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Economic Feasibility, Benefits and Challenges of On-Farm Artisanal Cheese Making in South Africa

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Abstract: There is limited information regarding artisanal cheese making that can help entrepreneurs evaluate business opportunities and make realistic business decisions. The objective of this study was to assess the economic feasibility, benefits and challenges of on-farm artisanal cheese making. A model was designed to evaluate the economic feasibility of processing hard pecorino-style cheese and soft fresh ricotta on four different smallholder farms. The study assumed a small-scale family-owned business with an average herd size of 10 lactating cows, using 80 L of raw milk a day to make cheese. Projected Cash Flow Statement was used to determine the economic feasibility of cheese making. Sensitivity analysis was conducted using a factor of 10% to determine the changes in net cash flows by varying the milk volume, cheese selling price and both. The positive projected cash flow after the sensitivity analysis for the four farms ranged from $24,073.84 to $33,783.5. The breakeven quantity for the four farms ranged from 325.82 kg to 357.88 kg per year.Overall, the results show that artisanal cheese making is economically viable under the given model assumptions. However, the major challenge noted is that most farmers lack knowledge in terms of the processing techniques, market opportunities and production costs involved in cheese making. Access to this information by small-scale milk producers is vital in considering cheese making as a business.

Keywords: aging chamber; breakeven point; cheese cost; cheese ingredient; cheese equipment; projected cash flow; sensitivity analysis

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1. Introduction

Development of the dairy sector in rural areas has the potential to uplift producers and benefit local communities nutritionally. In a review by Loeper [1], they noted that small-scale farmers find it challenging to participate in the modern economy. This is mainly because they have limited access to credits, insurance and markets. In addition, these farmers also face stiff competition from big producers and milk production is seasonal [2], affecting their profit margins. Milk production is seasonal for most small-scale farmers since they do not have adequate irrigation systems and limited funds to buy commercial feeds for supplementation during the dry season [3]. On the other hand, during the peak production periods, farmers who are not able sell all the milk, or have ways to preserve the milk, will be at a disadvantage due to post harvest loses. Moreover, most small-scale farms are often not able to compete with big commercial dairy farms, since the milk price is established by the big milk producers and is extremely competitive [2]. Similar trends in milk markets have also been reported in Honduras and Nicaragua by Holmann [4]. Development of a small-scale artisanal cheese making model might be the key to help overcome these challenges. This may allow a sustainable production system to meet the projected growing demand for dairy products.

The projected increase in demand for dairy products in developing countries should be supported by an increase in production [5], focusing mainly on empowering small-scale farmers. Small-scale farmers in South Africa have the potential to become a long-term viable and sustainable option for increasing food security [1]. However, the potential of the smallholder dairy sector in Africa remains largely untapped and financial support is mostly presented as the main barrier for producers to venture into cheese making. The greatest advantage of on-farm cheese production is that it does not require sophisticated technology equipment as compared to commercial companies. The advanced equipment is usually out of reach for most small holder dairy farmers. Cheese can be processed using economical and locally available resources and ingredients, making it an ideal sustainable business.

According to several reports, there is limited information that can help small-scale dairy farmers make informed decisions when it comes to artisanal cheese making [6–8]. Few available studies in the United States of America focus on large scale cheese making companies [7–9], without specific evaluation of production costs and assessment of challenges and benefits for small-scale producers. Bouma et al. [7] highlighted that high start-up and operating costs are significant barriers for most artisan cheese entrepreneurs.

There is, therefore, a need to evaluate the potential of small-scale farmers in artisanal cheese making considering resources availability and financial needs. This will help identify problems and existing opportunities, taking into consideration certain realities, specific to the rural smallholder dairy systems. This needs to be done through the assessment of the feasibility of on-farm cheese making. A hard pecorino style cheese was selected for these trials based on the results of a previous survey in the Western Cape Province [10]. The survey results suggest that this type of cheese is among the already known types and it is appreciated by consumers. Pecorino cheese has also relatively easy processing techniques which can be potentially duplicated by resource limited rural farmers. Therefore, the specific objectives of this study were to assess the benefits, challenges and evaluate initial investments cost for equipment and ingredients for on-farm artisanal cheese making. In addition, future projections were also highlighted.

2. Materials and Methods

2.1. Farms Selection and Description

Farms were selected based on a preliminary survey conducted by the Agriculture Research Council (ARC) in the Eastern Cape Province of South Africa. Farms producing at least 100 L of milk per day were first identified according to the ARC database. The farms were also selected based on legal milk standards and if they followed proper hygiene practices during milking to give microbiologically safe milk [5]. Based on that data, seven farms were selected. The farm managers were interviewed, and they were given a summary of the project. From the seven, four farms were willing to participate. On average the farms had 10 milking cows producing an average of nine L of milk/day/cow. All the farms used a pasture-based system (kikuyu, lucerne, ryegrass and clover) with few commercial grain supplements given during milkings. This study focused on farms with available facilities for processing and milking parlour without the need to build new facilities. They all had free extra rooms close to the milking parlour that could be used for cheese processing and aging. Therefore, costs for building were not included in the calculations. The selected farms also had clean water supply for washing hands and disinfecting equipment. Cheese processing experiment was set-up on each independent farm to determine all initial capital investment costs for equipment and ingredients, taking note of benefits and challenges involved. At least two different cheese batches were produced at each independent farm. Traditionally pasteurised cow milk was used to make a hard pecorino-type cheese and a soft fresh ricotta cheese.

2.2. Economic Feasibility Appraisal Model

2.2.1. Projected Consolidated Cash Flow

Projected cash flow method is a popular method in business and financial analysis [11]. The projected Cash Flow Statement (CFS) is one of the valuable financial tool, which provides important information on business financial transactions. The CFS can reveal the company's liquidity and solvency position as well as its future direction. Any potential entrepreneur values the importance of potential cash flows as the business has financial obligations to meet for example purchasing inventories and capital assets, pays salaries and wages, etcetera.

The projected cash flow was calculated using the formula;

$$\text{Beginning Cash} + \text{Projected Inflows} - \text{Projected Outflows} = \text{Ending Cash}$$

There are various ways to calculate the cash flows. The traditional cash flow statement is usually divided into three sections, namely cash flows from operating activities, cash flows from investment activities, and cash flows from financing activities. The cash flow used in this study was divided mainly into two sections: cash flows from operating and investment activities because the farmers under consideration did not have any external funding for the cheese making business. The net cash flows from operation activities included the difference between the cash inflows from the cheese sales and the cash outflows from cost of ingredients used in the production process. The cash flows from the investment activities included the cost of capital expenditure involved in the enterprise like the cost of equipment, humidifiers, shelves, and etcetera. The projected cash flow statement is denominated in US dollar although the costs data was collected in South African Rands. All the prices were converted to US Dollar at an average exchange rate of the month of January 2018 of 1 USD: R12.21, extracted from Standard Bank South Africa.

2.2.2. Sensitivity Analysis

The sensitivity analysis was conducted on all the four farms using a factor of 10% [12,13] to determine the changes in net cash flows by varying the milk volume of production, selling price of the cheese and both volume and price. These variables were selected as they were identified to be the most sensitive parameters in the business model which can give a sense of a realistic outlook to shape the business decisions. It was conducted following a "one assumption at a time scenario" to determine the effect of changing some variables on the net cash flows while holding other variables constant. Firstly, the volume of milk for cheese-making was decreased by 10% which has an effect on reducing the cheese yield and all the variable costs. Secondly, the selling price of cheese was reduced by 10% to determine the changes in projected net cash flow. Lastly, both milk price and volume were reduced by 10% to determine the effect on cash net flows. The proposed variations included in the sensitivity analysis provide important insights for potential small-scale artisanal cheese makers to consider when deciding to venture into business.

2.3. Business Model Assumptions

The general assumptions used for the model are summarised in Table 1, as modified from Bouma et al. [7] and Durham et al. [8]. These assumptions were proposed to be able to control unforeseen circumstances. The study assumed a small-scale family-owned business with an average herd size of ten cows in milk to produce two types of cheese; the pecorino and ricotta. Cheese was processed using 80 L from the daily milk production. Cheese batches were produced at each independent farm under typical artisanal processing conditions as described in detail by Nyamakwere et al. [14].

Table 1. Assumptions used in the model design.

Variable	Assumptions
Type of Business	Small-scale family-owned dairy farms. Artisanal cheese makers, with herd size of at least 10 lactating cows
Milk Source	Raw milk was sourced from the selected four farms and milk cost was not included in the model
Milk Quantity/Volume	The model used a constant 80 L per day production.
Production Period for Pecorino cheese	The model used 305 days for pecorino cheese. The initial 60 days were reserved for aging of the first batch.
Production Period for Ricotta cheese	The model used 365 days for ricotta cheese.
Processing Plant	Farmers used their existing structures at the farm for cheese processing and aging. Hence zero cost for buildings.
Equipment	New equipment was procured for cheese processing and aging.
Labour	All farmers used paid labour. The wage rate was based on the prescribed minimum wage for farm workers in South Africa which is $1.47/hour according to the Department of Employment and Labour (Act No. 9 of 2018).
Inflation	The model assumed constant prices for the whole year
Initial Capital Outlay	Farmers used their own funds to procure the required equipment.
Projected cash flows	The model used one-year projected cash flows.
Guaranteed market for the Cheese	The cheese has guaranteed market which is farm gate sales. Hence the model did not include marketing and distribution expenses for the cheese.

2.4. Variables Used in the Model

The Projected Cash Flow model used a number of variables in computing cash inflows and outflows. The cash inflows were computed from the revenue from the sale of pecorino and ricotta cheese as shown in Table 2. The cash outflows were computed from the investment activities and variable costs are shown in Tables 3 and 4, respectively.

Table 2. Annual revenue from pecorino and ricotta Cheese.

Variable	Value Used
Pecorino Cheese Annual Revenue	Farm A: \$11.62 × 305 days × 5.6 kg Farm B: \$11.62 × 305 days × 7.3 kg Farm C: \$11.62 × 305 days × 6.6 kg Farm D: \$11.62 × 305 days × 6.0 kg
Ricotta Cheese Annual Revenue	Farm A: \$10.73 × 365 days × 5.8 kg Farm B: \$10.73 × 365 days × 6.9 kg Farm C: \$10.73 × 365 days × 6.5 kg Farm D: \$10.73 × 365 days × 6.3 kg

2.4.1. Expected Revenue from Cheese Production

The expected revenue from pecorino and ricotta cheese differed due to the differences in price, yield per farm and the number of days in production per year. Pecorino cheese was priced at $11.62 per kg and Ricotta at $10.73. These prices were determined by prevailing retail prices and the availability of substitutes. Farm B had the highest yield of 7.3 kg per 80 L of milk used for pecorino cheese and on the other hand, Farm A yielded the lowest cheese of 5.6 kg (Table 2). Farm C and D had almost similar yield of 6.6 kg and 6.0 kg, respectively. The similar pattern was observed on Ricotta cheese (Table 2), Farm B had the highest yield of 6.9 kg and Farm A had the lowest yield of 5.8 kg. Farm C and D were also noted to have a similar yield of 6.5 kg and 6.3 kg, respectively.

2.4.2. Expenditure from Investment Activities

The investment expenditure is summarised in Table 3. Equipment, ingredients, and processing techniques were suggested by a cheese expert from a cheese company in Italy (Formaggi della Famiglia Busti, Acciaiolo, PI—Italy), and also based on information gathered from a previous survey which evaluated different hard and semi hard cheeses in the

Western Cape Province [10]. Investment activities included all the expenditure on equipment which had a life time of more than a year. Some of the major investment activities in the artisanal cheese making considered in the model included draining table/trolley, stainless steel milk containers, humidifier, air conditioner, wooden shelves, to mention but a few (Table 3). The equipment was sourced from local shops which are easily accessible to the farmers. The cost of investment did not vary per farm since the model was standardised across all the farms. All the equipment and ingredients were tested for performance in a pilot study which was done at an experimental dairy farm of Stellenbosch University (Western Cape Province, South Africa). All prices in this study were quoted according to the commercial market prices between January 2017 and January 2018 in United States dollars (US$).

Table 3. Investment Equipment and Costs.

Investment Items	Cost Price
Gas burner and gas tank	$56.92
Medium ricotta basket moulds (20 units)	$59.75
Large Cylindrical moulds 1–1.5 kg (10 units)	$111.45
Stainless steel milk container (2 × 20 lt)	$316.38
Humidifier	$252.09
Air Conditioner	$393.12
Wooden Shelves	$163.80
Stainless steel milk container (40 L)	$163.80
Stainless steel pot 50 L	$229.32
Plastic tub 50 L	$7.86
Dish towels	$8.19
Plastic bucket 20 L	$6.47
Stainless steel skimmer	$25.39
Plastic basket filter and stainless-steel strainer	$40.69
Stainless steel Draining table/trolley	$545.54
Stainless steel Disc Mixer	$40.95
Stainless steel curd cutter	$36.86
Stainless steel curd whisk	$28.67
Total	**$2487.25**

Table 4. Variable costs used in the Model.

Cost Narration	Reference
Labour Cost per year—Pecorino	R18 × 4 h × 3 people × 305 days
Labour Cost per year—Ricotta	R18 × 1 h × 2 people × 365 days
Packaging Material Pecorino	150 mm × 5 m roll for 8 kg Cheese @ $4.50
Packaging Material Ricotta	500 g container @ $0.20
Thermophilic-Mesophilic bacteria culture for 1.525 kg per year	$367.20
Animal rennet for 1.22 kg per year	$533.06
Cheese salt	$637.81
Dish washing soap (230 L) per year	$499.59
Disinfectant (230 L) per year	$1248.98
Lactic acid 4.575 kg per year	$108.16
LP Gas	$4484.03
Packaging Material—Plastic	$961.71
Stove Lighter	$8.19

2.5. Aging Chambers

The aging chambers for the hard cheese were set up in the laboratory of the Animal Sciences Department at Stellenbosch University, with controlled temperature, humidity, and ventilation. An artisanal aging chamber was setup 18 °C and humidity between 70 and 80%. The temperature and humidity ranges in the aging chamber were selected according to the levels used in commercial factories in the ripening of hard cheeses and also based on previous studies [15–19]. A domestic air conditioner and humidifier were used to control temperature and humidity, respectively. The aging chamber had wooden shelves which were bought and assembled in a 3 m × 3 m room. This equipment was selected due to its affordability and accessibility to rural farmers. Costs for assembling the artisanal chamber with the equipment to control temperature and humidity were calculated and compared with the cost of purchasing a commercial chamber. The cheese blocks were aged in these chamber for 60 days and the fresh ricotta cheese did not need the aging space, only required a short-term cooler (4 °C) storage space after processing.

2.6. Variable Costs Used in the Model

The variable costs used in the model are summarized in Table 4. The production of both cheeses involved consumables such as bacterial culture, rennet, lactic acid, cheese salt, cleaning detergents and packaging material, which were used as inputs in the production process. The variable costs were projected for the whole year to estimate the expected costs. The costs varied depending on the cheese type, with the number of days in production, to determine the input requirement. Pecorino cheese required a greater number of people and labour hours compared to the ricotta. Three people were noted to be enough to perform the whole pecorino cheese making process. The process takes around 4 h to complete from milk heating to whey drainage, with experience less time might be needed. Thus, a producer following this protocol can be able to make two cheese processing sections per day.

Labour

The farm workers were involved in all processes so that they could have an insight of every step and be able to duplicate the processes independently. Four people were involved in the whole process and a cheese expert from Italy was consulted to help guide through all the processes. Labour costs were calculated according to the Department of Employment and Labour Act South Africa [20]. However, we would also want the farmers to operate mostly as a family without fixed roles and sharing responsibilities to reduce labour costs.

2.7. Breakeven Analysis

Breakeven Analysis (BEA) was used to determine the point in production at which quantity and sales of the artisanal cheese farmers make neither profit nor loss. The breakeven point (BEP) in units, BEP in sales and Contribution Margin ratio were calculated according to the formulas below adopted from Cafferky and Wentworth [21]. The values used for calculating the BEP for each farm are shown in Table 5.

$$\text{BEP (Units/kg)} = \frac{\text{Total Fixed Cost(TFC)}}{\text{Revunue per Unit} - \text{Variable Cost per unit}}$$

$$\text{BEP (Sales)} = \frac{\text{Total Fixed Cost(TFC)}}{\text{Contribution Margin Ratio}}$$

where the Contribution Margin Ratio $= \frac{\text{Sales Value} - \text{Variable Costs}}{\text{Sales Value}}$

Table 5. Variables used for the Breakeven Analysis.

Farms	Fixed Costs/Year ($)	Total Variable Costs/Year ($)	Sales Revenue/Year ($)	Output/Year (kg)
A	2489.25	161,876.39	42,748.47	3825.0
B	2489.25	16,643.76	52,914.54	4745.0
C	2489.25	16,468.76	48,865.15	4385.5
D	2489.25	16,330.83	45,953.69	4129.5

3. Results and Discussion

3.1. Feasibility of Cheese Making

The study used projected cash flow statements to determine the feasibility of a cheese making model. The results of the projected cash flows are presented in Table 6. The study results show that all the farms incurred cash out flow from investment activities of US$2487.25. This figure was the same due to the same cost structure across the farms on investment activities. In contrast, much higher figures were reported by Bouma et al. [7] which was mostly because their evaluations were based on bigger companies in the United States of America using highly modified technology equipment.

Table 6. Projected Cash flows for the farms.

Variable	Farms			
	Farm A	**Farm B**	**Farm C**	**Farm D**
Cash Flows from Operating Activities				
Income from Pecorino Cheese	19,863.72	25,893.78	23,410.81	21,282.56
Labour Cost—Pecorino	−5395.58	−5395.58	−5395.58	−5395.58
Cost of Ingredients:	−8848.73	−9140.68	−9020.47	−8917.43
Income from Ricotta Cheese	22,884.75	27,020.76	25,454.34	24,671.13
Labour Cost—Ricotta	−1076.17	−1076.17	−1076.17	−1076.17
Packaging Material—Ricotta	−866.91	−1031.33	−971.54	−941.65
Net Cash Flows Provided by Operating Activities	26,561.08	36,270.78	32,401.40	29,622.87
Net Cash Flows Provided by Investment Activities	−2487.24	−2487.24	−2487.24	−2487.24
Projected Cash at the end of the Year	**24,073.84**	**33,783.55**	**29,914.16**	**27,135.63**

Farm B recorded the highest projected cash flow of US$33,783.55, with net cash inflow from operation activities of US$36,270.78. This was followed by Farm C with the projected cash flow of US$29,914.16, with the net flows of US$32,401.40 from operating activities. The results for Farm D show that, the project net cash flow was US$27,135.63 with the associated net cash flows of US$29,622.87 from operating activities. Farm A recorded the least projected net cash flows of US$24,073.84, with the net cash flow from operating activities of US$26,561.08. The difference in the projected cash flows was mainly due to varying level of cheese yield across the farms. The study results also noted that the farms with relatively higher cheese yield also have high projected net cash flows. According to our production scale, 80 L of milk gave an average of 6.0 kg of pecorino cheese (7.5% yield) at day 60, Cipolat-Gotet et al. [22] also reported a similar cheese yield percentage. Total cheese yield percentage depends largely on milk composition, particularly fat and protein proportions [4,23,24]. This shows that cheese yield is important as it translates into the potential revenue of the enterprise. For the ricotta cheese, the average yield was 10.0%, variable yields have been reported in literature ranging from 5.0% to 16.0% [25]. They further noted that yield is significantly increased when raw milk is added to the whey during processing.

3.1.1. Sensitivity Analysis

Sensitivity analysis was conducted to determine the effect of changes in milk price and volume on the projected cash flows. It was conducted on the "per case scenario", with price being reduced by 10%, and volume reduced by 10% and finally, reducing both price and volume by 10%. The results after sensitivity analysis are presented in Table 7. The reduction of milk price by 10% yielded different results on the farms' projected cash flows. Farm A had the highest reduction in projected cash flows of 11.67%, followed by Farm D (10.9%), then Farm C (10.8%) and lastly, Farm B (10.7%). On the other hand, the reduction in milk volume by 10% resulted in disproportionate effects on the projected cash flows. Farm B recorded the lowest reduction in the projected cash flows (15.7%), followed by Farm C (16.3%), then Farm D (16.9%) and Farm A with the highest reduction of 18.4%. The last case scenario was a reduction of both milk price and volume by 10%. Farm A recorded the highest drop in projected cash by 19.1%, followed by Farm D with 18.0%, Farm C with 17.9% and Farm B recorded the least drop of 17.3%.

Table 7. Projected Cash Flows and Sensitivity Analysis.

Farms	Variable	Base Case	Sensitivity Analysis		
			10% Decrease in Volume	10% Decrease in Price of Cheese	10% Decrease in Volume & Price
Farm A	Projected Cash at the end of the Year	24,073.84	21,263.25	19,644.51	19,475.52
	% Drop in Projected Cash		11.67%	18.4%	19.1%
Farm B	Projected Cash at the end of the Year	33,783.55	30,156.47	28,492.09	27,826.03
	% Drop in Projected Cash		10.7%	15.7%	17.3%
Farm C	Projected Cash at the end of the Year	29,914.16	26,675.02	25,027.65	24,567.05
	% Drop in Projected Cash		10.8%	16.3%	17.9%
Farm D	Projected Cash at the end of the Year	27,135.63	24,173.34	22,540.26	22,257.91
	% Drop in Projected Cash		10.9%	16.9%	18%

Overall, the study results show positive projected cash flows across all the farms after the sensitivity analysis. This suggests that the artisanal cheese making model is viable, given the project assumptions and the conditions under consideration.

3.1.2. Breakeven Analysis

Farm A had the highest BEP units of 357.88 kg/year, followed by farm D (346.69 kg/year), then farm C (337.30 kg/year) and lastly farm B (325.82 kg/year) (Table 8). The BEP sales also followed the same trend, and this corresponds to the yields, farm B with the highest yields for both cheeses requires the least BEP units and sales.

Table 8. Breakeven point (BEP) in units, BEP in sales and the Contribution Margin Ratio.

Farms	BEP (Units [1]) (Kg)	BEP (Sales [2]) ($)	Contribution Margin Ratio [3]
A	357.88	4011.69	0.62
B	325.82	3607.61	0.69
C	337.30	3771.59	0.66
D	346.69	3829.62	0.65

[1] BEP in Units, [2] BEP Sales and [3] Contribution margin ratio were calculated using the formulas in Section 2.7.

The contribution margin ratio is the difference between a company's sales and variable costs, expressed as a percentage. This ratio shows the amount of money available to cover fixed costs. Farm B had the highest contribution margin percentage of 69%, followed by farm C, then D and A. It is good to have a high contribution margin ratio, as the higher the ratio, the more money per product sold is available to cover all the other expenses [21].

3.1.3. Evaluation of Aging Chamber Costs

The costs for the aging chambers were also determined, that is comparing the artisanal and commercial. The commercial chamber used was the "STAGIONELLOTM Line", Model STGTWCOMB, size of 140 × 78 × 211 with a temperature range of −3 °C to 35 °C. The chamber is entirely built in AISI 304 stainless steel CE certified to be used in contact with food and was purchased for US$25,409.25 in 2015. This chamber accommodated 30 cheese blocks of approximately 1.5 kg each. For the artisanal chamber, wooden shelves that were enough for the room used costs US$229.32 and the room accommodated 30 cheese blocks. According to calculations by Bouma et al. [7], an artisan cheese facility would require an aging room estimation of 0.01096 m^2/kg. In the artisanal chamber the domestic humidifier and air conditioner were successfully used. Both the humidifier and air conditioner suitable for this purpose costs US$163.80 each. Therefore, the initial investment for the artisanal chamber required US$556.92. These figures clearly show that the artisanal chamber is cheaper to use as an aging chamber compared to the commercial. The cost of building the room from foundation were not included in the calculations since we noted that all the interviewed farmers had space or rooms already available on the farm.

However, those that want to build processing and aging facilities should construct rooms in a way that can allow an extension in case production grows bigger. Bouma et al. [7] noted that most artisanal cheese producers initially build smaller processing facilities giving them problems later when the business grows. Initial capital investments in aging facilities and equipment must be carefully considered through financial consultations [9]. The cost of production must be low enough while returns are satisfactory so that farmers are motivated to stay in business. This makes proper business planning even more important before establishment.

3.2. Benefits of On-Farm Cheese Making

An on farm artisanal cheese making business was noted to have both social and economic benefits for the farmer involved and the community at large. The farmer will have an additional extra income, compared to just selling raw milk and the results indicates a positive annual projected cash flow. In addition, currently in South Africa some farmers are not able to meet higher demanding milk standards of bigger processing companies, when selling raw milk, making it difficult to compete on the market [2]. Thus, the big dairy farms influence milk market prices more putting small-scale producers at a disadvantage. Bigger processing plants want farms that can have a consistent milk supply at higher volumes. The milk should also be of good quality in terms of somatic cell counts, bacterial counts, protein, and fat. Milk producers get bonuses according to milk quality, volume, production, and supply consistence, as highlighted by farmers in the current study. However, most of the farmers interviewed during the preliminary survey indicated that, at times it is difficult to meet the prescribed standards. As a result, most small-scale milk producers are forced to sell raw milk to locals at a lower price of US$0.49 limiting their profit margins. A similar trend has also been reported in Kenya [26]. Processing of value-added products such as cheese can be ideal for these small-scale producers to help overcome such challenges and be able to grow in the dairy industry.

One of the main advantages of artisanal cheese making is that the equipment needed for small-scale cheese processing is simple, affordable, and accessible to rural farmers. Equipment and ingredients such as cheese moulds, pots, ricotta baskets, curd cutter, disc mixer, whisky, skimmer, pH meters, animal rennet, and bacteria starter culture can now be found in most South African cheese shops. Fellows [27] has also listed similar equipment and ingredients for small-scale artisanal cheese making. In the past few years, cheese ingredients were only sold at a much larger scale for bigger processors only, but recently due to the increased growth in number of small-scale artisanal producers, smaller packages are now available from different cheese factory shops. The equipment can also be customarily made from metal fabrication shops. Furthermore, cheese has been successfully processed using raw milk; thus, there was no need to purchase expensive pasteurizing equipment. Several other cheese types have been reported to be successfully processed from raw milk [28]. Nevertheless, one additional advantage of using pasteurized milk is that the cheese can be sold almost immediately, thus, has a faster cash flow and lower aging costs [8]. Similarly, the fresh cheese can be consumed almost immediately, thereby reducing expenses for storage space and having a faster cash flow. Moreover, the study was able to establish good aging conditions using affordable equipment. There was no need for bigger technologically modified equipment and that ensures sustainability of the business. The artisanal aging chamber assessed during these trials was noted to be cheaper than a commercial chamber. Farmers need to be well informed and trained to make all the necessary procurements much easier.

Another benefit lies in the fact that selling artisanal cheese gives higher profit margins compared to raw milk. However, the product price should be carefully calculated and not just based on comparing with the current market prices. Durham et al. [8] and Nicholson and Stephenson [9] stated that product pricing should be well calculated to cover all operational costs and make reasonable profits. Most startups fail to determine retail price that can cover all costs incurred resulting in major losses [29].

The other benefit is that the pecorino style cheese is already known and appreciated by the local consumers in South Africa [10]. This cheese type was noted to fall under the artisanal specialty category and can be easily marketed in specialty stores and also attracts visiting tourists. In addition, artisanal cheese is preferred for its nutritional benefits and unique taste [30–32]. Cheese has several nutritional benefits important for the development and growth of children in rural areas, where essential nutrients intake is limited. Furthermore, most of the farm workers who tasted ricotta reported that it is similar to sour milk (*amasi)* which is a local product that people are accustomed to. This means that further introduction of similar products will be easy as it will be easily accepted and appreciated by the consumers. Cheese types adjusted to local peoples' taste and preferences were reported to have gained more support in Japan [33]. Thus, it is important to produce more consistent cheese products according to local people's taste preference and nutritional requirements. Overall, we had positive feedback from all the farmers, and they indicated that they are willing to venture into cheese making. The developed step by step cheese making protocol is easy and can be successfully duplicated.

3.3. Challenges of On-Farm Cheese Making

According to our assessment one of the major challenges noted is that most small-scale famers are hesitant to start new projects as a result of lack of enough information regarding production techniques, costs and market opportunities. The farmers do not see cheese making as a growing business opportunity. Similar challenges were also noted by Nicholson and Stephenson [9], they reported that most entrepreneurs do not have enough understanding of the processes and capital needs. According to our experience, if milk producers are given access to the necessary information, they will be able to consider cheese processing as a new business venture and they are likely to succeed. On the other hand, it is expected not to have rural farmers in South Africa that are into cheese making since cheese is not a local traditional product. People tend to venture into businesses they are accustomed to. This is the main reason why most of the cheese producers in South Africa are originally from Britain, Italy, France, or Sweden [34]. To help overcome these and other related challenges, the farmers can invest in joining dairy societies, attending workshops and agricultural shows. This is a practice that has worked well for several farmers interviewed during the preliminary survey. Successful influential cheese producers and mentors can be invited to the meetings to share different processing techniques and managerial skills.

Other challenges were experienced during the actual cheese making process. Maintenance of good hygiene standards during milking and processing is of utmost importance. One of the farmers indicated that they were currently having problems with higher microbial counts in milk. This milk was used for cheese making resulting in cheeses with significantly higher microbial counts. The cheese making process is such a long process involving several steps which requires careful attention to limit chances of cross contamination. Farmers need to be well trained and informed about all the critical control points during processing in order to produce safe products. In addition, workers involved should wear proper protective clothes such as a cap, apron, boots and sometimes a face mask. Poor non-hygienic handling practices during processing might lead to contamination with bacteria such as *Listeria monocytogenes* and *Escherichia coli*, these microbes are of importance as they have strains that can be pathogenic [35,36]. Contamination with these pathogens can also come as a result of faecal contamination [37,38]. For the current study, all equipment was washed and disinfected before each use. The workers were also informed about personal hygiene and hand washing techniques.

Producers should be well informed and trained about food safety and critical control points during processing. However, in cases where the cheeses are noted to be highly contaminated, producers can try and reduce the microbial counts by extending the aging period. In fact, bacterial survival chances decrease with age as the moisture content and water activity decreases [39–41]. Alternatively, the cheese blocks can be treated by irradiation or the cheeses' surfaces can be washed with high pressure water [42,43]. One of our studies that evaluated the efficacy of irradiation treatment on cheese surfaces has shown that it is an effective and economical method that can be used by small-scale producers [14].

3.4. Other Factors to Consider in Cheese Making

Other factors cheese makers should take into consideration includes market availability, cow breed and future business growth. Artisanal cheese makers must study the market to note if there are enough customers in their respective areas willing to purchase artisanal cheeses. In addition, although this project was designed for small-scale producers aimed at selling the products to the local communities, as the business grows bigger producers should have reliable options to reach all customers across regions. In order to grow the market faster, producers should consider joining dairy societies, farmers markets and related competitions. This will help to have exposure and the product can quickly penetrate the markets. Durham et al. [8] noted that award winning cheeses attract more distant customers expanding producers' markets. Making use of trending marketing tools like the social media networks (Facebook, WhatsApp, Twitter, and Instagram) can also be useful. Well established markets and financial guarantee will give farmers room to properly expand.

Furthermore, farmers need to be well informed about the quality of cheese from different breeds so that they can be able to select the best breeds for cheese making. Breed is one of the main genetic aspects that affects milk and cheese quality composition [44–46]. During the preliminary survey it was noted that most small-scale farmers use cow breeds such as the Jersey, Holstein-Friesian (HF) and crosses from the two. According to the findings by Bland et al. [23] and Auldist et al. [47], the Jersey milk possesses the qualitative characteristics that best contributes to higher cheese yield and better coagulation properties. Thus, farmers willing to venture into cheese making should make use of breeds that gives best quality properties in terms of both milk and cheese. The use of local breeds such as the Nguni, Brahman, and Afrikaner, which are not suitable for dairy farming, will result in lower outputs. However, it is important to note that the performance of these breeds is also linked to other factors such as the environment, management, feed quality and processing techniques [48–50]. These factors also help to make a cheese unique to that farm or region, thus, creating niche markets. Therefore, farmers should be well informed and educated about the performance of the different dairy breeds according to their respective areas and feeding programs to help in animal selection.

Lastly, producers should be prepared for an initial lag phase as the business is starting, to cover substantial operating costs until positive profits are achieved. The payback period as the time needed to recoup the initial capital outlay is also another important risk factor, liquidity is reported to be the main reason most cheese companies fail [8]. Another long-term challenge includes the ability to expand. As the business grows the farmers should be prepared to invest more in building processing and aging rooms. Cooling systems might also be needed to maintain the cold chain and keep the fresh cheese in case it is not sold out immediately after processing. Thus, farmers should be prepared to invest in buying cooling fridges in future. Additionally, the processing can also be labour intensive and to reduce working long hours, producers can invest in automated equipment, especially when production is increased. Therefore, farmers should plan for such future developments so that they can be able to expand profitably. This is important since Manzana et al. [51] reported that most small-scale dairy farmers lack the capacity to plan ahead.

4. Conclusions

Based on the results from this study, it can be noted that small-scale artisanal cheese making is a viable enterprise since all the four farms recoded a positive projected net cash flow after sensitivity analysis. Processing of value-added products such as cheese is ideal for small-scale dairy farmers to help them overcome several challenges they face in the dairy industry. Cheese can be successfully processed using simple affordable equipment and ingredients. The results of this study will provide small-scale milk producers with baseline information to help evaluate cheese making as a low-cost alternative dairy business. Investing in farmers' education and training regarding cheese making techniques and production costs is vital. This information should be properly disseminated to the farmers to help in decision making. Given access to all production costs, benefits and challenges, farmers are able to consider and start cheese making as a business.

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