}Z_2 + \beta_{33}Z_3) + (\varphi_{31}Q_1 + \varphi_{32}Q_2 + \varphi_{33}Q_3 + \cdots + \varphi_{3n}Q_n) + \mu_3 \end{cases} \quad \textbf{(09)}$$

With:

- P_1, P_2, P_3, the different profitability indicators (MN, RBC, PML);
- Z_I the Shea butter production systems used by the processors i;
- Q_j refers to the socioeconomic characteristics of processor j ;
- α_i represents the constant limits; $\beta_{j\ and}$ φ_i are respective regression coefficients of Z_i and Q_j ; μ_1, μ_2, μ_3 are error limits.

The explanatory variables that could influence this performance and be introduced into the model are summarized in the table 1.

Table 1. Summary of explanatory variables introduced into the regression model

Codes	Variables	Types of variables	Terms and conditions	Expected signs of the coefficients
AGE	Age	Continued	-	+/-
EXPTBK	Experience in the production of Shea butter	Continued	-	+
EDUC	Formal education	Discontinued	0= No; 1= Yes	+
ACCRED	Access to agricultural credits for processing	Discontinued	0= No; 1= Yes	+
DISTANPAK	Distance between the processor's residence and the Shea parks	Continued	-	-
DISTANCRMM	Distance between the transformer's residence and the modern machine used	Continued	-	-
USESMTBK	The practice of a modern processing system (use of the crusher + mill complex, churn, and roaster	Discontinued	0= No; 1= Yes	+
USESsMTBK	The practice of a semi-modern processing system (single use of crusher and mill)	Discontinued	0= No; 1= Yes	+/-
USESTBBK	Practice of a traditional system (no use of modern equipment)	Discontinued	0= No; 1= Yes	-
NOIXDnDEP	NUTS not pulped before boiling	Discontinued	0= No; 1= Yes	-
NOIXDpDEP	NUTS partially pulped before boiling	Discontinued	0= No; 1= Yes	+/-
NOIXDdEP	NUTS completely pulped	Discontinued	0= No; 1= Yes	+
USEmFO	Simultaneous use of family and casual labor	Discontinued	0= No; 1= Yes	+/-
USEmOU	Use of casual labor only	Discontinued	0= No; 1= Yes	+/-

Source: developed by us after analyzing the 2023 survey data

4. RESULTS AND DISCUSSIONS

4.1. Statistical description of variables introduced into the model

- **Quantitative variables**

Table 2 presents the averages and standard deviation of the quantitative variables of the respondents. This table reveals that the average age of shea processors is approximately 41.35 years, with a dispersion of ±9.89. From the same table, we note that the number of years of experience of the processors is 15.59 years on average, with a dispersion of ±9.76. In addition, these women travel a distance of 7.20 (±14.56) km to access the shea parks from where they obtain their supplies in collecting nuts and 2.29 (±2.42) km to access the modern machine during the crushing, grinding, churning activity, etc.

Table 2. Summary of Quantitative Variables

VARIABLES	AVERAGE (STD. DEV)
AGE OF THE RESPONDENT	41.35 (±9.89)
NUMBER OF YEARS OF EXPERIENCE IN SHEA BUTTER PRODUCTION	15.59 (±9.76)
DISTANCE BETWEEN THE PROCESSOR'S RESIDENCE AND THE SHEA PARKS	7.20 (±14.56)
DISTANCE BETWEEN RESIDENCE AND MODERN MACHINE USED	2.29 (±2.42)

Source**:** developed by us after analyzing the 2023 survey data

❖ **Qualitative variables**

Table 3 shows the distribution of women surveyed according to the qualitative variables related to them. Indeed, a careful analysis of the table shows that almost all respondents (i.e. more than 90%) were illiterate and had not received any formal education. About 7% of the respondents had a primary education level, and 3% had a secondary one. However, very few of them, i.e. 1%, could read on the one hand and could read and write on the other hand (2%). However, 18.75% of these women partially pulp the nuts after collection with pulps on the shells during boiling compared to 87.5% of those who completely pulp them before boiling. It should also be mentioned that a processor does not leave her nuts without pulping before boiling. We also find that agricultural credit is less granted to women in the study area. So, only 33% of the processors in our sample have access to agricultural credit, which they use to process shea into butter.

Table 3. Summary of qualitative variables

Variables	Terms and conditions	Average (std. Dev)
NOIXDpDEP	Yes=1/No=0	18.75 (±8.99)
NOIXDnDEP	Yes=1/No=0	00
NOIXDdEP	Yes=1/No=0	87.5 (±7.82)
USEmFO	Or i=1/Not=0	14.75 (±9.47)
USEmOU	Yes=1/No=0	86.25 (±17.41)
Access to agricultural credit for processing	Yes=1/No=0	0.33 (±0.47)
Formal education	No schooling (Yes=1/No=0)	0.9 (±0.30)
	Primary school (Yes=1/No=0)	0.07 (±0.25)
	Secondary school (Yes=1/No=0)	0.03 (±0.17)

Source: developed by us after analyzing the 2023 survey data

4.2. Economic profitability of shea butter production following three processing systems exploited: SMTBBK, SSMTBK, and STMTBK

Here, we have to analyze and compare the economic profitability of each shea butter production system. For this purpose, profitability indicators such as Net Margin, Average Labor Productivity (PML), Benefit Cost Ratio (RBC), and Break-Even Point (SR).

Table 4 provides information on the yield and production costs for the three categories of Shea-butter processors. Indeed, a thorough analysis of this table shows us that with traditional processes, the average yield for processing one kilogram into butter is 51% (i.e. 510g of butter) produced through a total variable and fixed average investment of FCFA 713.53 against 54% (i.e. 540g of butter) for an average investment of 820.09 FCFA in the semi-mechanized model and 68% (i.e. 680g of butter) for an average investment of FCFA 920.05 in the mechanized model. Therefore, the lower efficiency of traditional processes lowers their yield. Also, despite the production cost at the semi-mechanized and mechanized processes level, they are offset by a higher yield. We can also note a compromise provided by the semi-mechanized process between the artisanal and the mechanized one caused by the equipment cost, which is more expensive than at the level of the artisanal methods but less expensive than the fully mechanized one.

Table 4. Yield and production cost of shea butter production

Indicators	Modern System (SMTBK) (N=08)		Semi-Modern System (SSMTBK) (N=48)		Traditional System (STTBK) (N=144)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Yield (Kg of butter/Kg of nuts)	0.68	0.21	0.54	1.24	0.51	0.32
Total variable cost (FCFA/Kg)	498.51	321.54	509.84	423.56	554.58	421.41
Total fixed cost (FCFA/Kg)	421.54	315.23	310.25	254.71	158.95	123.38
Total cost (FCFA/Kg)	920.05	636.77	820.09	678,27	713.53	544.79

Source: developed by us after analyzing the 2023 survey data

Table 5 provides the results of the analyses carried out on the performance indicators of the economic profitability of Shea butter production. This table shows the average and standard deviation of the indicators of this performance, such as the net margin, the average labor productivity, and the profit/cost ratio. Then, the analysis of these different indicators reveals that the net margin of Shea butter production per unit of measurement (kg) of almond or Shea nut of the processors having applied the traditional system is on average CFA 499.77 /Kg lower than that of the processors having used the semi-modern system which is on average FCFA 1965.25/Kg which is also lower than that of the processors having used the modern/mechanized system (FCFA 2749.25/Kg). Thus, we notice that the net margin for the three categories of processors is higher than zero; this means that processing shea nuts or almonds into butter is cost-effective from a profit point of view. However, it should be noted that there is a higher profit with the mechanization of the processing systems.

In addition, the Average Labor Productivity showed a trend equal to the values of the net margin. It is FCFA 2749.25 / man-day, FCFA 1965.25 /person-day, and FCFA 499.77/person-day, respectively, for the processing having followed mechanization, semi-mechanized systems, and the one following traditional systems. It follows that shea butter production is very economically profitable from the point of view of labor remuneration in the shea butter

production areas, which is only for women who have used modern and semi-modern systems. This profitability observed at the level of these two categories of processors can be justified because the average productivity of family labor is higher than the price p of a person-day of salaried labor paid in the 2KP, FCFA 750 on average. Again, we note a higher difference between women who have adopted the modern system and those who have not. However, the average value of the average productivity of family labor obtained at the level of women who used the traditional system shows that this activity is not profitable because it is largely lower than the price p of a person-day paid in the production zones.

Table 5. Performance indicators of Shea-butter processors

Indicators	Modern System (SMTBK) (N=08)		Semi-Modern System (SSMTBK) (N=48)		Traditional System (STTBK) (N=144)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Gross margin (FCFA/Kg)	3059.50	2354.41	2386.25	2541.37	658.72	254.45
Net margin (FCFA/Kg)	2749.25	1287.48	1965.25	3254.12	499.77	178.68
Average labor productivity (FCFA/Man-day)	2749.25	1287.52	1965.25	3254.02	499.77	178.40
Benefit/Cost Ratio	4,701		2,596		0.927	

Source: developed by us after analyzing the 2023 survey data

Furthermore, the benefit-cost ratio reflects the capacity of an investment to generate additional income for an activity. Thus, the results of our investigations show that the benefit/cost ratios of the three categories of women processors are respectively 4.701 (Modern System), 2.596 (Semi-modern System), and 0.927 (Traditional System). These results, therefore, reflect that the investment of one Franc made by the processors who practiced the modern system brings them FCFA 4.701 and FCFA 2.596 for those who practiced the semi-modern system. In contrast, the same investment made by these women who adopted the traditional system only brings them FCFA 0.927.

4.3. Determinants of the economic profitability of shea-butter processing

The results of estimating the simultaneous seemingly linear regression model (SUR) are in the table below. Indeed, several factors related to the production techniques of Shea butter and those related to the producers themselves were introduced into this model to see how the different indicators (MN, PML, RBC) fluctuate. These results show that the estimated model is highly significant at the statistical threshold of 1% for p = 0.000 despite the low value of the R-squares for all economic performance indicators representing explained variables.

Table 6. Results of the regression model

Variables		Net margin (MN)		Average labor productivity (PML)		Benefit Cost Ratio (RBC)	
		Coefficient (Standard deviation)	**p**	**Coefficient (Standard deviation)**	**p**	**Coefficient (Standard deviation)**	**p**
Constant		30813.6 (76155,17)***	0.000	28527.01 (12310.92)***	0.000	2541.56 (427.54)***	0.003
Characteristics of the Processor	Age	-	-	-5243,851 (632,478)*	0.078	-	-
	Experience in Shea butter production	411235.32 (63542, 78)**	0.012	-	-	613135.02 (512, 8)**	0.0023
	Formal education	85424.12 (23541.01)**	0.040	95404.12 (13521,01)	0.282	-	-
	Access to agricultural credit for processing	12453.23 (6521.57)**	0.035	22433.03 (9501.51)	0.812	-24530.03 (521.67)	0.156
Distances traveled	Distance between the processor's residence and the modern machine used	-89562.36 (52387.7)***	0.001	-	-	-79552.16 (62287,1)**	0.039
	Distance between the processor's residence and the Shea parks	874.7 (6521.89)	2,458	1745.9 (2591.29)	7,854	-	-
Use of labour	Use of family labor only	65878.02 (321.45)**	0.0423	-15078.08 (23521,05)***	0.009	-	-
	Simultaneous use of family and casual labor	-56214.25 (4524,256)***	0.000	-3620.61 (25201.47)	0.812	-	-
	Use of casual labor only	-	-	12264.01 (2788.5)	0.785	-62274.48 (14798.52)*	0.874
Processing method used (Production system)	The practice of a modern processing system (use of the crusher + mill complex, churn, and roaster	6514.89 (521.80)**	0.051	-46414.79 (3521.12)*	0.0723	146514.89 (13521,245)	2,124
	The practice of a semi-modern processing system (single use of crusher and mill)	5418.71 (451.23)*	0.0612	-95418.01 (8401,323)**	0.023	695419.77 (401,323)	
	Practice of a traditional system (no use of modern equipment)	-	-	-	-	-86021.19 (21354.53)***	0.009
Quality of nuts	NUTS not pulped before boiling	589.78 (123.54)***	0.000	8589.70 (45123.24)	0.587	-	-
	NUTS partially pulped before boiling	-4512.96 (5621.85)*	0.090	-	-	854512.06 (20821.65)	0.874
	NUTS completely pulped	-5254.03 (21256.04)*	0.0801	-	-	-	-
Model Summary	-	R1: 0.19 P: 0.001 obs: 200		R2: 0, 33 P: 0.006 obs: 200		R1: 0.22 P: 0.001 obs: 200	

Source: developed by us after analyzing the 2023 survey data

Let us note that the estimated model indicates that the observed variations in the variables explain, respectively, at 19%, 33%, and 22%, the variations in the net margin, average labor productivity, and the profit-cost ratio. So, let us describe how the variables explain the dependent variables.

4.3.1. Net Margin (MN)

The analysis of the independent regression results reveals that the experience in shea butter production, formal education, and access to agricultural credit for processing positively and significantly influence the net margin at the 5% threshold. These results are normal and perfectly meet our expectations. Indeed, the experience of the processor in the processing of Shea nuts into butter and her level of formal education, as factors increasing knowledge in an individual, are likely to help the processor not only to be able to think but also to learn from her past mistakes for an optimal combination of production factors that can maximize yield and profit. Also, the higher the processor's knowledge level, the more her capacity to adopt new processing technologies or effectively manage their shea butter production business increases. In addition, the positive sign of the coefficient of the variable "access to agricultural credit" reflects that processors with access to financing (loans or credits) have seen their increased capacity to invest in improved equipment or increase production.

It should also be noted that the distance between the processors' residence and the modern machine they use has a negative and significant influence at 1% on the net margin of butter production. This result stipulates that the shorter the distance for the processor who intends to adopt the equipment for Shea butter production, the higher her economic performance from the profit point of view since the long distance may generate other transaction costs to be borne by the processors.

Also, the quality of the nuts influences both positively and negatively the profit performance of women Shea butter processors. Thus, when the nuts are pulped and well-arranged before boiling, this positively affects the butter quality at the 1% threshold and increases the processors' income. However, when the nuts are not pulped before boiling, the quality of the butter and its market price for processors are reduced.

Regarding the production systems adopted by the processors in the study areas, we understand through our analysis results that these systems influence the economic performance indicators of women processors in various ways. Thus, the modern processing system combining the crusher + mill complex, churn, and roaster has a positive and significant impact of 5% on the processors' profit at the statistical threshold. On the other hand, the practice of the semi-modern processing system, which combines the unique use of the crusher and mill in the transformation process, has a positive but significant influence at the threshold of 10%. The positive influence of production systems on these results is correct. It can be justified by the primary role of mechanization, "agricultural technologies," improving production by helping processors produce more output quickly and efficiently.

Finally, labor is a key determinant of economic performance in terms of profit for shea nut-butter processors. Thus, our results revealed that the simultaneous use of family and casual labor significantly and positively impacts the net margin at the 1% threshold. Combined family and casual laborers will allow processors to maximize profit margins and meet increased demand without hiring long-term workers. This maintains cost flexibility and gives them a

greater diversity of skills and experiences. Otherwise, this combination will optimize costs, improve productivity, and strengthen economic resilience within the local population.

4.3.2. Average Labor Productivity (PML)

For this indicator, the analysis of the independent regression revealed that only the age among the socioeconomic characteristics of the processor negatively influenced the PML at a 10% level. This result is all the more logical as physical strength decreases with age, which is likely to slow the pace of work, especially in demanding manual tasks, such as churning or transporting materials. This can directly affect the amount of Shea processed per day. Otherwise, age is likely to influence the productivity of Shea processors through a balance between experience and physical strength. Older processors will compensate for decreased physical strength with increased efficiency and in-depth knowledge of the processes. In comparison, younger processors benefit from greater physical endurance but may lack the experience necessary to maximize their productivity. The combination of these factors determines the average productivity of each age group.

In addition, the sole use of family labor has positively impacted the PML at the 1% threshold. Due to its direct interest in the business's success, family labor is often more involved in maintaining the quality of the finished product, which will increase the processors' profit. Finally, the practice of the modern processing system (use of the crusher + mill complex, churn, and roaster) and semi-modern system (single use of the crusher and mill) hurt the PML at the threshold of 10% and 5%, respectively. This result means that using machines in Shea nuts processing reduces the labor force, increasing its marginal productivity and the processor's income.

4.3.3. Benefit-Cost Ratio (RBC)

Our independent regression analysis showed that several socio-economic and technical factors influence RBC. These include the experience of the processor in shea butter production with a positive coefficient at 5% threshold, the distance between the processor's residence and the modern machine used followed by a negative coefficient at 5% threshold, and the practice of the traditional system (no use of modern equipment) also with a negative coefficient at 1% threshold. Indeed, the result states that the experience of Shea processors positively impacts the benefit-cost ratio. It is normal because it will optimize production costs, improve product quality, increase productivity, and better manage the activity's financial aspects. Thus, an experienced processor can maximize profits while minimizing costs, leading to a more favorable benefit-cost ratio and, consequently, a stronger economic performance.

Furthermore, the traditional production system influences the benefit-cost ratio in a complex way. Although it enables reducing some fixed costs and adding value to a product of artisanal quality, it is often associated with low productivity and high variable costs due to the time and intensive labor required. As a result, although the traditional system may be economically viable in some local contexts, its overall impact on the benefit-cost ratio is generally negative compared to more modern systems that allow productivity gains and better economic efficiency.

5. CONCLUSION AND RECOMMENDATIONS

This test has first enabled the evaluation of the economic performance of Shea nut-butter processors in the 2KP based on the behavior of performance indicators such as Net Margin or profit, Average Labour Productivity, and the benefit-cost ratio, and secondly, the identification of the socioeconomic and technical characteristics that will influence this performance.

It should be noted that the economic profitability of Shea butter production varies considerably depending on the production system used, whether traditional, semi-mechanized, or fully mechanized. It (profitability) is positive from the point of view of net margin for all the production systems adopted. On the other hand, average labour productivity and the benefit-cost ratio show profitability only in semi-mechanized and mechanized systems, which provides these systems with a profitable character. Also, we have concluded that the economic performance of Shea butter production is strongly influenced by the production system chosen, the experience of the processors, labor costs, the quality of the final product, and access to markets. Semi-mechanized and mechanized systems offer better profitability thanks to increased productivity, although this requires larger initial investments.

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