

Profitability Analysis of Various Maize Value-Added Products in the North-West Region of Cameroon

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Abstract

Maize value-added products play a crucial role in reducing post-harvest losses, enhancing food security, and generating income. While extensive research has focused on maize production in Cameroon, the exploration of its value-added products and their profitability in the North-West Region remains underexplored. This study examined the profitability of maize value-added products in Mezam Division, with the objectives to: 1) identify various maize-based products, 2) assess the diversity of these products, 3) conduct a cost-benefit analysis of selected products, 4) examine the relationship between profitability and product diversity, and 5) identify key constraints impacting profitability. To achieve these objectives, structured questionnaires were administered to 500 small-scale maize entrepreneurs randomly selected from five subdivisions. Descriptive statistics were used to analyze objective 1 and 5, while the Shannon Diversity Index was employed to assess product diversity. Additionally, a cost-benefit analysis was conducted on four selected products namely pap, parched corn, peeled parboiled corn, and corn beer, and a correlation analysis was used to examine objective 4. In total, 13 maize value-added products were identified, with a diversity index of 4.4. The total cost of processing the four selected products per entrepreneur using 18 kg of maize per product was FCFA 83631.5 (US \$132.75), while the total revenue was FCFA 121864.5 (US \$193.43), resulting in an economic profit of FCFA 38,233 (US \$60.69). Pap emerged as the most profitable product, with an economic profit of FCFA 27,875 (US \$44.24), while corn beer was the least profitable, with an economic profit of FCFA 2133.46 (US \$3.39). The correlation analysis revealed a strong negative relationship between product diversity and profitability ($r = -0.91$), indicating that entrepreneurs can maximize profitability by focusing on a few high-

demand products like pap and parched corn. Key constraints to profitability included fluctuating market prices, high production costs, limited access to finance, and inadequate storage facilities. Despite these challenges, our findings indicate that maize value addition is profitable in Mezam Division. Entrepreneurs can leverage this data for informed decision-making and future investments. It is recommended that the government promote maize value addition and provide financial support for modern processing equipment to boost profitability and income generation.

Keywords

Maize, Maize Value-Added Products, Cost-Benefit Analysis, Economic Profits

1. Introduction

Agro-processing has emerged as a vital strategy for tackling postharvest losses (PHL) through effective value addition by transforming raw agricultural products into processed goods. This innovative approach includes a variety of activities that extend the shelf life of perishable items, reducing waste and generating a diverse array of marketable products [1]. Thus, investing in value-added agricultural processing presents a transformative opportunity that can significantly enhance the livelihood of smallholder farmers, empowering them to access new markets and achieve greater economic stability. The 2002 United States Farm Bill describes value addition as the innovative transformation of agricultural commodities through various production techniques. This process not only broadens the consumer base but also boosts revenues, allowing producers to engage in the processing of their products [2] [3]. Maize, often referred to as corn, exemplifies a value-added cereal crop, capable of being transformed from its harvested state into plenty of economically valuable by-products that society relies on for consumption and utility [4]. The importance of maize value-added products cannot be overstated as they play a pivotal role in reducing post-harvest losses, enhancing food security, and generating income for farmers [5]-[7]. Known as the “Queen of Cereals,” maize is celebrated for its versatility and high production potential amongst cereals with a wide array of applications in variety of products [8]. The processing and consumption of maize are diverse, varying significantly across countries, yet maize flour and meal remain among the most popular products. The remarkable versatility of maize allows for the creation of over 3500 value-added products used daily, showcasing its integral role in our diets [7]. Remarkably, from just one ton of maize, one can produce 29 kg of maize oil, 241 kg of 21% protein feed, 46 kg of 60% gluten meal, and substantial quantities of starch, sweeteners, or ethanol [9]. This potential for transformation not only underscores the economic viability of maize but also heralds a new era in agricultural sustainability and food security.

As the demand for value-added foods and industrial applications increases,

maize continues to be a pivotal cereal crop [10]. In developed nations, maize serves diverse purposes, including livestock feed and biofuel production, while in many other countries, it is primarily used for human consumption [11]. The utilization and processing of maize vary worldwide. For instance, in the US, maize is a key ingredient in glucose-fructose syrup production, whereas Brazil focuses on animal feed. The European Union heavily relies on maize for animal feed and biofuels, with expectations of increasing bioethanol usage. In China, maize is primarily used for animal feed and industrial purposes, while Mexico has experienced significant growth in industrial maize processing. Japan predominantly imports maize for feed production, starch, ethyl alcohol, and distilled beverages [12]-[16]. During processing, maize undergoes either wet or dry milling, depending on the desired end products. Wet milling produces glucose-fructose syrups, starch, oils, alcohols, and ethanol, while dry milling yields cereal flakes, maize flour, grits, meal, and brewer's grits for beer. Both milling methods generate valuable by-products, with distiller's dried grains and soluble (DDGs) being widely used as livestock feed [9].

Maize is a crucial dietary staple in Africa, Asia, and Latin America, consumed in various forms such as porridges, breads, and tortillas. In Africa, it is a key starchy food, accounting for 22 to 25 percent of staple consumption and serving as the largest single source of calories, closely followed by cassava. However, the significance of maize varies by region; for instance, Southern Africa has the highest consumption at 85 kg per capita annually, compared to 27 kg in East Africa and 25 kg in West and Central Africa [13].

The versatility of maize extends beyond basic consumption, [7] highlighted a range of value-added products derived from maize, including corn oil—valued for its high smoke point and used in cooking and industrial applications like soap and paint. Corn syrup, primarily glucose-based, and snacks like corn flakes and corn pops also showcase maize's diverse applications. [5] identified 17 common maize value addition techniques in Nigeria, with popular methods including pap making, solid gel (eko) production, and local roasting. [17] studied the entrepreneurial skills of rural women in Abeokuta, Ogun State, revealing that primary value-added products included popcorn (85.7%), corn cake (80.0%), and “kokoro” (52.9%).

Despite being recognized as a strategic commodity for enhancing food security and reducing poverty in Africa, many countries have not fully capitalized on the opportunities for adding value to maize products. This underutilization limits efforts to leverage maize as a significant driver of economic growth and improved livelihoods across the continent [18]. The analysis of critical factors such as costs, pricing, market research, profit margins, return on investment, and operational efficiency is therefore essential for evaluating the profitability of agricultural value-added products which can spur many to take advantage of this activity. For instance, [19] employed the Value Addition model to analyze maize value addition among entrepreneurs in Taraba State, Nigeria, while [20], used descriptive statistics and regression analysis to affirm the profitability of maize farming in Ondo State. These studies consistently concluded that maize value addition is a viable and profitable enterprise, encouraging more entrepreneurs to engage in this sector. [21] found

similar profitability in Tanzania, reporting a gross margin of 1182650.79 TZS per hectare for smallholder farmers. In contrast, [22] showed low profitability in Zimbabwe, with only one season achieving a Benefit-Cost Ratio (BCR) above 1 due to high input costs. Additionally, [23] assessed the profitability of value-added cashew products in Southeast Nigeria, finding positive returns. [24] also confirmed the profitability of cashew processing in Benue State. Overall, these studies highlight the potential for profit in agricultural value addition.

In Cameroon, maize holds particular significance, especially as it is predominantly cultivated by small-scale subsistence farmers, who represent over 35% of the rural population [25] [26]. The cultivation of maize spans various regions, with the West and North-West regions serving as primary production hubs, closely followed by the Adamawa and North regions [27]. Among these, the North-West Region (NWR) is a major contributor, producing approximately 69% of the country's maize yield [28]. Furthermore, maize plays a vital role in the local beverage industry in Cameroon, with traditional maize-based drinks such as "sha," "kwasha," and "nkang" being widely consumed [29]. It is equally enjoyed in several forms, including boiled whole grains, porridge, couscous, and a traditional cake known as komba [30]. In Bafia, maize is transformed into various products, including maize beer, flat maize cakes with vegetables or groundnuts, maize porridge, maize fufu, maize milk, roasted maize, and boiled maize, among others [31].

Despite extensive research on maize production in Cameroon [32]-[34] there has been limited assessment of the profitability of maize value-added products in the North-West Region of Cameroon. Existing research has focused on overall maize profitability, such as the cost-benefit analysis conducted by [25], which evaluated the profitability of maize production only in the Tubah subdivision of Mezam division across two primary farming systems: mono-cropping and multi-cropping. Their findings indicated that both systems were ultimately deemed unprofitable due to challenges like inadequate credit, limited access to improved seeds, insufficient fertilizer use, and high labor costs.

This gap in research limits our understanding of how small-scale maize entrepreneurs in the Mezam Division of the North-West Region of Cameroon are leveraging value-added opportunities for income generation. Also, many potential investors remain unaware of the economic benefits of diversifying maize products, which further hinders investment in this area. To address this gap, this paper aims to analyze the profitability of maize value-added products processed in Mezam. The specific objectives include: 1) identifying various maize-value added products, 2) assessing the diversity of these products, 3) conducting a cost-benefit analysis of selected products, 4) examining the relationship between profitability and product diversity, and 5) to identifying key constraints impacting profitability. The findings from this research will provide valuable insights for small-scale entrepreneurs, helping them enhance profit margins and create employment opportunities, thereby contributing to achieving the Sustainable Development Goals (SDGs) 1 and 2, which focus on ending poverty and hunger respectively. Additionally, this study will serve as a resource for potential investors, particularly small

and medium-sized enterprises, enabling them to make informed decisions in the maize processing sector.

2. Methodology

2.1. Study Area

The Mezam Division, located in the North-West Region of Cameroon, is one of seven administrative divisions with Bamenda as its center. It covers an area of 1745 km² and it lies between latitudes 5°20' N and 6°15' N and longitudes 9°7' E and 10°21' E [35]. According to the 2005 census, Mezam had a population of approximately 524,127, resulting in a density of 300.6 inhabitants per km² [36]. The division consists of seven subdivisions: Bafut, Bali, Bamenda 1, Bamenda 2, Bamenda 3, Santa, and Tubah. The region has a cool, temperate climate influenced by mountainous terrain, with average annual rainfall of about 2400 mm and temperatures averaging 23°C [37]. It experiences a wet season from March to October and a dry season from November to February. The area's climatic conditions and three main soil types volcanic, hydromorphic, and ferralitic are conducive to agriculture. Over 80% of the rural population relies on agriculture, which includes a significant livestock sector [38]. Key crops grown in Mezam include maize, rice, potatoes, beans, plantains, cocoyams, cassava, and yams. Maize is a key food crop and it is grown by nearly every household in the region [33].

2.2. Sampling and Sample Size Selection

The sample size was estimated because the populations of small-scale maize entrepreneurs involved in maize value addition in the study area was unknown. This was done using the formula:

$$n = (z^2 (p) (1 - p)) \div c^2 [39],$$

where: n = required sample size, z = standard normal deviation set at 95% confidence level;

p = percentage picking a choice or response rate and c = margin of error [39]. Therefore, the sample size required to conduct our study was, $1.96^2 * 0.5 (1 - 0.5) \div 0.05^2 = 385$. To enhance reliability, minimize potential biases, and ensure a more representative sample, 115 additional respondents were included, bringing the total sample size to $n = 500$. This adjustment aimed to strengthen the robustness and validity of the study's findings.

Three sampling techniques were applied to select the 500 respondents. Firstly, purposive sampling was used to select Mezam Division from 58 divisions in Cameroon due to its high level of maize production [40]. Secondly, stratified random sampling was used to select 5 subdivisions (Bamenda 1, Bamenda 2, Bamenda 3, Tubah, and Santa) from seven subdivisions of Mezam Division and two villages from the five selected subdivisions. Lastly, the snowball sampling technique was used to select 500 small maize entrepreneurs for the administration of a structured questionnaire since no specific register existed for maize entrepreneurs that were involved in the processing and commercialization of maize value-added products

(Figure 1).

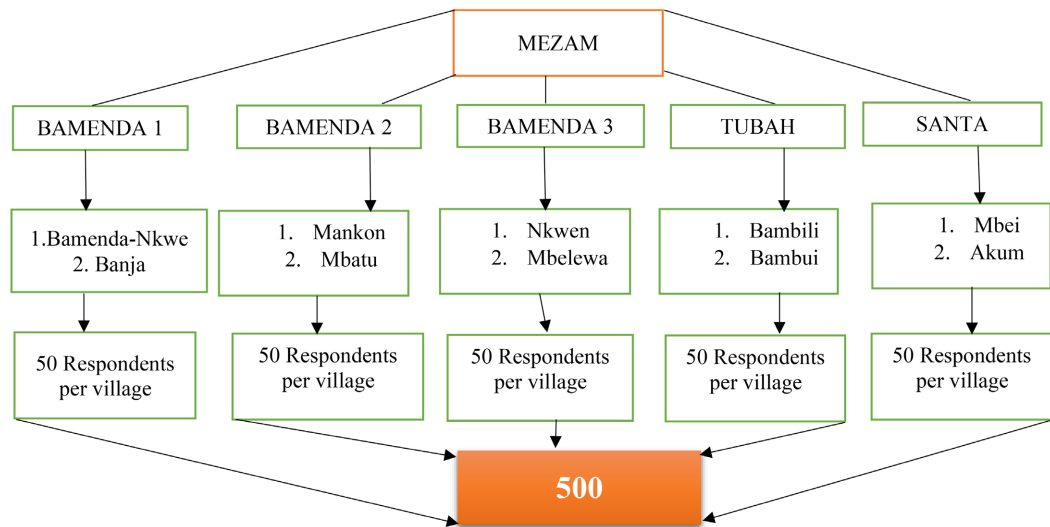


Figure 1. Schematic representation of the sampling procedure used in the selection of farmers for questionnaire administration.

2.3. Data Collection

Questionnaires were administered to 500 entrepreneurs between November 2023 and February 2024. The participants were asked whether they were involved in maize processing and to provide information on the various maize products they produce, along with the associated costs and revenues.

2.4. Data Analysis

The questionnaires were coded and the data was input into Microsoft Excel 2019 before being transferred to R Studio version 3.5.1 for inferential statistics. Descriptive statistics were applied to identify various maize value-added products and the constraints impacting their profitability. Additionally, the Shannon-Weaver Diversity Index (H) was employed to assess product diversity using the formula: $H = -\sum[(p_i) \times \log(p_i)]$ [41] where H = Shannon-Weaver Diversity Index, $p_i = ni/N$, ni = number of maize value-added products per respondents i , and N = total number of individuals. Thus, index is said to be good if it is ≥ 3.5 [42]. The cost-benefit analysis focused on the top four-ranking maize value-added products, as respondents were well-acquainted with these consistently produced, high-demand items and could provide accurate cost and benefit estimates. Additionally, these products also accounted for over 50% of the identified maize products in the study area. The costs for processing 18 kg of corn (used as a baseline) and the quantities of four local products—pap, parched corn, corn beer, and peeled parboiled corn (corn with husk and outer layers removed, partially boiled, and dried for easier cooking with beans)—were analyzed following [43] and [44]. The economic profits and Benefit-Cost Ratio were calculated following [45]. A Pearson correlation coefficient was then used to investigate the relationship between product diversity and profitability.

The Gross Margin (GM) was calculated based on the formula provided by [43]: $GM = TR - TVC$, where TR represents, total revenue (value added output multiplied by price) and TVC represents total variable cost (including labor, processing/marketing, raw materials, and transportation). In addition to the Gross Margin, the Net Profit (NP) was determined using the formula from [44]: $NP = TR - TFC$, where TFC denotes total fixed costs, including rent and equipment. Finally, the Economic Profit (EP) was calculated using the formula $EP = TR - TC$, where TC represents the total cost, which is the sum of TVC, TFC, and Opportunity Cost (OP), with OP referring to the costs of foregone alternatives related to family labor and equipment. To quantify opportunity costs for family labor and equipment use, a monetary value was assigned based on prevailing market rates for similar services or equipment rentals in the division. For family labor, this involved estimating the cost of hiring external labor for the same tasks or considering the wages that family members could earn elsewhere if not engaged in the business. Regarding equipment use, the opportunity cost was calculated by determining the cost of renting or leasing equipment from a third party.

The Gross Profit Margin (GPM) was calculated using the formula $GPM = (\text{Gross Profit} \div \text{Sales}(TR)) \times 100$, as described by [46], while the Net Profit Margin (NPM) was determined using $NPM = (\text{Net Profit} \div \text{Sales}) \times 100$, based on [47]. The Economic Profit Margin (EPM) was similarly calculated using the formula $EPM = (\text{Economic Profit} \div \text{Sales}) \times 100$. Additionally, the Rate of Return on Investment (ROR) was determined using $ROR = ((TR - TC) \div TC) \times 100$, and the Benefit-Cost Ratio (BCR) was calculated using $BCR = TR \div TC$, following the methods outlined by [45] and [48].

2.5. Limitation of the Study

This study was conducted during the dry season, although maize is grown year-round in both the rainy and dry seasons in the Mezam Division. The decision to focus on the dry season was mainly driven by the production of high-value products such as dry pap, parched corn, and peeled boiled corn. These products benefit from the sun's drying capabilities, which are often hindered by rainfall during the wet season. In contrast, during the rainy season, some entrepreneurs prioritize selling fresh maize immediately after harvest, while others store it until it dries, preparing it for processing in the dry season. However, future research should explore the rainy season as well, enabling a comparison of profitability and an assessment of any significant seasonal differences, which could lead to more informed recommendations.

3. Results

3.1. Diversity of Maize Value-Added Products in Mezam, Cameroon

Out of the 500 total respondents, 446 respondents (89.2%) agreed that they were involved in maize value addition, while 10.8% indicated no involvement. A total of 13 distinct maize value-added products were identified from the 446 small

maize entrepreneurs (**Table 1**). Pap was the most abundant (18.8%) followed by corn beer (17%), parched corn (16%), and peeled parboiled corn (10.5%). These four products represented 62.3% of the total value-added products recorded while the remaining nine products represented 37.7% (**Table 1**).

Table 1. Diversity of maize value-added products in Mezam, Cameroon.

Product	Number	Percentage (%)	Ranks
Pap	84	18.8	1
Corn beer	76	17	2
Parched corn	71	16	3
Peeled parboiled corn	47	10.5	4
Boiled corn	39	8.8	5
Accra	35	7.9	6
Roast corn	34	7.6	7
Corn flour	22	4.9	8
Corn fufu	19	4.3	9
Pop corn	10	2.2	10
Feed	6	1.4	11
Starch	2	0.4	12
Corn pudding	1	0.2	13
Total	446	100	

3.2. Diversity Index of Different Value-Added Products in the Different Subdivisions

The Shannon-Weaver Diversity Index (H) of 4.4 was calculated for Mezam Division, with diversity index for the various subdivisions ranging from 4.1 to 4.5 (**Table 2**).

Table 2. Mezam subdivisions and their diversity index of maize value-added products.

Subdivision	Diversity index of maize value-added products
Bamenda 1	4.5
Bamenda 2	4.5
Bamenda 3	4.5
Tubah	4.4
Santa	4.1
Average	4.4

3.3. Profitability of Maize Value-Added Products

The total cost of processing 4 different maize products, each made from 18 kg of maize was FCFA 83631.5 (US \$132.75). Amongst the cost incurred, variable cost accounted for over 90%; FCFA 78137.82 (US \$124.02) of total cost while fixed cost represented less than 4%; FCFA 3117.58 (US \$5) and opportunity cost less than

3%; FCFA 2376.21 (US \$3.77) of total cost (**Table 3**). The total revenue generated from the sales of the four different maize products was FCFA 121864.5 (US \$193.43), giving an economic profit of FCFA 38,233 (US \$60.69). Pap emerged as the most profitable product amongst these 4 maize products processed with a benefit cost ratio of 1.6 while corn beer was the least profitable with benefit cost ratio of 1.2 (**Table 4**). The total cost of pap (cooked, dried and wet) production was FCFA 46557.2 (US \$73.91) and the total revenue generated from the sales of pap was FCFA 74432.2 (US \$118.15) resulting in an economic profit of FCFA 27,875 (US \$44.24).

Table 3. Cost items for maize value addition (pap, parched corn, peeled parboiled corn and corn beer) in FCFA (US dollars).

Cost item	Peeled parboiled corn	Parched corn	Corn beer	Pap		
				Cooked Pap	Dry Pap	Wet Pap
Fixed cost						
Rent	157.7 (0.25)	200 (0.32)	100 (0.16)	300 (0.47)	200 (0.32)	200 (0.32)
Maintenance cost equipment	200 (0.32)	459.3 (0.73)	95.4 (0.15)	478.77 (0.76)	372.6 (0.59)	353.81 (0.56)
Total fixed cost	357.7 (0.57)	659.3 (1.05)	195.4 (0.31)	778.77 (1.24)	572.6 (0.9)	553.81 (0.87)
Variable cost						
Raw materials	4953.50 (7.86)	5108.50 (8.11)	4822.40 (7.65)	4666.70 (7.41)	4941.20 (7.8)	4836.10 (7.67)
Processing	1936.70 (3.07)	7894.40 (12.5)	1809.50 (2.87)	8485.00 (13.47)	7628.34 (12.11)	2461.10 (3.91)
Labor	2003.42 (3.18)	2810.40 (4.46)	2002.02 (3.18)	3507.74 (5.57)	2895.70 (4.59)	2029 (3.22)
Transportation	422.3 (0.67)	775.5 (1.23)	426.5 (0.67)	641.9 (1.02)	498.6 (0.79)	581.3 (0.92)
Total variable cost	9315.92 (14.78)	16588.80 (26.33)	9060.42 (14.38)	17301.34 (27.46)	15963.84 (25.34)	9907.50 (15.73)
Opportunity cost	265.4 (0.42)	451.6 (0.72)	179.8 (0.29)	792.66 (1.26)	338.95 (0.54)	347.8 (0.55)
Total cost	9939.02 (15.77)	17699.70 (28.09)	9435.62 (14.98)	18872.77 (29.96)	16875.39 (26.79)	10,809 (17.16)
%TVC	93.7%	93.7%	96%	91.7%	94.6%	91.7%
%TFC	3.6%	3.7%	2.1%	4.1%	3.4%	5.1%
%OPC	2.7%	2.6%	1.9%	4.2%	2%	3.2%

TVC: Total Variable Cost, TFC: Total Fixed Cost, OPC: Opportunity Cost, FCFA: Franc of Central African States. (US \$1 = FCFA630).

Table 4. Cost-benefit analysis of value-added maize products in FCFA (US dollars).

Cost item	Peeled parboiled corn	Parched corn	Corn beer	Pap		
				Cooked pap	Dry pap	Wet pap
Unit price	753.98 (1.19)	1000 (1.59)	252.6 (0.4)	583.33 (0.93)	2000 (3.17)	819.7 (1.3)
Quantity sold(kg)	16.53	23.4	45.8	51.03	13.91	20.55
Total Revenue	12463.29 (19.78)	23,400 (37.14)	11569.08 (18.36)	29767.33 (47.25)	27,820 (44.16)	16844.84 (26.74)
Gross profit	3147.37 (4.99)	6811.20 (10.81)	2508.66 (3.98)	12465.99 (19.78)	11856.16 (18.92)	6937.34 (11.01)
Net profit	2789.67 (4.43)	6151.90 (9.76)	2313.26 (3.67)	11687.22 (18.55)	11283.56 (17.9)	6547.7 (10.39)
Economic Profit	2524.27 (4.01)	5700.30 (9.05)	2133.46 (3.39)	10894.56 (17.29)	10944.61 (17.37)	6036 (9.58)
GPM	0.25	0.29	0.22	0.42	0.43	0.41
NPM	0.22	0.26	0.20	0.39	0.41	0.39
EPM	0.20	0.24	0.18	0.37	0.39	0.36
B/CR	1.3	1.3	1.2	1.6	1.6	1.6
ROR	25.4	32.2	22.6	57.7	64.9	55.8

GPM: Gross Profit Margin, NPM: Net Profit Margin, EPM: Economic Profit Margin, BCR: Benefit Cost Ratio, ROR: Rate of Return.

Amongst these different varieties of pap, dry pap emerged as the most profitable with an economic profit of FCFA 10944.61 (US \$17.37). Thus, from 18 kg of maize grains, entrepreneurs incurred a total cost of FCFA 16875.39 (US \$26.79) to produce 13.91 kg of dry pap valued at FCFA 2000 (US \$3.17) per kg. The cost incurred included variable costs, which constituted 94.6% of the total cost, and fixed costs, which constituted 3.4% as well as opportunity cost which constituted 2% of the total cost. The variable costs included the cost of raw materials, water, grinding, drying, and marketing expenses, such as packaging materials, labor costs, transportation costs, and other miscellaneous items. The fixed costs included the cost of equipment maintenance and space, as well as the opportunity cost of labor and equipment. Additionally in terms of the rate of return (ROR), dry pap lead with 64.9% showing that it is the most profitable.

Following pap, parched corn emerged as the second most profitable product processed from 18 kg of maize. From this amount, an average of 23.4 kg of parched con was produced and sold at FCFA 1000 per kg (US \$1.6). The total production cost being FCFA 17699.7 (US \$28.1), with variable costs accounting for 93.7% of this total. These variable costs included expenses for raw materials, groundnuts, firewood, labor, transportation, paper, marketing, and salt. Fixed costs, which

made up 3.7%, involved equipment maintenance (such as frying pans, spoons, and basins) and rent. Opportunity costs (2.6%) included family labor and equipment use. Considering all these factors, the economic profit reached FCFA 5700.3 (US \$9.05). The benefit-cost ratio was calculated at 1.3, and in terms of the rate of return (ROR), parched corn ranked just below pap with a ROR of 32.2%.

To process “Peeled parboiled corn”, a total cost of FCFA 9939.02 (US \$15.77) was incurred, resulting in the production of 16.53 kg valued at FCFA 753.98 per kg (US \$1.19), which generated a total revenue of FCFA 12463.29 (US \$19.78). Entrepreneurs involved in this process achieved an economic profit of FCFA 2524.27 (US \$4.01). Lastly, corn beer was identified as the least profitable value-added product. Approximately 45.8 kg of corn beer was produced and sold at FCFA 252.6 (US \$0.4) per kg, yielding a total revenue of FCFA 11569.08 (US \$18.36). The total costs, which included expenses for water, grinding, labor, equipment maintenance, and transportation, amounted to FCFA 9435.62 (US \$14.97), giving an economic profit of FCFA 2133.46 (US \$3.39). The economic profit margin for corn beer was 0.18, further confirming its status as the least profitable among the four products.

3.4. Relationship between Profitability and Diversity Index

The result of the Pearson correlation showed a strong negative correlation between product diversity index and average profitability ($r = -0.91$).

3.5. Constraints in the Profitability of Maize Value-Added Products

Fluctuating market prices, high production costs, limited access to finance and credit and poor storage facilities were identified as the primary constraints impeding the profitability of maize value-added products representing 88.2% of the constraints identified. Other challenges included, insufficient machinery, frequent power failures, seasonal variations in production, and Lack of technical know-how, collectively accounting for 11.8% of the issues encountered (**Table 5**).

Table 5. Constraints in the profitability of maize value-added products.

Constraints in profitability	Frequency	percentage	Rank
Fluctuating market prices	126	28.3	1
High production cost	104	23.3	2
Limited access to finance and credit	85	19.1	3
Poor storage facility	78	17.5	4
Frequent power failures	16	3.6	6
Insufficient machinery	18	4.04	5
seasonal variations in production	10	2.24	7
Lack of technical know how	9	2.02	8
	446	100.0	

4. Discussion

4.1. Diversity of Maize Value-Added Products

The analysis of maize value-added products in the Mezam Division of Cameroon highlights four key products including pap, corn beer, parched corn, and peeled boiled corn comprising 62.3% of the 13 identified products. This dominance reflects their role as traditional staples in local cooking practices, with consistent availability and cultural significance driving consumer demand. The simplicity in their production also fosters local engagement. In contrast to just 13 local products identified, [6] noted the versatility of maize in Nigeria, with around 28 food items and medicinal uses, while [7] identified additional products like corn oil and corn syrup, further emphasizing maize's diverse applications. The difference in product diversity between the study and those in Nigeria may be attributed to cultural traditions and preferences. Nigeria's higher product diversity can be explained by its larger maize processing industry, which includes extensive milling and manufacturing operations, resulting in a greater variety of commercialized maize-based products. Additionally, Nigeria's larger, more urbanized population likely drives the demand for processed and packaged maize products, in contrast to Cameroon. Moreover, Nigeria's more advanced agricultural and food processing sector fosters innovation and the development of new maize-based products. The results of the Shannon diversity index show that there is a wide variety of maize products available in the Mezam Division, giving consumers many options to choose from. This suggests that in each market in the division, you can easily find three or more of these maize products. However, the strong negative relationship between profitability and diversity suggests that entrepreneurs should concentrate on a subset of high-demand products like pap and parched corn to boost profitability. Our results are similar to those of [31], who identified eleven value-added maize products in Cameroon, particularly in Bafia, showcasing the extensive diversity in maize value addition across the country. The similarity may be due to the use of similar maize processing techniques across various regions of the country. These methods are widely known and practiced by different ethnic groups in Cameroon, resulting in a convergence of maize-based products produced in different areas, although slight variations may occur due to local preferences. Additionally, the similarity could be attributed to the high demand for processed maize products in other parts of Cameroon, as maize is a staple food and plays a significant role in the economy.

4.2. Profitability of Maize Value-Added Products

The findings reveal that variable costs account for over 90% of the total costs associated with maize processing in Mezam, while fixed and opportunity costs represent less than 7%. This indicates that processors, particularly those transforming maize, primarily rely on traditional methods and lack modern processing equipment. As a result, they face challenges in accessing credit since they do not possess valuable assets for collateral. This finding aligns with [23], who reported that

variable costs also account for over 90% of the resources used for adding value to cashew products in the South-East zone of Nigeria. In contrast, [25] reported high production costs and low revenue in maize produced in Tubah Sub-division, leading to losses in both multi-cropping and mono-cropping systems. Also, the figures for gross profit, net profit, and economic profit indicate that value addition to maize provides substantial financial rewards, demonstrating the economic viability of the maize value addition enterprise. This finding aligns with [21], who analyzed the profitability of maize production among smallholder farmers in various localities within the Mbinga District of Tanzania, concluding that maize production is indeed profitable for these farmers. Similarly, [4] found that processing maize is not only profitable but also integral to the value-added concept. Furthermore, [19] conducted an analysis of maize value addition among entrepreneurs in Taraba State, concluding that this enterprise is profitable and encourages entrepreneurial involvement. The negative correlation between product diversity and profitability indicates that higher product diversity is associated with lower profitability in Mezam. This finding suggests that farmers could enhance their profitability by concentrating on high-demand products with higher returns.

The study found that all value-added products have benefit-cost ratios (BCR) exceeding 1, indicating positive net income for processors. This contrasts with [22], who noted that maize enterprises in Zimbabwe are not particularly profitable with overall $BCR < 1$. The rate of return (ROR) for maize products was significant, with returns for pap above 50%, supporting the FAO's observation that small-scale entrepreneurs prefer ventures with returns above 30% [49]. Furthermore, pap emerged as the most profitable product due to its high profit margins, making it a compelling investment choice followed by parched corn and corn beer being the least, suggesting it is less economically attractive. This observation is consistent with [17], who noted that different value-added products yield varying profitability levels, necessitating careful consideration by entrepreneurs regarding resource allocation.

4.3. Constraints in the Profitability of Maize Value-Added Products

Fluctuating market prices emerged as a significant challenge for maize entrepreneurs, creating uncertainty in revenue streams and complicating long-term planning. A substantial portion of respondents in the Mezam division reported being affected by this volatility, indicating a systemic issue within the maize market. This finding agrees with research by [50], which identified similar problems in South-east Nigeria. Additionally, many respondents cited high production costs as a critical barrier to profitability, placing economic pressure on small-scale entrepreneurs who struggle to cover these expenses. This also aligns with [19], who highlighted high input costs and significant loading and unloading expenses as constraints on maize value addition in Taraba State, Nigeria.

5. Conclusion

This study highlights that maize value addition is profitable and represents a

significant source of income for small-scale entrepreneurs in the Mezam Division of the North-West Region of Cameroon. The identification of 13 products with high diversity suggests that there are various avenues for income generation in the maize industry. However, the negative correlation between product diversity and profitability suggests that strategic focus should be placed on high-return products such as pap and parched corn which are among the most profitable with pap leading as the most economically viable product. Despite challenges such as fluctuating market prices, high production costs, limited access to finance, and inadequate storage facilities that constrain the profitability of these products, entrepreneurs can navigate these obstacles by implementing several strategies. They can reduce production costs through bulk purchasing and increased production volumes, diversify their market reach, establish stable pricing through partnerships with suppliers and conduct comprehensive market research to accurately forecast trends. Based on the findings, it is recommended that the government actively promote maize value addition due to its rate of return. Additionally, providing support to entrepreneurs through access to credit for modern processing equipment and storage facilities will significantly enhance profitability and income generation. This strategic intervention can foster a thriving agro-processing sector, ultimately benefiting entrepreneurs and thus contributing to food security.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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