8-2022

Tennessee Value-Added Dairy: State of the Industry, Consumer Perceptions, and Investment Opportunities

Caitlin Zaring
czaring@vols.utk.edu

To the Graduate Council:

I am submitting herewith a thesis written by Caitlin Zaring entitled "Tennessee Value-Added Dairy: State of the Industry, Consumer Perceptions, and Investment Opportunities." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

Elizabeth A. Eckelkamp, Major Professor

We have read this thesis and recommend its acceptance:

Mark T. Morgan, Kim L. Jensen, Jennie LZ. Ivey

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Tennessee Value-Added Dairy: State of the Industry, Consumer Perceptions, and Investment Opportunities

A Thesis Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Caitlin Samantha Zaring

August 2022

This thesis is dedicated to my best friend and the world's best Nana. Not a day goes by that I don't think about you and miss you.

Acknowledgments

I would like to start by thanking my parents, Pete and Sherrie Zaring. It's hard to express into words how grateful I am for your love and support. You have shown me how to be strong, confident, and to not stop until I've surpassed my goals. Daddy, you've shown me what it means to work hard and constantly reminded me to do what makes me happy. Mom, you've taught me that women can be strong and successful, and you constantly remind me. I would not be who I am or where I am without you, so thank you. Next, I'd like to thank Jaren Weir. You've been my rock. You work harder than anyone I know, and still manage to have energy to keep me smiling and laughing. Thank you for listening to me when I have a bad day or am stressed, and for supporting my decision to continue my education.

Thank you to all my office mates and graduate students in the department, I have loved getting to know each of you. Thank you Malerie, Abby, Cassidy, Beatrice, and Alison for being a wonderful support system through this process. I'd also like to thank my lab mates Arup and Abby and the DBII support team, Shep and Dana, for all your help with classes, conducting surveys, practicing presentations with me, and reading and editing my writing. I could not have done it without all of you.

I would like to thank my committee members Dr. Kim Jensen, Dr. Mark Morgan, Dr. Jennie Ivey. Each of you have taken time out of your schedules to mentor, push, and encourage me throughout this process, and I cannot thank you enough. Additionally, I would like to thank all of the farmers and processors who allowed me to come to your operation and flood you with questions about your operation and finances. Thank you for being so open, honest, and gracious. I would like to thank the members of the Center for Profitable Agriculture (CPA) and the

Tennessee Department of Agriculture for answering my many questions throughout these past two years. A special thank you to Hal Pepper of CPA. Hal, your kindness to me, faith in me, and enthusiasm for me have been more than I could ever ask for. It has been a pleasure to get to know you and I cannot wait to continue to work with you for the next few years at least.

Finally, I would like to thank Liz for agreeing to take me as a MS student, and soon, a PhD student. Liz, you have had a level of confidence in me that I never expected. You have not only pushed me to be the best student I can be, but you have pushed me well beyond where I thought I could be. You have encouraged and supported me even when I was at my wit's end. Because of you I have learned more about the dairy industry than I ever thought I would be able to. Thank you for giving me the opportunity to learn about and experience youth and adult extension, visit dairy processing plants and learn the processes used, and to learn different economic tools to help the dairy industry. I cannot express how grateful I am for all the time you've spent mentoring me. Thank you for everything and I cannot wait to continue working with you and learning from you.

Abstract

Value-added dairy enterprises (**VAD**) may increase profits and supplement a dairy farmer's income. Three studies were developed to assess Tennessee (**TN)** VAD, describe the VAD product consumer market, and assist current (**C**) and prospective (**P**) VAD with decisions before entering or expanding an operation. A 50-question in-person survey was administered to C and P VAD (n = 9 and n = 7, respectively) from June 2020 to September 2021. Surveys results showed that fluid products (n = 17) and cheeses (n = 13) were the most common. Most C and P VAD were financially sound (< 40% debt to asset ratio), with four making a profit, and three not breaking even. Most C VAD income came from farming activities, while most P VAD income came from off-farm. To assess consumer familiarity and attitudes toward purchasing farmstead milk (**FSM**), a 90-question online consumer survey was distributed through Qualtrics from March to May 2021 to adult Tennessee residents who at least occasionally consumed dairy products and were a primary household food shopper. 817 completed surveys were obtained. Respondent age and local foods purchase frequency impacted FSM familiarity and purchase likelihood. Other impacts were farm background, marriage, locations, gender, and dairy foods budget. Younger respondents with a local foods preference were more likely to be familiar with and purchase FSM. An excel-based decision-making tool to gauge initial investment, processing time, and a profitability timeline for a VAD enterprise was designed and validated using seven scenarios against four equipment options. Scenarios tested change in herd size (69, 462, and 690 cows), mean daily production per cow (22, 28, and 33 kg), and herd percentage processed (7, 61, 100%). Nine of 28 options had < 8 hr processing time and ≤ 20 yr profitable timeline. Scenarios with 69 head or 7% of herd used were not profitable. A profitable projected timeline for feasible

scenarios was 5.13 ± 2.10 yr and net-present value was $1,964,448 ± 1,128,623. This study provided information about TN VAD enterprises, consumer familiarity and preferences for FSM, and a financial feasibility analysis tool for those entrepreneurs interested in a TN VAD.

Table of Contents

List of Tables

List of Figures

Chapter 1 – Review of literature

Introduction

The Tennessee dairy industry has seen significant re-structuring throughout the years, with the number of dairy farms declining from 2,398 in 1975 (Snell and Martin, 1976) to 156 in January 2022 (J. Strasser, Tennessee Department of Agriculture, Nashville, TN, personal communication). Some dairy farmers have interest in adding value to their dairy products through on-farm processing into bottled milk or packaged products such as ice cream, yogurt, cheeses, and other processed dairy products. While dairy industry participants are interested in adding value, research regarding the feasibility of adding value through on-farm processing is lacking or was performed several years ago, thus limited research has been published regarding value-added dairy operations. However, published literature included several types of value-added products: produce, meats and other animal products, seafoods, and flowers. Each value-added operation had lessons to be learned from and applied towards value-added dairy. Consumer perceptions and willingness to pay premiums have been researched extensively through local agricultural products, with the majority of value-added dairy research having been conducted here. Literature provided few resources for the economic feasibility of value-added operation, but provided much information on the declining state of the dairy industry, possible reasons for this decline, and producer and farm economics. The purpose of this literature review was to describe the state of the value-added agriculture markets, identify consumers perceptions, describe premiums for value-added products, outline characteristics of value-added consumers, describe current dairy industry economics, and determine the need for value-added dairy operations.

Value-added agriculture

The United States Department of Agriculture (**USDA**) defined value-added agriculture (**VAA**) in three ways: 1) changing the physical state or form of a product into a superior form, 2) segregating the product in a way to enhance product value, and 3) producing a product in a way that enhances its value (Agricultural Marketing Service [AMS], 2020). Changing physical state could be done by processing raw milk into bottled milk or other dairy products (Coltrain et al., 2000; Born and Bachmann, 2006; Lev et al., 2018). Segregating the product could be accomplished by labeling milk produced in Tennessee with the TN Milk logo or by marketing the farm's story as the oldest family-owned dairy farm in the state (Lu and Dudensing, 2015). Producing a product could be done by raising and marketing organic dairy cattle, fruits vegetables, etc. State and federal support of VAA began with Bank of North Dakota grants that aided start-up value-added (**VA**) processors in 1919 (Kilkenny and Schluter, 2001). One hundred years later in 2019, every US state had at least one VAA grant program (U.S. Department of Agriculture [USDA], 2019, 2021). As the number of VAA programs have grown, the agriculture industries involved have grown. Currently, VA industries include: fruits and vegetables, flowers, fresh and saltwater seafoods, avians, mammals, and insects.

Value-added horticulture. Value-added can include parts of an agriculture products, such as citrus peels. Currently used as animal feed or discarded entirely (Garcia-Castello et al., 2015), citrus peels contained polyphenols which have many health benefits including anti-carcinogen, anti-viral, and anti-inflammatory properties (Oboh and Ademosun, 2012; Gómez-Mejía et al., 2019). Gómez-Mejía et al. (2019) reported that clementine, orange, and lemon peels have phenolic compounds such as hesperidin, rutin, and naringin. These compounds were used in cosmetics, dietary supplements, food additives, and pharmaceuticals as preventative therapies for various diseases. Another example of VA produce came from Brazil's mushroom and banana industries. Bananas were Brazil's third most exported fruits (FAOSTAT, 2022) and oyster mushrooms were the most grown mushroom in Brazil (de Siqueira et al., 2011). Carvalho et al. (2012) proposed using banana tree waste as a medium to grow oyster mushrooms due to its low to no cost and abundance. A common theme emerged from these two industries that was seen throughout most of the other industries, utilization of waste materials destined for waste disposal. Value-added mushrooms and agritourism were seen in Michigan by certified and recreational morel foragers (Malone et al., 2022). Morel harvest season occurred from late April to mid-June, with peak period in May (Michigan Department of Natural Resources, 2022). Ranging from < $66/kg to > $220/kg, with certified foragers having sold on average $79.20/kg and recreational foragers morel value at $93 total, fresh morels were seen as a way to make a small profit. When foragers began to save the morels for out of season sales or for distant market sales by drying and preserving the morels, a value-added venture was seen and prices spiked to $2,200/kg (Malone et al., 2022). Finger millets, a type of grain, was a common food source in India and surrounding regions (Verma and Patel, 2013). Often used in flour-based foods such as unleavened pancakes, dumplings, and porridge, finger millets were seen as a good source of minerals like magnesium, manganese, and phosphorous. These minerals were linked to a reduced risk of heart attacks and seen to be important for the development of tissues and energy metabolism, lowering cholesterol levels and reduced cancer risks (Shashi et al., 2007). Verma and Patel (2013) saw that by advertising the health benefits and creating new and non-traditional methods to consume finger millet, consumers were at a higher likelihood to purchase and consume finger millet. Another common thread seen among these industries was the use of various product forms to add value to a product, through cooking or preserving.

Value-added animal agriculture. Fish byproducts have been a potential VA route for decades as most byproducts were discarded (Rustad, 2003). More than 82 billion kilograms of seafoods were caught annually with nearly 25% by weight discarded annually (Rustad, 2003). Byproducts (heads, viscera, bone, skin, etc.) could be used in agriculture and foods or pharmaceuticals, adding value to products otherwise discarded. Some fisheries partook in the VA opportunities through sale of cod-head fertilizer in Norway (Rustad, 2003), roe, fried fish milt, fish oil supplements, and fish skin pet treats.

Another way to add value to a product was through genetics. McMillin and Brock (2005) found that the small ruminant industry, particularly goats, used genetic selection and diets to alter or add value. Flavor and fat content of goat meat has been repeatedly affected by the use of high concentrate diets (McMillin and Brock, 2005); this was also seen in cattle, sheep, and pigs (Warren et al., 2008; Wood et al., 2008). Another way McMillin and Brock (2005) reported adding value to goat meat was through higher priced smoked or fermented sausages. Another common value-added route was freezer meats, most commonly beef. Lesser (1979) reported that of New York’s beef producers, half sold some direct to consumer or freezer beef (approximately one-third of the beef sold in the state). Part of the appeal for these farmers was the ability to retain higher margin portions in areas of low packer concentration and high assembly cost (Lesser, 1979).

Hunting and trapping were other VA opportunities, providing billions to USA and Canada’s economies annually (Leitch et al., 1993; Arnett and Southwick, 2015). In North

Dakota, hunters and trappers of furbearing mammals (top five by profit in ND: red foxes, coyotes, racoons, minks, and beavers) harvested nearly $500,000 worth of raw furs annually (Leitch et al., 1993). Harvesters spent approximately $30,000,000 annually on hunting and trapping that goes back to North Dakota's economy (Leitch et al., 1993); this did not include prices of processed furs for sale. Leitch et al. (1993) reported an additional $12,000,000 annually in non-monetary enjoyment—something common among value-added processors. Value-added consisted not only of profits to be made and captured, but also intangible benefits such as social aspects. Hunting was considered a form of agritourism by the author. A 2012 survey revealed that 2.1 million Canadians spent $14,500,000 on nature related activities, and among this was $1,800,000 that went towards non-commercial hunting and trapping (approximately $996/person; Shulman, 2014). A 2011 survey reported that 13.7 million Americans (≥ 16 years) spent $33,700,000 on hunting and trapping (U.S. Fish and Wildlife Service, 2009). In 2006, hunting and trapping related activities resulted in 6.1 million jobs and generated $79,600,000 in tax revenues (Outdoor Industry Association, 2012). From these agritourism or VA hunting activities, consumers' money went to items both tangible (hunting licenses, traps, firearms, trapping wire, etc.) and intangible (social benefits, environmental benefits, conservation of species). The goal of each VA opportunity was to increase profitability through the sale of something otherwise designated for waste, reduce costs, and obtain intangible benefits. Each of these prior discussed industries capitalize on making money from an item otherwise designated as waste and on increasing profits through an act like agritourism. When considering a dairy operation that either produces or purchases in raw milk and then processes it into a dairy product such as bottled milk, cheese, or yogurt, this is called a value-added dairy (**VAD**). This type of operation focuses on building a new product from raw milk.

Additionally, VAA has involved marketing techniques (AMS, 2020). Included here were organic (Álverez Pinilla et al., 2018), non-GMO and rBST-free (Lu and Dudensing, 2015), grass fed or pasture raised, cage-free or free-range (Lu and Dudensing, 2015), humane, sustainable, and local promotional programs (Patterson et al., 1999; Keeling Bond et al., 2009; Khachatryan et al., 2018; DeLong et al., 2020). As seen earlier with citrus and other products health benefits—value can be added by marketing or promoting health benefits such as cancer-fighting abilities of milk and milk products with high conjugated linoleic acid (**CLA**) concentrations (Shantha et al., 1995; MacDonald, 2000; Maynard and Franklin, 2003). Another marketing technique that was often synonymous with VA was the term “local.” In a Tennessee (**TN**) consumer study about milk purchases, respondents associated local milk with being locally owned, processed, and farm to table, or "value-added" (Eckelkamp et al., 2021).

Consumers’ definition of local varied throughout the literature and a singular definition of “local” had yet to be identified. A survey of 1052 USA consumers found that the label “locally grown” was most associated (> 70%) with products sold within 80.5 km of their production location (Onozaka et al., 2010). A survey of the “Made with Tennessee Milk” logo reported that consumers considered dairy products local if they could be obtained within 109 km (Upendram et al., 2019), a slightly wider range than that seen by the prior study. Consumers from Washington decided a local definition ended at the state’s borders, but some producers defined local as their county and the adjacent counties despite their proximity to large urban markets (Ostrom, 2006). A southeast Missouri mail survey found that locally grown was defined as regional, even if that meant crossing state boundaries (Brown, 2003).

Nicholson and Stephenson (2007) surveyed 27 cattle and small ruminant VAD operations in New York, Wisconsin, and Vermont. They found that cheese was most commonly produced, followed by fluid milk and yogurt. Supplemental products were ice cream, butter, and cream (Nicholson and Stephenson, 2007). These VAD operations were operational approximately six years, with 17 processing ≤ 3 year and 6 processing > 10 year (n = 27 surveys). The mean years farming for cow dairies was 6.9 ± 17.7 year and processing 6.5 ± 13.3 year (n = 17). Surveyed VAD operations produced 255,926 ± 239,702 kg of milk annually, and of this 123,665 ± 138,675 kg were processed annually (48% of production). These VAD operations had 43 ± 33 mature animals (cattle, sheep, or goats; Nicholson and Stephenson, 2007). Another group surveyed VAD operations (n = 31 respondents) through an online platform and reported that 64% of respondents had been involved in on-farm processing < 10 yr (Smith et al., 2013). Additionally, they found that 69% of VAD operations made cheese, 59% made milk, 31% made ice cream, 25% yogurt, and 21% butter.

Challenges and opportunities. Worldwide, VA processors shared the same concerns and hopes for their industries. In the Idukki district in India, VAA was comprised of bio-manure, food processing, nurseries, grading and sorting, drying and warehousing, and plantation tourism (Emmanuel et al., 2018). Most respondents were involved in food processing (n = 13; 22% of 60 total respondents; Emmanuel et al., 2018). Respondents were asked what problems faced the VAA industry and the top two most common factors were climate conditions and economics. Economic concerns included: lack of government financial support, high marketing costs, high tariffs, and difficulty obtaining loans. Lack of training was stated at the most common weakness in VAA (Emmanuel et al., 2018). A study of 81 selected TN dairy farms reported that primary contributors to success of an operation included increased milk production per head, reception of higher than average milk price, increased numbers of milked dairy cattle, and the ability to have controlled feed costs per cow (Haden and Johnson, 1989). A survey by Smith et al. (2013) asked respondents to state factors influencing their decision to start a VAD operation. These included commodity milk price (61%; n = 19), desire to work with the public (41%; n = 13), opportunity to promote dairy industry (39%; n = 12), desire to maintain or expand a family operation (29%; n = 9), and product differentiation (16%; n = 5). When asked the most difficult part in starting a VA business, 26% of respondents said state and federal regulations (n = 8), 19% responded product marketing (n = 6), and 17% responded securing funding (n = 5). When asked "If you had to do it all over again, would you?" 26 respondents said yes (84%). Smith et al. (2013) also asked respondents to state their level of satisfaction with their decision to start a VAD operation, 52% of respondents were extremely satisfied and 45% were satisfied (n = 16 and n = 14, respectively). Only one respondent stated they were neutral (Smith et al., 2013). These surveys showed that economics had a strong impact on a VA business, but despite this, the majority of those in a VA operation were satisfied with their operation. Smith's study reiterated what was learned from the other VA sectors, such as hunting and foraging, that there are intrinsic benefits to a VA business.

Consumer preferences and premiums

Evaluation of consumer desires within a market area were often done through different survey types. Marketing research surveys included brand, consumer experience, market, and product surveys (QualtricsXM, 2020). These were done in person, over the phone, by mail, or online. Brand and consumer experience surveys were used when assessing a specific company, such as determining why a consumer chooses one product over the competitors' products. Market surveys were used to determine product availability and diversity. Product surveys were used to determine what a consumer was drawn to and what they were willing to buy. Market and product surveys were the most useful for starting or expanding a VAD operation.

Consumer preferences

Product surveys, or consumer perception and willingness to pay (**WTP**) surveys, of local products were used for decades, primarily in the 1990s (Adelaja et al., 1990; Gallons et al., 1998; Patterson et al., 1999) and 2000s (Brown, 2003; Maynard et al., 2003; Keeling Bond et al., 2009). One study found that consumers cared more about who produced, processed, and marketed the food than if it was within their state or region (Hand and Martinez, 2010). This finding suggested consumers placed more value on the farmer interaction than production in a specific region, state, or county. Onozaka et al. (2010) reported that consumers believed availability of local products was the largest point of concern. Certain perceptions were closely associated with local foods. These included food characteristics, environmental and health effects, and economic effects.

Food characteristics included: freshness, taste, shelf-life and safety, and quality. Respondents agreed that local TN milk and milk products would be fresher than those non-local or out of state (Upendram et al., 2019; Regmi et al., 2020; Jensen et al., 2021). Tennessee grown and sold produce (apples (n = 216), broccoli (n = 224), cabbage (n = 228), peaches (n = 228), and tomatoes (n = 229)) was perceived by consumers to be either the same as or better (40.6%, 25.4%, 36.4%, 37.2%, and 67.2%, respectively) than out-of-state grown produce every time when the "do not know" category was excluded (Brooker et al., 1987). This same survey also found 43.8% of respondents believed in-state grown apples would taste the same or better than out of state grown, 25.9% for broccoli, 36% for cabbage, 33.8% for peaches, and 66.8% for tomatoes (Brooker et al., 1987). In another study, most respondents believed dairy products labeled as “Made with Tennessee Milk” (**MTML**) tasted better than other dairy products without this label (Upendram et al., 2019). Brooker et al. (1987) found that 35% of respondents believed in-state grown apples would have a longer shelf life than out-of-state grown apples, 22.8% for broccoli, 34.2% for cabbage, 33.8% for peaches, and 57.7% for tomatoes, when the “do not know” category was removed. Findings from the Brooker et al. (1987) study that showed tomatoes were highly viewed as tasting better, being fresher, and having a longer shelf-life are all expected due to the prominence of the “Granger Tomato”; a granger tomato is a tomato produced in Granger County, TN; they are a well-known VAA product in TN. One survey found that respondents neither agreed nor disagreed with the statement that dairy products labeled “MTML” were safer than those without (Regmi et al., 2020). New on-farm processed milk consumers agreed with this previous finding and had no opinion on safety of on-farm processed milk, while repeat on-farm processed milk consumers disagreed and believed it was safer than milk not processed on-farm (Jensen et al., 2021). Finally, inattentive repeat consumers believed that on-farm processed milk was of higher quality than other milk, while attentive repeat, inattentive new, and attentive new consumers did not perceive a difference in quality between on-farm processed milk and alternatives (Jensen et al., 2021).

Environmental and health effects of local VA products included: being better for the environment, carbon footprint reduction, maintained farmland, and general health benefits. Onozaka et al. (2010) found that consumers believed there were additional health benefits of local products and that through the purchase of local products, consumers were helping maintain farmland in the corresponding area. Three Tennessee studies found that respondents believed local dairy products were better for the environment than non-local dairy products (Upendram et al., 2019; Regmi et al., 2020; Jensen et al., 2021). Jensen et al. (2021) also found that inattentive and repeat customers thought on-farm processed milk helped reduce their carbon footprint, while new consumers and attentive repeat consumers were neutral on the subject. Economic perceptions were also explored throughout literature. Multiple surveys concluded that respondents believed local products would support the local and state economy and provide fair returns to farmers to support the farm's income (Onozaka et al., 2010; Upendram et al., 2019; Regmi et al., 2020; Upendram et al., 2019; Jensen et al., 2021).

Profiles of value-added product consumers

Many studies have attempted to profile a likely VA consumer. However, a single and consistent profile had yet to be created due to the variation among location and consumer populations. An online survey conducted through Qualtrics found that gender did not affect consumers' decisions to purchase milk labeled with a "Tennessee Milk" logo (**TML**; Delong et al., 2020). This finding confirmed prior VAA research findings (Patterson et al., 1999; Brown, 2003; Zepeda and Li, 2006; Khachatryan et al., 2018; Regmi et al., 2020), but contradicted others. One Iranian study found females were more likely to purchase full fat yogurt ($P < 0.10$) and cream cheese ($P < 0.001$; Ahmadi Kaliji et al., 2019), but males were more likely to purchase butter ($P < 0.10$; Ahmadi Kaliji et al., 2019). Best and Wolfe (2009) conducted telephone surveys of southeastern USA consumers and reported that males had a higher purchase likelihood of locally produced dairy products, which conflicted with research previously discussed. Another demographic where conflicting results were seen was consumer age. The majority of research suggested that age had no impact on consumers' knowledge of or purchase likelihood (**PL**) of VAA products (Patterson et al., 1999; Brown, 2003; Zepeda and Li, 2006; DeLong et al., 2020; Regmi et al., 2020). Ahmadi Kaliji et al. (2019) reported that as age increased, respondents were more likely to purchase lowfat yogurt ($P < 0.001$) and butter ($P < 0.05$). Another study found that those between 25 and 64 yr had a higher PL of local dairy products (Best and Wolfe, 2009). Despite these findings, Khachatryan et al. (2018) found that older participants were less likely to purchase in-state produced ornamental plants ($P < 0.001$) and Keeling Bond et al. (2009) found that older and single consumers were less likely to purchase local produce ($P < 0.05$) than young, married individuals. Literature provided a nearly even split regarding the impact of race on VAA purchases. Khanal et al. (2020) found that Caucasians were 2.5% more likely to exhibit a local bias, or a probability of choosing local foods over non-local, than other races ($P < 0.01$). This coincided with findings from Keeling Bond et al. (2009). Other research found that race had no impact on PL of VAA products (Zepeda and Li, 2006; Delong et al., 2020), and yet another study found that Caucasians had a lower PL of *Arizona Grown* produce (Patterson et al., 1999).

Few research has been conducted to determine the impact of working or living on a farm on PL of VAA products. The same was seen true for respondents' area of residence, whether urban or rural. Brown (2003) surveyed respondents in southeast Missouri (n = 544) and reported that those with a farm background who lived in a rural location were more likely to search out locally grown foods. Conversely, DeLong et al. (2020) reported that a farm background did not influence a consumer's decision to purchase milk with a TML. Another subsequent study found that neither farm background nor rural location impacted a consumer's choice to purchase MTML (Regmi et al., 2020). Patterson et al., (1999) reported rural locations were less likely to prefer local foods, but a 2009 study found that consumers in urban areas, were less likely to purchase local foods (Keeling Bond et al., 2009). One of the few consumer demographics that was consistent was the impact of children. Most research asserted that the presence of children has a positive impact on PL of VAA products (Best and Wolfe, 2009; Patterson et al., 1999; Khanal et al., 2020). However, household size was not a consistent predictor. Khanal et al. (2020) found as household size increased by one, respondents were 0.4% less likely to prefer local products ($P < 0.01$). However, other researchers found a positive relationship between household size and PL of local foods (Khachatryan et al., 2015; Zepeda and Li, 2006). Yet a TN study found that no association was seen between PL and household size (Delong et al., 2020).

Family economics played a role in consumers decision to purchase local or VAA products. Annual household income had split effects on PL of VAA products. Best and Wolfe (2009) reported having an annual income > $30,000 had a positive impact on PL, while another survey found that an annual income of > $66,000 increased PL of local by 1.5% over non-local ($P < 0.01$; Khanal et al., 2020). Other studies found that annual household income had no impact on knowledge of and PL for VAA products (Patterson et al., 1999; Brown, 2003; Delong et al., 2020; and Regmi et al., 2020). Yet, other studies reported that the higher the annual income, the less likely a consumer was to purchase VAA and local products (Zepeda and Li 2006; Khachatryan et al., 2015; Ahmadi Kaliji et al., 2019).

Literature reported that a respondent's educational status either had no significant effect on (Brown, 2003; Zepeda and Li, 2006; Khachatryan et al., 2015; DeLong et al, 2020; Regmi et al 2020) or had a positive effect on knowledge of and PL for VAA and local products. College graduates with a bachelor's degree or higher had a greater knowledge of and PL of VAA products (Patterson et al., 1999; Best and Wolfe, 2009). Khanal et al. (2020) reported that respondents with at least a high school education were slightly more likely to choose local foods (0.006; $P < 0.05$). A TML survey found that as consumers spent more money on milk per months, respondents were more likely to purchase milk with a TML ($P < 0.05$), and that as their weekly budget of milk increased by $10, consumers were 7% more likely to purchase logoed milk ($P < 0.05$; DeLong et al., 2020).

Other factors that influenced consumers decision to purchase local VAA products were knowledge of, location, price, perceptions, and labeling. Patterson et al. (1999) found that knowledge of *Arizona Grown* products promoted preference for local products with the *Arizona Grown* logo. Massachusetts and New Hampshire consumers were less likely to choose local dairy products (-0.002 and -0.045, respectively; $P < 0.01$), but those in Maine, Rhode Island, and Vermont were more likely to choose local dairy products (0.00, 0.011, and 0.056, respectively; $P < 0.01$; Khanal et al., 2020). As price of local VAD products increased, respondents were less likely to purchase dairy products ($P < 0.001$; Ahmadi Kaliji et al., 2019). A TN milk survey found that as TN milk price increased by $1, consumers were 29% less likely to purchase TML milk ($P < 0.01$), and as consumers had a higher WTP for local foods, PL of TML milk increased by 4% ($P < 0.01$; DeLong et al., 2020). The same study reported that if consumers purchased organic milk, they were 12% more likely to purchase TN milk ($P < 0.05$; DeLong et al., 2020). Consistent with the prior study, Florida residents had a higher PL for locally grown ornamental plants than imported plants ($P < 0.001$; Khachatryan et al., 2015). Certified organic and organically produced, non-certified, ornamental plants commanded a higher PL when compared to conventionally produced plants ($P < 0.001$; Khachatryan et al., 2015). Those who felt local foods were of better quality, were slightly more likely (0.065%) to choose milk made in TN ($P < 0.05$; Regmi et al., 2020).

Accepted consumer premiums for value-added products

The type of consumer and what products they were drawn to purchasing impacted their WTP for VA products. A study by Maynard and Franklin (2003) found that health-conscious consumers appeared more willing to pay premiums for dairy products with high CLA due to their perceived cancer-fighting effects. Consumers were willing to pay $0.064 more per liter for high-CLA milk, $0.532/kg of high CLA butter, and $0.427/L of high CLA yogurt (Maynard and Franklin, 2003). Hu et al. (2011) found that consumers with diabetes or heart disease were not willing to pay a premium for VA blueberry products. Best and Wolfe (2009) found consumers (n = 679) who frequently shopped for and purchased premium food labels were more likely (63%) to pay a higher premium for local dairy products than any other consumer, including health conscious shoppers (37%), generic label shoppers (27%), brand-name item shoppers (24%), and value-oriented (23%) shoppers.

Certain demographics affected a consumers' WTP for VA products, these included the presence of children, age, gender, income and education status, farm background and weekly dairy expenditure. Households with children < 19 years old were likely to pay a $0.038/L premium for high CLA milk and $0.429/kg premium for high CLA butter (Maynard and Franklin, 2003). Households with children < 12 years old in the house did not impact TN consumers' WTP for milk with MTML (Regmi et al., 2020), but consumers with children < 19 years old had overall higher WTP for locally produced and processed meats (Maynard et al., 2003). One study found females more likely to pay more for local products (Brown, 2003) while another found gender had no impact (Regmi et al., 2020). The same two studies found that those with a farm background were more likely to pay a higher premium than those without for a local product (Brown, 2003), whereas the second found farm background had no impact on WTP (Regmi et al, 2020). Again, Brown (2003) found that household income > $50,000 annually and a graduate or professional degree equated to higher WTP, while Regmi et al. (2020) reported annual household income and college graduation, along with age and whether consumers lived in rural locations, no impact on WTP. These two studies opposite findings promoted a conclusion that consumer populations were vastly different (conducted in Missouri and Tennessee), and determining a singular local or VAA purchaser profile would be unlikely. Another study determined that unmarried consumers had a higher WTP for locally produced and processed steak (Maynard et al., 2003). Finally, and most relevant of the consumer demographics for VAD products, was that TN respondents with a higher weekly dairy expenditure were willing to pay $0.115 premium ($P < 0.05$) for MTML products (Regmi et al., 2020).

Other aspects that impacted consumers' WTP for VA products were product labeling, which included local logos and production method logos. A study of 49 of Spanish dairy farms and 265 dairy products found that organic labeling had no impact on what price a consumer would pay for on farm produced dairy products (Álvarez Pinilla et al., 2018). However, the same study found that a longer expiration date and a certificate of origin had positive impacts on WTP for VAD products ($P < 0.01$ and $P < 0.05$, respectively; Álvarez Pinilla et al., 2018). A study of Florida grown ornamental plants found that respondents were WTP between $12.30 and $12.32

more for certified organic ornamental plants, and $7.63 to $7.67 more for organically produced without a certification (Khachatryan et al., 2015). The same study reported consumers were WTP $7.17 to $7.22 more for ornamental plants that advertised being grown in state, and a smaller premium of $5.42 to $5.48 for ornamental plants grown in the USA, but not necessarily the state the consumers were being surveyed in (Khachatryan et al., 2015). A 2019 study of the MTML revealed that consumers were willing to pay a 16% premium, $1.72 more, to purchase milk with this logo (Upendram et al., 2019). Another TN survey regarding TN milk found that surveyed consumers were willing to pay $0.087/L (12% premium) of bottled milk labeled with the TML, which stated that milk was produced and processed in TN (DeLong et al., 2020). Maynard et al. (2003) surveyed 61 consumers regarding WTP premiums, locally produced ground beef, steak, chicken, and sausage. Respondents were given the opportunity to indicate whether they would pay a low premium (20%), high premium (40%), or no premium for ground beef, steak, and sausage. They were also given the option to select premium levels for chicken, however the low premium was 50% and the high premium was 100%. They reported that 20% of respondents would pay a high premium of local produced steak and chicken. Fifteen percent would pay a high premium for locally produced ground beef, while 34% would pay a high premium for locally produced sausage. Unsurprisingly, more respondents were willing to pay a low premium (64% for ground beef, 52% for steak and sausage, and 36% for chicken), while nearly all were willing to pay no premium to receive locally produced products at the same price (100% for ground beef and sausage, and 98% for steak and chicken; Maynard et al., 2003).

Production methods for VAA focused on animal welfare concerns which included: pasture access, antibiotic use, rBST use, polled genetics, and dehorning. Verified pasture access for cattle producing yogurt (Olynk and Ortega, 2013; Bir et al., 2021), cheese (Bir et al., 2020), and ice cream (Olynk and Ortega, 2013) were linked to the agency verifying production claims and consumers' WTP (Table 1.1[1]). One study found generally higher WTP for cheese blocks made from cows with polled genetics versus those verified dehorned with pain relief, regardless of verification body (USDA, retailer, industry; Bir et al., 2020). Studies determined consumers had higher WTP for dairy products with USDA verification than industry, and the lowest WTP for retailer verified products regardless of product or verification focus (rBST, humane, antibiotic usage, etc.).

Finally, a consumers WTP was affected simply by the product produced—more labor-intensive products sold for higher premiums. Product components were also found to impact a consumers WTP. Álvarez Pinilla et al. (2018) found that cheese ($P < 0.01$) and yogurt ($P < 0.01$) had a higher margin per liter (**ML**) than liquid milk (0.688 and 1.518 euros, respectively). The same study found that if products contained sheep milk, they had a higher ML ($P < 0.01$). Bir et al. (2020) reported \$0.39/L and \$2.49/L premiums for traditional yogurt and Greek yogurt, respectively, that were free of high fructose corn syrup. The same study found that yogurt consumers were willing to pay \$0.79/L and \$2.04/L more to purchase traditional yogurt and Greek yogurt that was made with lowfat milk (2.25% fat) when compared to skim milk (1.25% fat; Bir et al., 2021). A study of TN milk consumers conducted through Qualtrics in 2021 showed that among both repeat and new attentive VAD milk consumers, all were willing to pay more (\$0.99 to \$2.67 premium) for lowfat (2.25% fat) milk compared to whole milk, creamline milk, and full fat homogenized milk ($P < 0.05$; Jensen et al., 2021). Attentive repeat customers

[1] Tables and figures can be found in Appendix A.

were willing to pay $0.63 less for ultra-pasteurized milk ($P < 0.05$), when compared to vat pasteurized milk, while attentive new customers were willing to pay $0.29 less for ultra-pasteurized milk ($P < 0.05$; Jensen et al., 2021). The same study found that attentive repeat customers would pay the same for vat pasteurized and high-temperature short-time (HTST) pasteurized milk, while attentive new customers would pay $0.10 less for HTST milk ($P < 0.05$), when compared to vat pasteurized (Jensen et al., 2021).

Packaging of VAD milk was also studied and reported. New and attentive customers were willing to pay $0.24 less for paper containers and $0.44 less for glass containers versus plastic jugs ($P < 0.05$, respectively; Jensen et al., 2021). Attentive repeat customers were willing to pay the same for glass containers and plastic jugs, but would pay $1.49 less for paper containers, when compared to plastic ($P < 0.05$, respectively; Jensen et al., 2021).

Dairy industry and value-added business economics

In 1975, Tennessee contained 2,398 Grade “A” dairies (Snell and Martin, 1976). There was a decrease of 93.5% over the next 47 years. The Tennessee Department of Agriculture records the remaining Tennessee grade “A” dairies every month. These numbers drop each year: 342 in January 2016; 276 in January 2018; 171 in January 2021; 156 in January 2022 (J. Strasser, Tennessee Department of Agriculture, Nashville, TN, personal communication). This reduction has many causes; one being the high cost of production, often higher than the amount farmers are paid.

Tennessee dairy industry compared with USA dairy industry

A TN survey of 81 dairy farms found that production per cow, number of cows, mailbox milk price, forage costs, and level of debt all influenced financial performance (Haden and

Johnson, 1989). Each of these factored into the cost of production, which was made up of operating costs and overhead, including a dairies three most financially consuming categories: feed, labor, and hauling costs. The average total production cost for 2020 was $27.95 per hundredweight (**CWT**) in Tennessee (Economic Research Service [ERS], 2021b). However, the price farmers were paid per CWT was usually less than the production cost. Tennessee's milk market is split into two regions, the Southeast and the Appalachian. The Southeast region consists of the western two-thirds of Tennessee, while the Appalachian region consists of the eastern one-third of Tennessee. Mean mailbox milk price for the Southeast region was $18.31 per CWT in 2020 compared to $18.05 in the Appalachia region (Agricultural Marketing Service [AMS], 2021). A price discrepancy of $9.64 to $9.90 per CWT can be seen and as a result, farmers were putting more money into their dairies than they received. Operating costs breakdown across TN and USA dairy farms from 2016 to 2021 can be seen in Table 1.2 in Appendix A. Looking on a larger scale, from 2016 to 2021, the average total operating cost on a TN dairy farm was $16.45 per CWT, while the average across the USA was $13.72. Because of this, TN dairy farmers were loosing $6.86 per CWT on average while the standard USA dairy farmer was only loosing $2.38 per CWT (ERS, 2021b).

Studies of value-added dairy enterprises

The same was seen in New York, Wisconsin, and Vermont in Nicholson and Stephenson (2007) survey; milk was sold for $7.02 ± 6.90 per CWT (n = 16). With negative profit margins, dairy farmers must find alternative methods to survive. This may be through other farming activities, seeking off-farm employment, or investing in a value-added dairy operation.

Moss et al. (2012) stated the dairy industry contributed 12,924 jobs and $3,169,120,348 to Tennessee's economy in 2010. Dairy production contributed $278,198,666 and 5,113 jobs, while dairy processing contributed $2,890,921,682 and 7,811 jobs.

According to Moss (2012), adding a value-added enterprise to a dairy farm would put the cost of production at $23.70 per CWT, and thus did not recommend a value-added dairy facility for the authors designated average of 100 cows in a conventional dairy system in Tennessee despite positive profits in an operation processing cheese, milk, and yogurt. A study of 265 dairy products from 49 Spanish VAD found that those who produced more intensive items, such as cheese or yogurt vs bottled milk alone, could produce less product to cover their fixed costs because of the higher profit they could obtain (Álvarez Pinilla et al., 2018). They found that a VAD was more likely to be profitable if they produced anything other than bottled milk alone, and those who only produced bottled milk needed to process substantially more milk (197,787 L) than cheese producers or producers who processed milk, cheese, and yogurt (146,096 L and 103,916 L, respectively). In addition to Moss (2012), Nicholson and Stephenson (2007) found that prices needed to cover cost of production for cheese in NY, WI, and VT was ~ $22/kg and $2.27/L milk.

One study found that 25% of dairy farmers income came from livestock sales, crop sales, government payments, or receipts and that the net cow dairy farm income was $15,000 annually (Nicholson and Stephenson, 2007). Nicholson and Stephenson (2007) also reported that northeastern VADs had up to 98% of their processing enterprise income come from dairy product sales. Only one of their 27 VAD processors had a positive net income from both the dairy farm and the VAD facility (~ 4%). The most common outcome among the 27 surveyed VAD was that processing enterprises were semi-successful (58% had a negative net income; n =

26) while the farm was not (Nicholson and Stephenson, 2007). Durham et al. (2015) used a mean investment cost of a cheese processing facility at $609,480 USD. If dairy farms were already at a negative net income, investment in VAD was not economically feasible (Smith et al., 2013, Durham et al., 2015). These studies complemented Moss (2012) findings which stated that a VAD operation was not feasible for a dairy farm that was already in the negative; the positive profits were not enough to offset the dairy's already negative cash flow even after 10 years of investment.

Farmers' income was a common issue among the majority of farms and VA operations. In 2020, mean net farm income across all agricultural sectors in TN was $8,693 per TN operation (Economic Research Service [ERS], 2021c; National Agricultural and Statistical Service [NASS], 2021). One way to combat low farm income explored was marketing value-added agriculture through community-supported agriculture (**CSA**) box sets. United States of America farmers not involved in value-added agriculture made a mean profit of 14% (Paul, 2019). The mean gross farm income for Massachusetts was $85,346 and the net farm income was $12,044 and was not considered a living wage (Paul, 2019). However, when CSA farmers in the same area were surveyed (n = 16), there was a 51% profit (Paul, 2019). However, gross farm income was lower, $23,500. Interestingly, net farm income was virtually the same as other farmers, $12,000 (Paul, 2019). A large-scale survey (n = 354) in 2003 of CSA across the United States showed a 66% profit margin among CSA farmers (Lass et al., 2003). Gross farm income was $32,082 while net farm income was $21,118 (Lass et al., 2003). While still not a livable wage, this provided more income than traditional farming and showed that CSAs alone may not be a solution to provide farmers with a living wage but may be combined with other VA enterprises to support the low farm income.

Value-added dairy budgeting and decision tools

For every consumer dollar spent on food, 8% goes to the farmer, and approximately 21% goes to the processor (Economic Research Service [ERS], 2021a). This number is substantially higher in the dairy sector. In 2020, the mailbox milk price equaled approximately 30% of annual household expenditures on dairy products (Economic Research Service [ERS], 2022). The producer portion of the retail price per product type was 61% for butter, 51% for whole milk, 33% for cheese, and 14% for ice cream (ERS, 2022). Through VAA, a farmer could increase profit by claiming more of the consumer dollar.

Durham et al. (2015) created a decision-making tool for artisan cheese producers and validated the model using five different cheese types and four different production levels. They determined that at the smallest operation level, 3409 kg/yr processed, it would not be feasible to sell gouda cheese at retail price of $48.50/kg (> 15 yr payback period), but if they were to produce and sell 6818 kg the operation would be profitable in 10 yr. Durham et al. (2015) study found that farmstead milk operations rarely persist past 10 yr, but if they were to diversify beyond cheese production, such as agritourism, they had a greater chance to stay in business. The reason for this was the hours required to process additional cheese to cover production costs without affording sufficient help. Smith et al. (2013) found that of the 31 VAD surveyed the most common funding sources for starting a VAD were bank loans (68%), personal savings (59%), family loans or gifts (45%), and government grants (35%); many respondents used more than one of these as funding sources.

Factors beyond profitability have been considered by VAA processors. Emmanuel et al.

(2018) reported that 84% of respondents (n = 60 agricultural operation owners) saw increased earning capacities in the value-added sector, 98% thought it would sustain local human relations, and 94% thought it would help the family, 86% thought it would be lower stress than other sectors of agriculture, and 78% thought it would be a suitable option for balancing work and family. Respondents thought a value-added enterprise would generate employment and develop the rural communities further (100% and 98%, respectively), and 96% thought it would help promote local and traditional goods and possibly increase demand for agricultural products (98%).

Conclusion

The various industries employing VAA methods have utilized waste materials to turn a profit from products previously disposed of (i.e. citrus peels and fish viscera), altered products form for the addition of value (i.e. finger millets transformed to non-traditional products and the preservation of morels through drying), and sought out benefits beyond additional profits (i.e. increased and improved interpersonal relationships throughout the community, developed rural areas, improved family lives, and balanced work and personal lives for producers). Value-added consumers believed VA products were fresher, tasted better, were better for the environment, and supported state and local economies and farmers' incomes. However, a single consumer profile had yet to be created due to variances in consumer behaviors and perceptions, and this was reflected in consumers WTP for VA products in relation to their demographics. United States consumers would pay more for production and welfare labels including organic, no antibiotic use, and dehorning protocols. Consumers WTP was highest for those labels verified by USDA, and production and packaging affected consumers WTP for dairy products. Little research has been done regarding start-up costs and years-to-be-profitable within a VA operation. Additionally, literature was sparse regarding feasibility of a long-term VA operation. Limited research had been done regarding VAD operations and products, and the majority of the literature pertained to TN. Most literature regarding VAD product consumers varied, but regions tended to remain consistent (i.e. most TN consumer research confirmed similar consumer profiles). The author suggests additional research into the economics of a VAD operations and consumers of VAD products.

References

Adelaja, A. O., R. G. Brumfield, and K. Lininger. 1990. Product differentiation and state promotion of farm produce: an analysis of the Jersey Fresh tomato. J of Food Distribution Research 21(856-2016-57094):73-86. https://doi.org/10.22004/ag.econ.27108.

Agricultural Marketing Service [AMS]. 2020. USDA value-added ag definition. Accessed Sep. 10, 2020. https://www.agmrc.org/business-development/valueadded-agriculture/articles/usda-value-added-ag-definition.

Agricultural Marketing Service [AMS]. 2021. Mailbox milk price report. Accessed Mar. 20, 2022. https://www.ams.usda.gov/sites/default/files/media/2020MailboxPrices.pdf.

Ahmadi Kaliji, S., S. M. Mojaverian, H. Amirnejad, and M. Canavari. 2019. Factors affecting consumers' dairy products preferences. AGRIS on-line Papers in Economics and Informatics 11(665-2019-4000):3-11. https://doi.org/10.7160.aol.2019.110201.

Álvarez Pinilla, A. M., B. García Cornejo, J. A. Pérez Méndez, and D. Roibás Alonso. 2018. The profitability of value-added products in dairy farm diversification initiatives. Spanish Journal of Agricultural Research. https://doi.org/10.5424/sjar/2018162-11813.

Arnett, E. B. and R. Southwick. 2015. Economic and social benefits of hunting in North America. International Journal of Environmental Studies 72(5):734-745. https://doi.org/10.1080/00207233.2015.1033944.

Best, M. J. and K. L. Wolfe. 2009. A profile of local dairy consumers in the southeast and the potential for dairies to market value-added products locally. J of Food Distribution Research 40(856-2016-57808):22-31. https://doi.org/10.22004/ag.econ.162111.

Bir, C., M. S. Delgado, and N. O. Widmar. 2021. US Consumer Demand for Traditional and

Greek Yogurt Attributes, Including Livestock Management Attributes. Agricultural and Resource Economics Review 50(1):99-126. https://doi.org/10.1017/age.2020.12.

Bir, C., N. O. Widmar, N. M. Thompson, J. Townsend, and C. A. Wolf. 2020. US respondents' willingness to pay for Cheddar cheese from dairy cattle with different pasture access, antibiotic use, and dehorning practices. J Dairy Sci 103(4):3234-3249. https://doi.org/10.3168/jds.2019-17031.

Born, H. and J. Bachmann. 2006. Adding value to farm products: an overview. in National Sustainable Agriculture Information Service (ATTRA). National Center for Appropriate Technology, Butte, Montana.

Brooker, J. R., D. B. Eastwood, and R. H. Orr. 1987. Consumers' perceptions of locally grown produce at retail outlets. J of Food Distribution Research 18(856-2016-57338):99-107. https://10.22004/ag.econ.26863.

Brown, C. 2003. Consumers' preferences for locally produced food: a study in southeast Missouri. Am J Alternative Agr 18(4):213-224. https://doi.org/10.1079/AJAA200353.

Carvalho, C. S. M. d., L. V. B. d. Aguiar, C. Sales-Campos, M. T. d. A. Minhoni, and M. C. N. d. Andrade. 2012. Applicability of the use of waste from different banana cultivars for the cultivation of the oyster mushroom. Brazilian Journal of Microbiology 43(2):819-826. https://doi.org/10.1590/S1517-83822012000200048.

Coltrain, D., D. Barton, and M. Boland. 2000. Value added: opportunities and strategies. Arthur Capper Cooperative Center, Department of Agricultural Economics, Cooperative Extension Service, Kansas State University.

de Siqueira, F. G., E. T. Martos, R. d. Silva, and E. S. Dias. 2011. Cultivation of Pleurotus sajorcaju on banana stalk and Bahia grass based substrates. Horticultura Brasileira 29(2):199-204. https://doi.org/10.1590/S0102-05362011000200011.

DeLong, K. L., K. L. Jensen, S. Upendram, and E. Eckelkamp. 2020. Consumer preferences for tennessee milk. J of Food Distribution Research 51(856-2020-1665):111-130. https://doi.org/10.22004/ag.econ.305485.

Durham, C. A., A. Bouma, and L. Meunier-Goddik. 2015. A decision-making tool to determine economic feasibility and break-even prices for artisan cheese operations. J Dairy Sci 98(12):8319-8332. https://doi.org/10.3168/jds.2014-9252.

Eckelkamp, E., C. Zaring, S. Upendram, E. A. Paskewitz, H. Sedges, and K. Johnson. 2021. Tennessee Consumer Perceptions of Milk: Purchase Considerations, Safety, and Price. University of Tennessee, Knoxville, Tennessee.

Economic Research Service [ERS]. 2021a. Food dollar series. Accessed Sep. 16, 2021. https://www.ers.usda.gov/data-products/food-dollar-series/.

Economic Research Service [ERS]. 2021b. Milk production costs and returns per hundredweight sold, by state. Accessed Mar 2, 2022. https://www.ers.usda.gov/data-products/milk-cost-of-production-estimates/.

Economic Research Service [ERS]. 2021c. Data Files: U.S. and state-level income and wealth statistics. Accessed June 30, 2022. https://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/.

Economic Research Service [ERS]. 2022. Price spreads from farm to consumer. Accessed Mar 1, 2022. https://www.ers.usda.gov/data-products/price-spreads-from-farm-to-consumer/.

Emmanuel, M., J. J. Thoomkuzhy, and M. E. John. 2018. Antecedents of value added agriculture. J Manage 5(3).

FAOSTAT. 2022. Food and Agriculture Organization of the United Nations - Crops Primary. Food and Agriculture Organization of the United Nations, ed. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gallons, J., U. C. Toensmeyer, J. R. Bacon, and C. L. German. 1997. An analysis of consumer characteristics concerning direct marketing of fresh produce in Delaware: a case study. J of Food Distribution Research 28(856-2016-57649):98-106. https://doi.org/10.22004/ag.econ.26603.

Garcia-Castello, E. M., A. D. Rodriguez-Lopez, L. Mayor, R. Ballesteros, C. Conidi, and A. Cassano. 2015. Optimization of conventional and ultrasound assisted extraction of flavonoids from grapefruit (Citrus paradisi L.) solid wastes. LWT-Food Science and Technology 64(2):1114-1122. https://doi.org/10.1016/j.lwt.2015.07.024.

Gómez-Mejía, E., N. Rosales-Conrado, M. E. León-González, and Y. Madrid. 2019. Citrus peels waste as a source of value-added compounds: Extraction and quantification of bioactive polyphenols. Food chemistry 295:289-299. https://doi.org/10.1016/j.foodchem.2019.05.136.

Haden, K. L. and L. A. Johnson. 1989. Factors which contribute to the financial performance of selected Tennessee dairies. Southern Journal of Agricultural Economics 21(1378-2016-110366):105-112. https://doi.org/10.1017/S0081305200000960.

Hand, M. S. and S. W. Martinez. 2010. Just what does local mean? Choices 25(316-2016-7157):1-4.

Hu, W., T. Woods, S. Bastin, L. Cox, and W. You. 2011. Assessing consumer willingness to pay for value-added blueberry products using a payment card survey. J of Agricultural and Applied Economics 43(2):243-258. https://doi.org/10.1017/S1074070800004193.

Jensen, K. L., D. M. Lambert, A. L. Rihn, E. Eckelkamp, C. S. Zaring, M. T. Morgan, and D. W. Hughes. 2021. Effects of inattention and repeat purchases: A choice-based conjoint study of consumer preferences for farmstead milk attributes. J of Food Products Marketing 27(8-9):399-416. https://doi.org/10.1080/10454446.2022.2034699.

Keeling Bond, J., D. D. Thilmany, and C. A. Bond. 2009. What influences consumer choice of fresh produce purchase location? Journal of Agricultural and Applied Economics 41(1379-2016-112744):61-74. https://doi.org/10.1017/S1074070800002558.

Khachatryan, H., A. Rihn, B. Campbell, B. Behe, and C. Hall. 2018. How do consumer perceptions of "local" production benefits influence their visual attention to state marketing programs? Agribusiness 34(2):390-406. https://doi.org/10.1002/agr.21547.

Khanal, B., R. A. Lopez, and A. Azzam. 2020. Testing local bias in food consumption: The case of fluid milk. Agribusiness 36(2):339-344. https://doi.org/10.1002/agr.21632.

Kilkenny, M. and G. Schluter. 2001. Value-added agriculture policies across the 50 states. Rural America/Rural Development Perspectives 16(2221-2019-2460):12-18.

Lass, D., A. Bevis, G. Stevenson, J. Hendrickson, and K. Ruhf. 2003. Community supported agriculture entering the 21st century: Results from the 2001 national survey. Amherst: University of Massachusetts, Department of Resource Economics.

Leitch, J. A., J. F. Baltezore, and J. Dammel. 1993. Economic Values of Wild Fur Harvest in North Dakota.

Lesser, W. H. 1979. Marketing Freezer Beef in New York State.

Lev, L., G. Feenstra, S. Hardesty, L. Houston, J. Joannides, and R. P. King. 2018. Value added: should you produce your own specialty food products? United States Department of Agriculture.

Lu, R. and R. Dudensing. 2015. What do we mean by value-added agriculture? Agricultural and Applied Economics Association 30(4).

MacDonald, H. B. 2000. Conjugated linoleic acid and disease prevention: a review of current knowledge. Journal of the American College of Nutrition 19(sup2):111S-118S. https://doi.org/10.1080/07315724.2000.10718082.

Malone, T., S. M. Swinton, A. Pudasainee, and G. Bonito. 2022. Economic Assessment of Morel (Morchella spp.) Foraging in Michigan, USA. Economic Botany:1-15. https://doi.org/10.1007/s12231-022-09548-5.

Maynard, L. J. and S. T. Franklin. 2003. Functional foods as a value-added strategy: The commercial potential of "cancer-fighting" dairy products. Applied Economic Perspectives and Policy 25(2):316-331.

Maynard, L. J., K. H. Burdine, and A. L. Meyer. 2003. Market potential for locally produced meat products. J of Food Distribution Research 34(856-2016-56876):26-37. https://doi.org/10.22004/ag.econ.27321.

McMillin, K. and A. Brock. 2005. Production practices and processing for value-added goat meat. Journal of Animal Science 83(suppl_13):E57-E68. https://doi.org/10.2527/2005.8313_supplE57x.

Michigan Department of Natural Resources. 2022. Finding morels in Michigan's forests. in Morel mushroom hunting. Vol. 2022. Michigan Department of Natural Resources, ed.

Michigan Department of Natural Resources, Lansing, Michigan.

Moss, J. J. 2012. Feasibility of On-farm Milk Processing, Packaging, and Marketing for Tennessee Dairy Farmers. MS Thesis. Department of Agricultural and Resource Economics, Univ. of Tennessee, Knoxville.

Moss, J., K. Jensen, B. English, and R. Holland. 2012. The Tennessee Dairy Industry and Its Value-Added Opportunities. Knoxville, TN: UT Extension. https://extension.tennessee.edu/publications/Documents_W_284.

National Agricultural Statistical Service [NASS]. 2021. Quick Stats: Tennessee. https://quickstats.nass.usda.gov/.

Nicholson, C. F. and M. W. Stephenson. 2007. Financial performance value-added dairy operations in New York, Vermont and Wisconsin. https://doi.org/10.22004/ag.econ.9732.

Oboh, G. and A. Ademosun. 2012. Characterization of the antioxidant properties of phenolic extracts from some citrus peels. Journal of food science and technology 49(6):729-736. https://doi.org/10.1007/s13197-010-0222-y.

Olynk, N. J. and D. L. Ortega. 2013. Consumer preferences for verified dairy cattle management practices in processed dairy products. Food Control 30(1):298-305. https://doi.org/10.1016/j.foodcont.2012.07.030.

Onozaka, Y., G. Nurse, and D. T. McFadden. 2010. Local food consumers: How motivations and perceptions translate to buying behavior. Choices 25(1):1-6.

Ostrom, M. 2006. Everyday meanings of "local food": Views from home and field. Community Dev J 37(1):65-78. https://doi.org/10.1080/15575330609490155.

Outdoor Industry Association. 2012. The outdoor recreation economy 2012.

Patterson, P. M., H. Olofsson, T. J. Richards, and S. Sass. 1999. An empirical analysis of state agricultural product promotions: a case study on Arizona Grown. Agribusiness 15(2):179-196. https://doi.org/10.1002/(SICI)1520-6297(199921)15:2<179::AID-AGR3>3.0.CO;2-K.

Paul, M. 2019. Community-supported agriculture in the United States: Social, ecological, and economic benefits to farming. J of Agrarian Change 19(1):162-180. https://doi.org/10.1111/joac.12280.

QualtricsXM. 2020. 20 most valuable types of surveys. Accessed Apr. 16, 2021. https://www.qualtrics.com/experience-management/research/common-types-of-surveys/.

Regmi, H., S. Upendram, K. L. Jensen, and K. L. DeLong. 2020. Consumer preferences for dairy products logoed as made with Tennessee milk. in Agricultural and Applied Economics Association. Kansas City, MO.

Rustad, T. 2003. Utilisation of marine by-products. Electronic Journal of Environmental, Agricultural and Food Chemistry 2(4):458-463. https://doi.org/10.31665/JFB.2019.6184.

Shantha, N. C., L. N. RAM, J. O'leary, C. L. HICKS, and E. A. DECKER. 1995. Conjugated linoleic acid concentrations in dairy products as affected by processing and storage. J of Food Science 60(4):695-697. https://doi.org/10.1111/j.1365-2621.1995.tb06208.x.

Shashi, B., S. Sharan, S. Shittalamani, A. Shankar, and T. Nagarathna. 2007. Micronutrient composition, antinutritional factors and bioaccessibility of iron in different finger millet (Eleusine coracana) genotypes. Karnataka J of Agricultural Sciences 20(3):583-585.

Shulman, C. 2014. 2012 Canadian Nature Survey: Awareness, participation, and expenditures in nature-based recreation, conservation.

Smith, S., E. Chaney, and J. Bewley. 2013. Planning considerations for on-farm dairy processing enterprises. J Dairy Sci 96(7):4519-4522. https://doi.org/10.3168/jds.2012-6541.

Snell, J. and G. Martin. 1976. Changes in the Tennessee Dairy Industry. Bulletins.

U.S. Department of Agriculture [USDA]. 2019. USDA fiscal year 2019 budget summary. Accessed Oct. 8, 2021. https://www.usda.gov/obpa/budget-summary.

U.S. Department of Agriculture [USDA]. 2021. USDA fiscal year 2021 budget summary. Accessed Oct. 8, 2021. https://www.usda.gov/obpa/budget-summary.

U.S. Fish and Wildlife Service. 2009. 2006 National Survey of Fishing, Hunting and Wildlife-associated: Recreation. US Department of the Interior, Fish and Wildlife Service.

Upendram, S., K. L. Jensen, K. L. DeLong, R. J. Menard, and E. Eckelkamp. 2019. Consumer dairy product expenditures and preferences for dairy products made with Tennessee milk. University of Tennessee.

Verma, V. and S. Patel. 2013. Value added products from nutri-cereals: Finger millet (Eleusine coracana). Emirates Journal of Food and Agriculture:169/176-169/176. https://doi.org/10.9755/ejfa.v25i3.10764.

Warren, H. E., N. D. Scollan, M. Enser, S. Hughes, R. I. Richardson, and J. D. Wood. 2008. Effects of breed and a concentrate or grass silage diet on beef quality in cattle of 3 ages. I: Animal performance, carcass quality and muscle fatty acid composition. Meat science 78(3):256-269. https://doi.org/10.1016/j.meatsci.2007.06.008.

Wood, J., M. Enser, A. Fisher, G. Nute, P. Sheard, R. Richardson, S. Hughes, and F. Whittington. 2008. Fat deposition, fatty acid composition and meat quality: A review. Meat science 78(4):343-358. https://doi.org/10.1016/j.meatsci.2007.07.019.

Zepeda, L. and J. Li. 2006. Who buys local food? J of Food Distribution Research 37(3):1-11. https://doi.org/10.22004/ag.econ.7064.

Appendix A

Table 1.1. Premium prices paid for dairy products with production attributes advertised and verified

Dairy product	Attribute/advertisement	Premium	Significance
Traditional yogurt	Advertised Dairy animals had pasture access	$2.59/L[3]	*P* < 0.001
	Advertised dehorning and disbudding of calves was not permitted	$3.27/L[3]	*P* < 0.001
	USDA verified pasture access	$4.96/L[1]	*P* < 0.05
	Industry verified pasture access	$3.61/L[1]	*P* < 0.05
	Retail verified pasture access	$3.61/L[1]	*P* < 0.05
	USDA verified no antibiotic use	$5.13/L[1]	*P* < 0.05
	Industry verified no antibiotic use	$4.62/L[1]	*P* < 0.05
	Retail verified no antibiotic use	$2.65/L[1]	*P* < 0.05
	USDA verified rBST free	$4.23/L[1]	*P* < 0.05
	Industry verified rBST free	$3.66/L[1]	*P* < 0.05
	Retail verified rBST free	$2.99/L[1]	*P* < 0.05
Greek yogurt	Advertised Dairy animals had pasture access	$7.53/L[3]	*P* < 0.001
	Advertised dehorning and disbudding of calves was not permitted	$7.59/L[3]	*P* < 0.001
Ice cream	USDA verified pasture access	$6.32/L[1]	*P* < 0.05
	Industry verified pasture access	$5.11/L[1]	*P* < 0.05
	Retail verified pasture access	$4.65/L[1]	*P* < 0.05
	USDA verified no antibiotic use	$5.75/L[1]	*P* < 0.05
	Industry verified no antibiotic use	$5.18/L[1]	*P* < 0.05
	Retail verified no antibiotic use	$2.64/L[1]	*P* < 0.05
	USDA verified rBST free	$4.75/L[1]	*P* < 0.05
	Industry verified rBST free	$3.55/L[1]	*P* < 0.05
	Retail verified rBST free	$4.63/L[1]	*P* < 0.05
Cheese	USDA verified pasture access	$12.26/kg[2]	*P* < 0.05
	Industry verified pasture access	$8.14/kg[2]	*P* < 0.001
	Retail verified pasture access	$12.43/kg[2]	*P* < 0.05
	USDA verified no antibiotic use	$10.36/kg[2]	*P* < 0.05
	Industry verified no antibiotic use	$11.02/kg[2]	*P* < 0.05
	Retail verified no antibiotic use	$6.61/kg[2]	*P* < 0.05
	Usda verified polled	$6.92/kg[2]	*P* < 0.05
	Industry verified polled genetics	$5.38/kg[2]	*P* < 0.05
	Retailer verified polled genetics	$6.08/kg[2]	*P* < 0.05
	Usda verified dehorned with pain relief	$6.75/kg[2]	*P* < 0.05
	Industry verified dehorned with pain relief	$3.79/kg[2]	*P* < 0.05
	Retailer verified dehorned with pain relief	$4.19/kg[2]	*P* < 0.05

[1] Olynk and Ortega, 2013, [2] Bir et al., 2020, [3] Bir et al., 2021

Table 1.2. Cost of production for Tennessee and USA dairy farms from 2016 to 2021.

	Tennessee total						U.S. total					
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Milk sold	17.66	19.98	18.04	20.1	19.3	20.82	16.83	18.25	16.82	19.26	18.87	19.34
Cattle	1.38	1.28	1.18	1.15	1.19	1.3	1.47	1.37	1.26	1.23	1.27	1.39
Other income [1]	0.78	0.72	0.72	0.76	0.74	0.87	0.54	0.5	0.5	0.53	0.51	0.6
Total, gross value of production	19.82	21.98	19.94	22.01	21.23	22.99	18.84	20.12	18.58	21.02	20.65	21.33
Operating costs												
Purchased feed	7.25	7.05	7.34	7.82	7.53	11.4	6.68	6.49	6.76	7.2	6.93	10.5
Homegrown harvested feed	3.7	3.83	4.38	4.68	4.37	4.88	2.63	2.72	3.12	3.33	3.11	3.47
Grazed feed	0.19	0.19	0.19	0.2	0.21	0.21	0.07	0.07	0.08	0.07	0.07	0.07
Total, feed costs	11.14	11.07	11.91	12.7	12.11	16.49	9.38	9.28	9.96	10.6	10.11	14.04
Veterinary and medicine	0.78	0.76	0.77	0.79	0.79	0.82	0.77	0.75	0.76	0.78	0.78	0.8
Bedding and litter	0.27	0.27	0.27	0.28	0.28	0.29	0.2	0.19	0.2	0.2	0.2	0.21
Marketing	0.24	0.23	0.24	0.24	0.24	0.25	0.18	0.18	0.18	0.19	0.18	0.19
Custom services	0.97	0.94	0.96	0.98	0.98	1.01	0.67	0.65	0.66	0.67	0.67	0.69
Fuel, lube, and electricity	0.69	0.78	0.88	0.91	0.77	0.77	0.52	0.59	0.67	0.69	0.58	0.59
Repairs	0.67	0.69	0.71	0.73	0.74	0.82	0.61	0.62	0.64	0.66	0.67	0.74
Other, operating costs [2]	0	0	0	0	0	0	0	0	0	0	0	0
Interest on operating capital	0.03	0.08	0.16	0.17	0.03	0.01	0.03	0.06	0.14	0.14	0.03	0.01
Total, operating costs	14.79	14.82	15.9	16.8	15.94	20.46	12.36	12.32	13.21	13.93	13.22	17.27
Allocated overhead												
Hired labor	1.5	1.57	1.63	1.72	1.77	1.89	1.83	1.87	1.99	2.1	2.2	2.31
Opportunity cost of unpaid labor	4.84	5.05	5.16	5.14	5.29	5.61	1.71	1.77	1.82	1.88	1.92	1.99
Capital recovery of machinery and equipment [3]	3.44	3.52	3.65	3.74	3.77	4.21	3.77	3.86	4	4.1	4.13	4.62
Opportunity cost of land	0.08	0.08	0.08	0.09	0.09	0.09	0.02	0.02	0.03	0.02	0.02	0.02
Taxes and insurance	0.25	0.24	0.25	0.25	0.25	0.26	0.18	0.18	0.18	0.18	0.18	0.19

Table 1.2. Continued.

	Tennessee total						U.S. total					
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
General farm overhead	0.77	0.78	0.81	0.83	0.84	0.9	0.53	0.54	0.55	0.57	0.58	0.62
Total, allocated overhead	10.88	11.24	11.58	11.77	12.01	12.96	8.04	8.24	8.57	8.85	9.03	9.75
Costs listed												
Total, costs listed	25.67	26.06	27.48	28.57	27.95	33.42	20.4	20.56	21.78	22.78	22.25	27.02
Net value												
Production value less total costs listed	-5.85	-4.08	-7.54	-6.56	-6.72	-10.43	-1.56	-0.44	-3.2	-1.76	-1.6	-5.69
Production value less operating costs	5.03	7.16	4.04	5.21	5.29	2.53	6.48	7.8	5.37	7.09	7.43	4.06
Supporting information												
Milk cows (head per farm)	119	119	119	119	119	119	245	245	245	245	245	245
Output per cow (pounds)	15,629	15,629	15,629	15,629	15,629	15,629	21,698	21,698	21,698	21,698	21,698	21,698

[1]Income from renting or leasing dairy stock to other operations; renting space to other dairy operations; co-op patronage dividends associated with the dairy; assessment rebates, refund, and other dairy-related resources; and the fertilizer value of manure production.
[2]Costs for third-party organic certification.
[3]Machinery and equipment, housing, manure handling, feed storage structures, and the breeding herd
Table was sourced from USDA Economic Research Service (ERS, 2021b) and was last updated May 2, 2022. All units are dollars per hundredweight, unless otherwise stated.

Chapter 2 – Current and future Tennessee value-added cow dairy enterprises

Abstract

Few resources exist regarding U.S. value-added dairy (**VAD**) operations and their enterprise economics. Enterprise economics could include start-up costs, equipment and maintenance costs, years to break even, and additional profits. The objective of this project was to describe the current state of Tennessee's VAD. A 50-question in-person survey was presented to dairy producers and processors. The survey included five sections: 1) respondent information, 2) farm information, 3) processing information, 4) processing equipment, and 5) business economics. A mixture of short-answer, multiple choice, and Likert-Scale questions were used. Data were reported for 16 cattle producer-processors in 13 counties. Data were separated into current and prospective VAD (n = 9 and n = 7, respectively). The MEANS and FREQ procedures of SAS 9.4 were used to describe data. Current (**C**) and prospective (**P**) VAD respondents were 38 ± 11 and 38 ± 13 yr old, respectively. Seven VAD processed their own milk, eight were considering processing their own milk, four processed purchased milk, and two were considering processing purchased milk. In C VAD, farming activities were the main income source (36 ± 44% of household income). P VAD relied on off-farm income (62 ± 39% of household income). In TN, 6.2% of all cow dairies were also VAD, primarily located in East TN. Ice cream was produced by the most producers, but fluid milk had the highest production volume (1,669,990 L). Creamline milk and aged cheese were the most often considered for production by producer-processors. C and P VAD producers were in good financial standing with a low debt-to-asset ratio (< 40%). Study outcomes will be used to assist farmers considering entering or expanding a value-added enterprise through marketing, production, or economic suggestions.
Keywords: value-added, local, economics

Introduction

Value-added agricultural products were products that were sold for more than the commodity price of the raw product due to a change in the physical form (i.e. selling bottled milk vs raw milk), segregation of the product (i.e. separating one farms milk from another by adding a "Tennessee Milk" logo), or the modified production of a raw product (i.e. organic production; Agricultural Marketing Service [AMS], 2020). Value-added dairy (**VAD**) operations were defined as a business that transform raw milk produced on or near their facility into a finished product. Often, many VAD operations were involved in other value-added (**VA**) operations which usually included agritourism. When asked, producers' justification for entering a VAD operation were to escape low commodity milk prices (61%, n = 19), a desire to maintain or expand a family operation (29%, n = 9), and to differentiate products (16%; n = 5; Smith et al., 2013).

In 2020, mean net farm income, across all agricultural sectors, was $8,693 per TN operation (Economic Research Service [ERS], 2021c; National Agricultural and Statistical Service [NASS], 2021c). One way to combat low farm income explored was marketing value-added agriculture through community-supported agriculture (**CSA**) box sets. United States farmers not involved in value-added agriculture made a mean of 14% profit (Paul, 2019). However, when CSA farmers in Massachusetts were surveyed (n = 16), there was a 51% profit (Paul, 2019). A large-scale survey (n = 354) in 2003 of CSA across the United States showed a 66% profit margin among CSA farmers (Lass et al., 2003). These profit margins, however, were still not equivalent to a livable wage. This revealed that CSA provided more income than traditional farming, but that CSA alone may not be a solution to provide farmers with a living wage. It is possible that when combined with other VA enterprises, such as agritourism, CSA may help to provide farmers with a livable wage to support low farm income.

The mean total production cost for raw milk in 2020 was $27.95 per hundredweight (**CWT**) in Tennessee (Economic Research Service [ERS], 2021a). However, the price farmers were paid per CWT, or the mailbox milk price, was usually less than the production cost ($18.31/CWT in the Southeast region and $18.05/CWT in the Appalachia region; Agricultural Marketing Service [AMS], 2021). A price discrepancy of $9.64 to $9.90 per CWT was seen. The same was seen in New York, Wisconsin, and Vermont as milk was sold for $7.02 ± 6.9 per CWT (n = 16; Nicholson and Stephenson, 2007). Dairy farmers experienced negative profit margins and needed to find alternative methods to gain a positive profit. Value-added dairies were proposed as a potential alternative. Studies showed that a payback period for a VAD operation was as early as 1 to 3 yr (Smith et al., 2013) or as late as 10 yr (Durham et al., 2015). Emmanuel et al. (2018) reported that most respondents (84%, n = 50) saw increased earning capabilities in the value-added sector and thought it would promote their family life (94%, n = 56). Further, VAD respondents stated that 97% of respondents were satisfied (n = 14) or extremely satisfied (n = 16) with their decision to enter a VAD operation (Smith et al., 2013). Tennessee had 196 Grade “A” cow dairies in 2019, but by March 2022, this number had dropped to 144, a 27% decrease (Eckelkamp et al., 2021; J. Strasser, Tennessee Department of Agriculture, Nashville, TN, personal communication). Part of this decrease may be from the persistently low milk price discussed earlier. A 2019 survey of dairy producers in TN (n = 90) found that 6% of TN cow dairy farmers were current VAD, but 15% indicated their interest in marketing milk through a VAD enterprise (Eckelkamp et al., 2021). This survey suggested a potential population of 13 current and 32 prospective cow VAD.

Literature was limited on VAD, including start-up cost and maintenance costs of a VAD enterprise. In reference to Tennessee (**TN**), there was limited research into a profile of a successful VAD enterprise. This study aimed to quantify VAD enterprise in TN through a survey of current and prospective VAD operations in terms of farm demographics, products created and sold, processing facility equipment needs, owner risk behaviors, and financial performance of the VAD operations.

Materials and methods

A study of existing and prospective TN VAD operations was conducted through a 50-question in-person survey administered to the VAD owner or manager to reduce no response rate (UTK IRB-20-05941). Participation was voluntary and respondents had the option not to answer and stop the survey at any time. Nineteen operations across 17 counties in TN were involved in the survey; 16 cattle operations (84.2%; n = 16) and three small ruminant operations (15.8%; n = 3), with two operations declining to participate in the survey (95% response rate). This publication will focus on the 16 dairy cattle operations (n = 16 farms) surveyed, but tables with small ruminant data can be seen in Appendix B. Respondents could own or operate dairy farms, dairy processing facilities, or both. Operations were identified through a joint effort of the University of Tennessee Extension, Tennessee Department of Agriculture, the Center for Profitable Agriculture, and personal contacts made by the participating operations.

Incentives of responding to the survey included the option to meet with a multi-disciplinary team of retail, economic, food science, and dairy extension experts to discuss plans of entering or expanding a VAD enterprise. Additional incentives were the implementation of a

USDA Dairy Business Innovation Initiative (DBII) grant that could cover or aid in various start-up or expansion costs including equipment, marketing, and feasibility studies. Agreement to partake in the survey did not increase chances of receiving funding from this grant, but did provide respondents with extra resources for filling out the DBII grant application.

Survey information

The survey consisted of 50 questions across five categories: 1) respondent information, 2) farm information, 3) processing information, 4) processing equipment, and 5) business economics. Questions consisted of short-answer, multiple-choice, fill-in-the-blank, and Likert-scale (Appendix B). Surveys were administered in person by one to two trained evaluators to preserve confidentiality of respondents.

Respondent information. Respondents were asked their age, years they owned or managed the dairy farm, years a current VAD owned or managed the processing facility, role in the operation, location in Tennessee (East, Central, and West), and the impact of COVID-19 on their operation and their decision to enter a VAD enterprise. Finally, they were asked to identify needed resources from a predetermined list.

Farm information. Respondents were asked their number of lactating cows, percentage of herd involved or planned to be involved in the value-added enterprise (based on dividing number of cows to be used in the value-added enterprise by the number of lactating cows and multiplying by 100), annual herd mean somatic cell count, mean milk production per cow per day, annual rolling herd mean milk production, and breeds milked. Respondents were also asked the number of family farm employees, non-family farm employees, and their current milk marketing system.

Processing information. Respondents were asked to identify dairy products they processed or considered processing and the annual amounts of each produced: soft cheese, aged cheese, homogenized milk, creamline milk, ice cream, butter, cream, drinkable yogurt, traditional yogurt, lotions and soaps, and others. Respondents were also asked for the total annual raw product processed. Respondents were asked the number of family processing employees, non-family processing employees, their weekly hours worked by both family and non-family employees, if the processing facility was new or retrofitted and its dimensions, pasteurization method, waste creation (yes or no), own or purchased raw product to process, and serving sizes. For prospective processors, all questions were phrased as “what do you plan to do.”

Processing equipment. Respondents were asked what equipment they owned, whether it was bought new or used, and the purchase price. Equipment included: bulk tank, chiller, clean out of place tank, in-line pasteurizer, homogenizer, separator, chart recorder, vat pasteurizer, butter churn, cheese drain table, cheese vat, cheese press, ice cream freezer, filler capper sealer, holding tank, aging room, freezer, refrigerator, other, and package deal. Respondents were also asked the dimensions of their aging room, freezer, and refrigerator, if applicable.

Business economics. Respondents were asked to state their level of agreement with a series of four statements designed to assess their propensity for risky behaviors using Likert-scale question (1 = strongly disagree, 5 = strongly agree). First, “I am the kind of businessperson who is more willing to take financial risks than others” (**FinanceRisk**). Second, “I must be willing to take substantial financial risks to be successful in business” (**RiskSuccess**). Third, “I am reluctant about adopting new production or processing methods until I see them work for others” (**NewMethod**). Fourth, “I am more concerned about a large loss to my enterprise than about missing a substantial gain” (**LossGain**).

Current VAD respondents were asked about the operation’s annual profit, annual product sales, annual value-added net income, and debt-to-asset ratio (i.e. a survey conducted in 2021 requested information from 2020). They were asked about what portion of their household income came from the dairy, other value-added enterprises, other farming activities, and income from additional sources such as spousal off-farm income. Current VAD respondents were also asked about their total operating expenses during the year prior. Among this list was annual operating cost, annual electric, water, sewage, trash, gas, packaging supplies, cleaning and sanitation supplies, processing supplies, and any other amenities or supplies we failed to list.

Respondents were also asked where they sold or planned to sell and marketed or planned to market their product. Respondents were also asked how many employees, weekly hours, and annual budget was or was planned to be devoted to marketing. Finally, current VAD were asked whether they planned to grow, stay the same, decrease, or cease their business in their five-year plan. All respondents were asked how predetermined external factors impacted their decision to start their operation. These factors included state regulations, federal regulation, start-up cost, knowledge about processing, labor for processing, product marketing, and liability risk.

Statistical analyses

The survey enterprises were categorized as cattle and small ruminant (n = 16 and n = 3). Cattle and small ruminant data were separated to remove skewed data from differences in herd size and production capacity between large and small ruminants. The small ruminant enterprise data can be seen in Appendix B. Cattle enterprise data will be referenced from here on, and all data were be broken into two categories—current processors and prospective processors. Due to the limited number of VAD cattle operations in Tennessee (n = 16), no statistical inferences may be made despite having a 100% response rate (n = 16). The MEANS procedure of SAS 9.4 (SAS Institute, Inc., Cary, NC) was used to calculate the mean ± SD, min and max, and n for numeric values. In respondent information, this included respondent's age and years they owned or managed the dairy farm and processing facility. In farm information, this included number of lactating cows, percentage of herd involved in or planned to be involved in the value-added enterprise, annual herd mean somatic cell count, mean milk production per cow per day, annual rolling herd mean milk production, and number of family farm employees and non-family farm employees.

In processing information, this included products considered and produced in kg, liters of raw milk processed per year, number of family and non-family processing employees, hours family and non-family employees worked in processing facility per week, area of the processing facility. In processing equipment, this included equipment prices, and area of freezer, refrigerator, and aging rooms. In business economics, this included percentage of income from various sources, FinanceRisk, RiskSuccess, NewMethod, LossGain, annual operating costs, and costs of amenities and marketing, number of marketing employees and hours spent marketing a week, and factors affecting start-up decision (state and federal regulations, start-up cost, processing knowledge, labor for processing, product marketing, and liability risk).

The FREQ procedure (SAS 9.4) was used to describe categorical variables. In respondent information, this included respondent's role in the operation and location of operation in Tennessee. In farm information, this included breeds milked and where the enterprise's milk is marketed. In processing information, this included if the facility was new or retrofit, waste creation, pasteurization method, processing own or purchased raw product, and serving sizes produced. In processing equipment, this included whether equipment was purchased new or used and if respondents purchased equipment as part of a package deal. In business economics, this included operation's annual profit, annual product sales, annual value-added net income, debt to finance ratio, outlets products are or might be marketed and sold, and respondent's five-year plan.

Results and discussion

Current VAD respondents were 38 ± 11 yr old (n = 9) and prospective VAD respondents were 38 ± 13 yr old (n = 7; Table 2.1). In contrast, the mean age of farmers in TN, farmers nationwide, and dairy farmers nationwide were 59 yr, 57 yr, and 50 yr respectively (National Agricultural Statistics Service [NASS], 2019a, 2019b). Current VAD respondents owned or managed their dairy farm for 14 ± 11 yr (n = 8) and their processing facility for 8 ± 7 yr (n = 9; Table 2.1). Prospective VAD owned or managed their farm for 15 ± 15 yr (n = 7). The 2017 Census of Agriculture reported 79% of dairy farm owners had been farming for 11 years at minimum (NASS, 2019b). Five respondents of the current category were both dairy farm and processing plant owner-managers, two were dairy farm owner-managers, and two were processing plant owner-managers. Of the prospective VAD, two planned to be dairy and processing owner-managers, and five owned a dairy farm and planned for another family member to manage the processing facility. Figure 2.1[2] shows the distribution of the remaining cow dairy farms in TN as of March 7, 2022 (J. Strasser, Tennessee Department of Agriculture,

[2] All tables and figures are located in Appendix B.

Nashville, TN, personal communication). West TN housed one prospective processor in one county, Central TN housed five current processors in five counties with two prospective processors in two counties, and East TN housed four current prospectors in four counties with four current processors in two counties.

In a 2019 survey, 6% of responding TN cow dairy farmers were current VAD, but 15% indicated their interest in marketing through a current VAD enterprise (Eckelkamp et al., 2021). Using numbers from Eckelkamp et al. (2021) and the current TN cow dairy population, up to 22% of TN cow dairy farmers considered a VAD, but 9% would employ a VAD. However in our study, 6.2% of producers with cow dairies were currently processing VAD, while only 4.8% of TN cow dairies were interested in entering a VAD market. This could indicate that producers liked the idea of a value-added enterprise but did not plan to pursue creation of their own, or that they liked the idea but it was not feasible for their operation. Between the two TN surveys, Grade "A" licensed cow dairies dropped from 196 to 144 which could indicate the percentage of respondents interested in VAD discontinued their business during that time (Eckelkamp et al., 2021; J. Strasser, Tennessee Department of Agriculture, Nashville, TN, personal communication).

Farm information

Most VAD enterprises processed (n = 7) or planned to process (n = 8) their own herd's milk. Herd size was numerically higher in current VAD than prospective VAD (462 ± 699 vs. 132 ± 252 mature cows, respectively; Table 2.1) with a greater percentage of the herd designated for VAD (61 ± 49% vs. 50 ± 44% of respondents' herd, respectively). Variability was high in our data set, with herds between 13 and 1,900 cows. The mean herd size for the state of TN was reported to be 175 cows in 2021 (Progressive Publishing, 2021). Current VAD' mean production per cow per day (**APD**) was 28 ± 8.3 kg (n = 8), while prospective VAD' APD was slightly lower at 22 ± 5.8 kg (n = 7; Table 2.1). Sen's unpublished work stated that TN dairy farm APD was 26 ± 11 kg (Sen, 2021). Of current VAD, the rolling herd mean was 8,526.1 ± 2,543.7 kg and 6,700.1 ± 1,770.7 kg for prospective VAD (Table 2.1). The somatic cell count of current VAD farms was 293,750 ± 126,597 cell/mL, while prospective VAD was 279,000 ± 73,007 cell/mL (n = 7; Table 2.1). This somatic cell count is slightly higher than the TN mean of 274,000 cell/mL (Norman et al., 2022), with another publication yielding a SCC of 289,940 cell/mL (Eckelkamp et al., 2021).

Current VAD had 3 ± 2 family farm employees and 7 ± 10 nonfamily farm employees (n = 8), whereas prospective VAD thought they would need 3 ± 1 family employees on the farm and 2 ± 4 nonfamily farm employees (n = 7). Data regarding farm employees, especially in the dairy industry, has focused on immigrant vs. domestic workers and wages paid but does not further break up workers into family and non-family employees (National Agricultural and Statistical Service [NASS], 2021a, 2021b). Sen (2021) reported the mean number of family farm employees was 3 ± 1, and the mean number of non-family farm employees was 4 ± 6.

A breed breakdown can be seen in Figure 2.2. Of the 15 herds, one was Holstein only, one was Brown Swiss only, one was Guernsey only, and two were Jersey only. The rest were herds with multiple breeds, with the majority being Holstein-Jersey herds (n = 8). Of the current VAD, two sold to a co-op, one sold to independent contracts plants, and six were solely on-farm processing. Of the prospective, four sold to a co-op, one was planning on-farm processing, one had an independent plant contract, and one produced milk for personal consumption only. Sen

(2021) found that of the 90 cow dairies surveyed in TN, 45 of them sold their milk to a co-op, 40 had a direct plant contract, and 5 employed on-farm processing.***Processing information***

Current VAD had 2 ± 1 family processing facility employees and 4 ± 4 non-family processing facility employees (n = 9). However, prospective VAD had 3 ± 1 family employees (n = 6) and 1 ± 1 non-family employees in the processing facility (n = 4). Hours family and non-family workers dedicated to the processing facility were virtually identical (44 ± 35 and 44 ± 34 hours per week; n = 9). Ice cream was the most often produced (n = 5), but creamline milk had the highest mean kg produced (278,352 ± 220,424 kg; n = 4). For full descriptors of amounts processed by current VAD, see Table 2.2. Since 1975, fluid milk consumption has drastically decreased, while cheese consumption has drastically risen. Butter and yogurt consumption have made less drastic increases as well, while ice cream consumption has dropped slightly (Economic Research Service [ERS], 2021b). Current VAD were processing on average 2,764,183 ± 4,554,239 L/yr (n = 9), in a processing facility 400 ± 240 m^2. Prospective VAD planned to process 511,081 ± 836,694 L/yr (n = 4).

There were nine enterprises with current processing facilities, and seven prospective processing enterprises. See Figure 2.3 for a list current and planned products from current VAD and Figure 2.4 for planned products from prospective VAD. In reference to the other category, one VAD produced a fitness chocolate milk with added whey. Most VAD used or planned to use vat pasteurization (n = 5, respectively), where 3 current VAD and 1 potential VAD used high-temperature short-time (**HTST**), and one current VAD used a combination of the two. Five current VAD built new processing facilities while four made retrofits to a current building, whereas six of the prospective VAD had started or were planning to start building new processing facilities, and one planned to retrofit a current building. Six of the nine current VAD generated dairy waste from their VAD. Every current processor ($n = 9$) produced individual ($\leq$ 0.5 L milk, $\leq$ 0.2 L ice cream, or $\leq$ 0.2 kg cheese blocks) and family serving sizes ($\geq$ 3.8 L milk and ice cream or $\geq$ 0.23 kg cheese blocks). Most current processors ($n = 8$) produced multi-serving sizes (0.95 L milk, 1.89 L ice cream, or 0.45 kg cheese blocks).

Processing equipment

Equipment cost is shown in Table 2.5 with purchase type (new or used) in Table 2.6. Current VAD spent the most on HTST (\$70,000 ± 77,782; Table 2.5). Most prospective VAD were too early in the process to purchase equipment, but two had purchased bulk tanks. Additional equipment purchased by various prospective VAD included chiller, vat pasteurizer, filler capper sealer, and refrigerator. The aging room area was 209 ± 99 m^2 for current VAD ($n = 2$), freezer space was 27 ± 14 m^2 ($n = 3$), and refrigerator was 19 ± 11 m^2 ($n = 4$). Refrigerator storage for prospective VAD was 7 m^2 ($n = 1$).

Business economics

Respondents' level of riskiness was rated on a Likert-scale of 1 to 5 (1 = strongly disagree to 5 = strongly agree). Current VAD were slightly more willing to take financial risk (3.9 ± 1.3 vs. 3.7 ± 1.0 for prospective VAD). Current VAD had slightly less agreement than prospective VAD with the idea that substantial financial risks were necessary to be successful (3.9 ± 0.9 vs. 4.1 ± 0.7). Current and prospective VAD were both in slight disagreement (2.9 ± 1.2 and 2.9 ± 1.5, respectively) that they would only try new methods once others had used them successfully. Current and prospective VAD were both neutral (3.0 ± 1.0 and 3.1 ± 1.1, respectively) on their concern about a substantial loss instead of a substantial gain to their enterprise. Current VAD spent $220,857 ± 228,401 (n = 9) to build their processing facilities ($579 ± 547 per m^2). One prospective processor built their facility for $200,000. Current VAD annual operating costs were $551,919 ± 473,201 per year (n = 7). Cost breakdowns for amenities and supplies can be seen in Table 2.2.

Employees dedicated to marketing were the same between current VAD and those planning a VAD enterprise, 1 ± 1 with the one usually being the owner/manager (n = 8 and n = 3, respectively). The current processing enterprise spent 14 ± 14 hours on marketing per week (n = 7) and prospective VAD enterprise planned to spend 16 ± 4 hours per week on marketing (n = 3). Current VAD enterprise spent $11,248 ± 15,224 on marketing annually (n = 8), but prospective VAD enterprise planned to spend $1,250 ± 354 annually (n = 2). Current VAD enterprise planned to grow by 50% ± 32% over the next five years.

Current VAD enterprise respondents received 26 ± 43% of their income from the VAD, 19 ± 38% of their income from other value-added enterprises, 36 ± 44% from farm income, and 19 ± 33% from off-farm income (n = 9). Prospective VAD enterprise respondents received 6 ± 15% of their household income from the dairy, 3 ± 4% from other value-added enterprises, and 30 ± 34% from farming, and 62 ± 39% of their income from off-farm income. Four current respondents reported most of their income came from farming, two from the VAD, and two from other value-added enterprises. Four prospective VAD reported most of the income as off-farm, while two reported the majority of income coming from farming activities. Following the 2017 Census of Agriculture, it was determined that 84% of dairy producers used farming as their primary occupation, but farming included all farming aspects such as crops and other livestock (NASS, 2019a).

Respondents were asked how certain aspects impacted their consideration on entering a value-added processing facility on a Likert scale (1 = strong negative impact, to 5 = strong positive impact). Current VAD felt that state regulations had strong negative to no impact (2.6 ± 0.9; n = 9), and prospective VAD felt a strong negative to some negative impact (2.4 ± 0.5; n = 7). Eckelkamp et al. (2021) asked TN dairy producers to rank how state regulations, federal regulations, start-up cost, processing knowledge, labor for processing, and marketing dairy products impacted their consideration to enter a VAD processing enterprise. According to Eckelkamp et al. (2021), state regulations had no impact for most producers considering a VAD enterprise. Our current VAD felt that federal regulations had some negative impact to no impact (2.8 ± 0.7; n = 9) while there was a strong negative to some negative impact for prospective VAD (2.3 ± 0.5; n = 7). Eckelkamp et al. (2021), found federal regulations had no impact on most producers. Similar, but slightly more negative associations, for state and federal regulations were seen by VAD in our study compared to Eckelkamp et al. (2021). Current VAD felt that startup costs had strong negative to some negative impact (2.0 ± 0.7; n = 9) while a strong negative impact was felt for prospective VAD (1.4 ± 0.5; n = 7). Survey-takers from Eckelkamp et al. (2021) felt a strong negative impact for startup cost. This makes sense because building and purchasing equipment to process milk safely is expensive. Durham et al. (2015) found the mean investment cost of a cheese processing facility was $608,480 ± 125,627. Current VAD felt that knowledge of processing had some negative to a strong positive impact on their decision to enter the value-added enterprise (3.7 ± 1.4; n = 9) whereas prospective VAD felt a strong negative to some negative impact (2.1 ± 0.4; n = 7). The previous study found that processing knowledge had some negative impact on whether producers considered value-added processing (Eckelkamp et al., 2021). This corresponds to our prospective VAD as they reported limited processing knowledge. However, we did find that those current VAD were more confident in their processing knowledge before starting an enterprise than the prospective VAD.

Labor for processing had some negative impact to no impact for both current VAD (3.2 ± 0.7; n = 9) and prospective VAD (3.0 ± 0.6; n = 7). Our results were similar to other studies, they found the majority had some negative impact assigned with labor for processing (Eckelkamp et al., 2021). This was not unsurprising because labor shortage was a current issue in both the agricultural and specifically in the dairy industry, and finding labor for a processing facility with long working hours would also be difficult. Product marketing had some negative impact to some positive impact for current VAD (3.1 ± 1.1; n = 9) the same was seen in prospective VAD (3.3 ± 0.8; n = 7). Eckelkamp et al. (2021) found most producers indicated that marketing of dairy products would have some negative impact on their thoughts to open a value-added enterprise. This was the only question to vary from our results and this might be because our VAD were significantly younger than those in Eckelkamp et al.'s work (58 yr). Younger generations may be more comfortable with social media, and this was a main way that producers did and considered marketing their products. Liability risk had a strong negative impact to some negative impact (2.2 ± 0.7; n = 9) on current VAD whereas prospective VAD had some negative to no impact (2.8 ± 0.8; n = 7).

Current VAD respondents were asked what level of profit their creamery made. Three said they made a comfortable profit, one made a small profit, and three were not breaking even. Seven of the current VAD respondents reported sales of ≥ $100,000 the year prior to survey administration. Four reported a value-added net income of $75,000, one reported $0 to 4,999 in sales, and two reported ≤ $0. The debt to asset ratio can be seen in Table 2.4.

Counts where current VAD sell and market their product and where prospective VAD plan to sell and market their products can be seen in Figures 2.5 and 2.6. The “sell other” category consisted of scheduled events, retail shops, food trucks, distribution companies, school clubs, local food banks, online ordering, market wagons, and agritourism stands. The “market other” category consisted of publicized grand openings, apparel, tv shows, and trucks with logos.

Conclusion

Value-added dairy producers were younger than the mean in TN by 21 yr and younger than the USA mean by 12 yr (38 yr vs. 59 yr vs. 50 yr). We found that 6.2% of the cow dairies in TN were actively operating a VAD enterprise and farms had been in business 14 ± 11 yr. Most producers milked cattle solely for on-farm processing. Fluid products (homogenized milk, creamline milk, and cream) were the most common product produced and considered among the current VAD (n = 9), followed by cheese (soft and aged; n = 7), then ice cream (n = 6). Among the prospective VAD, fluid products (n = 8) were the most produced, followed closely by cultured products and cheeses (n = 7 and n = 6, respectively). Our VAD primarily sold their product to restaurants, wholesale distributors and on-farm stores, but they marketed through social media, farm websites, product sampling, word of mouth, and the Pick TN program. East TN has most dairies and VAD operations. Most current and prospective VAD were in great financial standing of < 40% debt to asset ratio, four were making a profit, while three were not breaking even. The majority of income from current producers came from farming activities, i.e. not value-added, and of the prospective VAD, the majority of income came from off-farm income.

Results from this study revealed that dairies a herd size larger than the TN average were more likely be involved in a VAD, but farms smaller than the average herd size were more likely to consider a VAD. Interestingly, the top dairies in TN based on herd size are all involved in VAD processing in some way, but quite a few diversify their product by marking VAD products while still selling to their regular milk marketing choice (plant contract or co-op). Although producers desired more cost control over milk sold, entrance costs into VAD were prohibitive for operations below the TN mean. Future research determining costs based on variance herd size and production options will be conducted using this data.

References

Agricultural Marketing Service [AMS]. 2020. USDA value-added ag definition. Accessed Sep. 10, 2020. https://www.agmrc.org/business-development/valueadded-agriculture/articles/usda-value-added-ag-definition.

Agricultural Marketing Service [AMS]. 2021. Mailbox milk price report. Accessed Mar. 20, 2022. https://www.ams.usda.gov/sites/default/files/media/2020MailboxPrices.pdf.

Durham, C. A., A. Bouma, and L. Meunier-Goddik. 2015. A decision-making tool to determine economic feasibility and break-even prices for artisan cheese operations. J Dairy Sci 98(12):8319-8332. https://doi.org/10.3168/jds.2014-9252.

Eckelkamp, E., A. Sen, D. Bilderback, and S. Schexnayder. 2021. The potential impact of value-added dairy processing. Vol. W 1053. UT Extension, Knoxville, TN.

Economic Research Service [ERS]. 2021a. Milk production costs and returns per hundredweight sold, by state. Accessed Mar 2, 2022. https://www.ers.usda.gov/data-products/milk-cost-of-production-estimates/.

Economic Research Service [ERS]. 2021b. Dairy products: Per capita consumption, United States (pounds per person). Accessed Feb 21, 2022. https://www.ers.usda.gov/data-products/dairy-data/.

Economic Research Service [ERS]. 2021c. Data Files: U.S. and state-level income and wealth statistics. Accessed June 30, 2022. https://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/.

Emmanuel, M., J. J. Thoomkuzhy, and M. E. John. 2018. Antecedents of value added agriculture. J Manage 5(3).

Lass, D., A. Bevis, G. Stevenson, J. Hendrickson, and K. Ruhf. 2003. Community supported agriculture entering the 21st century: Results from the 2001 national survey. Amherst: University of Massachusetts, Department of Resource Economics.

National Agricultural Statistics Service [NASS]. 2019a. 2017 census of agriculture United States summary and state data. Accessed Mar 1, 2022. https://www.nass.usda.gov/Publications/AgCensus/2017/index.php.

National Agricultural Statistics Service [NASS]. 2019b. Dairy cattle and milk production - 2017 census of agriculture highlights. Accessed Mar 1. 2022. https://www.nass.usda.gov/Publications/Highlights/index.php.

National Agricultural Statistics Service [NASS]. 2021a. Farm labor (May 2021). Accessed Mar 1, 2022. https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Farm_Labor/.

National Agricultural Statistics Service [NASS]. 2021b. Farm labor (November 2021). Accessed Mar 1, 2022. https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Farm_Labor/.

National Agricultural Statistical Service [NASS]. 2021c. Quick Stats: Tennessee. https://quickstats.nass.usda.gov/.

Nicholson, C. F. and M. W. Stephenson. 2007. Financial performance value-added dairy operations in New York, Vermont and Wisconsin. https://doi.org/10.22004/ag.econ.9732.

Norman, H. D., F. L. Guinan, J. H. Megonigal Jr., and J. Durr. 2022. Milk somatic cell count from Dairy herd improvement herds during 2021. in Council on Dairy Cattle Breeding (CDCB). Vol. SCC23 (2-22). CDCB.

Paul, M. 2019. Community-supported agriculture in the United States: Social, ecological, and economic benefits to farming. J of Agrarian Change 19(1):162-180. https://doi.org/10.1111/joac.12280.

Progressive Publishing. 2021. 2021 U.S. dairy statistics. Accessed Mar 5, 2022. https://www.progressivedairy.com/site/stats/us-dairy-stats.

Sen, A. 2021. Current state of the Tennessee dairy industry and barriers to producers' permanency. in Department of Animal Science. Vol. Masters of Science. University of Tennessee, Knoxville, TN.

Smith, S., E. Chaney, and J. Bewley. 2013. Planning considerations for on-farm dairy processing enterprises. J Dairy Sci 96(7):4519-4522. https://doi.org/10.3168/jds.2012-6541.

Appendix B

Table 2.1. Respondent and farm descriptors of Tennessee current and prospective value-added dairy operations (VAD).

Variable	Current VAD			Prospective VAD		
	Mean ± Std. Dev.	Minimum	Maximum	Mean ± Std. Dev.	Minimum	Maximum
Respondent Demographics		(n = 9)			(n = 7)	
Age (yr)	38 ± 11	24	62	38 ± 13	24	56
Years owned or managed dairy farm	14 ± 11	2	37	15 ± 15	3	40
Years owned or managed processing facility	8 ± 7	1	23	NA	NA	NA
Farm Descriptors		(n = 8)			(n = 7)	
Mature cow herd size (#)	462 ± 699	23	1900	138 ± 252	13	700
Percent of milk processing or intended for VAD	61 ± 49	4	100	50 ± 44	22	100
Average production per cow per day (kg)	28 ± 8.3	17.3	42	22 ± 5.8	13.6	32.3
Rolling herd average (kg)	8,526 ± 2,544	5,268	12,824	6,700 ± 1,771	4,159	9,843
Somatic cell count (cell/mL)	293,750 ± 126,597	200,000	600,000	279,000 ± 73,007	200,000	350,000

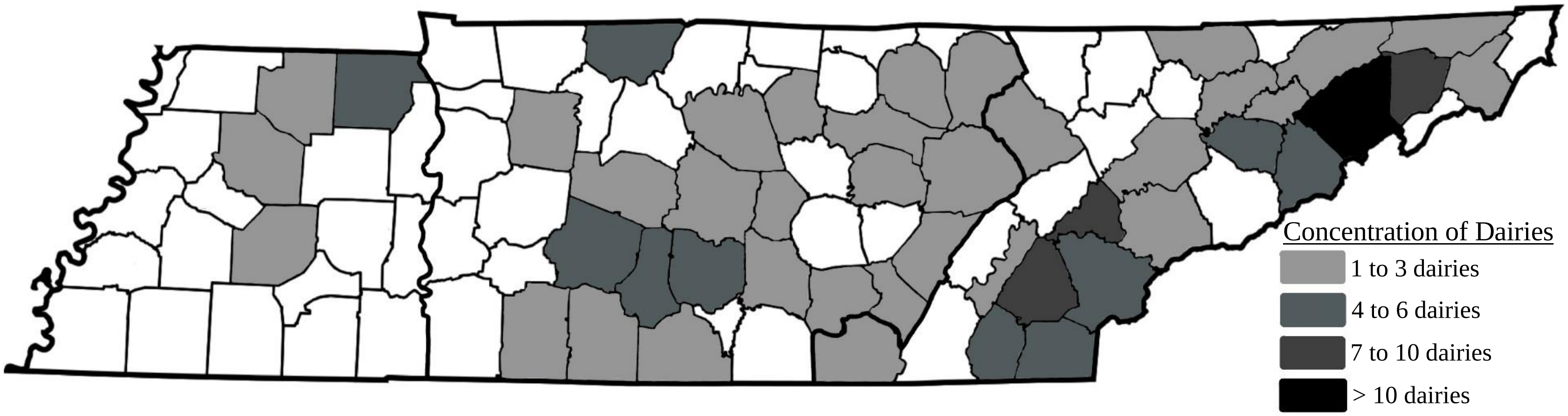

Figure 2.1. Distribution of grade "A" licensed dairies by region in Tennessee

West Tennessee (TN) had 16 grade “A” cow dairies in February 2022.
Central TN had 48 grade “A” cow dairies in February 2022.
East TN had 82 grade “A” cow dairies in February 2022

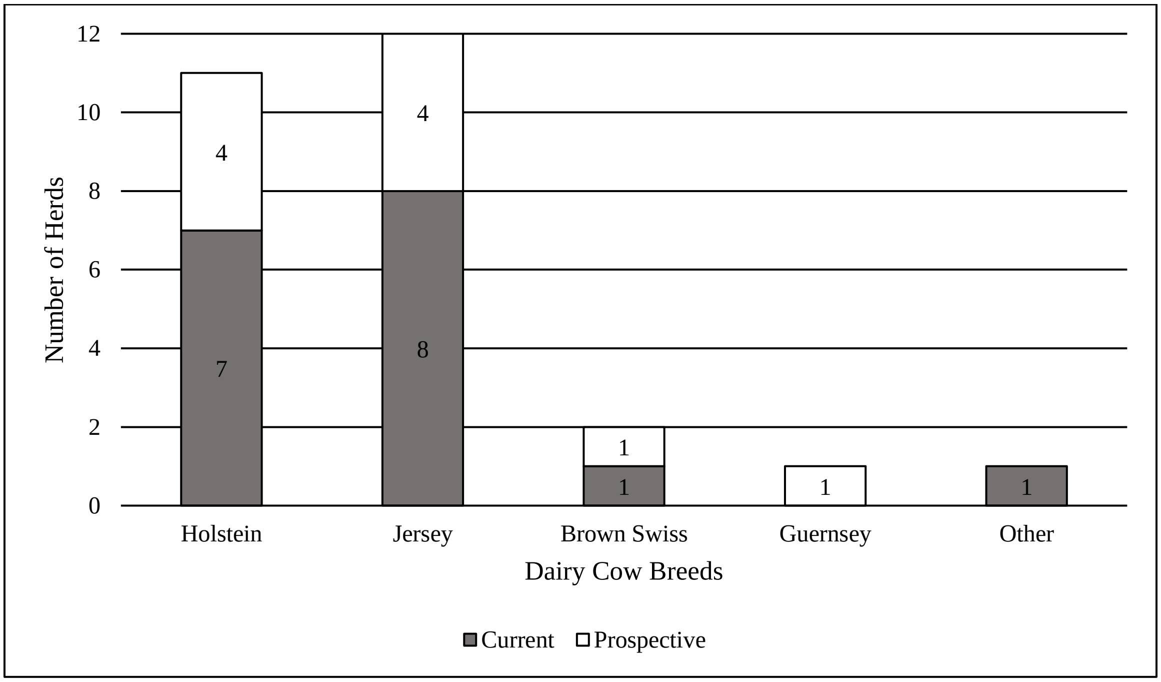

Figure 2.2. Distribution of dairy cow breeds across current (n = 9) and potential (n = 7) value-added dairy processors

Table 2.2. Volume of dairy products produced by current value-added dairy processors (n = 9) in Tennessee

Variable	Mean ± St. Dev.	Total Processors
Soft cheese (kg)	5,909	1
Aged cheese (kg)	116,212 ± 80,245	3
Homogenized milk (kg)	220,339 ± 93,046	2
Creamline milk (kg)	278,352 ± 200,424	4
Ice cream (kg)	27,981 ± 42,488	5
Butter (kg)	1,941 ± 469	2
Cream (kg)	35,525 ± 39,612	2
Drinkable yogurt (kg)	NA	0
Traditional yogurt (kg)	NA	0
Lotions and soaps (kg)	NA	0
Other products (kg)[1]	17,786	1

[1] Other products category consisted of a whey protein chocolate milk.

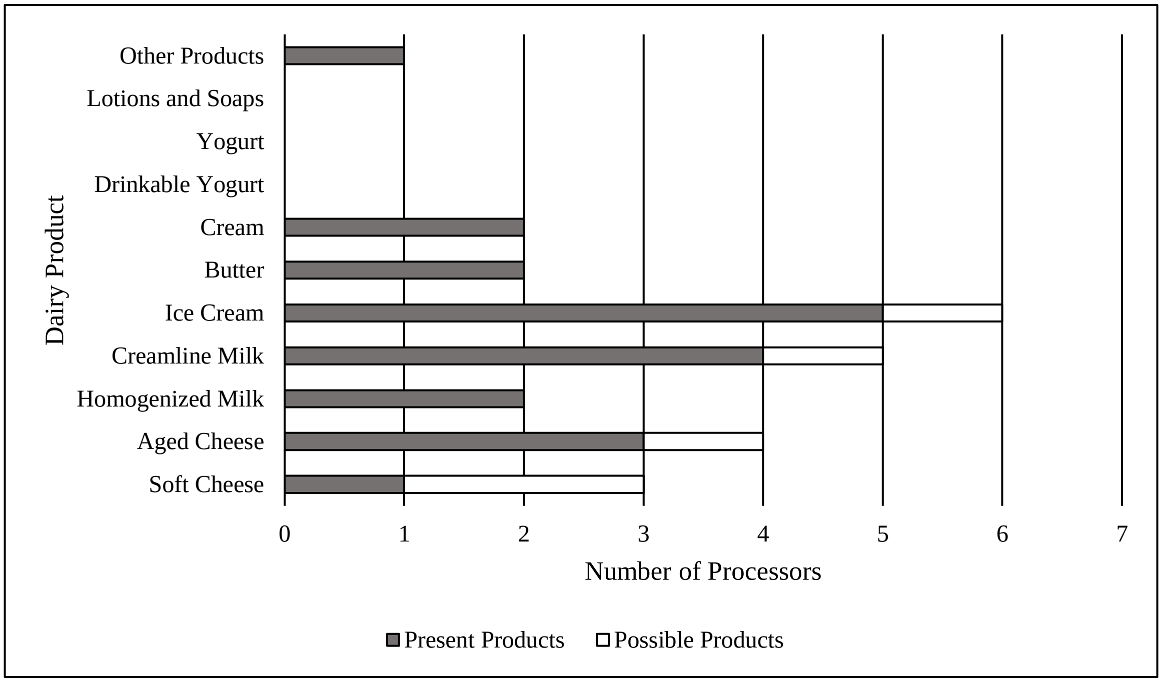

Figure 2.3. Current value-added dairy processor (n = 9) dairy product production status

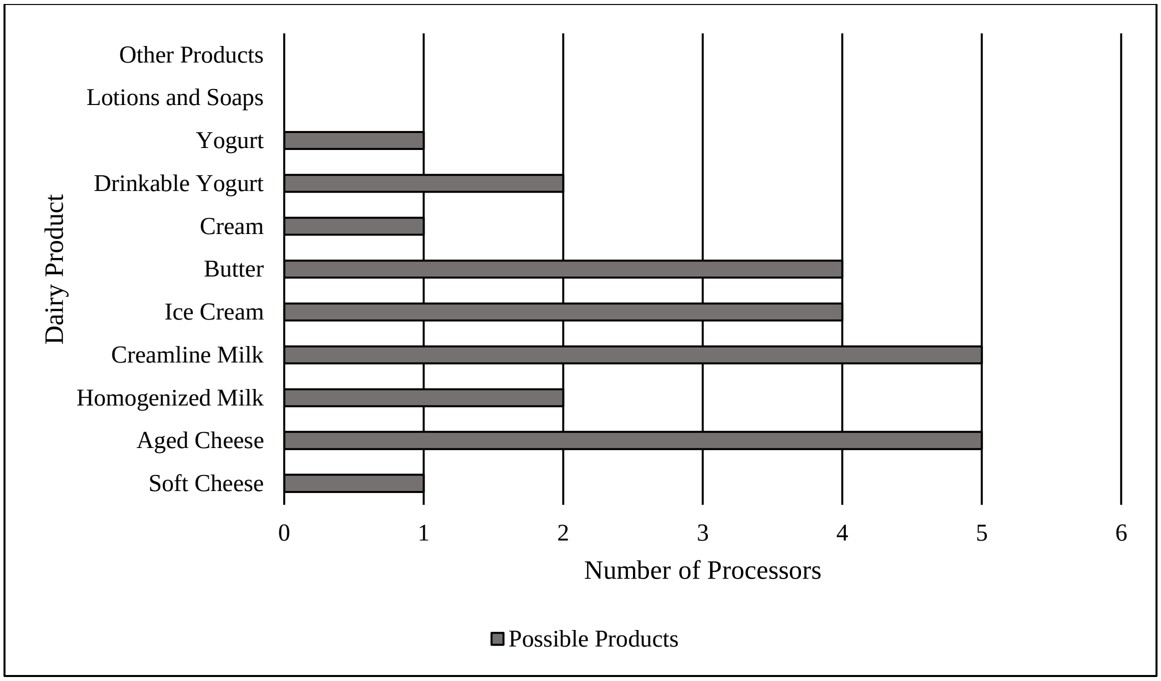

Figure 2.4. Prospective value-added dairy processor (n = 7) dairy products considered for production

Table 2.3. Current value-added dairy processors (n = 9) amount spent on processing amenities annually

Variable	Current Processor Mean ± St. Dev.	Current Processor N
Electric ($)	14,953 ± 13,935	6
Water	6,811 ± 10,732	7
Sewage	111 ± 192	3
Trash	2,044 ± 905	5
Gas (propane or natural)	16,519 ± 24,334	6
Packaging	33,266 ± 31,472	7
Cleaning and sanitation	9,380 ± 6,616	6
Processing supplies	19,253 ± 25,297	7
Cost other 1[1]	21,476 ± 17,811	4
Cost other 2[2]	46,050 ± 74,619	4
Cost other 3[3]	4,669 ± 4,853	3
Marketing	11,248 ± 15,224	8

[1] Cost other 1 included insurance, distribution costs, labor, and phone bills.

[2] Cost other 2 included transportation and postage, cost to purchase milk, ingredients, and internet.

[3] Cost other 3 included credit card fees, rent, and website costs.

Table 2.4. Current (n = 9) and prospective (n = 7) value-added dairy processor debt to finance ratio out of $100

	Current	Prospective
$0	1	NA
$3 to $4.99	NA	1
$5 to $9.99	1	1
$10 to $14.99	NA	1
$10 to $14.99 and $15 to $19.99*	1	NA
$15 to $19.99	NA	1
$20 to $39.99	1	1
$40 to $69.99	1	NA
> $70	1	NA
"I prefer not to disclose"	2	1

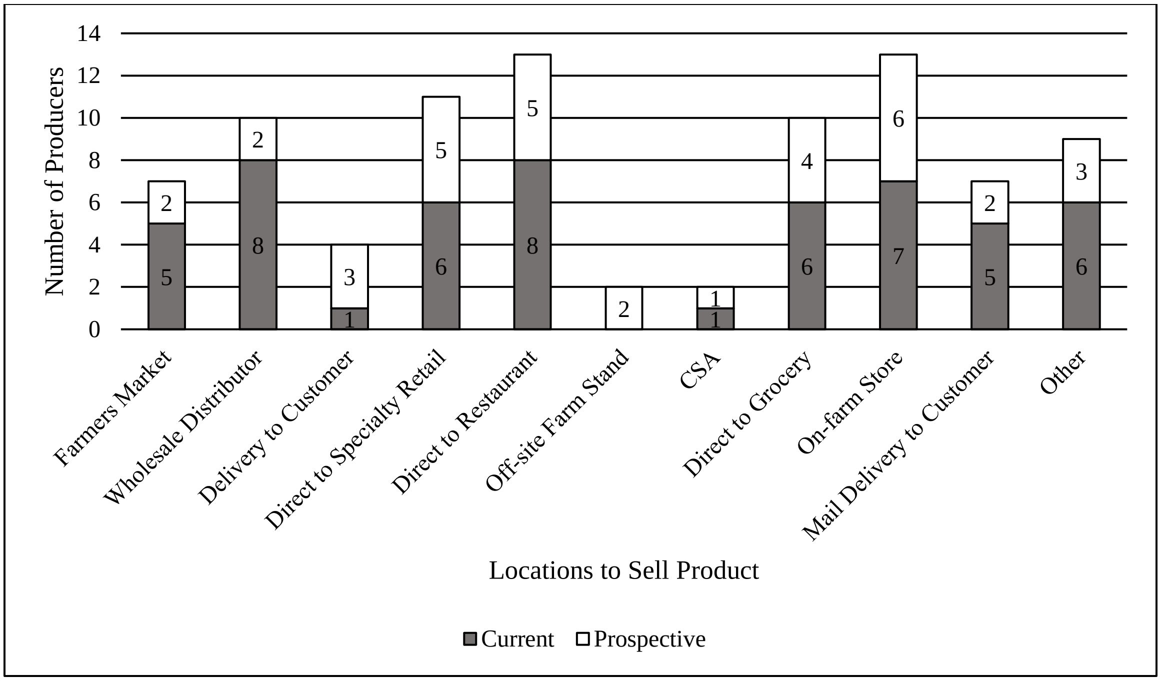

Figure 2.5. Outlets current (n = 9) and prospective (n = 7) value-added dairy processors sell or plan to sell their products

[1] Other included scheduled events, food trucks, publicized grand openings, market wagon, agritourism stands, websites for ordering, gyms, local food banks, football teams and clubs, retail ice cream shop, distribution direct to stores.

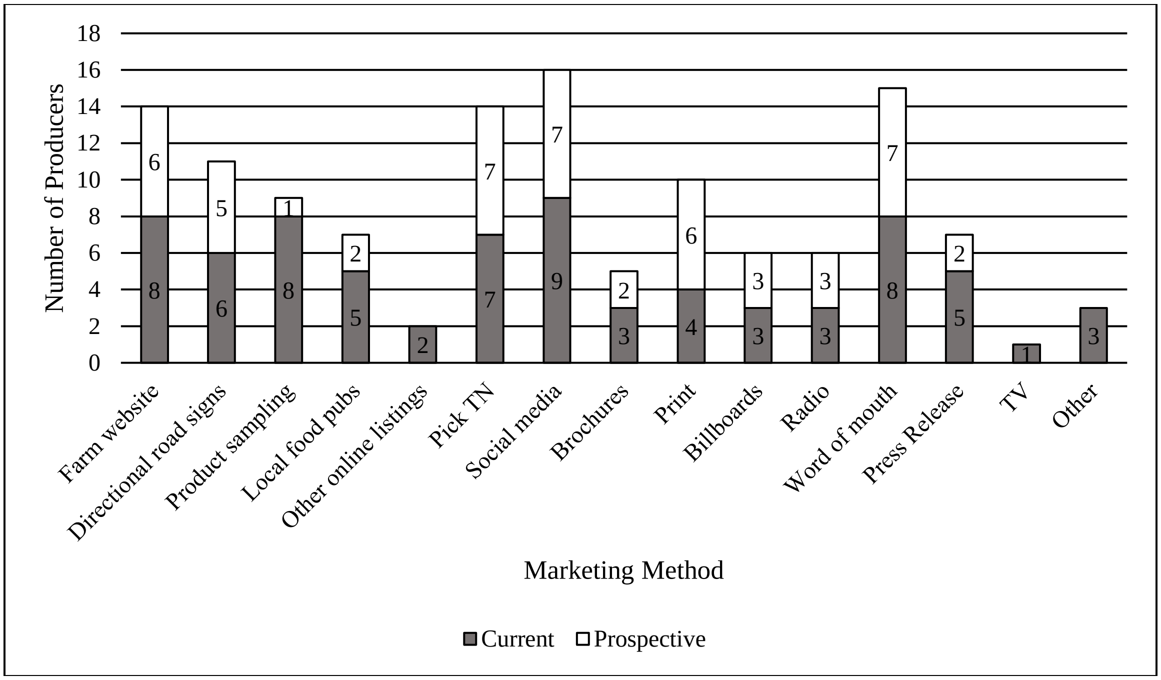

Figure 2.6. Methods current (n = 9) and prospective (n = 7) value-added dairy processors market or plan to market their products

[1] Other included TV shows, trucks with logos, apparel, publicized grand openings, others social media pages

Table 2.5. Processing equipment purchase prices by value-added dairy processor status

Equipment	Current processor purchase price ($) Mean ± St. Dev.	Total current processors	Prospective processor purchase price ($) Mean ± St. Dev.	Total prospective processors
Bulk tank	5,875 ± 2,780	4	3,500 ± 2,121	2
Chart recorder	18,067 ± 19,215	3	1,000	1
Clean out of place	6,888 ± 5,125	4		NA
In line pasteurizer	70,000 ± 77,782	2		NA
Homogenizer	10,000	1		NA
Separator	2,800	1		NA
Chart recorder	2,100 ± 141	2		NA
Vat pasteurizer	15,000	1	24,000	1
Cheese drain table	18,847	1		NA
Cheese press	18,847	1		NA
Ice cream freezer	21,000 ± 9,644	3		NA
Filler capper sealer	8,900 ± 1,556	2	2,500	1
Holding tank	6,750 ±4,596	2		NA
Aging room	25,000	1		NA
Freezer	13,500 ± 11,325	3		NA
Refrigerator	9,025 ±7,590	4	0	1
Equipment package Deal	168,500 ± 174,104	4		NA
Other equipment 1[1]	9,453 ± 6,208	4		NA
Other equipment 2[2]	2,950 ± 1,485	2		NA
Other equipment 3[3]	12,750 ± 13,081	2		NA
Other equipment 4[4]	12,000	1		NA
Other equipment 5[5]	5,500	1		NA

[1] Other equipment 1 included date sprayers, cheese molds, fridge cooling units, and cappers.
[2] Other equipment 2 included date labelers and mixing tanks.
[3] Other equipment 3 included vat boilers and date sprayers.
[4] Other equipment 4 included labelers.
[5] Other equipment 5 included lab testing equipment.

Table 2.6. Processing equipment bought new or used by current (n = 9) and prospective (n = 7) value-added dairy processors

Equip.[1]	TCP[2]	TPP[3]	Equip.[1]	TCP[2]	TPP[3]	Equip.[1]	TCP[2]	TPP[3]
Bulk Tank			Chart Recorder			Clean out of Place		
New	NA	1	New	3	NA	New	3	NA
Used	7	1	Used	2	1	Used	3	NA
In Line Pasteurizer			Homogenizer			Separator		
New	3	NA	New	NA	NA	New	NA	NA
Used	NA	NA	Used	2	NA	Used	2	NA
Chart Recorder			Vat Pasteurizer			Butter Churn		
New	4	NA	New	2	1	New	NA	NA
Used	3	NA	Used	2	NA	Used	1	NA
Cheese Drain Table			Cheese Vat			Cheese Press		
New	1	NA	New	2	NA	New	2	NA
Used	1	NA	Used	1	NA	Used	1	NA
Ice Cream Freezer			Filler Capper Sealer			Holding Tank		
New	3	NA	New	NA	NA	New	1	NA
Used	1	NA	Used	4	1	Used	2	NA
Aging Room			Freezer			Refrigerator		
New	3	NA	New	3	NA	New	4	NA
Used	NA	NA	Used	1	NA	Used	2	1
Package Deal			Other Equip 1[4]			Other Equip 2[5]		
New	2	NA	New	2	NA	New	1	NA
Used	2	NA	Used	2	NA	Used	1	NA
Other Equip 3[6]			Other Equip 4[7]			Other Equip 5[8]		
New	2	NA	New	1	NA	New	1	NA
Used	NA	NA	Used	NA	NA	Used	NA	NA

[1] Equipment purchased; [2] Total current processors; [3] Total prospective processors; [4] Other equipment 1 included date sprayers, cheese molds, fridge cooling units, and cappers; [5] Other equipment 2 included date labelers and mixing tanks; [6] Other equipment 3 included vat boilers and date sprayers; [7] Other equipment 4 included labelers; [8] Other equipment 5 included lab testing equipment.

Table 2.7. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processors location and roles

	Current Processors (n = 2)	Prospective Processors (n = 1)
Dairy farm owner or manager	1	NA
Dairy farm and processing facility owner or manager	1	1
Located in west TN	NA	NA
Located in central TN	2	1
Located in east TN	NA	NA

Table 2.8. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processor age and years in operation

	Current Processors (n = 2)	Prospective Processors (n = 1)
Respondent age (yr)	66 ± 13	60
Years respondent owned or managed the dairy farm	7.5 ± 6.4	4
Years respondent owned or managed the processing facility	2.6 ± 3.4	NA

Table 2.9. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processor herd statistics and farm employees

Variable	Current Processors (n = 2)	Prospective Processors (n = 1)
Number of mature lactating animals	98 ± 32	19
Percentage of herd dedicated to value-added enterprise	100	100
Average production per animal per day (kg)	3.2 ± 3.8	1.5
Rolling herd average (kg)	970.5 ± 1,156.8	443.6
Somatic cell count (cell/ml)	400,000 ± 494,975	NA
Number of family farm employees	2.5 ± 2.1	2
Number of non-family farm employees	1.5 ± 2.1	NA

Table 2.10. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processor herd makeup and milk market

Variable	Current Processors (n = 2)	Prospective Processors (n = 1)
Species milked		
Goat	1	1
Sheep	1	NA
Breed		
Alpine	1	1
Nigerian	NA	1
Sannan	1	NA
Nubian	1	NA
Nigerian Dwarf	1	NA
La Mancha	1	NA
East Friesian	1	NA
Milk dedicated to on-farm processing	2	NA
Milk dedicated to other	NA	1

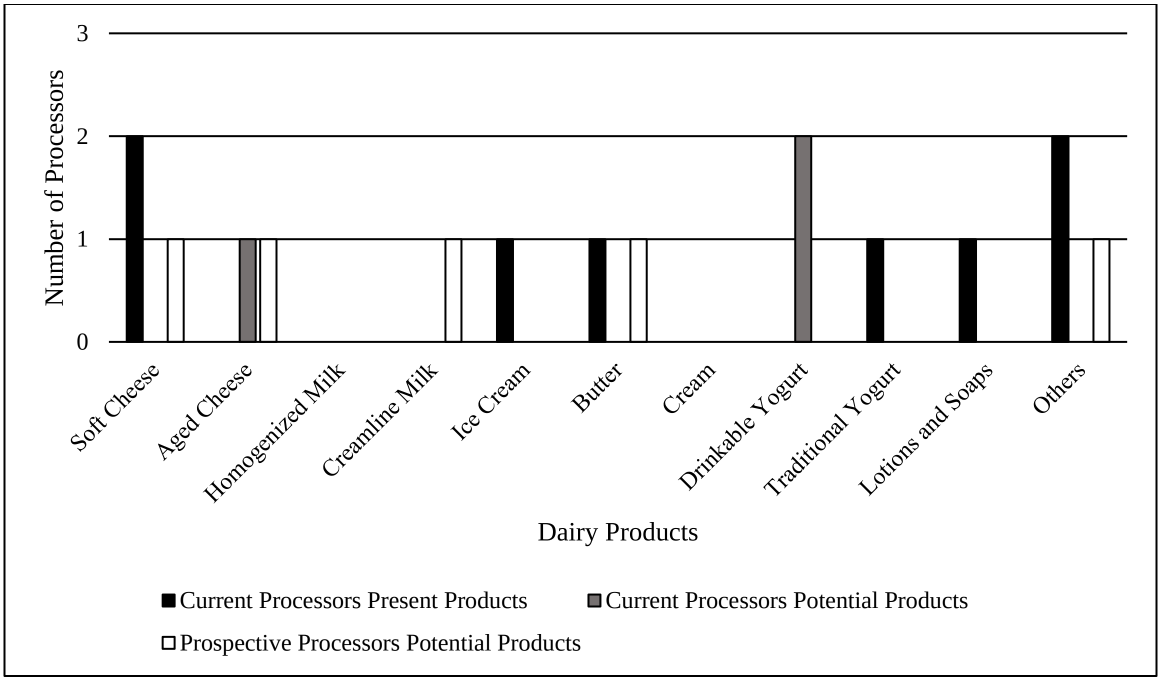

Figure 2.7. Small ruminant value-added dairy processor products being processed and considered for processing

*Current processors present other products were caramel, fudge, and jameed.
*Prospective processors potential other products were caramel and fudge.

Table 2.11. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processors processing facility information

Variable	Current Processors (n = 2)	Prospective Processors (n = 1)
Pasteurization method	Vat (n = 2)	Vat (n = 1)
Processing facility built new	2	NA
Processing facility built as retrofit	NA	1
Processing waste (yes or no)	Yes (n = 2)	No (n = 1)
Current processors using their own milk	2	NA
Prospective processors using their own milk	NA	1
Liters processed per year	71953 ± 45193	5678
Processing facility area (m^2)	29.7 ± 0	NA

Table 2.12. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processors processing employees

Variable	Current Processors (n = 2)	Prospective Processors (n = 1)
Mean family processing employees	1.5 ± 0.7	2
Mean non-family processing employees	0.75 ± 1.06	2
Maximum total processing employees	2.25 ± 0.35	4
Hours family processing employees worked per week	9	NA
Hours non-family processing employees worked per week	10.75 ± 15.2	NA

Table 2.13. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processors amounts of products processed

Dairy Product Processed (kg)	Current Processors (n = 2)	Prospective Processors (n = 1)
Soft cheese	909.1 ± 0	NA
Aged cheese	NA	NA
Homogenized milk	NA	NA
Creamline milk	NA	NA
Ice cream	NA	NA
Butter	181.8 ± 0	NA
Cream	NA	NA
Drinkable yogurt	NA	NA
Traditional yogurt	727.3 ± 0	NA
Lotions and soaps	NA	NA
Other products[1]	636.4 ± 0	NA

[1] Other products included jameed, caramel, fudge, and raw milk

Table 2.14. Small ruminant value-added dairy current (n = 2) and prospective (n = 1) processor equipment

Equip.[1]		TCP[2]	TPP[3]	Equip.[1]		TCP[2]	TPP[3]	Equip.[1]		TCP[2]	TPP[3]
Bulk Tank				Chiller				Clean out of Place			
	New	2	1		New	1	1		New	NA	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA
In Line Pasteurizer				Homogenizer				Separator			
	New	NA	NA		New	NA	NA		New	NA	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA
Chart Recorder				Vat Pasteurizer				Butter Churn			
	New	1	1		New	2	1		New	NA	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA
Cheese Drain Table				Cheese Vat				Cheese Press			
	New	1	NA		New	1	NA		New	NA	1
	Used	NA	NA		Used	NA	NA		Used	NA	NA
Ice Cream Freezer				Filler Capper Sealer				Holding Tank			
	New	NA	NA		New	NA	NA		New	NA	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA
Aging Room				Freezer				Refrigerator			
	New	NA	NA		New	1	NA		New	1	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA
Package Deal				Other Equip 1				Other Equip 2			
	New	NA	1		New	1[4]	NA		New	1[6]	NA
	Used	NA	NA		Used	NA	1[5]		Used	NA	NA
Other Equip 3				Other Equip 4				Other Equip 5			
	New	1[7]	NA		New	NA	NA		New	NA	NA
	Used	NA	NA		Used	NA	NA		Used	NA	NA

[1] Equipment purchased
[2] Total current processors
[3] Total prospective processors
[4] Tabletop stove burner and ice machine
[5] Blast chiller
[6] Curing racks and vacuum pump
[7] Soap molds

Table 2.15. Small ruminant value-added dairy processor financials, future plans, and income by processor status

	Current Processor (n = 2)	Prospective Processor (n = 1)
Profit of value-added dairy enterprise	Barely breaking even (n = 1) Not breaking even (n = 1)	NA
Five-year business plan		
Percentage planned to grow operation by (%)	50	NA
Routes to grow operation	Moving more existing product (n = 2) Increasing product price (n = 1) Creating new products (n = 1) Expanding into new stores (n = 1)	NA
Plan to maintain operation	NA	NA
Percentage planned to grow operation by (%)	NA	NA
Routes to decrease operation	NA	NA
Routes to cease operation	NA	NA
Annual sales from dairy products	$0 (n = 1) ≥ $100,000 (n = 1)	NA
Annual value-added enterprise net income	≤ $0 (n = 1)	NA
Household income from value-added dairy enterprise (%)	0	0
Household income from other value-added enterprises (%)	0	0
Household income from farming activities (%)	1 ± 1.4	1
Household income from off-farm income (%)	99 ± 1.4	99
Debt-to-asset ratio	$1 to 2.99 (n = 1)	$0

*Annual operating costs and cost breakdowns were not reported

Table 2.16. Small ruminant value-added dairy processor respondent risk behaviors by processor status

	Current Processor (n = 2)	Prospective Processor (n = 1)
I am the kind of businessperson who is more willing to take financial risks than others	3.0 ± 1.4	4
I must be willing to take substantial financial risks to be successful in business	3.0 ± 1.4	4
I am reluctant about adopting new production or processing methods until I see them working for others	4.5 ± 0.7	1
I am more concerned about a large loss to my enterprise than about missing a substantial gain	4.0 ± 0	4

Table 2.17. Small ruminant value-added dairy processor factors affecting start-up decisions by processor status

	Current Processor (n = 2)	Prospective Processor (n = 1)
State regulations	4.0 ± 1.4	3
Federal regulations	3.5 ± 0.7	3
Start-up costs	2.0 ± 0	2
Knowledge of processing	2.0 ± 1.4	4
Labor for processing	2.0 ± 1.4	3
Product marketing	2.0 ± 1.4	4
Liability risk	3.0 ± 0	2

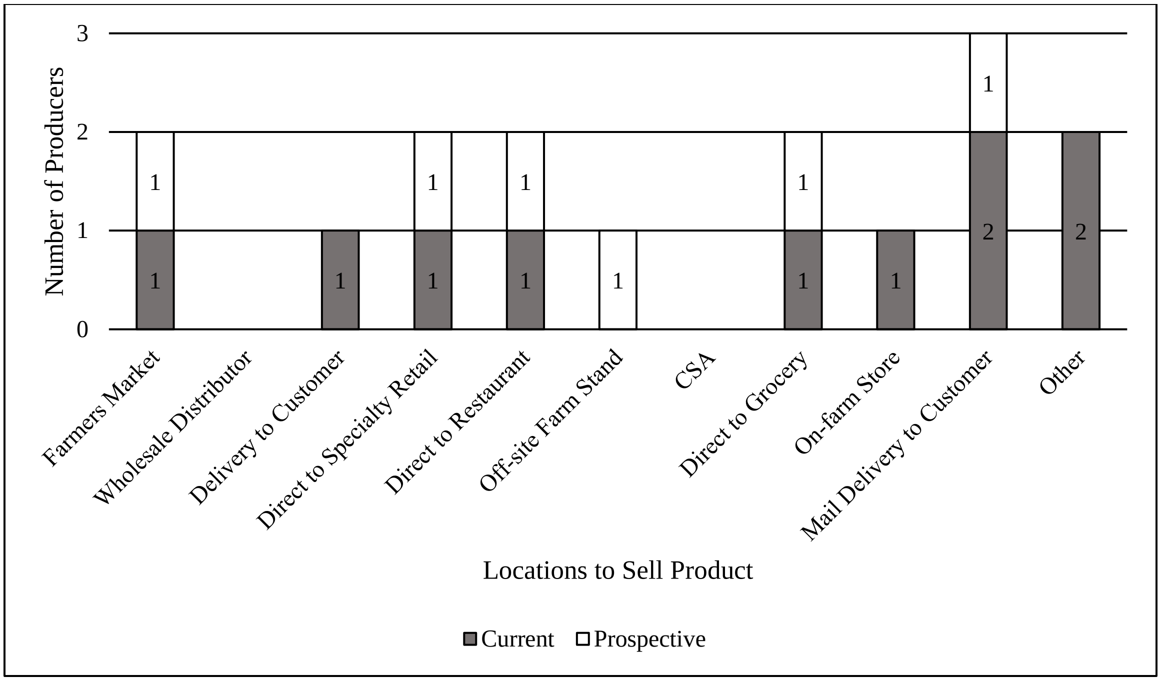

Figure 2.8. Outlets current and prospective small ruminant value-added dairy current (n = 2) and prospective (n = 1) producers sell or plan to sell their products

[1] Other included local harvest, herd shares, and buy on farm but no farm store

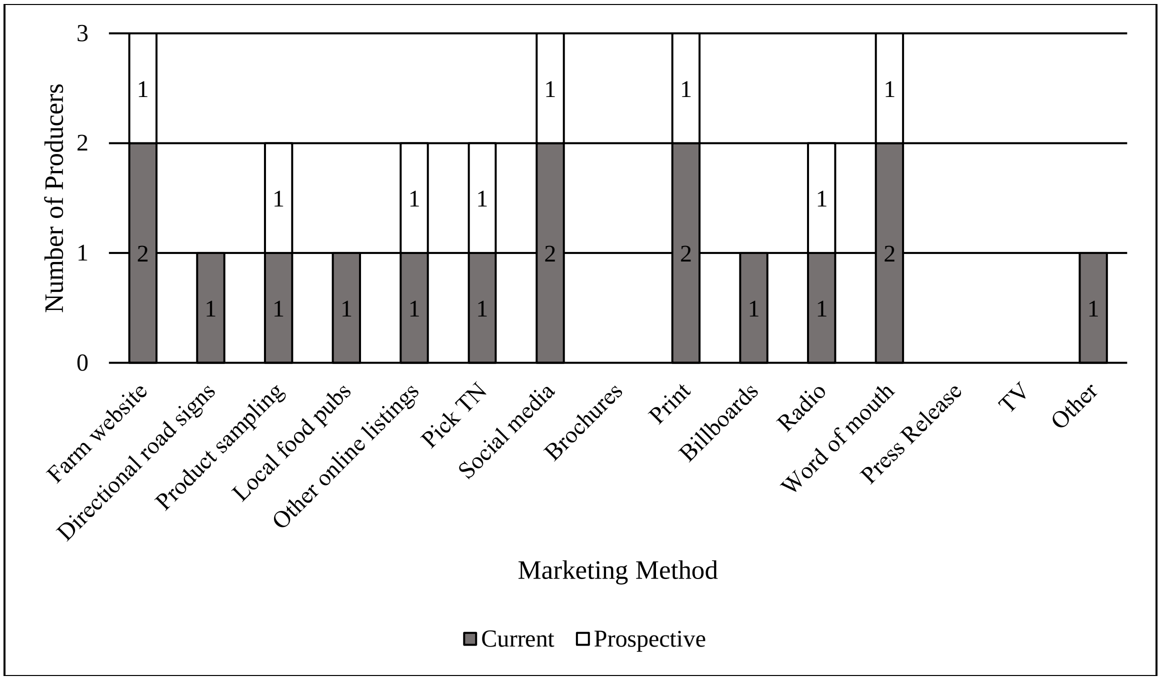

Figure 2.9. Methods current and prospective small ruminant value-added dairy current (n = 2) and prospective (n = 1) producers market or plan to market their products

[1] Other included a family fun day

Value-added Enterprise Assessment
University of Tennessee

You and Your Operation

1. What is your role in your operation?
   - ☐ Dairy farm owner/manager
   - ☐ Processing plant owner/manager
   - ☐ Both
   - ☐ Other (please describe) ________________________________
2. What is your age? ___________
3. How many years have you owned or managed your dairy farm? _____________
4. How many years have you owned or managed your processing facility? ____________
5. Please indicate you County, State. ____________________, _______
6. Please indicate your level of agreement with each of the following statements.

Statement	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
I am the kind of businessperson who is more willing to take financial risks than others					
I must be willing to take substantial financial risks to be successful in business					
I am reluctant about adopting new production or processing methods until I see them working for others					
I am more concerned about a large loss to my enterprise than about missing a substantial gain					

7. What species do you milk or will you purchase milk from?
   - ☐ Cattle
   - ☐ Sheep
   - ☐ Goats
   - ☐ Other (please list) ____
8. Please indicate which of these bests describes your enterprise
   - ☐ Value-added processing with own farm milk
   - ☐ Considering value-added processing with own farm milk
   - ☐ Value-added processing with purchased milk (skip dairy farm specific information)
   - ☐ Considering value-added processing with purchased milk (skip dairy farm specific information)
   - ☐ Other ____

9. Please describe any other value-added, direct marketing or agritourism activities you are currently involved in, if any.

____
____
____
____

Dairy Farm Specific Information (skip if not involved in a dairy farm)

10. What is your current herd/flock size and the number of animals for the enterprise?

	Total herd	Value-added enterprise herd
Number of mature animals (dry and lactating)	________________	________________
Number of youngstock	________________	________________
Number of males	________________	________________

11. What breed(s) do you milk?

____

12. What is the number of farm-specific workers, including yourself? Please record numbers for both types of workers even if zero (0). Record yourself as a family member.
___________ Number of family members
___________ Number of non-family employees

13. How do you market most of your milk?
    - ☐ Milk cooperative
    - ☐ Independent contract with a plant
    - ☐ On-farm processing
    - ☐ Other (please list) ____

14. What is your:
_____________ Average production per animal (pounds per animal per day)?
_____________ Yearly average bulk tank somatic cell count (SCC) in cells/mL?

15. Which situation best describes your farm:
    - ☐ Freestall with traditional parlor
    - ☐ Tiestall with traditional parlor
    - ☐ Open barn with traditional parlor
    - ☐ Pasture with traditional parlor
    - ☐ Freestall with robotic milker
    - ☐ Tiestall with robotic milker
    - ☐ Open barn with robotic milker
    - ☐ Pasture with robotic milker
    - ☐ Other (please list) ____

Processing Facility Specific Information

16. Please select and indicate the total annual volume produced in pounds for all value-added enterprises you are involved in.

	Planned	Current	Annual Volume (lbs)
☐ Soft cheese	_______	_______	__________________
☐ Aged cheese	_______	_______	__________________
☐ Homogenized milk	_______	_______	__________________
☐ Cream-top/line milk	_______	_______	__________________
☐ Ice cream or mix	_______	_______	__________________
☐ Butter	_______	_______	__________________
☐ Cream	_______	_______	__________________
☐ Drinkable yogurt	_______	_______	__________________
☐ Traditional or Greek yogurt	_______	_______	__________________
☐ Lotions, soaps, etc.	_______	_______	__________________

☐ Other (please list) ____

17. How many gallons are used/you plan to use annually for your value-added enterprise?
____

18. What type of pasteurization do you use/plan to use?
    - ☐ Low temperature (vat)
    - ☐ High temperature short time (HTST)
    - ☐ Ultra-high temperature (UHT)
    - ☐ Other (please list) ____

19. What serving sizes are you planning on processing?
    - ☐ Single serving (8 to 16 oz bottles; ½ pint ice cream, 8 oz blocks)
    - ☐ Multi-serving (Quarts, ½ gallons; 16 oz blocks)
    - ☐ Family size (1 or multi-gallons; ½ pound or more blocks)
    - ☐ Other (please describe) ____

20. Was/will your processing facility built new or a retrofit of an existing facility? ________

21. What is/will be the number of processing-specific workers, including yourself? Please record numbers for both types of workers even if zero (0). Record yourself as a family member.

    ___________ Number of family members
    ___________ Number of non-family employees
    ___________ Unknown/yet to be determined

Skip questions 22-27 if still in the planning stages.

22. What are the dimensions of your processing facility and the cost of the construction itself?
____

23. In what year was the processing facility built or retrofitted? _______________

24. On average, how many hours do family members work in a week devoted to the value-added enterprise? ____

25. On average, how many hours do non-family members work in a week devoted to the value-added enterprise?
____
____

26. What was your estimated annual operating cost for the value-added enterprise in 2019?
____

27. Of your total operating cost, what percentage or actual value goes to the following:

Amenities and Supplies	% of Annual Operating Cost	Actual Annual Value
Electricity		
Water		
Sewage		
Trash		
Gas (propane or natural)		
Packaging		
Cleaning and Sanitation		
Processing Supplies		
Other (please list)_____________		
Other (please list)_____________		

28. From the below list, indicate the purchase price, whether it was new or used, and which value-added enterprise(s) it is used for. If you are in the planning stages, indicate “Need” in the purchased column.

Item	Price	Purchased New or Used	Enterprise(s)
Bulk tank			
Chiller			
COP tank			
In-line pasteurizer			
Homogenizer			
Separator			
Chart recorder			
Vat pasteurizer			
Butter churn			
Cheese drain table			
Cheese vat			
Cheese press			
Ice cream freezer			
Filler/capper/sealer			
Holding tanks			
Aging rooms			
Freezer storage – sqft ___x___			
Refrigerated storage – sqft ___x___			
Other (please describe)			

29. Of the following, what all is included/planned in your packaging?
- ☐ Caps
- ☐ Bottles
- ☐ Labels
- ☐ Containers
- ☐ Sealing plastic
- ☐ Wax
- ☐ Other (please list) ___________________

30. Does/will your processing facility generate any waste dairy products (whey/skim, etc)?
- ☐ Yes
- ☐ No
- ☐ Other (please list) ____

31. If so, what do you do/plan to do with your waste dairy products?

____

____

____

32. If there is a cost associated with disposal, what is the approximate value of that cost? If you are unsure, indicate with “unknown.”

____

Value-Added Marketing

33. Before starting your enterprise, did you do any market research and if so, what kind?
____
____
____

34. Do/will you have any dedicated marketing personnel? If so, how many and how many hours a week do they spend on marketing?
____

35. Annually, how much do you/do you plan to spend on marketing? ____________________

36. Through what types of outlets do you sell/plan to sell your value-added products? (Please mark all that apply)?
- ☐ Farmers market(s)
- ☐ Direct to restaurant
- ☐ Direct to grocery
- ☐ Wholesale distributor
- ☐ Off-site farm stand
- ☐ On-farm store
- ☐ Delivery to customers
- ☐ CSA/box program
- ☐ Mail delivery to customers
- ☐ Direct to other specialty retailer (including gift shops and wineries)
- ☐ Delivery to schools
- ☐ Other (please list) ____

37. How do you market/plan to market your value-added products (Please mark all that apply)?
- ☐ Farm website
- ☐ Social media
- ☐ Billboards
- ☐ Directional road signs
- ☐ Brochures/rack cards
- ☐ Radio
- ☐ Product sampling
- ☐ Print (newspaper, etc.) ads
- ☐ Word of mouth
- ☐ Local food publications (Nourish Knoxville, etc.)
- ☐ Press releases
- ☐ Other online listings (LocalHarvest, etc.)
- ☐ Television ads
- ☐ Pick Tennessee/Kentucky Proud/Got to Be NC
- ☐ Other (please list) ____

38. What are the most common questions asked to you by your customers?
____
____
____

39. Do you currently/do you plan to communicate breed, animal raising methods, processing methods, etc. as part of your marketing?
____
____

40. Describe your target audience/ideal customer.
____
____

Enterprise Economics

41. Aside from financial success, what are your personal definitions of success?
____
____
____

Skip questions 42-45 if still in the planning stages.

42. In 2019, which of the following options best describes your value-added enterprise, including the cost of your own and other family members labor?
    - ☐ I'm making a comfortable profit
    - ☐ I'm making a small profit
    - ☐ I'm barely breaking even
    - ☐ I'm not breaking even
    - ☐ Other (please describe) ____

43. Over the next 5 years, assuming current conditions persist, which of the following best describes your value-added enterprise?
    - ☐ I plan to grow my sales revenue by _________ percent and this increase will come from (check all that apply)
        - ☐ Moving more existing products
        - ☐ Increasing product pricing
        - ☐ Creating new products
        - ☐ Expanding into new geographic markets
        - ☐ Expanding into new stores
    - ☐ I plan to stay the same size in terms of sales revenue
    - ☐ I plan to decrease my sales by _______ percent
        - ☐ Move less existing products
        - ☐ Decrease product pricing
        - ☐ Reducing geographic sales area
        - ☐ Reducing storefronts that sell my products
    - ☐ I plan to cease operations
        - ☐ Close the business
        - ☐ Transfer the business to another family member
        - ☐ Sell the business to another owner
    - ☐ Other, please describe ____

44. My 2019 sales from dairy products were:

☐ $0 (no sales)	☐ $20,000 - $29,999	☐ $75,000 - $99,999
☐ $1 - $9,999	☐ $30,000 - $49,999	☐ $100,000 or greater
☐ $10,000 - $19,999	☐ $50,000 - $74,999	☐ I prefer not to disclose

45. Which of the following best describes your overall value-added enterprises' net income in 2019 (before taxes)?

- ☐ Less than $0
- ☐ $0 - $4,999
- ☐ $5,000 - $9,999
- ☐ $10,000 - $14,999
- ☐ $15,000 - $19,999
- ☐ $20,000 - $24,999
- ☐ $25,000 - $34,999
- ☐ $35,000 - $49,999
- ☐ $50,000 - $74,999
- ☐ $75,000 or greater
- ☐ I prefer not to disclose

46. What percentage of your 2019 household income comes from the following sources:

- ☐ Value-added enterprise (dairy only) __________
- ☐ Value-added enterprise (other) __________
- ☐ Farming activities __________
- ☐ Off-farm income __________

47. For every $100 of enterprise assets you have in 2019, how many dollars are financed with debt? (Circle the answer)

- ☐ $0
- ☐ $1 - $2.99
- ☐ $3 - $4.99
- ☐ $5 - $9.99
- ☐ $10 - $14.99
- ☐ $15 - $19.99
- ☐ $20 - $39.99
- ☐ $40 - $69.99
- ☐ greater than $70
- ☐ I prefer not to disclose

48. What impact does each of the following factors have on your personal consideration of a value-added enterprise?

Factors	Impact Level				
	Strong negative impact	Some negative impact	No impact	Some positive impact	Strong positive impact
State regulations					
Federal regulations					
Start-up costs					
Knowledge about processing					
Labor for processing					
Product marketing					
Liability risk					

49. Has COVID-19 impacted your enterprise/plans for your enterprise? Please explain how.

____

____

____

____

50. What educational resources or information would be helpful to your business? (Select all that apply)

- ☐ Start-up costs
- ☐ Federal regulations
- ☐ Product marketing
- ☐ Farmers market regulations
- ☐ Food packaging
- ☐ New product development
- ☐ Business feasibility
- ☐ Managing milk quality on the farm
- ☐ State regulations
- ☐ Food safety
- ☐ Employee training on products and equipment
- ☐ Human resources and employee management
- ☐ Interstate shipping certification (NCIMS)
- ☐ Direct marketing products
- ☐ Developing a marketing plan
- ☐ Expanding into wholesale and retail markets
- ☐ Using social media as a marketing and sales tool
- ☐ Maintaining and assessing financial records on the processing operation
- ☐ Maintaining and assessing financial records on the dairy operation
- ☐ Other (please describe) ____

Chapter 3 – A profile of likely Tennessee farmstead milk consumers

Abstract

Farmstead creamery numbers have increased since 2019 as more farmers, lenders, and policymakers have come to see value-added dairy (**VAD**) products as a way for dairy producers to escape persistently low milk prices and increase profitability. Tennessee (**TN**) has 18 VAD operations with potential for additional operations in the marketplace. While the VAD segment of the dairy industry has growth potential in the state, little is known about how consumers view farmstead (produced and processed on-farm) dairy products. The objective of this study was to identify and describe consumers that were more likely to be familiar with and purchase farmstead milk (**FSM**). This information can be used by farmers and the dairy industry in targeted marketing of farmstead milk. A Qualtrics survey was developed and distributed from March 2021 to May 2021 with 817 complete responses. Respondents were TN residents, ≥ 18 yr old, and primary food shoppers of a household consuming dairy products. The survey included questions about familiarity with locally produced and processed milk, agritourism preferences, FSM perceptions, demographics, prior and future FSM purchases, purchase likelihood on and off-farm, purchase behavior, and likelihood to purchase products with predetermined attributes. Short-answer, multiple-choice, and Likert-scale questions were used in the survey. Analyses were done in Stata 16 using logit models with logit modules to determine variables associated with respondents that had 1) heard of FSM (**FSM1**), 2) previously purchased FSM (**FSM2)**, or 3) future interest in purchasing FSM (**FSM3**). Few variables impacted FSM1, FSM2, and FSM3. Respondents' age and their local foods purchase frequency were the only variables to impact each model. Familiarity with and purchase likelihood of FSM was consistently lower across all models for older individuals, but higher for those who purchased local foods frequently. Our findings suggested that some consumer demographics may impact knowledge and purchase likelihood of FSM, but these may change based on region. Producers may benefit from specialized marketing strategies targeting younger, local foods-oriented consumers.

Keywords: value-added, milk, consumer preference

Introduction

Starting or expanding a business requires an understanding of financial inputs, processing procedures and equipment, and market demand for current and potential products. This can be done by speaking with lenders, extension specialists, independent consultants, taking classes, or an individual's own research. Understanding the surrounding market requires knowledge of the target consumer and the current market options. This knowledge might be obtained by determining what products consumers consider purchasing and how saturated a market is with these products through marketing analyses. A processor that wants to produce cheddar cheese might invest in a marketing analysis through a third-party consultant to assess the capacity and consumer desires within the target area for cheddars. If the market is saturated with multiple stores selling cheddar cheese, the market will be very competitive, and a business might have lower odds of success. Without this marketing analysis, an enterprise might invest in a cheddar operation and be unable to recoup the cost because competition is too high or there is insufficient consumer demand.

Consumer preferences towards a product may be swayed by various outside sources. A 2020 study of Tennessee (**TN**) milk consumers found that 65% of consumers trusted doctors to learn about milk, followed by other family members (23%) and community educators (20%; Eckelkamp et al., 2020). However, while 46% did go to doctors to receive information on milk, 43% sought information from online articles, only 27% went to registered dieticians/nutritionists and 4% sought out industry peer-reviewed journal (Eckelkamp et al., 2020). This study showed a discrepancy between where consumers place their trust and where consumers actually seek information about milk. If consumers are receiving information from sources that are misinformed this could hinder a consumer's willingness to purchase a FSM product.

Ways to evaluate consumer desires within a market area are often surveys of various kinds. Marketing research surveys include brand, consumer experience, market, and product surveys (QualtricsXM, 2020). These can be done in person, over the phone, by mail, or online. Brand and consumer experience surveys are often used when assessing a specific company or brand, such as determining why a consumer chooses one product over the competitors' products. Market surveys are used to determine what products are in the market and what are not. Product surveys are used to determine what a consumer is drawn to and what they would be willing to buy. Market and product surveys are the most useful for starting or expanding a VAD enterprise.

Several surveys focused on consumer perceptions of local products and their willingness to pay were conducted in the 1990s (Adelaja et al., 1990, Gallons et al., 1997, Patterson et al., 1999) and 2000s (Brown, 2003, Maynard et al., 2003, Keeling Bond et al., 2009). The topic re-emerged in 2018 and remained a hot topic due to the COVID-19 pandemic. The pandemic had severe impacts on processing plants partly due to the close quarters in and out of the plant that many workers experienced (Waltenburg et al., 2020). Infections of COVID-19 linked to these plants, both employees and not, equated to 6 to 8% of all U.S. cases as of July 21, 2020 (Taylor et al., 2020). The high number of COVID-19 cases led to temporary shut-down of processing facilities which impacted meat availability for consumers. There was an increase in Google searches for “farmers market,” “butcher,” “pick your own,” and “farm fresh” around this time. The most significant spike for the terms “farmers market”, “pick your own”, and “farm fresh” were between March and May of 2020. This spike coincided with COVID-19 reaching the United States and stay-at-home orders were issued. The term “butchers” had a smaller spike around this time, with the most significant spike around November and December 2020. The term “farmers market” increased between July and September, coinciding with the previous five years’ trend in search history (Google). These trends showed that consumers sought out localized products, and this interest persisted through the pandemic. This benefitted programs like “Pick TN,” which advertises local producers-processors in Tennessee who sell their meat, dairy, and crops. This study aims to provide marketing and product data to these producer-processors on Tennessee consumers’ desires. The objective of this survey was to determine how consumer demographics impact a consumers’ likelihood of hearing about and purchasing local farmstead milk (**FSM**); from this information consumer profiles can be created to identify those more and less likely to have heard of FSM, previously purchased FSM, or plan to purchase FSM in the future.

Hypotheses

Demographics have not been reliable for predicting a potential consumer due to the variation among respondents. However, based on the literature we hypothesized some potential consumer attributes. Hypotheses can be seen in Table 3.1[3]. We hypothesized that age would not impact respondents’ likelihood to have heard of FSM, previously purchased FSM or purchase FSM in the future. Additionally, we hypothesized gender would not impact whether respondents

[3] All tables and figures are seen in Appendix C.

have heard of or purchased FSM. We believe that income will not impact a consumer's likelihood to purchase or have heard of FSM. We hypothesize that farm background, rural locations, and the presence of children < 12 years old in the home will have positive effects on consumers' likelihood to have purchased or to purchase FSM. We hypothesize household size, weekly dairy expenditure amounts, and marital status will have positive impacts on purchase likelihood. We hypothesize that level of education will not impact purchase likelihood. We do not believe that weekly food budget will impact purchase likelihood. We hypothesize that local foods purchase habits will positively impact purchase likelihood and whether respondents have heard of FSM. East TN will be more likely to purchase FSM due to the population density in relation to the number of dairies in Tennessee. We hypothesize that having a farm background or living in a rural area will increase respondents' chance of having heard of FSM. We hypothesize that weekly food budget and dairy expenditures would positively impact if consumers have heard of FSM. We anticipate a positive association between education and having heard of FSM.

Material and methods

This subset of a choice set experiment survey categorized Tennessee consumer desires, created an ideal consumer profile, and determined willingness to pay based on specific fluid milk attributes (Jensen et al., 2022). The survey was distributed through QualtricsXM from March 2021 to May 2021 and targeted 840 respondents who were Tennessee (**TN**) residents, ≥ 18 years of age, and the primary food shopper of a household that consumed milk or dairy products. The survey required a sample representative of the TN population, thus a stipulation of similar percentage breakdowns per region (East, Middle, West) were given to QualtricsXM. The survey remained open an additional two weeks to obtain a similar percentage to that of the West TN population density and concluded May 2021. The survey had 817 usable responses with distributions similar to the state distribution by region (East: 36.7% vs. 36.5%; Middle: 42% vs. 41.2%; West: 21.3% vs. 22.3%, respectively), thus resulting in a representative sample of Tennessee's population. Of our 817 responses, a maximum of 756 were used in our models due to errors in transferring of data or incomplete surveys.

Each respondent could answer 90 questions about their familiarity with locally produced and processed milk, prior and future purchases, purchase likelihood both on and off-farm, desires of a dairy farm visit, perceptions of local milk products, general demographics, purchase behaviors, and likeliness to purchase milk with various attributes. Jensen et al. (2022) can be reviewed for a full explanation of the survey choice sets. Multiple choice and open-ended questions captured age, gender, children, marital status, education, income, and farm background. Likert scale questions (1 = a great deal, …, 5 = not at all; 1 = extremely important, …, 5 = not important at all; 1 = strongly agree, … 7 = strongly disagree) were used to determine respondents purchase behaviors and perceptions of local dairy products. The survey was reviewed by the University of Tennessee Institutional Review Board for appropriate human subject protocols and approved under UTK IRB-21-06261-XM; a copy of the survey is available upon request from the corresponding author.

Analyses were done in Stata 16.1 (StataCorp LLC, College Station, TX). Respondent demographics were described using tabulate and summarize commands. Logit commands in Stata were used to determine variables associated with respondents that 1) had heard of local farmstead milk (**FSM1**), 2) had previously purchased local farmstead milk (**FSM2**), and 3) had interest in purchasing local farmstead milk in the future (**FSM3**). Logit commands included margins dydx(*), estat classification, and estat summarize and were used to analyze models further. Collinearities and confounding effects were checked with Regression command and estat VIF commands. Each model had the same variables.

FSM1 = f (TN region, age, local, farm, rural, children, college, male, weekly food budget, weekly dairy expenditure, household, income, married)

FSM2 = f (TN region, age, local, farm, rural, children, college, male, weekly food budget, weekly dairy expenditure, household, income, married)

FSM3 = f (TN region, age, local, farm, rural, children, college, male, weekly food budget, weekly dairy expenditure, household, income, married)

Respondents' age was reported in yr. Descriptors are defined and described in Table 3.2. Briefly, respondents were grouped by education level (college-educated: yes or no), family status (children: yes or no), annual household income level ($5,000 to $150,000), and farm background (yes or no). Income level was asked in categories (reference question 34 in Appendix C) to control for and minimize "prefer not to answer" selections as disclosure of annual household income may be considered a sensitive topic. A local index was created to determine the respondent's willingness to purchase local foods based on a Likert-scale question (1 =not at all, …, 5 = a great deal) about the frequency of past local food purchases. The higher the number, the more inclined towards local foods respondents were to purchase local foods (1 = not at all likely to purchase local foods, …, 5 = purchase local foods a great deal). An index was used for this variable (reference question 28 in Appendix C) because the series of local questions were highly correlated. For example, someone who purchases local foods a great deal is also likely to shop at local farmers markets on a regular basis or are willing to pay price premiums for local foods.

To further test our models and visualize results, we built consumer profiles based on model results and summary statistics of respondent demographics, building a higher likelihood and a lower likelihood profile for each model using assigned numbers reflective of the summary statistics and margins coefficient from the logit models. This was done using Microsoft Excel. Categorical variables were grouped into binary options, with zero being not likely and one being very likely. These categorical variables were *location*, *farm*, *rural*, *children*, *college*, *male*, and *married*. Numerical variables, excluding local, were selected by choosing the value representing the 25th and 75th percentile. These included *age* (36 and 63 yr), ***WFB*** (weekly food budget; $62 and $175), ***WDE*** (weekly dairy expenditure; $4 and $13), *household* (2 and 4), and *income* ($25,000 and $75,000 annually). Since the final variable, *local*, was a Likert-scale question, the lowest (1 = never purchase local foods) and the highest (5 = purchase local foods frequently) options were selected. The same values were used for each of the three models. They were assigned to different profiles (i.e. low and high) based on the coefficient margins sign from the model. To determine probability, assigned values were multiplied by the dy/dx value given from our logistic regression margins statement. Following this, each calculated value was then added together using the "=sum" function and added to the intercept of the model. From this calculated value, the probability that each profile would succeed (i.e. probability that a high likelihood and a low likelihood person would have heard of, have purchased, or be interested in purchasing FSM in the future) was calculated using the following equation "= exp(sum of profile) / (1 + exp(sum of profile)", then converted into a percent.

Results and discussion

Survey respondent demographics

The survey was completed, with usable results, by 817 respondents (n = 817). Approximately 62% of respondents were female, and 38% were male (Table 3.3). This was expected because research asserts females were primary food shoppers (Schafer and Schafer, 1989; DeLong et al., 2020), which was a criterion for taking the survey. The mean respondent age was 49 ± 17 yr (Table 3.4), slightly higher than the state mean of 39 yr (U.S. Census Bureau, 2022). This was expected because our survey only considers those 18 and older. In contrast, the Tennessee state mean includes those under 18 years, which comprise approximately 21% of the state's population (U.S. Census Bureau, 2022). The distribution of respondents closely resembled the state's distribution of persons 18 and older, with 37% in East Tennessee, 42% in Central Tennessee, and 21% in West Tennessee (Table 3.3). In contrast, the state's distribution was approximately 35% East Tennessee, 43% Central Tennessee, and 23% West Tennessee (U.S. Census Bureau, 2022).

More of our respondents had a bachelor's degree or higher than the state mean (40% and 29%, respectively; Table 3.3). A contributing factor could be that our age range was ≥ 18 yr, and the state's education age range considered those ≥ 25 yr. This may have explained why our percentage was 11% higher than the state mean (U.S. Census Bureau, 2022). Additionally, our respondents were proportionally more Caucasian than other races at 83% (Table 3.3) versus the state mean of 72% (U.S. Census Bureau, 2022). Twenty-three percent of our respondents had children ≤ 12 in the house and approximately 26% had a farm background of some kind (Table 3.3). Our respondents had a higher percentage of marriage at 53% (Table 3.3). In contrast, the state mean was 49%, including those ≥ 15 (U.S. Census Bureau, 2022). In comparison, ours only accounted for those ≥ 18. Our household numbers were 2.7 ± 1.5 (Table 3.4), whereas the state mean was 3.1 (U.S. Census Bureau, 2022). Our mean annual income was lower than the state's mean annual income ($59,229 ± 41,030 and $56,071, respectively; Table 3.4; U.S. Census Bureau, 2022). Among respondents, 25% lived in rural areas (Table 3.3). Finally, our respondents spent $10.62 ± 9.51 on dairy products a week (Table 3.4). They had a weekly food budget of $124.82 ± 90.12 (Table 3.4), meaning they spent 8.5 ± 10.6% of their weekly food budget on dairy products.

Farmstead milk budget

Respondents would purchase FSM an average of 30 times per year (n = 817; i.e. 2.5 times per month). Respondents indicated that they would purchase 6.6 L each purchase (n = 741; those who selected “prefer not to answer” were not included). When asked how much respondents would spend on FSM per purchase, they indicated they would spend $1.41/L (n = 735; those who selected “prefer not to answer” were not included). Using these numbers, we concluded that TN consumers would be willing to spend $178.00 ± $190.94 annually on FSM. Respondents spent $552.24 ± 494.52 on dairy products, which indicated consumers would spend 32% of their yearly dairy products budget on FSM. In the survey, we re-iterated that spending the chosen amount would mean less money to spend elsewhere to remind respondents of the reality of the question. Another noteworthy point was that this survey represented a certain population in a certain time point. A consumer’s willingness to spend at the time of the survey may differ from their willingness to spend six months after taking the survey.

Demographic impacts across familiarity with and purchase likelihood of farmstead milk

Variable impacts on each model can be viewed in Tables 3.5, 3.6, and 3.7 in Appendix C. West TN respondents were 16% less likely to have heard of FSM than those in East TN ($P < 0.001$; Table 3.5), possibly because they were not in a VAD saturated area. In 2022, fifty-four percent of dairy operations were in East TN and 8% were in West TN (J. Strasser, Tennessee Department of Agriculture, Nashville, TN, personal communication). Fifty-six percent of the current and prospective VAD enterprises were in East TN while 6.25% were in West TN (n = 1; Zaring, 2022). No difference between consumers' likelihood of hearing of FSM in East TN and Central TN was detected. While less saturated than East TN, Central TN is still more saturated with dairies, VAD enterprises, and general populations than West TN. Additionally, TN region did not impact a consumers likelihood to have purchased FSM in the past (Table 3.6) or be interested in purchasing FSM in the future (Table 3.7). Suggesting that despite a respondents' proximity to dairy farms and VAD enterprises, those in East TN were equally likely to have purchased or be interested in purchasing FSM than those in Central or West TN.

A respondents' area of residence (rural vs. urban) had no significant impact on whether or not they had heard of, had purchased, or would be likely to purchase FSM in the future. Findings from our study confirm prior research from TN which found that area of residence did not impact whether a person would purchase 'Made with Tennessee Milk' dairy products (Regmi et al., 2020). A study found that those in rural locations were less likely to prefer *Arizona Grown* local produce (Patterson et al., 1999), while another study of local produce found urban consumers were less likely to purchase (Keeling Bond et al., 2009). Respondents with a farm background were 10% more likely to have heard of FSM ($P < 0.05$), and 19.6% more likely to have purchased FSM in the past ($P < 0.001$). However, those with a farm background were no more or less likely to be interested in purchasing FSM in the future. Prior literature varies on farm background's impact on familiarity with and purchase likelihood of local products. A survey of southeast Missouri residents (n = 544) reported that those with a farm background who lived in rural locations were not only more likely to search out locally grown foods, but they were likely to pay a higher premium for local foods versus a conventional food product (Brown, 2003). It is postulated that a nostalgia factor could be at play for consumers who have farm background. Similarly, a TN study found that consumers were more willing to pay for a local dairy products labeled with a 'Made with Tennessee Milk' logo, but they were not likely to pay more for this logo (Regmi et al., 2020). Conversely, DeLong et al. (2020) reported that a farm background did not influence a consumers decision to purchase milk with a 'Tennessee Milk Logo'.

Only two variables impacted all three models, one was current local purchase habits. As respondents' frequency of purchasing local products increased (1 = do not purchase local at all, …, 5 = purchase a great deal), respondents were 12% more likely to have heard of ($P < 0.001$), 8.8% more likely to have purchased, and 2.3% more likely to be interested in purchasing FSM in the future ($P < 0.05$). These results were expected because purchasing local foods often requires visiting websites such as PickTN (https://www.picktnproducts.org/) or farmers markets, which exposed patrons to different FSM products. Additionally, these suggested that targeting markets with those who currently purchased local agricultural products may lead to a higher success rate for FSM operations.

Neither income nor weekly food budget affected respondents' having heard of, have purchased, or be interested in purchasing FSM. Like our research, annual household income had no impact on knowledge of and purchase likelihood for local produce and dairy products (Patterson et al., 1999; Brown, 2003; DeLong et al., 2020; Regmi et al., 2020). Regmi et al. (2020) reported that annual income did not impact consumers' willingness to pay for a dairy product labeled with a 'Made with Tennessee Milk' logo. A study of local produce in the southeast found that consumers with an annual income > $30,000 were more likely to purchase local produce (Best and Wolfe, 2009), while another survey found that consumers with an annual income of > $66,000 were 1.5% more likely to purchase local fluid milk than non-local ($P <$ 0.01; Khanal et al., 2020). Other studies of local foods in general, local ornamental plants, and local dairy products found that the higher the annual income, the less likely consumers were to purchase these products (Zepeda and Li, 2006; Khachatryan et al., 2015; Ahmadi Kaliji et al., 2019). Brown (2003) found that household income > $50,000 equated to a higher willingness to pay for local produce. As weekly dairy expenditure increased, respondents were 0.6% more likely to have purchased FSM in the past ($P < 0.05$), but it did not impact their familiarity with or their likelihood to purchase in the future. A prior 'Tennessee Milk Logo' (TML) survey found that as consumers spent more on milk per month, respondents were more likely to purchase milk with a TML ($P < 0.05$), and that as their weekly budget of milk increased by $10, consumers were 7% more likely to purchase logoed milk ($P < 0.05$; DeLong et al., 2020). Yet another TN survey found that spending more on dairy products improved the chances of someone purchasing locally produced and processed milk (Regmi et al., 2020). This same study found that TN consumers with higher weekly dairy expenditures were willing to pay $0.115 premiums ($P <$ 0.05) for milk products labeled with 'Made with Tennessee Milk' logo. Our results combined with prior literature suggested that FSM was not viewed as a luxury food.

The second variable that impacted all three models was respondents' age. As respondents aged one year, the probability of hearing of FSM decreased by 0.5% ($P < 0.001$). As age increased by 1-year, respondents were 0.4% less likely to have purchased FSM ($P < 0.05$), and 0.09% less likely to be interested in purchasing FSM in the future ($P > 0.10$). If considering the nostalgia factor discussed with farm background, it is interesting that older people are less likely to have heard of or purchase FSM. Additionally, Best and Wolfe (2009) found that consumers between 25 and 64 yr of age had a higher purchase likelihood of local products, while Keeling Bond et al. (2009) found that older consumers who were single were less likely to purchase than younger married respondents ($P < 0.05$). Another study of in-state produced ornamental plants found that older individuals were less likely to purchase ($P < 0.001$; Khachatryan et al., 2018). Despite our findings and prior discussed literature, most literature reports that age does not impact consumers knowledge of, purchase likelihood for, and willingness to pay for local produce and dairy products (Patterson et al., 1999; Brown, 2003; Zepeda and Li, 2006; DeLong et al., 2020; Regmi et al., 2020).

Another factor to impact two of the three models was marital status. Married respondents were no more likely than unmarried or single respondents to have heard of FSM, but they were 9.8% more likely to have purchased FSM ($P < 0.05$) and 4.3% more likely to be interested in purchasing FSM in the future ($P < 0.05$). Interestingly, Keeling Bond et al. (2009) found that when paired with older aged individuals, those individuals younger and single were less likely to purchase locally grown produce. One study did determine that unmarried customers had a higher willingness to pay for locally produced and processed steaks (Maynard et al., 2003).

Our study revealed that males were 10.7% more likely to have purchased FSM ($P < 0.05$) than females. This was interesting since our primary food shopper was female (Schafer and Schafer, 1989; DeLong et al., 2020), but was consistent with findings by Best and Wolfe (2009) that stated males had a higher purchase likelihood for locally produced dairy products. This showed a narrower pool of consumers than originally anticipated, and further studies may be warranted to understand why men were more likely to purchase than women. One possible reason that males have purchased more in TN might be due to promotional milk campaigns such as the "Fuel up to play 60" campaign between the Dairy Alliance and the Tennessee Titans professional football team which promotes whole chocolate milk as a pre- and post-workout recovery drink. Campaigns such as this being advertised to men could have impacted a respondents purchase likelihood because of the exposure to whole milk campaigns such as these. However, men were no more likely to have heard of or be interested in purchasing FSM in the future than females. Another study found females were likely to pay more for local products (Brown, 2003), while Regmi et al. (2020) and DeLong et al. (2020) found that gender did not impact whether TN consumers would be more likely to purchase or pay more for milk products with a 'Made with Tennessee Milk' logo and milk with 'Tennessee Milk' logo, respectively. Further, one Iranian study found females were more likely to purchase full fat yogurt ($P < 0.10$) and cream cheese ($P < 0.001$; Ahmadi Kaliji et al., 2019), but males were more likely to purchase butter ($P < 0.10$; Ahmadi Kaliji et al., 2019).

Other variables that had no impact on familiarity with and purchase likelihood of FSM were household size, presence of children < 12 in house, and college education. An Arizona study found that respondents who had a bachelor's degree or higher were more likely to be aware of the local promotional program known as *Arizona Grown* (Patterson et al., 1999). Other research reported college education had no impact on purchase likelihood or willingness to pay for local produce and dairy products (Brown, 2003; Regmi et al., 2020; Zepeda and Li, 2006; Khachatryan et al., 2015; DeLong et al., 2020). Our findings of children's impact was consistent with Regmi et al. (2020) and Khanal et al. (2020) local dairy product studies. Some research postulated a greater likelihood of purchasing local products children were present in the home (Best and Wolfe, 2009; Patterson et al., 1999). Finally, research shows that households with children < 19 yr old had an overall higher WTP for locally produced and processed meats (Maynard et al., 2003), and would pay $0.038/L premium for milk with added health properties advertised and $0.429/kg premium for butter with the same advertisements (Maynard and Franklin, 2003). Literature most relevant to this study based on location corroborates our findings, household size does not impact a respondents purchase likelihood of local milk (DeLong et al., 2020). However, other studies have hound positive relationships between household size and purchase likelihood of local produce and locally produced ornamental plants (Zepeda and Li, 2006; Khachatryan et al., 2015). Finally, another study of local fluid milk found that as household size increased by one, respondents were 0.4% less likely to prefer local milk ($P < 0.01$).

Have heard of farmstead milk consumer profiles

Likely consumer profiles for a TN consumer who had heard of FSM is seen in Table 3.8. A 36-year-old, married male who lived with another adult and children ≤ 12 in an East TN city with an annual income of $75,000, who purchased local food a lot, had a farm background, was college-educated, and spent $175/wk on food and a dairy budget of $13/wk, had a 41%

likelihood to have heard of FSM. Whereas a 63-year-old, unmarried female living in rural West TN with 3 adults who do not purchase local foods, had no farm background or college education, had an annual household income of $25,000 and spent $62/wk on food and $4/wk on dairy was only 19% likely to have heard of FSM.

Both probabilities were relatively low and suggested difficulty in predicting what type of person had heard of FSM. Based on p-values of the models, the only attributes that cause a significant change in a consumers' likelihood to have heard of FSM were WestTN ($P < 0.001$), age ($P < 0.001$), local ($P < 0.001$), and farm ($P < 0.05$). Of the two profiles, those in West TN and older were less likely to have heard of FSM, while those who purchased local foods frequently and had a farm background were more likely. This suggested that a potential marketing strategy would need to focus more heavily on targeting older West TN residents, who did not purchase local foods or have a farm background.

The mean probability for this model showed that a consumer with the average attributes of the survey respondents would be 50% likely to have heard of FSM. This profile served as a comparison reference for the high and low profiles, but had the limitation in that it is not an accurate profile of a consumer. All variables that were binary in our low and high models yielded continuous numbers (i.e. 0.418 rather than 0 or 1). This mean probability profile showed that our respondents' profiles were less likely to have heard of FSM than the survey population. Meaning this model is very conservative.

Have purchased farmstead milk in the past consumer profiles

Likely consumer profiles for a TN consumer who had purchased FSM in the past is seen in Table 3.9. A 36-year-old, married male living in rural East TN that had an annual income of

$25,000, children ≤ 12 in the house, and three other adults living in house, who purchased local food a lot, had a farm background, was college-educated, and spent $175/wk on food, with a dairy budget of $13/wk, was 58% likely to have purchased FSM in the past. Whereas, a 63-year old, unmarried female with one other person in the house, from a city in West TN, who never purchased local foods, with no farm background or college education that had an annual household income of $75,000 and spent $62/wk on food and $4/wk on dairy was 32% likely to have purchased FSM in the past. Finally, the mean probability which represented a standard survey respondent (while somewhat unrealistic), showed that the standard respondent was 44% likely to have purchased FSM in the past.

This model represented a clearer line between who is more and less likely to have purchased FSM. This model had more significant variables than the prior: age ($P < 0.05$), local ($P < 0.001$), farm ($P < 0.001$), male ($P < 0.05$), WDE ($P < 0.05$), and married ($P < 0.05$). From the profiles, we concluded that older respondents were less likely to have purchased FSM, but those that purchased local foods frequently, had a farm background, were male, spent more a week on dairy products, and those married were more likely to have purchased in the past. The same findings of age, local, and farm were seen in the last model, suggesting that these variables were more often targeted. Also suggesting that those same people that were targeted in marketing are purchasing local foods, but of those, a narrower group are purchasing; a conclusion we expected to see.

Interested in purchasing farmstead milk in the future consumer profiles

Likely consumer profiles for a TN consumer who was interested in purchasing FSM is seen in Table 3.10. A 36-year-old, married female living in rural East TN that had an annual income of \$25,000, children ≤ 12 in the house, and one other adult living in house, who purchased local food frequently, had a farm background, was college-educated, and spent \$175/wk on food, with a dairy budget of \$4/wk, was 94% likely to be interested in purchasing FSM in the future. In comparison, a 63-year-old, unmarried male with three other adults in the house, from a city in West TN, who never purchased local foods, with no farm background or college education that had an annual household income of \$75,000 and spent \$62/wk on food and \$4/wk on dairy was 92% likely to have been interested in purchasing FSM in the future.

This profile, combined with the only three significant variables (age ($P < 0.10$); local ($P < 0.05$); married ($P < 0.05$)), suggested that there was no specific profile of those interested in purchasing FSM in the future. Given that both profiles were > 90% likely to purchase, we can say that there is little that impacts whether those would purchase in the future assuming they are educated on the product like those were in our survey.

Based on the mean probability, a standard survey respondent was 93% likely to be interested in purchasing FSM in the future. As high and low profiles were 94% and 92% respectively, this model was the most accurate of the three models and showed little variation among customers. This confirmed the idea that any consumer could be a potential FSM purchaser.

Conclusion

This survey provided insight into what type of consumer a farmstead creamery owner or operator could target to purchase FSM. Few demographics impacted a respondents' choice to purchase local FSM or if they had heard of FSM before the survey. Among those that did, age had a negative impact across each model, farm background had a positive impact on FSM1 and

FSM2, marital status had a positive impact on FSM2 and FSM3, and propensity for purchasing local foods had a positive impact across all three models. West TN respondents were less likely to have heard of FSM. The older the individual, the less likely they were to have heard of, purchased, or purchase FSM in the future. Those who shop local frequently were more likely to have heard of, purchased, or be interested in purchasing FSM. Those with a farm background were more likely to have heard of or purchased FSM in the past, but farm background had no impact on future FSM purchases. Males and those with a higher weekly dairy expenditure were more likely to have purchased FSM. Finally, married respondents were more likely to have purchased or be interested in purchasing FSM in the future. The most likely consumer to purchase FSM would be a young, married individual who shopped local foods frequently.

One limitation recognized was that this survey is a snapshot in time, specifically during COVID-19. Results from this survey might and likely will change if this survey was to be repeated with the same methods 5 yr from now. Another limitation is that while the survey sample size is a representative sample of the TN population, it does not include those who do not have access to the internet, which could be excluding 18% of the population (National Center for Education Statistics, 2019). Another limitation cited was that consumer profiles built were baseline models and some profiles may not have been realistic or accurate. Thus they were used to give a visual to the data presented.

More studies are needed to target specific marketing areas, specific dairy products (ice cream, cheese, etc.), and to understand why consumers make the choices they do. Understanding these concepts will allow extension personnel to provide VAD with likely customers, increase visits and sales, and create targeted marketing materials. This study found that a 25 yr old urban single mom with a bachelor's degree who is a health-conscious Instagram blogger is equally likely to have heard of FSM as a 37 yr old married male farmer who dropped out of high school to run his family farm. However, the farmer is more likely to have purchased FSM than the single mom, but they are both equally and highly likely to be interested in purchasing FSM in the future. Results show that while a narrower group of people has purchased FSM before, the type of person who could be interested in purchasing FSM is vastly more varied and marketing should be done to target these various groups of people.

References

Adelaja, A. O., R. G. Brumfield, and K. Lininger. 1990. Product differentiation and state promotion of farm produce: an analysis of the Jersey Fresh tomato. J of Food Distribution Research 21(856-2016-57094):73-86. https://doi.org/10.22004/ag.econ.27108.

Ahmadi Kaliji, S., S. M. Mojaverian, H. Amirnejad, and M. Canavari. 2019. Factors affecting consumers' dairy products preferences. AGRIS on-line Papers in Economics and Informatics 11(665-2019-4000):3-11. https://doi.org/10.22004/ag.econ.294150.

Best, M. J. and K. L. Wolfe. 2009. A profile of local dairy consumers in the southeast and the potential for dairies to market value-added products locally. J of Food Distribution Research 40(856-2016-57808):22-31. https://doi.org/10.22004/ag.econ.162111.

Brown, C. 2003. Consumers' preferences for locally produced food: a study in southeast Missouri. Am J Alternative Agr 18(4):213-224. https://doi.org/10.1079/AJAA200353.

DeLong, K. L., K. L. Jensen, S. Upendram, and E. Eckelkamp. 2020. Consumer preferences for tennessee milk. J of Food Distribution Research 51(856-2020-1665):111-130. https://doi.org/10.22004/ag.econ.305485.

Eckelkamp, E., C. Zaring, S. Upendram, E. A. Paskewitz, H. Sedges, and K. Johnson. 2021. Tennessee consumer perceptions of milk: purchase considerations, safety, and price. University of Tennessee, Knoxville, Tennessee.

Gallons, J., U. C. Toensmeyer, J. R. Bacon, and C. L. German. 1997. An analysis of consumer characteristics concerning direct marketing of fresh produce in Delaware: a case study. J of Food Distribution Research 28(856-2016-57649):98-106. https://doi.org/10.22004/ag.econ.26603.

Google. Google trends. Accessed Mar. 20, 2021. https://trends.google.com/trends/?geo=US.

Jensen, K. L., D. M. Lambert, A. L. Rihn, E. Eckelkamp, C. S. Zaring, M. T. Morgan, and D. W. Hughes. 2021. Effects of inattention and repeat purchases: A choice-based conjoint study of consumer preferences for farmstead milk attributes. J of Food Products Marketing 27(8-9):399-416. https://doi.org/10.1080/10454446.2022.2034699.

Keeling Bond, J., D. D. Thilmany, and C. A. Bond. 2009. What influences consumer choice of fresh produce purchase location? Journal of Agricultural and Applied Economics 41(1379-2016-112744):61-74. https://doi.org/10.1017/S1074070800002558.

Khachatryan, H., A. Rihn, B. Campbell, B. Behe, and C. Hall. 2018. How do consumer perceptions of “local” production benefits influence their visual attention to state marketing programs? Agribusiness 34(2):390-406. https://doi.org/10.1002/agr.21547.

Khanal, B., R. A. Lopez, and A. Azzam. 2020. Testing local bias in food consumption: The case of fluid milk. Agribusiness 36(2):339-344. https://doi.org/10.1002/agr.21632.

Maynard, L. J. and S. T. Franklin. 2003. Functional foods as a value-added strategy: The commercial potential of “cancer-fighting” dairy products. Applied Economic Perspectives and Policy 25(2):316-331.

Maynard, L. J., K. H. Burdine, and A. L. Meyer. 2003. Market potential for locally produced meat products. J of Food Distribution Research 34(856-2016-56876):26-37. https://doi.org/10.22004/ag.econ.27321.

National Center for Education Statistics. 2019. Number and percentage of households with computer and internet access, by state: 2018. Accessed Jun. 1, 2022. https://nces.ed.gov/programs/digest/d19/tables/dt19_702.60.asp.

Ortez, M., C. Bir, N. O. Widmar, and J. Townsend. 2020. Dairy product purchasing in households with and without children. J Dairy Sci. https://doi.org/10.3168/jdsc.2020-19305.

Patterson, P. M., H. Olofsson, T. J. Richards, and S. Sass. 1999. An empirical analysis of state agricultural product promotions: a case study on Arizona Grown. Agribusiness 15(2):179-196. https://doi.org/10.1002/(SICI)1520-6297(199921)15:2<179::AID-AGR3>3.0.CO;2-K.

QualtricsXM. 2020. 20 most valuable types of surveys. Accessed Apr. 16, 2021. https://www.qualtrics.com/experience-management/research/common-types-of-surveys/.

Regmi, H., S. Upendram, K. L. Jensen, and K. L. DeLong. 2020. Consumer preferences for dairy products logoed as made with Tennessee milk. in Agricultural and Applied Economics Association. Kansas City, MO.

Schafer, R. B. and E. Schafer. 1989. Relationship between gender and food roles in the family. J Nutr Educ 21(3):119-126. https://doi.org/10.1016/S0022-3182(89)80094-9.

Taylor, C. A., C. Boulos, and D. Almond. 2020. Livestock plants and COVID-19 transmission. Proceedings of the National Academy of Sciences 117(50):31706-31715. https://doi.org/10.1073/pnas.2010115117.

U.S. Census Bureau. 2022. Population estimates, July 1, 2021 (V2021). Accessed Jan. 7, 2022. https://www.census.gov/quickfacts/fact/table/TN/PST045221.

Waltenburg, M. A., T. Victoroff, C. E. Rose, M. Butterfield, R. H. Jervis, K. M. Fedak, J. A. Gabel, A. Feldpausch, E. M. Dunne, and C. Austin. 2020. Update: COVID-19 among workers in meat and poultry processing facilities―United States, April–May 2020.

Morbidity and Mortality Weekly Report 69(27):887.
http://dx.doi.org/10.15585/mmwr.mm6927e2.

Zaring, C. 2022. Chapter 2: Analyses of the state of current and future value-added cow dairy enterprises in Tennessee. MS Thesis Chapter. Department of Animal Science, Univ. of Tennessee, Knoxville.

Zepeda, L. and J. Li. 2006. Who buys local food? J of Food Distribution Research 37(3):1-11. https://doi.org/10.22004/ag.econ.7064.

Appendix C

Table 3.1. Expected impacts of variables on familiarity with and purchase likelihood of farmstead milk based on the current literature

Variable	Heard of FSM	Sources	Purchase likelihood of FSM	Sources
TN region	+		+	
Age	·	Patterson et al., 1999	·	Patterson et al., 1999 Zepeda and Li, 2006 Best and Wolfe, 2009 DeLong et al., 2020 Regmi et al., 2020
Current local purchase habits	+		+	
Farm background	+	Brown, 2003	+	Brown, 2003
Area of residence	+	Brown, 2003 Keeling Bond et al., 2009	+	Brown, 2003 Keeling Bond et al., 2009
Children	·	Patterson et al., 1999	+	Patterson et al., 1999 Best and Wolfe, 2009 Ortez et al., 2020
College education	+	Patterson et al., 1999	·	Patterson et al., 1999 Brown, 2003 Zepeda and Li, 2006 DeLong et al., 2020
Male	·	Patterson et al., 1999	·	Patterson et al., 1999 Brown, 2003 Zepeda and Li, 2006 DeLong et al., 2020
Weekly food budget	+	Zepeda and Li, 2006 Best and Wolfe, 2009	·	Zepeda and Li, 2006 Best and Wolfe, 2009
Weekly dairy expenditure	+	Regmi et al., 2020	+	Regmi et al., 2020
Household size	?		+	Zepeda and Li, 2006 Khachatryan et al., 2018
Income	·	Patterson et al., 1999	·	Patterson et al., 1999 Brown, 2003 Keeling Bond et al., 2009 DeLong et al., 2020
Married	?		+	Keeling Bond et al., 2009

+ indicates positive association
- indicates negative association
· indicates no association
? indicates uncertain effects

Table 3.2. Lists of variables with coding used in logit models for familiarity with and purchase likelihood of farmstead milk

Variable Name	Coding
TN region (*location*)	1 = East Tennessee (Omit[1])
	2 = Central Tennessee
	3 = West Tennessee
Age	Years
Current local purchase habits (*local*)	1 = not at all
	2 = a little
	3 = a moderate amount
	4 = a lot
	5 = a great deal
Farm background (*farm*)	0 = otherwise
	1 = yes
Area of residence (*rural*)	0 = otherwise
	1 = rural
Children ≤ 12 yr	0 = no/no answer
	1 = children ≤ 12 years
College education (*college*)	0 = no/no answer (Omit[1])
	1 = Bachelor's or Higher
Gender (*male*)	0 = otherwise (Omit[1])
	1 = yes
Weekly food budget (*WFB*)	$ per wk
Weekly dairy expenditure (*WDE*)	$ per wk
Household	Total
Income	$ per yr
Marital Status (*married*)	0 = otherwise (Omit[1])
	1 = married

[1] Omit category was the base category that scenarios were run against.

Table 3.3. Comparison of survey respondent demographics to the distribution of Tennessee residents

Demographic	Percentage	State Estimate 18+[1]	State Percent 18+[1]
Region			
East (n = 300)	36.72%	1,959,391	36.54%
Central (n = 343)	41.98%	2,209,503	41.21%
West (n = 174)	21.30%	1,193,164	22.25%
College Education (n = 326)	39.90%		28.70%
Female (n = 504)	61.99%	3,500,059	51.30%
Male (n = 309)	38.01%	3,329,115	48.70%
Children (n = 190)	23.26%		
Farm Background (n = 212)	25.95%		
Race – Caucasian (n = 680)	83.23%	5,272,9100	77.20%
Race – Other (n = 137)	16.77%		22.80%
Married (n = 430)	52.63%	2,740,130	49.20%

[1] Numbers retrieved from U.S. Census Bureau, 2022 population estimates.

Table 3.4. Comparison of survey respondent demographics to the mean Tennessee population

Demographic	Number of Respondents	Mean ± Standard Deviation[1]	State Mean[1]
Age (yr)	817	49.02 ± 16.52	39 ± 0.2
Weekly Dairy Expenditure ($ per wk)	805	10.62 ± 9.51	
Weekly Food Budget ($ per wk)	801	124.82 ± 90.12	
Household Number (#)	816	2.70 ± 1.47	2.51 ± 0.01
Income ($ per yr)	765	59,228.76 ± 41,030.49	78,035 ± 785

[1] Numbers retrieved from U.S. Census Bureau, 2022 population estimates.

Table 3.5. Logistic regression that determined the impact of consumer demographics on whether or not they had heard of farmstead milk

Variable Name	Est. Coef.	Marginal effect
West Tennessee	-0.786*	-0.156*
Middle Tennessee	-0.272	-0.054
Age (yr)	-0.027*	-0.005*
Current local purchase habits	0.616*	0.122*
Farm background	0.509**	0.101**
Rural location	-0.031	-0.006
Children < 12 yr	0.356	0.071
College education (≥ bachelor's)	0.308	0.061
Male	0.226	0.045
Weekly food budget ($/wk)	0.001	0.0002
Weekly dairy expenditure ($/wk)	0.002	0.0005
Household (count)	0.055	0.011
Income ($/yr)	8.13e-07	1.61e-07
Married	0.162	0.032
…		
N = 736		
LRchi2(14) = 159.37		
Log likelihood ratio = -427.68368		
Pseudo R2 = 0.1571		
Correctly Classified 68.02%		

* indicates P < 0.001, ** indicates P < 0.05, and *** indicates P < 0.10
**** reference Table 3.2 for full list of variables and explanation of omitted variables (ex. East TN)

Table 3.6. Logistic regression that determined the impact of consumer demographics on whether or not they had purchased farmstead milk in the past

Variable Name	Est. Coef.	Marginal effect
West Tennessee	-0.093	-0.014
Middle Tennessee	-0.293	-0.045
Age (yr)	-0.026**	-0.004**
Current local purchase habits	0.569*	0.088*
Farm background	1.262*	0.196*
Rural location	0.015	0.002
Children < 12 yr	0.298	0.046
College education (≥ bachelor's)	0.316	0.049
Male	0.688**	0.107**
Weekly food budget ($/wk)	0.0005	0.0001
Weekly dairy expenditure ($/wk)	0.037**	0.006**
Household (count)	-0.067	-0.010
Income ($/yr)	-2.91e-06	-4.51e-07
Married	0.635**	0.098**
…		
N = 336		
LRchi2(14) = 72.76		
Log likelihood ratio = -157.86218		
Pseudo R2 = 0.1873		
Correctly Classified 75.30%		

* indicates $P < 0.001$, ** indicates $P < 0.05$, and *** indicates $P < 0.10$
**** reference Table 3.2 for full list of variables and explanation of omitted variables (ex. East TN)

Table 3.7. Logistic regression that determined the impact of consumer demographics on whether or not they had interest in purchasing farmstead milk in the future

Variable Name	Est. Coef.	Marginal effect
West Tennessee	0.220	0.008
Middle Tennessee	-0.194	-0.007
Age (yr)	-0.026***	-0.001***
Current local purchase habits	0.638**	0.023**
Farm background	0.688	0.025
Rural location	0.585	0.021
Children < 12 yr	0.229	0.008
College education (≥ bachelor's)	0.327	0.012
Male	-0.447	-0.016
Weekly food budget ($/wk)	0.007	0.0002
Weekly dairy expenditure ($/wk)	-0.011	-0.0004
Household (count)	-0.212	-0.008
Income ($/yr)	-4.86e-06	-1.74e-07
Married	1.204**	0.043**
…		
N = 736		
LRchi2(14) = 31.25		
Log likelihood ratio = -106.57938		
Pseudo R2 = 0.1279		
Correctly Classified 96.06%		

* indicates $P < 0.001$, ** indicates $P < 0.05$, and *** indicates $P < 0.10$
****reference Table 3.2 for full list of variables and explanation of omitted variables (ex. East TN)

Table 3.8. Consumer profiles for high and low probabilities to have heard of farmstead milk

Variable	Marginal effect	Mean Probability	High Probability Profile	Low Probability Profile
West Tennessee*	-0.156	0.219	0	1
Middle Tennessee	-0.054	0.418	0	0
Age (yr)*	-0.005	49	36	63
Current local purchase habits*	0.122	2.791	5	1
Farm background**	0.101	0.258	1	0
Rural location	-0.006	0.251	0	1
Children < 12 yr	0.071	0.240	1	0
College education (≥ bachelor's)	0.061	0.402	1	0
Male	0.045	0.377	1	0
Weekly food budget ($/wk)	0.0002	125	175	62
Weekly dairy expenditure ($/wk)	0.0005	11	13	4
Household (count)	0.011	3	2	4
Income ($/yr)	1.61e-07	60,115	75,000	25,000
Married	0.032	0.539	1	0
Predicted Probability		50%	41%	19%

* indicates $P < 0.001$, ** indicates $P < 0.05$, and *** indicates $P < 0.10$

Table 3.9. Probabilities of consumers more and less likely to have purchased farmstead milk in the past

Variable	Marginal effect	Mean Probability	High Probability Profile	Low Probability Profile
West Tennessee	-0.014	0.170	0	1
Middle Tennessee	-0.045	0.423	0	0
Age (yr)**	-0.004	45	36	63
Current local purchase habits*	0.088	3.163	5	1
Farm background*	0.196	0.318	1	0
Rural location	0.002	0.235	1	0
Children < 12 yr	0.046	0.348	1	0
College education (≥ bachelor's)	0.049	0.452	1	0
Male**	0.107	0.420	1	0
Weekly food budget ($/wk)	0.0001	142	175	62
Weekly dairy expenditure ($/wk)**	0.006	12	13	4
Household (count)	-0.010	3	4	2
Income ($/yr)	-4.51e-07	65,536	25,000	55,000
Married**	0.098	0.595	1	0
Predicted Probability		44%	58%	32%

* indicates $P < 0.001$, ** indicates $P < 0.05$, and *** indicates $P < 0.10$

Table 3.10. Probabilities of consumers more and less likely to be interested in purchasing farmstead milk in the future

Variable	Marginal effect	Mean Probability	High Probability Profile	Low Probability Profile
West Tennessee	0.008	0.219	1	0
Middle Tennessee	-0.007	0.418	0	0
Age (yr)***	-0.001	49.313	36	63
Current local purchase habits**	0.023	2.791	5	1
Farm background	0.025	0.258	1	0
Rural location	0.021	0.251	1	0
Children < 12 yr	0.008	0.240	1	0
College education (≥ bachelor's)	0.012	0.402	1	0
Male	-0.016	0.378	0	1
Weekly food budget ($/wk)	0.0002	125	175	62
Weekly dairy expenditure ($/wk)	-0.0004	11	4	13
Household (count)	-0.008	3	2	4
Income ($/yr)	-1.74e-07	60,115	25,000	55,000
Married**	0.043	0.539	1	0
Predicted Probability		93%	94%	92%

* indicates $P < 0.001$, ** indicates $P < 0.05$, and *** indicates $P < 0.10$

Questions included in survey

1. Do you consent to participate in the survey?
    - ☐ Yes
    - ☐ No
2. What is your age? ______
3. Are you a resident of Tennessee?
    - ☐ Yes
    - ☐ No
4. Do you or another member of your household consume milk or dairy products?
    - ☐ Yes
    - ☐ No
5. Are you a person who is primarily responsible for food shopping in your household?
    - ☐ Yes
    - ☐ No
6. In what region of Tennessee do you reside?
    - ☐ West
    - ☐ Middle
    - ☐ East

Tennessee's Farmstead Milk

Tennessee farmstead milk is where 1) a farmer produces the raw commodity, in this case milk, that is then 2) *processed and packaged on the farm in Tennessee.*

Tennessee farmstead milk may be sold directly at on-farm stores or farms stands, through farmers markets, through home delivery, online, or it may be sold by other sellers such as grocery stores, specialty stores, or restaurants.

---

7. Have you heard of milk that is both produced, processed, and packaged on a Tennessee dairy farm (Tennessee farmstead milk)?
    - ☐ Yes
    - ☐ No
    - ☐ Not sure

8. Did you hear about milk that is produced, processed, and packaged on a Tennessee dairy farm (Tennessee farmstead milk) from the following sources?
    - ☐ Media advertisements (TV, Radio, Newspaper, Magazines)
    - ☐ Signage on roadside
    - ☐ At a farmer's market
    - ☐ Pick Tennessee Products web pages or brochures
    - ☐ On a restaurant's menu
    - ☐ At a farm-stand or farm store
    - ☐ On a retail shelf
    - ☐ Word of mouth
    - ☐ Social media (Facebook, Twitter, Instagram, etc.)
    - ☐ From the farmer directly
    - ☐ Other, please describe: ________
9. Have you purchased fluid milk that was produced, processed, and packaged on a Tennessee farm (Tennessee farmstead milk)?
    - ☐ Yes, and I have purchased it directly on-farm only
    - ☐ Yes, and I have purchased it both directly from the farm and at locations off the farm
    - ☐ Yes, but I purchased it at a location other than the farm
    - ☐ No
10. In the future, would you be interested in purchasing milk that is produced, processed, and packaged on a Tennessee dairy farm (Tennessee farmstead milk)? *(Keep in mind the farmstead milk could be purchased at a variety of retail outlets including directly from the farm)*
    - ☐ Definitely yes
    - ☐ Probably yes
    - ☐ Maybe
    - ☐ Probably no
    - ☐ Definitely no
11. About how often would you purchase a half gallon(s) of Tennessee dairy farmstead milk?
    - ☐ Once a week or more frequently
    - ☐ Once every couple of weeks
    - ☐ Once a month
    - ☐ Once every couple of months
    - ☐ Once every 6 months
    - ☐ Once per year
    - ☐ Less frequently than once a year
    - ☐ Never
12. How many half gallons at a time would you purchase?
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4 or more

13. Each time you purchase Tennessee farmstead milk, about how much do you anticipate spending in total on the farmstead milk? ______ $/purchase
    - ☐ Some, but $3 or less
    - ☐ $3 - $3.99
    - ☐ $4 - $4.99
    - ☐ $5 - $5.99
    - ☐ $6 - $6.99
    - ☐ $7 - $7.99
    - ☐ $8 - $8.99
    - ☐ $9 - $9.99
    - ☐ $10 - $14.99
    - ☐ $15 - $19.99
    - ☐ $20 - $24.99
    - ☐ $25 or greater
    - ☐ Don’t know or prefer not to answer
14. Please indicate the placed where you would purchase Tennessee farmstead milk for at-home consumption.
    - ☐ Food cooperative
    - ☐ As part of a dairy farm visit/tour
    - ☐ Convenience store/quick stop market
    - ☐ Big box store (for example, Walmart)
    - ☐ On-farm store or stand
    - ☐ Online (through internet site or third party marketer site, such as Amazon)
    - ☐ Farmers market
    - ☐ Specialty store (for example, ice cream shop or cheese store)
    - ☐ Grocery store or supermarket
    - ☐ Home delivery service
    - ☐ Other, please describe: ____________________
15. You indicated you would potentially purchase Tennessee farmstead milk at an on-farm store or part of a farm visit, if so, how far would you travel to visit the farm to purchase this milk? _______ miles
16. How many times per year would you anticipate visiting a dairy farm that sold milk on-farm?
    - ☐ Less than once per year
    - ☐ Once per year
    - ☐ Twice per year
    - ☐ About once per month
    - ☐ Every couple of weeks
    - ☐ Weekly or more frequently
17. About how much would likely you spend on milk each visit? ____ $/visit
    - ☐ Some, but $3 or less
    - ☐ $3 - $3.99
    - ☐ $4 - $4.99
    - ☐ $5 - $5.99
    - ☐ $6 - $6.99
    - ☐ $7 - $7.99
    - ☐ $8 - $8.99
    - ☐ $9 - $9.99
    - ☐ $10 - $14.99
    - ☐ $15 - $19.99
    - ☐ $20 - $24.99
    - ☐ $25 or greater
    - ☐ Don’t know or prefer not to answer

18. Please indicate the importance of the following to your dairy visit(s):

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Processing facility educational tours					
Find out about new products through social media or email					
Ability to purchase and consume product on-site					
Knowing the history of the farm and/or farmers					
Find out about special events through social media or email					
Open spaces/countryside to enjoy outdoors					
Ability to sample products before buying					
Farm educational tours to see milking dairy cows					
Other, please describe: ________________					

19. In addition to farmstead milk, please indicate other farmstead dairy products you would likely purchase during a farm visit if they were available.

- ☐ Cheddar cheese
- ☐ Aged cheese
- ☐ Ice cream for on-site consumption
- ☐ Ice cream to take home or off-site consumption
- ☐ Butter
- ☐ Yogurt
- ☐ Buttermilk
- ☐ Cream
- ☐ Flavored milk (for example, chocolate milk)
- ☐ Other, please list: ___________________________________

20. On average, how much does your household spend on milk and dairy products per week?

- ☐ Less than $3
- ☐ $3 - $4.99
- ☐ $5 - $6.99
- ☐ $7 - $9.99
- ☐ $10 - $14.99
- ☐ $15 - $19.99
- ☐ $20 - $24.99
- ☐ $25 - $29.99
- ☐ $30 - $39.99
- ☐ $40 - $49.99
- ☐ $50 or more
- ☐ Prefer not to answer

21. In the past year have you purchased milk with any of the following logos:

- ☐ Tennessee Milk
- ☐ Pick Tennessee Products
- ☐ Other local or regional milk logo, please describe:
  ____
- ☐ Not sure

22. Other than fluid milk, please indicate farmstead processed dairy products you would likely purchase in the future at off-farm locations such as stores, farmers markets, etc.

- ☐ Cheddar cheese
- ☐ Aged cheese
- ☐ Ice cream for on-site consumption
- ☐ Ice cream to take home or off-site consumption
- ☐ Butter
- ☐ Yogurt
- ☐ Buttermilk
- ☐ Cream
- ☐ Flavored milk (for example, chocolate milk)
- ☐ Other, please list:____________________________________
- ☐ None of these

23. Please rate the importance of each of the attribute to you in making the decision to purchase fluid milk for at-home consumption.

	Extremely important	Very important	Moderately important	Slightly important	Not important at all
Locally produced					
Long shelf-life					
Good nutrition					
Safe to drink					
Good flavor					
Convenient availability					
Fresh product					
Low price					

Recyclable packaging					

24. In what type of packaging do you most often purchase fluid milk for at-home consumption?
    - ☐ Plastic
    - ☐ Paperboard
    - ☐ Glass
    - ☐ Other, please describe: ___________________________________
25. Please rate the following level of satisfaction with the fluid milk you typically purchase for at-home consumption

	Extremely satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Extremely dissatisfied
Taste of the fluid milk					
Packaging of the fluid milk					
Safety of the fluid milk (risk of becoming ill from drinking it)					
Freshness of the fluid milk					
Shelf-life of the fluid milk (how long unopened package lasts)					

26. Please indicate how much you agree or disagree with the following statements about milk and dairy products that are produced and processed on-farm in Tennessee

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Milk or dairy products produced and processed or packaged on-farm have to be transported shorter distances, so it is better for the environment							
Producing milk or dairy products produced and processed or packaged on-farm makes me feel as if I am helping the local economy							

Purchasing milk or dairy products produced and processed or packaging on-farm makes me feel as if I am supporting dairy farmers in my state							
Milk or dairy products produced and processed or packaged on-farm are fresher than those from out-of-state							
I know more about where milk or dairy products produced and processed or packaged on-farm came from, so I believe they are safer							
I believe milk or dairy products produced and processed or packaged on-farm are of higher quality than non-local milk or dairy products							
Purchasing milk or dairy products produced and processed or packaged on-farm reduces my carbon footprint							

27. On average, how much does your household spend on food or at-home consumption each week? __________ $/week
    - ☐ Less than $25
    - ☐ $25 - $49
    - ☐ $50 - $74
    - ☐ $75 - $99
    - ☐ $100 - $124
    - ☐ $150 - $199
    - ☐ $200 - $249
    - ☐ $250 - $299
    - ☐ $300 - $399
    - ☐ $400 - $499
    - ☐ $500 or more
    - ☐ Prefer not to answer
28. Please rate how much each statement is like you (1 = a great deal, …, 5 = not at all)

	A great deal	A lot	A moderate amount	A little	Not at all
I purchase local foods on a regular basis					
I shop at local farmers markets on a regular basis					
I am willing to pay price premiums for local foods					
I choose my grocer on whether they offer local foods					

I regularly read labels on foods when shopping					

29. What is your gender?
    - ☐ Male
    - ☐ Female
    - ☐ Prefer not to answer
30. What is your educational background? Mark the box next to the highest level of education you have completed.
    - ☐ Less than High School
    - ☐ High School Diploma or equivalent
    - ☐ Some college
    - ☐ Technical School Diploma or Associates Degree
    - ☐ Bachelor's Degree
    - ☐ Master's Degree
    - ☐ Doctorate or Professional Degree
    - ☐ Other, please describe: ______________________________
    - ☐ Prefer not to answer
31. How many people reside in your household including yourself?
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5
    - ☐ 6
    - ☐ 7
    - ☐ 8
    - ☐ 9
    - ☐ 10 or greater
    - ☐ Prefer not to answer
32. Are you now married, widowed, divorced, separated or never married?
    - ☐ Married
    - ☐ Widowed
    - ☐ Prefer not to answer
    - ☐ Never married
    - ☐ Divorced
    - ☐ Separated
33. Are children under the age of 12 present in the household?
    - ☐ Yes
    - ☐ No
    - ☐ Prefer not to answer
34. Please indicate your 2019 annual household income before taxes. (Remember all individual responses will be held strictly confidential)
    - ☐ Less than $10,000
    - ☐ $10,000 - $19,999
    - ☐ $20,000 - $29,999
    - ☐ $30,000 - $39,999
    - ☐ $40,000 - $49,999
    - ☐ $50,000 - $59,999
    - ☐ $60,000 - $69,999
    - ☐ $70,000 - $79,999
    - ☐ $80,000 - $89,999
    - ☐ $90,000 - $99,999
    - ☐ $100,000 - $149,999
    - ☐ $150,000 or more
    - ☐ Prefer not to answer

35. What is the race you primarily identify with?
    - ☐ Caucasian
    - ☐ Hispanic
    - ☐ Native American
    - ☐ African American
    - ☐ Asian/Pacific Islander
    - ☐ Other (for example, mixed race, please list: _________________)
    - ☐ Prefer not to answer
36. I live in an area that is:
    - ☐ Metro
    - ☐ Suburb
    - ☐ Small town
    - ☐ Rural
    - ☐ Prefer not to answer
37. Do you have a farm background? (Lived on a farm or worked on a farm)
    - ☐ Yes
    - ☐ No
    - ☐ Prefer not to answer

Chapter 4 – A decision tool to determine costs and net present value of on-farm bottled milk operations

Abstract

Few resources exist regarding U.S. value-added dairy enterprises (**VAD**) and their start-up costs, equipment and maintenance costs, years to break even, and additional profits. A decision-making tool was created using Microsoft Excel to provide current and prospective VAD with information to determine economic feasibility of a bottled milk VAD including: years-to-breakeven (**YBE**), time and equipment required to process milk, and net present value (**NPV**) calculations. Seven secenarios were run with low, mean, and high numbers of lactating cows in the herd, average production per cow per day, and percentage of the herd used in the VAD processing. Each scenario was tested against four equipment options and 112 distinct outcomes were reviewed. Equipment options consisted of most time efficient (**MEf**), most economical (**MEc**), basic pasteurizer and bottler (**BPB**), and build your own (**BYO**). Only 32% of the options were determined profitable (NPV $\geq$ 0). Across the profitable scenarios, the mean YBE was 5.13 $\pm$ 2.10 yr. The majoirty of profitable and feasible were the MEf options (5 of the 9) with a mean NPV of $2,410,669 and YBE of 4.88 yr. Of the seven scenarios tested, only two were not profitable under any circumstance (low cow number and low percentage of the herd used for value-added dairy processing). The basic pasteurizer and bottler options had the shortest years-to-break even (4.38 yr) and higher net-present values ($1,567,242) compared to the build your own and time efficient options. This decision tool can give VAD processors information needed to determine economic feasibility of a bottled milk VAD operation.

Keywords: value-added, dairy, economics, decision tool

Introduction

Value-added agricultural products were products sold for more than the commodity price of the raw product due to a change in the physical form (i.e. selling bottled milk vs raw milk), segregation of the product (i.e. separating one farms milk from another by adding a "Tennessee Milk" logo), or the modified production of a raw product (i.e. organic production; Agricultural Marketing Service [AMS], 2020). Value-added dairy (**VAD**) operations were defined as a business that transformed raw milk produced on or near their facility into a finished product. Often, many VAD operations were involved in other value-added (**VA**) operations which usually included agritourism. When asked, producers' main justification for entering a VAD operation was to escape low commodity milk prices (61%, n = 19; Smith et al., 2013).

One way to combat low farm income was marketing value-added agriculture through community-supported agriculture (**CSA**) box sets, similar to having an on or off-farm store to sell products. United States farmers not involved in value-added agriculture had a mean of 14% profit, but this became a 51% profit for farmers involved in CSA (Paul, 2019). A 2003 survey of United States CSA showed a 66% profit margin (n = 354) among CSA farmers (Lass et al., 2003). These profit margins, however, were still not equivalent to a livable wage. While CSA provided more income than traditional farming, CSA profits alone were not enough to provide farmers with a living wage. Lessons from CSA can be applied to other VA enterprises such as a VAD. These VAD may help provide farmers with a livable wage to support low farm income. Before a value-added dairy processing operation can be considered or opened, potential business owners must understand the start-up costs, years-to-breakeven, and time required to process raw milk into finished dairy products.

An artisan cheese making decision tool found that a processed production level of 3,409 kg/yr it was not feasible to sell gouda cheese at retail price of $48.50/kg as the operation would have a years-to-breakeven > 15 yr (Durham et al., 2015). However, if they produced and sold 6,818 kg/yr, the operation was profitable in 10 yr (Durham et al., 2015). More intensive VAD operations (facilities which process items such as cheese or yogurt which have more production steps than bottled milk) could produce less product to cover their costs due to the high profitability of more intensive products (Álverez Pinilla et al., 2018). VAD operations were more likely to be profitable if another dairy product was produced along side bottled milk, rather than just bottled milk (Álverez Pinilla et al., 2018). Operations that only processed bottled milk required 197,787 L of milk to be processed annually, while cheese producers and producers who processed milk, cheese, and yogurt only had to process 146,096 L and 103,916 L, respectively (Álverez Pinilla et al., 2018). Durham et al. (2015) found that VAD operations producing cheese alone rarely persist > 10 yr, but if they were to diversify beyond just cheese production, they had a greater chance to stay in business. One study found the price needed to cover production costs for cheese and milk in NY, WI, and VT was ~ $22/kg and $2.27/L, respectively (Nicholson and Stephenson, 2007). Finally, years-to-breakeven for a VAD operation ranged from 1 to 3 yr (Smith et al., 2013) to 10 yr (Durham et al., 2015; Moss et al., 2012).

Various literature gaps existed and included start-up cost and maintenance costs of a VAD enterprise. Additional gaps included years-to-breakeven (**YBE**) studies, required equipment and time budgets, as well as net present value (**NPV**) calculations. This study aimed to design and validate an interactive economic decision-making tool for a bottled milk VAD that would provide the user with estimated start-up costs, time budgets, equipment, NPV, and YBE.

Material and methods

A decision tool was created with Microsoft Excel 2019 (Microsoft, Seattle, WA) to determine the economic impact of various fluid milk processing enterprises. The model included startup cost predictions, time to process, useful life predictions, processing facility build costs, labor, fixed (electric, water, sewage, gas) and variable costs (trash, packaging, cleaning supplies, processing, other supplies; Table 4.1[4]). Labor cost ($2.71/cwt) was given in a per hundred pound of milk (**CWT**) basis by the University of Tennessee's Dairy Gauge program (C. Martinez, Department of Agricultural and Resource Economics, University of Tennessee, Knoxville, TN, personal communication). Other costs used in the model included utilities, supplies, and building expenses (Zaring, 2022a). The number of lactating cows in the herd (**MatureT**), mean production per cow per day (**APDkg**), mean fat and protein percentage, months milked each year, percentage of the herd used for VA (**VA%**), and all costs could be changed by end-users. Suggestions for equipment sizing and type were customized based on inputs provided, and users could select equipment and sizes appropriate for their operation. The model included processing time for each piece of equipment and a corresponding equipment price estimate.

The model was set up to calculate pounds (lbs), gallons (gal), kg, and L per yr for equipment run time calculations. Pounds of milk produced per yr was found using the following formula before it was converted to gallons, kilograms, and liters per year.

$$\text{lbs/yr} = \frac{(\text{APDlbs} * 305 \text{ lactation days}) * (\text{MatureT} * \text{VA\%})}{365.25 \text{ days per yr}} * (\text{months milking per yr} * 30.5 \text{ average days per month})$$

[4] Tables and figures can be seen in Appendix D.

To find gal/yr, lbs/yr was divided by 8.6 lbs since 1 gal of milk = 8.6 lbs of milk. Kilograms per d was lbs/d divided by 2.205. The convert function from gal to L was used to make L/yr then divided by 365.25 to get L/d. The 365.25 accounts for leap yr. The 30.5 d accounts for months having 31 and others having 30 d.

This model considered two pasteurization methods, vat and high-temperature short-time (**HTST**). A vat pasteurization system required milk to be cooked at a temperature of 62.8C for ≥ 30 minutes, while an HTST system required milk to be cooked at a temperature of 71.7C for ≥ 15 seconds. Both methods yielded milk with a shelf-life of 12 – 21 days. Vat pasteurizers with capacities that ranged from 15 L to 7,570 L were used in the model. Time required to pasteurize pre-determined volumes of milk from inputs was calculated by the following equation:

$$\frac{\text{gal/d required to process}}{\text{Capacity of Vat Pasturizer in gal}} = \frac{\frac{\text{Runs}}{\text{D}} \text{ x } 2}{24 \text{ h}} = \text{h needed}$$

Hours needed were given in decimal format and had to be converted to days (d), hours (h), minutes (min), seconds (s) format in the model. This was the same for all times given. Runs/d calculated from the first part of the equation was multiplied by 2 for the number of h it would take to complete each run of the system. The two hours consisted of 45 min for warm-up, 30 min to pasteurize, and 45 min to cool down.

HTST pasteurizers were used for the in-line pasteurizer option. Flow rate of the HTST system was given in gal/h. Time required to pasteurize milk volume given was calculated by the following formula and then converted into the time format previously described:

$$\frac{\text{gal/d required to process}}{\text{gal/h flow rate of HTST system}} = \frac{\frac{\text{runs}}{\text{d}}}{24 \text{ h}} = \text{h needed}$$

Two models of separators and homogenizers were used. The same formula was used to calculate the time required to complete as seen in the HTST pasteurizer after the flow rate, given in pints per hour (PPH) was converted to gal/h. One homogenizer model had a flow rate in gal/h so the time required to process was done using the same formula as the HTST system. The second model had a flow rate in L/h, so liters were converted to gallons for calculations. These had minimum and maximum flow rates so each was calculated at the minimum and maximum flow rate. Separators had flow rates of 15,000 PPH and 7,500 PPH, while homogenizers had flow rate ranges from 15 to 30 gallons per hour and 3,500 to 7,000 L/h.

The final equipment used was a bottler. These had a range of flow rates based on sizing of bottles, so the minimum, mean, and maximum for 2 L and 4 L was calculated. This bottler could be adjusted based on filling capacity, jug mouth size, jug size, and flow rate. The filler was considered a "model block"—a filler and capper combination. This flow rate was given in gal/min, so before using the HTST formula, rate had to be converted to gal/h. The model calculated all run times based off their flow rate (L/hr, gal/min, gal/h, PPH) or their capacity (L) and the volume of milk being processed based on inputs described above. The model was then programmed to sort all equipment under each category (vat and HTST pasteurizers, separators, standardizers, homogenizers, and bottlers) from shortest run time to longest run time using "=if" and "=iferror" statements. Options that resulted in greater than 8 h of total run time were not shown to end-users.

There were four different equipment outputs: 1) build your own (**BYO**), 2) most time efficient (**MEf**), 3) most economical (**MEc**), and 4) basic pasteurizer and bottler (**BPB**). The BYO section allowed the user to select their desired equipment and receive a total cost and total time to process (total processing time does not include time to clean up). The BYO default option selected a vat pasteurizer (757 L or 1,893 L capacity depending on the output level of scenarios), separator (up to 7,098 L/H), homogenizer (3,500 L/H), and a 2 L bottler (up to 16,353 L/H). The MEf section selected the equipment combination of a pasteurizer, separator, homogenizer, and bottler that would yield the shortest run time using an "=min" statement. For the purposes of model validation, the MEf option consisted of an in-line pasteurizer (up to 13,249 L/H), separator (up to 7,098 L/H), homogenizer (up to 7,000 L/H), and a 4 L bottler (23,848 L/H). The MEc option selected the equipment combination of a pasteurizer, separator, homogenizer, and bottler that had the smallest equipment cost using an "=min" statement. The MEc option consisted of a vat pasteurizer (15 L capacity), separator (up to 7,098 L/H), homogenizer (114 L/h or 7,000 L/H), and 4 L bottler (23,848 L/H). The BPB option included a basic vat pasteurizer (757 L capacity) and bottler set up (2 L gravity bottle filler). This equipment option was commonly considered by VAD in TN (Zaring, 2022a).

Validation scenarios

Seven scenarios each with their respective low, mean, and high inputs were used to validate the model. Scenarios contained the following variables: 1) *MatureT*, 2) *APDkg*, and 3) *VA%*. Each scenario has the one option from each of the three variables; two of which were set at the mean input level and the third rotated between low, mean, and high (Table 4.2). Values for *MatureT* were 69 cows (low), 462 cows (mean), and 690 cows (high); *VA%* values were 7% of herd (low), 61% of herd (mean), and 100% of herd (high); and *APDkg* values were 22 kg (low), 28 kg (mean), and 33 kg (high; Zaring, 2022a). Lows were categorized by the 25th percentile, means categorized by means, and highs categorized by 75th percentile because of skewed data in Zaring et al., (Zaring, 2022a) from a low overall sample size. All scenarios included each of the four equipment outcomes with NPV and YBE calculated for each equipment outcome and scenario.

Economic outcomes

Each validation scenario was measured through economic outputs and total processing time (**PT**). Economic outputs included years-to-breakeven (**YBE**), net present value (**NPV**), and total cost of equipment (**TC**). The *PT* included the time to run all daily milk through the selected equipment but did not include any time allotted for cleanup and sanitation pre- or post-processing. The *YBE* calculation reported how many years after startup that operation would no longer have a negative cumulative cash flow. This calculation used a 20-yr investment, a 10% terminal value of equipment, and a 5% terminal value of the building. The *NPV* reported the cumulative cash flow value after 20-yr of investment in USD. Both *NPV* and *YBE* were calculated using a cost to build (USD) a processing facility value (median value from Zaring, 2022a), labor rate, value of bottled milk sold (mean number used from Zaring, 2022b and Jensen et al., 2021), fixed and variable costs (median value from Zaring, 2022a), and a standard mailbox milk price for Tennessee ($/CWT; Economic Research Service [ERS], 2021).

The *EC* was the summed cost of all equipment selected in each option, reported in USD. Each scenario tested included four equipment options, and each equipment option reported the previously listed variables; thus, 28 options were considered, and 112 distinct outcomes were reviewed.

Background sheet calculations for net present value and years to breakeven

Another sheet that served as the background calculation sheet was used to house NPV and YBE calculations. Each of the described variables used in the background calculation sheet were the same repeated value for years 1 through 20 unless otherwise stated. Calculated first was the annual change in revenue, or the gross annual increase in income, that consisted of product revenue ($/unit), opportunity cost of raw product ($/CWT), and value of remaining raw product ($/CWT). The product revenue was calculated by determining the gallons per year processed and multiplying that value by the price bottled milk was to be sold for ($3.33/gal). The opportunity cost of raw product, or the money a producer would forfeit by choosing to process and sell their milk versus selling the raw milk as a commodity, was calculated by multiplying the Tennessee average commodity milk price ($19.83/cwt) by the total amount of milk (per cwt) the herd is capable of producing (not factoring in the amount of milk desired to be processed). This number was negative in the calculation sheet because this showed money a user would forgo by choosing to process their milk. Finally, the value of the remaining raw product was calculated by subtracting the amount of milk to be processed (per cwt) from the total amount of milk produced (per cwt) by the herd and multiplying this difference by the Tennessee average commodity milk price of $19.83/cwt. The values calculated for product revenue, opportunity cost of raw product, and value of remaining raw product were summed together to gather the total annual change in revenue. Total annual increase in cost was calculated next by adding together the annual labor, fixed, and variable costs. Labor ($/yr) was calculated by multiplying the labor rate (entered on a per cwt basis) by the total amount of milk to be processed per year (per cwt). The fixed and variable costs were predetermined and entered on the input sheet as the median value from Zaring (2022a).

Next, the net annual increase in income was calculated by subtracting the total annual increase in costs from the total annual increase in revenues. The terminal value of the equipment and building were calculated and applied only to year zero or the investment year. This was calculated using the following equation:

(equipment cost * terminal value of equipment) + (building costs * terminal value of building)

Total cash outflow was then calculated for the investment year by adding building costs to equipment costs, and for years ≥ 1 this value was our total annual increase in costs. Net cash flow was calculated for the investment year to be the negative value of the total cash outflow previously calculated. For years ≥ 1 this value was the total cash inflow, or the total annual change in revenue, minus the total cash outflow. Present value was the first variable to have different values each year. Year zero's present value was the same as the net cash flow of year zero, equal to the building costs added to the equipment costs. Years one and on varied based on the respective year. The present values for years one and on were calculated using the net cash flow and the discount rate in the following equation:

$$\text{present value of year x} = \frac{\text{net cash flow of year x}}{(1+0.08)^{\text{year x}}}$$

This calculation was the first in which years 1 through 20 would have a different value each year. When calculating the present value of year 12, the net cash flow of year 12 was divided by 1.08 raised to the 12th power. The NPV was calculated by adding the present values, also known as the cash flows, for each year up to the conclusion of the investment length (year 20 for this project).

Finally, YBE was calculated. This calculation required the cash flow or present value, the cumulative cash flow, and the absolute value of the cumulative cash flow. Cumulative cash flow was the total cash flow of the year in question added to the sum of all prior years (i.e. if calculating cumulative cash flow for year 5, the cash flow for years 0, 1, 2, 3, 4, and 5 were added together). Three additional variables were added and labeled as A through C. The value of A was the last year in which the cumulative cash flow was < 0. The value of B was the corresponding absolute value of the cumulative cash flow for the value of A, while C signified the cash flow of the year after the value of A. Example, if the last year cumulative cash flow was negative was year 5, then A = 5, B = absolute value of the cumulative cash flow for year 5, and C = cash flow of year 6. To calculate YBE, the value of B was divided by C and then added to A. This value would yield the exact YBE value.

Results and discussion

Each model assumed that the processor operated for 20 yr. Scenarios that were not profitable within 20 years were labeled infeasible and returned a YBE of 21 yr and a negative NPV. Scenarios were not feasible if PT was > 8 hr. Each scenario determined feasibility for each of the four equipment options (BYO, MEf, MEc, and BPB) by comparing EC, PT, YBE, and NPV. Outputs of scenarios may be seen in Table 4.3. One limitation seen through this study was that percent losses and unsold products were not taken into consideration in the model. Our model and subsequent output numbers were reliant on the assumption that all amounts of product designated for production was used and sold with no losses.

Scenario 1: Control

The first scenario tested the YBE of a potential VAD with mean MatureT (462 cows), mean APDkg (28 kg), and mean VA% (61%). This scenario required processing of 2,906 L/d, or 20,344 L/wk. Of the four equipment options, MEc was the only option not feasible due to the PT required to process raw milk per d (16 d 1 h 59 min). Of the three feasible equipment options (BYO, MEf, and BPB) for this scenario, there was a maximum difference of two year between

YBE (4.73 ± 1.09 yr). The BPB option had the smallest YBE with the largest NPV, while the MEf had the longest YBE and smallest NPV (YBE: 3.5 yr vs. 5.58 yr; NPV: $1,977,469 vs. $1,570,529, respectively). These three options for our control scenario had a NPV of $1,734,776 ± $214,512). The BPB option created non-homogenized or creamline milk, whereas the BYO and MEf options consisted of equipment to process homogenized milk, the standard milk sold in retail locations.

Low vs high milking cows: Scenario 2 and 3

The second scenario tested the YBE of a potential VAD with low MatureT (69 cows), mean APDkg (28 kg), and mean VA% (61%). This scenario required processing of 434 L/d, or 3,038 L/wk. No equipment options were feasible, as none returned a YBE of less than the 20-yr investment period. The mean NPV of the four options was -$1,515,558 ± 174,086.

The third scenario tested the YBE of a potential VAD with high MatureT (690 cows), mean APDkg (28 kg), and mean VA% (61%). This scenario would need to process 4,341 L/d, or 30,384 L/wk. Of the four equipment options, MEf was the only feasible option due to the PT required to process raw milk per d (3 h 27 min). The MEf scenario had a YBE of 3.05, and at the end of the 20-yr investment period, the enterprise would be worth $3,460,059.

Low vs high average production per day: Scenario 4 and 5

The fourth scenario tested the YBE of a potential VAD with mean MatureT (462 cows), low APDkg (22 kg), and mean VA% (61%). This scenario required processing of 2,284 L/d, or 15,985 L/wk. The MEc option was the only infeasible option of the four, due to PT per d. Of the three feasible equipment options for this scenario, there was a maximum difference of 3.5 yr between YBE (7.33 ± 1.85 yr). The BPB option had the smallest YBE with the largest NPV, while the MEf had the longest YBE and smallest NPV (YBE: 5.25 yr vs. 8.79 yr; NPV: $1,157,015 vs. $750,075, respectively). These three options for our low APDkg scenario had a NPV of $914,322 ± $214,512).

The fifth scenario tested the YBE of a potential VAD with mean MatureT (462 cows), high APDkg (33 kg), and mean VA% (61%). This scenario required processing of 3,425 L/d, or 23,977 L/wk. Of the four equipment options, MEf was the only feasible option due to the PT per d (2 h 44 min). The MEf option had a YBE of 4.29, and at the end of the 20-yr investment period, the enterprise would be worth $2,254,240.

Low vs high percent of milk going to value-added processing: Scenario 6 and 7

The sixth scenario tested the YBE of a potential VAD with mean MatureT (462 cows), mean APDkg (28 kg), and low VA% (7%). This scenario needed to process 334 L/d, or 2,335 L/wk. There were no feasible equipment options as none returned a YBE of less than the 20-yr investment period. The mean NPV of the four options was -$1,648,021 ± 174,086.

The seventh scenario tested the YBE of a potential VAD with mean MatureT (462 cows), mean APDkg (28 kg), and high VA% (100%). This scenario needed to process 4,764 L/d, or 33,351 L/wk. Of the four equipment options, MEf was the only feasible option due to the PT per d (3 h 47 m). The MEf option had a 2.69 YBE, and at the end of the 20-yr investment period, the enterprise would be worth $4,018,441.

Overview of scenarios

The decision tool model had 28 possible equipment options with 112 economic outputs (YBE, NPV, EC, and PT). Thirty-two percent (n = 9) of the options were feasible (profitable) under our constraints. No MEc options were feasible, and only two BYO and BPB options were feasible. Only two of the MEf options were infeasible. Only two of our tested scenarios had realistic and profitable equipment options in BYO, MEf, and BPB (Scenario 1 and 4), while two of our options were not profitable under any conditions (Scenario 2 and 6). Finally, three of our scenarios were profitable only when using the MEf option (Scenario 3, 5, and 7).

Herds with low cow numbers or low percentage of herds being used were not feasible options for a VAD operation. Álverez Pinilla et al. (2018) found that operations only bottling milk must process and sell 197,787 L/yr to stay profitable. Results from our study match conclusions made by Álverez Pinilla et al. (2018). Scenarios 2 and 4 would yield < 197,787 L/yr processed and would not be profitable in a 20-yr period. Years-to-breakeven for our scenarios and equipment option combinations ranged from 3.05 yr to 8.79 yr, with a mean of 5.13 year-to-breakeven. Other studies found years to breakeven as soon as 1 yr and as late as 10 yr (Smith et al., 2013, Durham et al., 2015), so our results were consistent with prior findings of VAD operation years-to-breakeven. Our study did not factor in debt previously incurred, such as debt from a dairy farm. This was identified as a limitation of the study as many dairy farms were already in a declining financial state (Paul, 2019; Moss et al., 2012; MacDonald et al., 2020). Consumers were willing to pay more for vat pasteurized or HTST pasteurized lowfat homogenized milk (~ 1.25% fat) in plastic or glass containers (Jensen et al., 2021). If this were true for most consumers, then despite the lower EC and YBE, it would not be realistic for producer-processors to consider a BPB option, which was most often considered and used by current and potential VAD processors in a recent TN study (Zaring, 2022a). The BPB option would not be realistic for VAD producer-processors because this option only consisted of a vat pasteurizer and a bottler, and would produce creamline full-fat milk, a trait not desired by consumers (Jensen et al., 2021; Bir et al., 2021).

Another limitation to the study was that equipment used in the scenario options were taken from four different companies, so pricing range was subject to new products from a limited range on pricing, sizing, and run times. As seen previously, many producer-processors purchase used equipment (Zaring, 2022a). Results from this validation study would not be accurate for VAD operators not purchasing new equipment directly from manufacturers. Each MEf option consisted of a greater TC investment ($1,032,640) than the BYO ($938,340 (scenarios 2 and 6) to $946,840 (scenarios 1, 3 to 5, and 7)) or BPB ($625,700) options due to the cost of an HTST system, whereas the BYO and the BPB options utilized a cheaper vat pasteurization system. The MEc had an TC investment of $850,410 (scenarios 2 and 6) to $921,140 (scenarios 1, 3 to 5, and 7). However, the mean NPV of a viable MEf system was higher than other equipment systems at $2,410,669 (BYO: $1,246,102 and BPB: $1,567,242). Similarly, the YBE was similar for BPB (4.38 yr) and MEf (4.88 yr) and lower compared to BYO (6.53 yr).

Conclusion

A decision-making tool was designed to allow processors of a potential VAD operation to gauge initial investment, time to process their product daily, and the time to be profitable following the opening of a VAD operation. Model validations determined that out of 28 possible scenario options, only 9 had a realistic processing time per day (< 8 hr, cleaning and sanitation time was not included) that were profitable within the 20-yr timeframe. Of the seven scenarios tested, only two were not profitable under any circumstance (low cow number and low percent of the herd used for value-added dairy processing). It was determined that while the basic pasteurizer and bottler options were most appealing to producer-processors and had the shortest years-to-break even (4.38 ± 1.24 yr) and the net-present values ($1,567,242 ± $580,149) was higher than the build your own option, consumers were less likely to purchase a full-fat creamline milk product. Our study showed that that the most efficient (MEf) equipment options had the most flexibility across scenarios and were the most profitable (mean NPV of $2,410,669 ± $1,339,219 and YBE of 4.88 ± 2.46 yr). Consumers were most likely to purchase a product from this type of equipment setup as it has the capability to produce a lowfat homogenized product, seen desirable by many value-added dairy product consumers. Across all profitable and realistic scenarios and equipment options, the years-to-breakeven was 5.13 ± 2.10 yr.

Limitations of this study included that the model assumed all product was produced and sold, meaning there was no loss or shrinkage percentage. Another limitation was that few producers will purchase dairy processing equipment brand new. The majority purchase used equipment, which was not factored into the model but should be researched in future. Validated data from this decision-making tool may be used in future to provide potential value-added dairy business owners with information to make informed decisions on entering an enterprise.

References

Agricultural Marketing Service [AMS]. 2020. USDA value-added ag definition. Accessed Sep. 10, 2020. https://www.agmrc.org/business-development/valueadded-agriculture/articles/usda-value-added-ag-definition.

Álvarez Pinilla, A. M., B. García Cornejo, J. A. Pérez Méndez, and D. Roibás Alonso. 2018. The profitability of value-added products in dairy farm diversification initiatives. Spanish Journal of Agricultural Research. https://doi.org/10.5424/sjar/2018162-11813.

Bir, C., M. S. Delgado, and N. O. Widmar. 2021. US Consumer Demand for Traditional and Greek Yogurt Attributes, Including Livestock Management Attributes. Agricultural and Resource Economics Review 50(1):99-126. https://doi.org/10.1017/age.2020.12.

Durham, C. A., A. Bouma, and L. Meunier-Goddik. 2015. A decision-making tool to determine economic feasibility and break-even prices for artisan cheese operations. J Dairy Sci 98(12):8319-8332. https://doi.org/10.3168/jds.2014-9252.

Economic Research Service [ERS]. 2021. Milk production costs and returns per hundredweight sold, by state. E. R. Service, ed. United States Department of Agriculture [USDA], Washington, DC.

Jensen, K. L., D. M. Lambert, A. L. Rihn, E. Eckelkamp, C. S. Zaring, M. T. Morgan, and D. W. Hughes. 2021. Effects of inattention and repeat purchases: A choice-based conjoint study of consumer preferences for farmstead milk attributes. J of Food Products Marketing 27(8-9):399-416. https://doi.org/10.1080/10454446.2022.2034699.

Lass, D., A. Bevis, G. Stevenson, J. Hendrickson, and K. Ruhf. 2003. Community supported agriculture entering the 21st century: Results from the 2001 national survey. Amherst:

University of Massachusetts, Department of Resource Economics.

Macdonald, J. M., J. Law, and R. Mosheim. 2020. Consolidation in U.S. Dairy Farming. United States Department of Agriculture. Accessed Nov 28, 2021. https://www.ers.usda.gov/publications/pub-details/?pubid=98900.

Moss, J., K. Jensen, B. English, and R. Holland. 2012. The Tennessee Dairy Industry and Its Value-Added Opportunities. Knoxville, TN: UT Extension. https://extension.tennessee.edu/publications/Documents_W_284.

Nicholson, C. F. and M. W. Stephenson. 2007. Financial performance value-added dairy operations in New York, Vermont and Wisconsin. https://doi.org/10.22004/ag.econ.9732.

Paul, M. 2019. Community-supported agriculture in the United States: Social, ecological, and economic benefits to farming. J of Agrarian Change 19(1):162-180. https://doi.org/10.1111/joac.12280.

Smith, S., E. Chaney, and J. Bewley. 2013. Planning considerations for on-farm dairy processing enterprises. J Dairy Sci 96(7):4519-4522. https://doi.org/10.3168/jds.2012-6541.

Zaring, C. 2022a. Chapter 2: Analyses of the state of current and future value-added cow dairy enterprises in Tennessee. MS Thesis Chapter. Department of Animal Science, Univ. of Tennessee, Knoxville.

Zaring, C. 2022b. Chapter 3: A profile of likely Tennessee farmstead milk consumers. MS Thesis Chapter. Department of Animal Science, Univ. of Tennessee, Knoxville.

Appendix D

Table 4.1. List of variables used in the net present value calculations of the value-added dairy bottling decision tool

Model input cost variables	Value used
Cost to build[1]	$220,857
Terminal value of equip	10%
Terminal value of building	5%
Labor rate[2]	$2.71 / cwt
Value of bottled milk sold[3]	$3.33
Milk price[4]	$19.83
Discount rate	8%
Yearly fixed cost[5]	$40,438
Yearly variable costs[6]	$61,899
Investment length (yr)	20

[1] Cost to build was the median value of building costs for processing facilities (Zaring, 2022a)
[2] Labor rate from University of Tennessee Dairy Gauge Program (C. Martinez, Department of Agricultural and Resource Economics, University of Tennessee, Knoxville, TN, personal communication)
[3] Cost of for a bottle of milk sold (Jensen et al., 2021; Zaring, 2022b)
[4] Mailbox milk price per hundred pounds of raw milk (Economic Research Service [ERS], 2021)
[5] Median value of yearly fixed costs (Zaring, 2022a)
[6] Median value of yearly variable costs (Zaring, 2022a)

Table 4.2. Outline of scenarios used to validate the value-added dairy bottled milk decision tool model at different herd sizes, production levels, and percentage of herd dedicated to the value-added operation

Scenario	Number of lactating cows in herd	Average production per animal per day	Percent of herd used in value-added processing
1[1]	Mean	Mean	Mean
2[2]	Low	Mean	Mean
3[3]	High	Mean	Mean
4[4]	Mean	Low	Mean
5[5]	Mean	High	Mean
6[6]	Mean	Mean	Low
7[7]	Mean	Mean	High

[1] Scenario 1: mean lactating cows in herd (**MatureT**; 462 cows), mean milk production per cow per day (**APDkg**; 28 kg per cow per d), mean percentage of herd in value-added processing (**VA%**; 61% of herd)
[2] Scenario 2: low MatureT (69 cows), mean APDkg (28 kg per cow per d), mean VA% (61% of herd)
[3] Scenario 3: high MatureT (690 cows), mean APDkg (28 kg per cow per d), mean VA% (61% of herd)
[4] Scenario 4: low APDkg (22 kg per cow per d), mean MatureT (462 cows), mean VA% (61% of herd)
[5] Scenario 5: high APDkg (33 kg per cow per d), mean MatureT (462 cows), mean VA% (61% of herd)
[6] Scenario 6: low VA% (7% of herd), mean MatureT (462 cows), mean APDkg (28 kg per cow per d)
[7] Scenario 7: high VA% (100% of herd), mean MatureT (462 cows), mean APDkg (28 kg per cow per d)

Table 4.3. Economic feasibility of investing in value-added dairy processing at different herd sizes, production levels, and percentage of herd dedicated to the value-added operation

	BYO[1]			MEf[2]			MEc[3]			BPB[4]		
Scenario	YBE[5] (yr)	NPV[6] ($)	PT[7]	YBE[5] (yr)	NPV[6] ($)	PT[7]	YBE[5] (yr)	NPV[6] ($)	PT[7]	YBE[5] (yr)	NPV[6] ($)	PT[7]
1[8]	5.11	$1,656,329	6h 48m	5.58	$1,570,529	2h 19m	4.97	$1,682,029	385h 59m	3.50	$1,977,469	7h 51m
2[9]	> 20	-$1,592,125	1h 42m	> 20	-$1,686,425	21m	> 20	-$1,504,195	61h 14m	> 20	-$1,279,485	1h 10m
3[10]	2.82	$3,545,859	10h 10m	3.05	$3,460,059	3h 27m	2.75	$3,571,559	576h 28m	1.98	$3,866,999	11h 44m
4[11]	7.95	$835,875	5h 21m	8.79	$750,075	1h 49m	7.72	$861,575	303h 16m	5.25	$1,157,015	6h 10m
5[12]	3.94	$2,340,040	8h 1m	4.29	$2,254,240	2h 44m	3.84	$2,365,740	454h 54m	2.74	$2,661,180	9h 15m
6[13]	> 20	-$1,724,588	1h 18m	> 20	-$1,818,888	16m	> 20	-$1,636,658	47h 3m	> 20	-$1,411,948	54m
7[14]	2.49	$4,104,241	11h 10m	2.69	$4,018,441	3h 47m	2.43	$4,129,941	632h 45m	1.76	$4,425,381	12h 53m

[1] Build your own equipment option (**BYO**)
[2] Most efficient equipment option (**MEf**)
[3] Most economical equipment option (**MEc**)
[4] Basic pasteurizer and bottler equipment option (**BPB**)
[5] Years to breakeven (**YBE**) in yr
[6] Net present value (**NPV**) in USD
[7] Processing time (**PT**) in hours and minutes
[8] Scenario 1: mean lactating cows in herd (**MatureT**; 462 cows), mean milk production per cow per d (**APDkg**; 28 kg per cow per d), mean percentage of herd in value-added processing (**VA%**; 61% of herd)
[9] Scenario 2: low MatureT (69 cows), mean APDkg (28 kg per cow per d), mean VA% (61% of herd)
[10] Scenario 3: high MatureT (690 cows), mean APDkg (28 kg per cow per d), mean VA% (61% of herd)
[11] Scenario 4: low APDkg (22 kg per cow per d), mean MatureT (462 cows), mean VA% (61% of herd)
[12] Scenario 5: high APDkg (33 kg per cow per d), mean MatureT (462 cows), mean VA% (61% of herd)
[13] Scenario 6: low VA% (7% of herd), mean MatureT (462 cows), mean APDkg (28 kg per cow per d)
[14] Scenario 7: high VA% (100% of herd), mean MatureT (462 cows), mean APDkg (28 kg per cow per d)

Chapter 5 Conclusions

Value-added (VA) agricultural products were products sold for more than the commodity price of the raw product due to a change in physical form, segregation of the product, or modification of the product during production. Avenues for value-added agriculture have been used to supplement farmers' low incomes caused by high production costs that leads to minimal profit margins. These studies were used to analyze the state of value-added dairies (VAD) and potential consumer markets for VAD in the state of Tennessee (TN). Additionally, a decision-making tool was developed from literature and the first two studies to provide potential VAD owners with information to make informed decision before entering a VAD operation.

From the first study, VAD producer-processor surveys, VAD producer-processors were 21 yr younger (38 yr) than the TN mean farmer age (59 yr) and 12 yr younger than the United States (US) mean farmer age (50 yr). Six percent of TN cow dairies were actively operating a VAD enterprise, and the attached dairy farms had been operational for a mean of 14 yr. Most producers (n = 7) produced milk solely for on-farm processing. Fluid products (homogenized and creamline milk and cream) were the most common product produced and considered among the current VAD (n = 9), followed by cheese (soft and aged; n = 7), then ice cream (n = 6). Among the prospective VAD, fluid products (n = 8) were the most produced, followed closely by cultured products and cheeses (n = 7 and n = 6, respectively). Current VAD sold their products to restaurants (n = 8), wholesale distributors (n = 8), and on-farm stores (n = 7), but they marketed through social media (n = 9), farm websites (n = 8), product sampling (n = 8), word of mouth (n = 8), and the Pick TN program (n = 7). East TN housed the most dairies and VAD operations in the state. The majority of current and prospective VAD were in great financial standing of < 40% debt to asset ratio, four were making a profit, while three were not breaking even at the time of the survey. Most current VAD income came from farming activities, while most prospective VAD income came from off-farm.

The TN VAD online consumer survey found few demographics impacted a respondents' choice to purchase local FSM or if they had heard of FSM before the survey. Among those that did, age had a negative impact across each model, farm background had a positive impact on FSM1 and FSM2, marital status had a positive impact on FSM2 and FSM3, and propensity for purchasing local foods had a positive impact across all three models. The most likely consumer to purchase FSM was a young, married individual who shopped local foods frequently. Those in west TN were less likely to have heard of FSM. The older the individual, the less likely they were to have heard of, purchased, or be interested in purchasing in the future. Those who shopped local products frequently were more likely to have heard of, purchased, or be interested in purchasing FSM. Those with a farm background were more likely to have heard of or purchased FSM in the past, but they did not care to be or not to be interested in purchasing FSM in the future. Males and those with a higher weekly dairy expenditure were more likely to have purchased FSM. Finally, those married more likely to have purchased or be interested in purchasing FSM in the future.

The final study, the development and validation of a decision-making tool designed to allow potential VAD processors to gauge initial investment, time to process, and time to be profitable following the opening of a VAD operation, tested 7 scenarios against equipment options. Model validations determined that out of 28 scenario options, only 9 had a realistic processing time per day (< 8 hr, cleaning and sanitation time was not included) that were profitable within the 20-yr timeframe. Of the seven scenarios tested, only two were not profitable under any circumstance (low cow number and low percent of the herd used for value-added dairy processing). Basic pasteurizer and bottler options were most appealing to producer-processors and had the shortest years-to-break even (4.38 ± 1.24 yr) and the net-present values ($1,567,242 ± $580,149) were higher than the build your own option. However, consumers were less likely to purchase a full-fat creamline milk product. Our study showed that that the most efficient (MEf) equipment options were most numerous and profitable given a mean NPV of $2,410,669 ± $1,339,219 and YBE of 4.88 ± 2.46 yr. Consumers were most likely to purchase a product from this type of equipment setup as it has the capability to produce a lowfat homogenized product, seen desirable by many value-added dairy product consumers. Across all profitable and realistic scenarios and equipment options, the years-to-breakeven was 5.13 ± 2.10 yr.

Data collected from the three projects will be used to assist farmers entering, expanding, or persisting in a VAD enterprise through marketing, production, or economic suggestions. These projects have paved a path for additional research into the VAD industry in TN. The VAD industry was limited in TN and to further study what VAD industry entails, producer processor surveys should be expanded across the southeast. Further, our first study evaluated 16 cow dairies and VAD operations and 3 small ruminant operations. Most, if not all, small ruminant operations in TN were tied to a value-added operation, and the number of these small ruminant operations has increased yearly. Thus, our producer-processor survey should be administered to all small ruminant VAD operations so conclusions could be drawn between profitability level of small ruminant vs cattle VAD. Additionally, follow-up surveys should be taken 1-yr, 3-yr, and 5-yr post initial survey to track progress of current and prospective VAD to see persistence and profitability. Additional consumer surveys should be done beginning with aged cheese, then expanding to ice cream and cultured products such as yogurt and flavored butters since many TN VAD operations are currently or considering processing these products. Results from these surveys could be used to inform VAD processors in Tennessee of their market and potential profit from these products. Finally, further development and eventual publication of the fluid milk decision-making tool should be enacted. Once this has been done, the tool should be adjusted and expanded to accommodate cheese followed by ice cream operations.

Our studies revealed that dairies with larger production output and herd sizes were more likely to consider and be successful in a VAD operation. This may be due to the startup cost of a processing facility. With startup costs and operating costs of a dairy being so high, this type of enterprise is not for those already struggling financially. Additionally, the time investment and the labor investment are significantly increased, thus many of the surveyed VAD employed family members in the operation. Many employed family members to help with the labor cost that was factored into the bottled milk decision tool. For VAD customers, the pool of prior customers is much narrower than the pool of potential customers. Suggesting that advertisement of VAD products should be expanded to encompass more individuals rather than the commonly done route of advertising to customers who have a farm background or frequently shop at farmers markets. This is where social media could be employed by producers to help attract new customer groups. Further research should be considered to understand the possibilities of the VAD enterprise in TN.

Vita

Caitlin Zaring was born and raised in Knoxville, Tennessee. After high school, she attended Roane State Community College and received an Associate of Science degree in Biology. She transferred to the University of Tennessee, Knoxville to pursue her Bachelor of Science in Animal Science and remained to pursue a Master of Science in Animal Science and a minor in Agricultural and Resource Economics. Her research is with the Tennessee dairy industry's VAD producers and processors. After obtaining her master's, she will continue her education and current research as she pursues a Ph.D. working with VAD producers and processors in Tennessee, Kentucky, and North Carolina. She is grateful for the support and love of her family as she continues to pursue her education and eventually a career improving the dairy industry.