A decision-making tool to determine economic feasibility and break-even prices for artisan cheese operations

Catherine A. Durham,^{*1} Andrea Bouma,[†] and Lisbeth Meunier-Goddik[†]

^{*}Department of Applied Economics, Food Innovation Center, Oregon State University, Portland 97209

[†]Department of Food Science and Technology, Oregon State University, Corvallis 97331

ABSTRACT

Artisan cheese makers lack access to valid economic data to help them evaluate business opportunities and make important business decisions such as determining cheese pricing structure. The objective of this study was to utilize an economic model to evaluate the net present value (NPV), internal rate of return, and payback period for artisan cheese production at different annual production volumes. The model was also used to determine the minimum retail price necessary to ensure positive NPV for 5 different cheese types produced at 4 different production volumes. Milk type, cheese yield, and aging time all affected variable costs. However, aged cheeses required additional investment for aging space (which needs to be larger for longer aging times), as did lower yield cheeses (by requiring larger-volume equipment for pasteurization and milk handling). As the volume of milk required increased, switching from vat pasteurization to high-temperature, short-time pasteurization was necessary for low-yield cheeses before being required for high-yield cheeses, which causes an additional increase in investment costs. Because of these differences, high-moisture, fresh cow milk cheeses can be sold for about half the price of hard, aged goat milk cheeses at the largest production volume or for about two-thirds the price at the lowest production volume examined. For example, for the given model assumptions, at an annual production of 13,608 kg of cheese (30,000 lb), a fresh cow milk mozzarella should be sold at a minimum retail price of \$27.29/kg (\$12.38/lb), whereas a goat milk Gouda needs a minimum retail price of \$49.54/kg (\$22.47/lb). Artisan cheese makers should carefully evaluate annual production volumes. Although larger production volumes decrease average fixed cost and improve production efficiency, produc-

tion can reach volumes where it becomes necessary to sell through distributors. Because distributors might pay as little as 35% of retail price, the retail price needs to be higher to compensate. An artisan cheese company that has not achieved the recognition needed to achieve a premium price may not find distribution through distributors profitable.

Key words: artisan cheese revenue, price, cost

INTRODUCTION

As cheese entrepreneurs consider entering the artisan business, they find it challenging to determine whether it will be a successful business venture. Several tools are useful to evaluate the economic feasibility of an investment; some of the most commonly used are net present value (NPV), internal rate of return (IRR), and payback period (PB).

Within an adequately designed economic feasibility model, the NPV formula can be used to determine the minimum revenue per unit required to be profitable. For artisan cheese makers, that provides a means for determining the cheese price necessary to succeed, as well as understanding cost structure. The break-even price is the lowest price the product can be sold for that achieves a nonnegative NPV—the point at which the sum of discounted revenues and costs over time is zero. To be a sustainable business, cost structure and market pricing associated with cheese type need to be considered and should not be pursued unless the NPV is greater than zero. Business risk is included in NPV calculations by increasing the discount rate utilized.

Additional measures of business health often used are IRR and PB, mainly because they are intuitive to understand the level of potential value. The IRR is complementary to the NPV calculation; it is essentially the discount rate that would take the NPV to zero. Thus, if the calculated IRR is not greater than the discount rate considered appropriate for the project, the project should not be considered attractive. In practice, IRR is generally used to examine comparable investments, rather than to stand alone. The IRR provides

Received December 17, 2014.

Accepted June 25, 2015.

¹Corresponding author: cathy.durham@oregonstate.edu

a way to examine projects with comparable risk and capital. Finally, the PB is commonly used to determine the time needed to earn back the initial capital investment. Although PB does not consider the time value of money and ignores the value of the venture beyond the point of payback, it is useful information especially for start-ups as liquidity can be the main reason a venture does not succeed. When evaluating risk of a potential venture, it is important to look at all of these financial measures across multiple scenarios to best understand the sensitivity of the overall system (Brigham, 1985).

A key parameter when determining business viability is price. Both Becker et al. (2007) and Nicholson and Stephenson (2007) concluded that product pricing was a challenge. Becker et al. (2007) suggest that smaller cheesemakers would have to depend, among other things, on their ability to adopt a “premium pricing strategy.” Specialty cheeses produced by local artisan companies are generally more expensive to produce per unit than cheeses produced in nonartisan settings, in part due to the large start-up and production costs associated with artisan cheese making and the smaller scale (Bouma et al., 2014). Determining the correct pricing structure and potential for achieving it is essential. However, many start-ups do not have the information needed to determine a reasonable retail price and instead select their price based on comparable cheese prices in the market place. Although the price of comparable cheeses is critical information, the artisan must, at a minimum, be able to obtain a price that covers costs associated with production and marketing of the cheese as well as a mark-up based on wholesale or distributor sales (Caldwell, 2010). However, many artisan cheese makers lack data on cost of goods sold (COGS), which includes inputs such as milk and nonmilk ingredients, labor, aging, packaging, sanitation, utilities associated with production, rent, insurance, and licensing. This is only the beginning: financing, product shrink, cost of marketing, sales, distribution, depreciation, and preventive maintenance are also critical. Artisan cheese makers must also study the market situation to determine if the retail price required to cover expenses can actually be obtained. Are there sufficient customers willing to pay the high price for the artisan cheese? How can the company reach these customers? Are there special circumstances that will help sell the cheese such as having won a cheese competition, being promoted in a popular cheese book, or producing a limited supply of a popular variety (Franklin and Cotterill, 1994).

The study reported here uses a decision-making tool developed to determine the economic feasibility of artisan cheese operations. The application of the tool is demonstrated in this study by exploring 3 sets of

scenarios: the first set explores how production volume affects NPV, IRR, and PB for a constant cheese type and retail price across a single market situation; the second determines the retail cheese price that achieves an NPV of zero across multiple cheese and milk types for a single production level and market situation; and the third explores minimum viable production and plant utilization given retail price and the plant size and capital investment.

MATERIALS AND METHODS

Artisan Cheese Economics Model

Development of the Excel model (Microsoft Corp., Redmond, WA) was described in Bouma et al. (2014). Briefly, 7 current artisan cheese makers were surveyed to determine all start-up and operating expenses along with income streams and sales and distribution systems. The 7 companies ranged in production size from 2,500 to 30,000 kg/yr. Five companies used goat milk and 2 used cow milk; all were located in rural or semi-rural settings. Four goat milk companies produced chevre and multiple hard cheeses. One goat milk company only produced Gouda-style cheeses. The cow milk companies exclusively produced hard cheeses. The 4 smallest companies sold cheeses through direct outlets, such as farmers markets or at the farm, and wholesale to select retail outlets and restaurants. The 3 largest sold additionally sold cheeses through distributors. All 7 were farmstead companies. The findings from the survey in conjunction with cost and operational information from equipment manufacturers were incorporated into an economic feasibility model. The model allows for adjustment in product offerings and pricing, initial capital investment needed, and operational costs, and calculates loan payment, depreciation, and taxation over a 15-yr operational period to produce cash-flow information. The cash-flow information was then used to calculate NPV, IRR, and PB. The tool was developed in Excel (Microsoft Corp.) to allow for maximum access. Subsequently, the model was beta-tested with multiple entrepreneurs during their business start-up to ensure model validity. Beta-testing was first conducted with the initial 2012 model and later repeated for the updated 2014 model.

Several model features have been updated. The changes incorporate additional information collected on labor and energy use and updated equipment costs, and allow for more flexible allocation of labor by the owner-operator as well as the frequency of cheese making. The model is currently used within the Oregon State University dairy extension program.

Sensitivity Analysis

A sensitivity analysis was undertaken to determine which variables affected the model output the most. Each variable was manipulated by factors of 1.25 and 0.75 to obtain a wide range of resulting NPV model output. These single-variable resulting data points were then evaluated for their rate of change to find which variables had the most impact. A suburban location was used for all other variables during sensitivity analysis. The most sensitive variables are important factors that can be influenced by business decisions and should give future entrepreneurs a realistic sense of how an artisan cheese business system works. The sensitivity analysis, as shown in Figure 1, examined the effect of a 25% change in the parameter on NPV; the first value shown was for a decrease in the retail price, which reduced revenue and thus NPV, and the rest were for cost parameters where an increase in the parameter led to higher costs and thus lower NPV. The figure shows that product retail price, salary and wage rates, and milk price were the most influential parameters in the model. The geographical location, not shown, was also influential. It affects several parameters simultaneously, such as the number of marketing outlets and distance to outlets. Salary and wages are highly dependent upon the local employment market and will not be discussed further. This study focuses on the relationships between cheese price and plant

size or utilization, and the connection between cheese prices and cheese yield, cheese aging, and labor within a single geographical location.

As noted above, 3 studies are reported. The first examined economic feasibility across plant size for a single cheese style, the second estimated the break-even price across cheese styles and milk type and plant capacity in the same location, and the third explored the effect of operating below full capacity. These provide insight into important factors for a potential owner to consider when starting an operation. In reality, many variables are interrelated within these areas. Milk price, product yield, aging time, and retail pricing are all factors within cheese styles.

Model Assumptions

As with all models, data output was strongly linked to the assumptions used within the model. General assumptions used for the model are outlined in Table 1. Variables used for the 2 investigations are outlined in Tables 2 and 3. In this section, details will be provided on critical and complex assumptions.

Growth and Processing Days per Year. The model was developed based on artisan processors producing between 2,500 and 30,000 kg/yr. Thus, scenarios investigated within this study were selected within this production frame. Four stylized operation designs were created as representative examples to cover industry

Figure 1. Sensitivity analysis: Change in net present value (NPV) following a 25% change in model parameters. RT = round-trip.

Table 1. General assumptions utilized in model

Parameter	Assumptions and explanations
Business type	Sole proprietorship. Self-employment tax based on 2011 Internal Revenue Service requirements of 13.3% from \$0 to \$106,800 and 2.9% for taxable income above \$106,800 ¹
Business growth per year	33% for yr 1 to 3 to scale-up production and subsequent 3% annual growth from yr 4 to 15
Milk procurement	All milk was purchased. If operation was also a dairy farm (i.e., farmstead), the cost at which the milk could have been sold in the market was used to represent the opportunity cost of that milk.
Plant	Facility size was based on a regression of sizes observed in survey; assumed that all facilities were built from the ground up.
Equipment	New equipment pricing based on processing capacity requirements at the end of the study period in yr 15
Pasteurizer	Processing volume per batch <1,893 L (500 gal): low-temperature, long-time batch/vat combination was used; sizes varied. Processing volume per batch >1,893 L (500 gal): HTST system with separate cheese vat was used.
Labor	All labor was paid. Owner/operator-claimed income was moved to after taxes. The owner was assumed to work up to 50 h per week. The owner was set to first work as cheese maker, then if there was available time, moved on to sales and marketing, and finally to retailing.
Long-term investment depreciation	Using the Modified Accelerated Cost Recovery System (MACRS), the current US tax depreciation system ² : Food processing equipment: 7 yr Company vehicles, computer and administration equipment: 5 yr Facility/building: 20 yr
Inflation	A study period of 15 yr was used for the entire model. General inflation of 1.5%/yr was used for all facets of the operation.
Initial capital investment	20% of necessary initial capital was considered invested as a down payment on a loan. All other necessary funds were borrowed as a business loan compounded monthly. We assumed that payments were made monthly until loan was paid off.

¹Internal Revenue Service (2011).²Internal Revenue Service (2010).

conditions: 3,402 kg (7,500 lb) processing 52 d/yr, 6,804 kg (15,000 lb) processing 104 d/yr, 13,604 kg (30,000 lb) and 27,216 kg (60,000 lb) each processing 156 d/yr. These target volumes represent baseline production, which was allowed to increase at 3% for 15 yr. Following beta-testing in 2012 with cheese entrepreneurs, it became clear that the target processing volume could not be achieved in yr 1. Instead, the model assumed that it takes 3 yr to reach target volume. The model was updated to allow fewer processing days per year and can now be set for minimum and maximum number of days processing, rather than a constant rate. For the 4 operation designs in this analysis, cheese making could take place on as few as 26 d/yr, with maximums varying by target volume. Maximum days per year for the 4 target volumes were 52 d/yr for the smallest, 104 d/yr for the 6,804 kg plant, and at 156 d/yr for the 2 largest plants. Between the minimum and maximum settings, cheese-making days were calculated by dividing the year's target production by yield, multiplying that by milk weight per liter to get necessary liters,

and dividing the result by pasteurizer volume in liters. Thus, the pasteurizer will only be operated at full volume, except if this makes them pasteurize less than the predetermined minimum allowed days per year. This imposes an efficiency goal on the processor. The effects and probable exceptions to this are discussed in the results.

Product Pricing. In the model, a specific retail price can be set for the style of cheese offered, but the actual price received by the processor will be determined by the venue in which it is sold. The venues in the model included direct sales through company presence at farmers markets, onsite and online sales, wholesale to local retailers and restaurants, and finally sales through distributors. In this analysis, we assumed that the price received from wholesale buyers and distributors were 60 and 35% of the retail price, respectively. Therefore, if a cheese was sold for a \$48.50/kg (\$22.00/lb) retail price at a farmers market, the same cheese was sold for \$29.10/kg (\$13.20/lb) to wholesalers and \$16.98/kg (\$7.70/lb) to distributors.

Table 2. Variables in scenarios used in this study

Variable	Value used
Raw milk price	\$0.47/L (1.78/gal) for cow milk \$1.19/L (\$4.5/gal) for goat milk
Labor	Manager: \$20.00/h Cheese maker: \$45,000/yr Retail worker: \$10.00/h
Cost of gasoline	\$1.06/L (\$4/gal)
Creamery location	Suburban
Production volume for yr 3 after scale-up	Volume 1: 3,402 kg/yr (7,500 lb/yr) Volume 2: 6,804 kg/yr (15,000 lb/yr) Volume 3: 13,608 kg/yr (30,000 lb/yr) Volume 4: 27,216 kg/yr (60,000 lb/yr)
Minimum cheese production, d/yr	26
Maximum cheese production, d/yr	Scenario 1: 52 Scenario 2: 104 Scenario 3: 156 Scenario 4: 156
Business loan parameters	6% APR, 5 yr
Cost of property	\$0; assumed already own land
Average distance driven to farmers markets	97 km (60 miles)
Average distance driven each week to deliver product for wholesale (e.g., restaurants and local grocers)	320 km (200 miles)
Maximum days at farmers markets producer would be realistically able to attend per year	156 (3 d/wk year round)
Maximum number of retailer outlets available for wholesales	20
Product attributes: Gouda	Yield: 10% Aging: 150 d Retail price \$48.50/kg (\$22/lb) for scenario 1 only

Location. The location of an artisan creamery determines access to each venue. The model allows the number of farmers markets and wholesale buyers and average miles to each market type to be adjusted. For the scenarios tested in this study, we assumed that the creamery was located in a suburban setting with access to 3 farmers markets per week along with access to up

to 20 wholesale outlets. This was based on an evaluation of the situation in Oregon and on survey data, but it will vary considerably by region. Average weekly driving was set at 97 km for each farmers market visited and 320 km for delivery to wholesalers. Based on production volume, the model automatically pushes sales from farmers markets to direct (onsite and online) sales

Table 3. Operating costs used in model

Cost description	Equation or reference
Nonmilk ingredient ¹	Cultures: \$0.018/L (\$0.07/gal) of milk processed Rennet: \$0.013/L (\$0.05/gal) of milk processed Salt: \$0.008/L (\$0.03/gal) of milk processed
Milk cost ²	$\text{milk price} \times \frac{\text{yearly production}}{\text{product yield}}$
Sanitation ¹	Sanitation chemical cost estimates vary with processing size, e.g., for processing volume of: 75.7 L of milk/d cost of \$8.30 946 L of milk/d cost of \$15.47
Distribution (fuel) ³	$\frac{\text{km}}{\text{km/L}} \times g_s$, where km = distance to distribute product, km/L = fuel efficiency (8 km/L or 18 mi/gal) for company vehicle, and g_s = gas price per liter + 3% inflation
Labor ³	See labor subsection
Farmers market fees ²	\$60/d at market
Packaging ²	\$1.1/kg (\$0.50/lb) cheese
Marketing of product ²	1% of farmers market and 3% of all other revenues
Energy use; all electric	$y = 2.03 \times \frac{\text{cents}}{\text{kWh}} \times \text{yearly cheese production} + 1,065.24$, where electric cost per kWh can be modified by user

¹Sourced by industry supplier quotes.

²Artisan cheese company survey result.

³Variable in model that can be modified by users.

to wholesale buyers and then to distributors as each market is saturated. As agri-tourism is growing, more artisan cheese companies sell products onsite. For this analysis, we allowed for up to 10% of target production to be sold onsite or online. Sale of cheeses at these outlets is at full retail price with limited expense. Therefore, they are generally more profitable than selling at farmers markets, which is labor intensive and requires attendance fees. Based on market information, we assumed that a direct sales option cannot be achieved before establishment of market recognition; hence, not until farmers market sales have occurred.

Location is an important factor and, given a particular location, as annual production increases, the additional product must be sold through wholesale and then distributors at lower prices. Further study is planned to explore the location and buyer availability effects.

Shrink. The model also incorporated 20% shrink of products. This percentage was found to be typical among artisan cheese makers. The product loss is primarily due to sampling to customers and occasional destruction of inferior quality products. Although not incorporated into the model, in practice, this shrink percentage may not apply to cheese sold through a distributor. For the volumes examined in this analysis, only the 27,216 kg (60,000 lb) plant would be greatly affected because it was the only one that had large sales through a distributor.

Economic Feasibility Measures Used in Model

Net Present Value. Net present value was calculated for various scenarios to estimate the potential returns from the artisan cheese start-up and evaluate the potential risks. Net present value takes into account the time value of money as well as the initial capital investment; it is the sum of the initial and discounted future cash flows (Gitman, 2003):

$$NPV = \sum_{t=1}^n \frac{CF_t}{(1+k)^t} - CF_0,$$

where CF_0 = initial capital investment, CF_t = cash flow in year t , and k = discount rate utilized.

For the NPV calculation, it is assumed that the company is sold in the final year examined, and this value is added to the final cash flow. In this analysis, a discount rate of 10% was used to evaluate NPV. This was determined through evaluation of the risk associated with starting a specialty food business. The lowest cost of capital was determined to be debt financing at 6%,

and an additional risk of 4% was added for conservative calculations.

Retail Pricing Minimum Determination. The minimum product retail price was determined by using the Solver function in Excel to establish the retail price needed to achieve an NPV equal to zero. The Solver tool uses generalized reduced gradient (GRG2) nonlinear optimization code, which was created by Leon Lasdon (University of Texas, Austin) and Allan Waren (Cleveland State University, Cleveland, OH). It is important to note that this price is only received by the firm for direct sales, as previously discussed.

Break-Even Capacity Utilization. Solver was also used to determine the minimum viable operation level for each of the 4 operations designs over a range of base retail prices.

RESULTS AND DISCUSSION

Study 1: Effect of Production Volume on Business Feasibility

The objective of this study was to determine economic feasibility for a company producing one cheese, 5-mo-aged cow milk Gouda, sold at a set retail price of \$48.50/kg (\$22/lb). The total annual production volume by yr 3 was investigated at 4 volumes: 3,402 kg (7,500 lb), 6,804 kg (15,000 lb), 13,604 kg (30,000 lb), and 27,216 kg (60,000 lb). Economic feasibility was calculated by NPV, IRR, and PB.

Returns are, of course, dependent on the initial investment. For each size of plant processing and aging facility, requirements and cost are given for production of Gouda in Table 4. The processing building and aging facility costs are included with the equipment cost for each in Table 5. The move to the larger HTST pasteurizing system was evident for the largest plant. Noncapital additional funds needed before reaching capacity are also included in Table 5. These funds are based on a cash-flow situation where the start-up takes out a loan with a 20% down payment and the owner-operator is withdrawing wages (based on job tasks) after business taxes to live on. This is equivalent to what the owner-operator would pay if all tasks assigned to the owner-operator were paid to a hired individual but reflects the more usual situation for artisan cheese start-ups. This approach allows the investment to be viewed more stringently.

Capital budgeting is a common method used to evaluate efficient use of investment funds. Net present value is one indicator of how much potential value an investment could add to a business venture. The sum of

Table 4. Size and construction costs of processing facility and aging facility¹

Production volume, ² kg		Size of processing facility, ³ m ²	Cost of production facility, \$	Size of aging facility, m ²	Cost of aging facility, \$
Year 3	Year 15				
3,401 (7,500 lb)	4,850	79.7	128,700	21.8	30,376
6,804 (15,000 lb)	9,701	104.2	168,300	43.7	36,678
13,608 (30,000 lb)	19,401	136.2	219,900	87.3	49,282
27,216 (60,000 lb)	33,803	178.1	287,550	174.7	74,490

¹Four operation designs differed based on annual production capacity. Gouda cheeses aged for 150 d were produced in each scenario.

²Used as processing variable in scenarios; 3-yr scale-up target volume.

³Processing area not including aging facility or any sort of retail space.

each year's present value (discounted) cash flow results in an NPV value, giving insight into whether or not the investment is worth making. Generally, potential investments are only considered viable if the NPV is at least a positive number, meaning that a company will gain value by making the business investment with the time value of money in consideration (Gitman, 2003).

In Table 6, the feasibility of artisan Gouda processing in a stylized suburban location is displayed through NPV, IRR, and PB. The results show that, at the hypothesized \$48.50/kg (\$22/lb) price, the smallest operation is not economically feasible. Higher prices, that would bring the smaller plants to a positive NPV, have certainly been observed, but these results demonstrate that even artisan cheese makers benefit from returns to scale. This is consistent with observations made by the authors over the past few years. To remain profitable, smaller-scale artisan cheese operators have had to work long hours without being able to afford to hire sufficient help. Consequently, those who stayed too small have been most likely to quit. In addition, the farmstead operators, who must look after the herd and milking in addition to cheese making and sales, are also more likely to quit. An individual operating a small farmstead operation has no real time off between milking, cheese making, farmers markets, and marketing. It seems inevitable that such operations rarely persist beyond a decade of business, and the operator eventu-

ally concludes that the time needed is too long and opts out. Thus, the outcome of our model is consistent with the situation observed among artisan cheese processors.

Another option for smaller-scale operators is to diversify beyond sale of cheese. This could be done through sale of high-quality breeding stock in the case of farmstead producers, cheese-making lessons, and emphasis on agri-tourism. In addition, truly unique or prize-winning cheeses attract more distant buyers and allow the operator to achieve a price that could allow continued success on a small scale with mail order and high-end wholesale and distribution.

Study 2: Effects of Cheese Style, Milk Type, and Plant Size on the Retail Break-Even Price

The objective of this scenario was to examine the minimum cheese price, for different types of cheeses, needed to obtain an NPV of zero or above. Production volumes for all styles were 3,402 kg (7,500 lb), 6,804 kg (15,000 lb), 13,604 kg (30,000 lb), and 27,216 kg (60,000 lb). Variables used in the scenario are summarized in Tables 2 and 3. The cheeses selected were goat milk Gouda and chevre and cow milk Gouda, fresh whole-milk mozzarella, and Camembert. These cheeses range from fresh, high-yield cheeses to aged, lower-yield cheeses. Yields used in the model for Gouda, fresh mozzarella, chevre, and Camembert were 10, 14, 20, and

Table 5. Costs (\$) of artisan processing facility, aging room, equipment, and additional capital needed for first year of production: Gouda cheese

Item	Production volume, kg			
	3,402	6,804	13,608	27,216
Facility	128,700	168,300	219,900	287,550
Aging room	30,376	36,678	49,282	74,490
Equipment	122,746	122,746	128,247	300,014
Additional funds needed until positive cash flow ¹	285,721	206,495	142,089	134,586
Total	567,543	534,219	539,518	796,640

¹Cumulative amount in initial years of operation by which revenues are less than costs (i.e., until positive cash flow). Scenario for additional funds calculation includes a 5-yr building and equipment loan with 20% down payment. Amounts include wages for owner-operator.

Table 6. Net present value (NPV), internal rate of return (IRR), and payback period (PB) for Gouda-style cheese production sold at \$48.50/kg (\$22/lb) at 4 different annual production volumes

Production volume, kg	NPV, ¹ \$	IRR, ¹ %	Payback ² in year:
3,401 (7,500 lb)	−184,793	2.7	15
6,804 (15,000 lb)	142,986	13.8	10
13,608 (30,000 lb)	678,211	23.5	6
27,216 (60,000 lb)	1,161,450	25.8	5

¹NPV and IRR are calculated on 100% self-investment.

²Payback of a loan with 20% down payment on loan.

14%, respectively. Gouda cheeses were set to age for 150 d and Camembert for 24 d, whereas the 2 fresh cheeses were aged and stored for 2 d before sale.

Costs outlined in Figure 2 demonstrate reasons for differences in the required minimum price across target volume, milk type, and cheese style. Fixed costs include loan payments and licensing fees. The average was taken by dividing those costs by target production in yr 3. Because a 5-yr loan was used, these costs would decrease considerably after yr 5 and would also be lower under a longer loan period. Although 5-yr loans have been observed in the industry, it is possible that

a longer loan could be obtained, particularly for the processing building. The loan amount included equipment and facilities for processing and aging. Across the same-size plant, different cheese types had different equipment requirements. These equipment differences were small across cheese types compared with volume. Although moving to the HTST unit for Gouda for the 27,216 kg (60,000 lb) plant was costly, average fixed costs were still declining because the cost was spread over greater production.

Variable cost structure across the 5 cheese styles for a 6,804-kg (15,000 lb) plant is summarized in Figure 3. The primary differences were seen across milk cost due to both type and yield. Production labor costs primarily varied due to aging. Nonmilk ingredient and sanitation costs varied due to differences in the amount of milk processed.

Minimum retail cheese price required to obtain an NPV ≥0 for the 5 cheeses at 4 production volumes are given in Figure 4. The cheese prices calculated by the model were within the range of current prices for artisan cheese at specialty cheese counters. These prices were all based on recovering the cost of business start-up and operating costs. Underpricing products could

Figure 2. Cost analysis for 5 cheeses produced at 4 different annual production volumes. Average cost under each scenario in yr 3. Fixed costs assume that the loan was for 80% (20% down payment) of building and equipment investment on a 5-yr loan at 6%, divided by target volume produced for sale (after shrink) from yr 3 production. Variable cost includes all variable costs of operation in yr 3 also based on yr 3 production.

be detrimental to survival of a small company, whereas overpricing products could have a negative effect on demand, which would be equally detrimental to survival. Cost structures associated with different cheese types are outlined in more detail below.

Effect of Cheese Style. Cheese style determined several parameters that the sensitivity analysis showed to be important: product yield, cheese aging days (and thus aging room capacity or need), and cheese retail price. Milk price was also critical and was affected by animal type. When selecting a mix of products, management should consider current competition as well as feasibility of each style. Cash flow is affected by product mix; fresh cheeses can be sold immediately whereas aged cheeses are sold later. Goat cheese makers, who often run a seasonal production, produce fresh chevre throughout the milking season and add production of hard cheeses during the spring milk flush. Chevre and other fresh cheeses are sold during summer months at farmers markets, whereas hard cheeses are sold year round to ensure continued cash flow. However, for the analysis, only single styles and milk types were utilized.

Effect of Milk Type. Animal milk type, as differentiated by the model through raw milk price as an

ingredient cost, was the second largest contributor to COGS. The 2 most commonly used animal milk types for artisan cheese production are currently cow and goat milks. The price used for goat milk was \$1.16/L (\$4.50/gal), and cow milk was priced at \$0.47/L (\$1.78/gal). This price difference for raw milk translated into a price difference for goat and cow milk Goudas of \$9.20/kg for an annual production volume of 3,401 kg and \$14.34/kg for an annual production volume of 27,216 kg (Figure 4).

Effect of Yield. Milk cost, as a raw ingredient, was affected mainly by the product yield of each style. Because the model calculated production volume by final yield (kg) of cheese, the higher the yield of cheese, the less milk was required to produce it. For example, for goat milk Gouda at a production volume of 3,401 kg, raw milk made up 44% of COGS, whereas for chevre at the same production volume, raw milk made up 39% of COGS. Yield also affects equipment cost and thus the initial investment.

Effect of Aging. Most cheese types require approximately the same amount of labor during production. However, aging, especially for washed rind cheeses, can add significant hours of labor. Following the initial

Figure 3. Comparison of variable costs for 5 cheese styles for annual production of 6,804 kg (15,000 lb) in yr 3.

Figure 4. Average minimum retail price per kilogram and pound to achieve positive net present value across 5 cheese styles varied by level of annual production in yr 3.

survey used to develop the model (Bouma et al., 2014), we calculated that artisan cheese makers spend 0.00785 h/wk per kg of cheese (0.00357 h/wk per lb) caring for cheeses during aging. Aging of cheese requires space. Cheeses aged in plastic or wax need temperature-controlled storage. Naturally rinded cheeses, such as Gruyere, also require humidity and airflow control. The original survey determined that the space needed to age cheese was 0.01096 m²/kg (0.0535 ft²/lb) of cheese being aged in the space at one time. It was assumed that the ceilings were 2.44 m (8 ft) high. Cheese makers who use racks on wheels and move them around likely would not use racks that are this high due to the risk of tipping the racks over, because cheeses dropped on the floor must be destroyed. Therefore, such aging systems (racks on wheels) would need a larger surface area. Fresh cheeses, such as chevre and mozzarella, do not require aging. For this scenario, fresh cow milk mozzarella and Camembert had similar yields, whereas

Camembert was aged for 24 d and fresh mozzarella was refrigerated for 2 d and then sold. The difference in aging procedures added almost 7% to the price of Camembert cheese compared with the mozzarella. The cost of aging included the cost of constructing and operating the aging room, cost of caring for cheeses during aging, and the cost of carrying inventory. Selecting cheese types that require longer aging would increase cost of each of these 3 parameters. Table 7 contains estimates of total aging space required for cheese aged for 3, 6, and 12 mo at the 4 different production volumes. The estimates in Table 7 include space to accommodate not just the initial 3-yr scale-up but also the subsequent 1.5% annual production growth. The financial penalty for underestimating aging space requirements is severe because growth in production would require construction of additional aging rooms. However, it is worth noting that several cheese makers have difficulty regulating humidity in aging rooms that are partly empty.

In contrast, aging rooms that are full of cheese are easier to stabilize at the desired humidity level, perhaps because cheeses act as humidity buffers.

Effect of Production Capacity. The data in Figure 4 demonstrate economies of scale; the more cheese that is produced, the lower the cheese price needed to obtain zero or positive NPV (in this, we are examining NPV at the full capacity of each of the 4 operations designs; in study 3, capacity utilization is examined). However, some instructive anomalies occur. For Gouda-style cheese made from goat milk, there was a sharp increase in the minimum cheese price necessary to break even as production volume doubled from 13,608 to 27,216 kg/yr. At first, it appeared that the reason for this was that the model selects an HTST unit to accommodate pasteurization for the higher volume of raw milk required, given the lower milk yield for Gouda cheese and the scenario's maximum for processing days per year. Not only is the HTST unit significantly more expensive but it also requires an additional cleaning-in-place (CIP) system for cleaning and sanitation. Although the average total cost of production per unit of cheese is somewhat higher at this larger scale due to the cost of HTST equipment, the additional equipment cost is not the primary reason for the higher break-even price. After investigation, it became clear that in this instance of the break-even price, the price received from distributors (35% of retail) was too low to cover production costs of the additional units sold. Because cumulative discounted revenue just covers cumulative discounted costs, the break-even price still indicates a reasonable investment, but further investigation tells us that, at the break-even price, the firm could do better by keeping production below the amount that requires sales to distributors.

Distributor sales can, of course, be a profitable venue if the base retail price is sufficient. In addition, our assumption on the price sold through distributors is at the low end of the range, at 35% of the retail price. It incorporates a margin for both the retailer and the distributor. In reality, the percentage received may be somewhat higher. It could vary by the type of cheese; for example, fresh versus aged will make a great difference in the percentage of loss or increased handling cost in distribution. An award-winning, unique, or celebrated cheese might receive a better percentage due to the distributor's downstream buyers demanding it or because the distributor needs to supply variety that includes that type of product.

The soft cheeses evaluated had higher yields and therefore required less milk. Consequently, the critical point requiring scale-up to HTST would happen at a larger production volume than the volumes examined for the lower-yielding cheeses. In this analysis, cheese-making days were limited to no more than 3 d/wk for the large plants (2 and 1 d/wk for the smaller plants). For larger artisan operations, it may be reasonable to specialize in labor assignments and process more frequently. Willingness to process more days per week would allow a plant to avoid switching to an HTST pasteurizer. The exact cut-off point for this has not been investigated; moreover, processing more frequently would require sufficient processing area, and aging capacity would need to be added. The maximums are set to reflect a reasonable allocation of labor for an owner-operator. Ideally, the owner-operator can do all of the tasks of the operation for the smallest plant until they reach a size where they use hired labor for retailing at farmers markets. In calculating costs, the owner-operator is assigned the wage appropriate to the task allocated, not the salary of the alternate highest paid employee, which would be the cheese-maker. Evaluating the return on investment (ROI) in this way allows the tax considerations applying to an owner-operator to be incorporated in the evaluation. Owner-operators are the more usual situation for artisan cheese making, but only having them draw wages at the rate each task would normally receive retains the investment considerations that should be applied.

If the scenario was for a farmstead artisan cheese maker who cannot store milk for extended periods of time, the minimum threshold would be higher (farmstead artisan cheese makers typically need to process 2 to 3 times per week) and likely have inefficient labor and energy use, particularly during the start-up years. However, for the non-farmstead cheese maker, allowing milk-processing days to vary with intended production allows the model to assess costs based on a more

Table 7. Aging space requirements to hold the maximum capacity needs for cheese aged for 3, 6, and 12 mo at 4 different production volumes¹

Production volume, yr 3 [yr 15] ²	Total aging space required, m ²		
	3-mo aging time	6-mo aging time	12-mo aging time
3,401 [4,850]	13.10	26.20	53.14
6,804 [9,701]	26.2	52.40	106.28
13,608 [19,402]	52.40	104.79	212.56
27,216 [38,803]	104.79	209.68	425.22

¹The floor space required (m²) was calculated assuming a 2.44-m ceiling; if the ceiling were lower, the aging room area would consequently increase. A survey of current artisan cheese companies showed that a factor of 0.01096 m²/kg (0.0535 ft²/lb) of cheese in aging room at one time gave adequate space for inventory maneuverability.

²Value in brackets indicates the production volume at end of yr 15 following annual 1.5% production increases.

efficient production plan. A cheese-maker purchasing milk, as this model assumes, would be equally efficient with respect to pasteurizing volumes during the 3 start-up years. Such an operating plan is not unusual for larger bovine dairy farms that convert part of their milk production on site. These farmers generally have exclusive contracts with large creameries and must officially purchase milk back from the creamery although the milk does not leave the farm. Although this adds an additional cost, it allows for flexibility in scheduling cheese processing as they can purchase only the amount desired for cheese making.

Retail pricing in the artisan cheese industry, although still relatively dependent on customer acceptance and market competition, is flexible compared with that for commodity cheeses. Artisan cheeses can be found from \$15 to \$100 per kg depending on style, unit size, and company prestige. Our analysis demonstrates the large differences in prices that cheese makers may need to charge for different cheeses. Current competition in the market should always be considered when choosing cheese product offerings. Our model demonstrates that fresh high-yield cheeses have the lowest production cost and production cost decreases as production volume increases. Thus, a goat milk producer might want to produce large quantities of chevre. However, many markets are saturated with local chevre, which would make market entry challenging. In contrast, if the local market offers little competition for more expensive cheese styles such as Gouda, it is likely a better business decision to produce Gouda, as long as the price can be set high enough to justify the lower yield and the cost of aging.

Study 3: Effects of Retail Price on Minimum Capacity Utilization to Achieve Positive NPV

To explore operation feasibility under uncertain demand, we examined how far quantity produced could decrease for a given retail price and still allow for a break-even NPV, given the initial investment in plant and equipment. In Figure 5, the minimum feasible capacity utilization is shown at varying price levels. Each line shown is for 1 of the 4 design target (yr 3) capacities. The capital investment (plant and equipment) necessary to produce the target yr 3 scale-up production levels with their associated maximum days processing per year is held constant. Then, we solved for the lowest capacity utilization that could achieve a break-even NPV of \$0.0 for prices from \$39.68 to \$83.78/kg (\$18 to \$34/lb) in steps of \$0.907/kg (\$2/lb). The uppermost data point on each line is at the break-even price for each design at full capacity (final point not shown for the largest plant as it would double

Figure 5. Minimum break-even (BE) capacity utilization as retail price is varied for 4 levels of capital investment.

the length of the vertical axis). These points represent the break-even price at full capacity as shown in Figure 5 for cow milk Gouda. Only the 2 largest operation designs can operate feasibly at less than \$39.68/kg (\$18/lb). To clarify, if the processor receives prices to the left of the line, at that level of capacity utilization, negative NPV will result; prices to the right of the line will lead to positive NPV. Alternatively, levels of capacity utilization above the line also increase NPV at a given price, but the outcome is constrained by plant capacity, and thus the lines are cut off at their operation design target capacity.

At the lowest 2 production levels with original target productions of 3,402 kg (7,500 lb) and 6,804 kg (15,000 lb) of cheese per year, the necessary production levels to break even are very close because the overall capital

requirement for the larger plant is only 16% higher (equipment requirement is identical because one was constrained to process only 52 d/yr and the other 104 d/yr). The capital investment differences come from the additional processing and aging space. As can be observed, the break-even scale of operation at each price is close for the 3 smallest plant sizes, as building costs are increasing at a decreasing rate (Bouma et al., 2014). Although equipment investment is higher, the increases are at less than a 1:1 ratio, partly because the maximum number of processing days is allowed to increase to the equivalent of 2 to 3 times per week. In addition, processing equipment does not double in price with capacity. To give some perspective, the necessary difference in retail price needed between the 6,804-kg plant operating at only 3,402 kg (50% utilization) and the 3,402-kg plant operating at capacity is only \$1.87/kg (\$0.85/lb); the difference between the 13,608-kg plant operating at only 6,804 kg (50% utilization) and the 6,804-kg plant operating at capacity is only \$0.53/kg (\$0.24/lb).

The largest plant showed a much larger difference for feasible capacity utilization due to the increase in investment required by the switch to an HTST unit for pasteurization. However, that design also demonstrates the ability to operate at \$44.09/kg (\$18/lb) and could operate with a break-even price of \$44.09/kg (\$17.49/lb) at full capacity. If this plant were to operate at only 3,402 kg, the cheese would need to retail for at least $\$70.24/\text{kg} - \$56.20/\text{kg} = \$14.04/\text{kg}$ (\$6.37/lb) more than the 3,402-kg plant would, although at 50% capacity, it would only need \$1.83/kg (\$0.83/lb) higher retail price than the 13,608 kg design.

It is important to note that these results are based on the 15-yr period of investment, and that the baseline break-even capacities shown are for the yr 3 target capacity. All prior and future utilizations are still based on the original growth pattern: one-third of yr 3 production in the first year, two-thirds in the second year, and after yr 3, growing at 3% per year. In reality, the producer would be adapting to market conditions and should be optimizing production. These results simply help to understand how far an artisan cheese maker could reduce production and still (at least) break even.

These results demonstrate several critical factors related to capital investment. One is that although the greater capital investment necessary for the larger capacity plants may be difficult to acquire over time, that investment will not require much greater prices to succeed at lower capacity utilization. Furthermore, this offers much greater flexibility for growth and potential, via lower costs of production for greater returns.

The 4 operation designs select equipment needs, the size of the aging processing facilities to the target pro-

duction, and processing days permitted. The 2 smallest operation designs have the same equipment, but the larger of these has additional processing and aging space. The implications of these results are that the additional space allows for a great deal more flexibility in production and an increase in capacity to produce 13,608 kg (30,000 lb) without significantly increased cost.

These results do tend to favor the medium to larger production volumes, although perhaps not the largest, but there are certainly some caveats regarding the investment. With a larger operation design, the entrepreneur is more likely to be borrowing capital or borrowing more of it. In general, for an investment to be considered, the cost of capital should be less than the discount rate used in calculating the NPV. In this analysis, a discount rate of 10% was used, which is greater than the 6% borrowing rate observed. Thus, these break-even capacity utilizations are reasonable with respect to borrowing for part of the investment. However, we observed that our start-ups used relatively short-term loans, and meeting loan payments over a loan period as short as 5 yr, as was observed for part of our sample, would require additional cash flow, as shown in Table 5. A portion of the additional funds in the build-up years covers the wages for the owner-operator or alternative hired staff. However, the potential profitability and ability to operate successfully over time with lower average fixed costs is considerable. Information provided in this type of tool can be part of the business plan and provide a basis for negotiation with a bank for a longer-term loan.

CONCLUSIONS

The factors affecting the profitability of artisan cheese-makers explored in this paper include retail price, cheese type, and scale of operation. Important consideration must be given to these factors as well as other operating decisions to be sure that a company will reach their investment goals. The cheeses that could be sold for the lowest price due to lowest production cost were fresh, high-moisture cow milk cheeses such as fresh mozzarella. Nevertheless, it is not enough to focus on cost of goods sold. One should note that economic feasibility based on cash-flow calculations is not designed to optimize the level of production. The jump in the break-even price for goat Gouda production demonstrates that production-level break-even can be too high if the price received from a distributor is less than variable costs. The optimal production level in that circumstance would be below the level requiring sales through a distributor. Once again, this does not mean that sales through a distributor cannot be

profitable. It will depend on the actual price received from the distributor and costs at an individual plant. Greater understanding of these issues and the scale of operation could be critical for the long-term success of artisan cheese-makers. For the artisan start-up, the difficult point may be the transition from a self-operated concern to one that produces a higher level of output and hires assistants beyond those used for retailing at the farmers market. If the original facility design is not adequate for expansion, it may not be able to make the transition without further capital investment. A second aspect may be more attitudinal: if the start-up has not planned for how they will expand and manage labor and distribution, the day-to-day demands of the creamery may block consideration of next steps. The development of a business plan that includes a strategy for stepwise expansion in terms of staffing, buildings, and equipment should assist in this preparation.

REFERENCES

- Becker, K. M., R. L. Parsons, J. Kolodinsky, and G. N. Matiru. 2007. A cost and returns evaluation of alternative dairy products to determine capital investment and operational feasibility of a small-scale dairy processing facility. *J. Dairy Sci.* 90:2506–2516.
- Bouma, A., C. Durham, and L. Meunier-Goddik. 2014. Start-up and operating costs for artisan cheese companies. *J. Dairy Sci.* 97:3964–3972.
- Brigham, E. F. 1985. *Financial Management: Theory and Practice*. Atlantic Publishers, Ocala, FL.
- Caldwell, G. 2010. *The Small Scale Cheese Business. The Complete Guide to Running a Successful Farmstead Creamery*. Chelsea Green Publishing, White River Junction, VT.
- Microsoft Excel. Define and solve a problem by using Solver. Accessed Feb. 19, 2015. <https://support.office.com/en-US/article/Define-and-solve-a-problem-by-using-Solver-9ed03c9f-7caf-4d99-bb6d-078f96d1652c?ui=en-US&rs=en-US&ad=US>.
- Franklin, A. W., and R. W. Cotterill. 1994. *Pricing and Market Strategies in the National Branded Cheese Industry*. Food Marketing Policy Center Research Report No. 26. University of Connecticut, Storrs, CT.
- Gitman, L. J. 2003. *Principles of Managerial Finance: Brief*. 3rd ed. Pearson Education Inc., Boston, MA.
- Internal Revenue Service (IRS). 2010. *How to Depreciate Property*. IRS Publication 946. IRS, Washington, DC.
- Internal Revenue Service. 2011. *Self-Employment Tax (Social Security and Medicare Taxes)*. <http://www.irs.gov/Businesses/Small-Businesses-&Self-Employed/Self-Employment-Tax-Social-Security-and-Medicare-Taxes>.
- Nicholson, C., and M. Stephenson. 2007. *Financial performance value-added dairy operations in New York, Vermont and Wisconsin*. Agric. Appl. Econ. Assoc. Annu. Mtg., Portland, Oregon. Agricultural and Applied Economics Association, Portland, OR.