ENGR 112 Final Exam

March 8th 2022

Instructions

The exam consists of 8 questions of varying weight. There are 120 points possible on the exam.

It is due (uploaded to BruinLearn) by 3pm on Thursday March 10th, 2022.

Academic Honor Policy

As an academic community, honesty in our academic work is vital. By signing below, I acknowledge that I have been directed to work individually on this examination. Further, I certify that I have neither given nor received prohibited aid or information on this examination.

Printed Name of Student: _____

Signature: _____

Student ID Number: _____

Final Exam – Take home – Questions:

The following questions are based on the following documents:

- Final Exam - Take home - Selected articles.pdf
- IBIS Dairy Farms in the US Industry Report_for exam.pdf
- Milk Cow Report.pdf

Please answer these questions using the information found in these documents.

1. The "Business Model Canvas" consists of nine basic building blocks. Sketch the canvas and label each of the nine blocks. Provide your guesses for each of the building blocks for the smaXtec company based on the articles and what was discussed in class (general business elements). Provide justification for your guesses. (45 points)

2. Draw and label all elements for the Customer Relationship funnel for a Physical Product. Identify specific examples of elements (where possible) based on the articles and industry of smaXtec. (15 points)

3. As part of the class we discussed “Porter’s Forces that Shape Industry Competition.” What are the forces? Based on the articles provided, please assess the forces that are acting on smaXtec. Provide justification for your response. (20 Points)

4. What is the TAM for the US (for simplicity you can break it up into hardware TAM and subscription TAM)? Where should smaXtec choose as its beachhead location? Provide justification for your decision. What is the size of that beachhead market? Provide the numbers that justify your market sizing. (12 points)

5. For the following set of questions imagine you started smaXtec. The questions are based on your fundraising activities and the implications to your equity and ownership. (15 points total)

You launched smaXtec and after 6 months of development, you decided to ask your friends and family for money. However, you have not generated any profit. They decide to give you $80,000 in a convertible note, with a 20% discount rate and a $2M cap.

a. Why did you use a convertible note for this deal (1 point)?

This $80,000 lasted you 6 months. During this time, you pitched to Angel investors. The Tech Coast Angels were impressed and decided to purchase 100,000 shares of smaXtec at $5 per share for 20% of the company.

b. What is the pre-money and post-money valuation of smaXtec (2 point)?

c. How many shares and at what share price did your friends and family receive (3 points)?

SmaXtec burned through the funds from the angels and courted a VC firm. You managed to negotiate a Series A funding round for $3M for a 40% stake.

d. Now what is your pre and post-money valuations (1 point)?

e. List out the entire cap table and how many shares and percentage are held by each group (8 points)

6. Per the lecture by Josh Geffon:
    a. What are the basic legal questions and decisions which have to be made by SmaXtec prior to and at the point of formation? (7 points)

    b. How would you answer these for SmaXtec and why (5 points)?

7. Theorize as to the IP associated with SmaXtec. What is it and what is the best way to protect it? (6 points)

8. For a given piece of IP you need to decide whether to submit a patent or keep it as a trade secret. Provide the pros and cons of each choice (5 points).

Economist - Technology Quarterly - Sep 12th 2019 edition

Sensors and AI are finding their way into the barnyard

With 80m cows in the rich world alone, there's no shortage of potential customers

Like elite athletes, dairy cows have exacting nutritional requirements. "If you're slightly up on protein, or down on carbs, you'll see a drop in milk production," says Robbie Walker, the boss of Keenan Systems, an Irish firm which makes feed-mixing wagons.

For that reason, the firm's latest products have gone digital. With the help of Intel, a big American chipmaker, Keenan has developed a computer that can be attached to its wagons. Every day the firm's nutritionists load the computer with the herd's dietary requirements. Sensors on the wagon weigh what the farmer puts into the mixer and compare it with what the recipe calls for. "It's a bit like making a cake," says Mr Walker. "Even if you're being careful, you usually put in a little too much of one ingredient, or not enough of another."

The collected data are transmitted over the mobile-phone network to the nutritionists, who can analyse any deviations from the ideal in what the animals were fed. A big deviation triggers a text message to the farmer. Smaller ones are noted, and the feed mix for the following day tweaked to correct any nutritional deficits that might have crept in.

Keenan is not the only firm trying to computerise cattle-farming. Cainthus, another Irish company, is one of several startups hoping to use computer vision to boost farmyard productivity. It uses cameras to track cows in barns and fields, relying on machine learning to analyse the images. The technology is sensitive enough, says David Hunt, the firm's boss, to track individual animals, and to alert farmers if a cow is not feeding when it should be, or moving in a way that suggests it might be sick.

For now, he says, the company is working mainly on Friesian and Holstein cows, whose distinctive markings "mean they're basically walking qr codes", though he hopes to expand to other breeds eventually. The technology works well enough to have persuaded Cargill, an agriculture-focused conglomerate and America's largest private company, to take a minority stake in Cainthus in 2018.

An alternative approach is to put the sensors inside the cows themselves. An Austrian firm called smaxtec has developed a sensor that can be swallowed. It lodges inside the reticulum, one of a cow's four stomachs, and stays there for the rest of the animal's life, monitoring body temperature, movement and stomach acidity, and uploading the results when the cow is near a wireless detector.

When fed to machine-learning algorithms, says Stefan Rosenkranz, smaxtec's co-founder, those data can be used for all kinds of things. They can detect when animals are in heat, and spot the early signs of calving up to 15 hours before it happens. They can identify diseases several days before they become obvious to human observers, allowing early treatment and a 15-30% drop in antibiotic use. A new sensor, due out next year, will add the ability to monitor digestion. Sales are doubling every year, says Mr Rosenkranz. And with 278m dairy cows in the world, there is no shortage of customers.

WHAT IS SMAXTEC?

A revolutionary cow understanding system.

Many can observe, only few can understand. With smaXtec, you take better care of your herd by gaining even more understanding for every single cow. Animal welfare, animal health and heat detection increase significantly and additionally you receive early calving alerts. The economic success of your farm and your personal work-life-balance as a farmer will increase immediately.

No one is as close to the animal as smaXtec
Safe. Easy. Better. That's how smaXtec works. The unique, awarded system measures the most important parameters at the safest and most precise spot: Inner body temperature and activity levels are measured directly in the reticulum 24/7. This way, smaXtec guarantees the highest data quality without external influences.

Simply better cow and herd management
smaXtec measures cow individual data around the clock and informs you immediately in case of irregularities. Thanks to the revolutionary direct measurement of inner body temperature, smaXtec detects health issues and calvings considerably earlier. Activity level measurement enables precise heat detection. Additionally, you can optimize feeding based on pH values.

Smartphone or computer – you have the choice.
You have everything you need to use the system! You only need a smartphone or computer and a functioning power outlet. The user friendly smaXtec software facilitates herd management with useful overviews. Our committed customer support team will assist you during installation as well as usage of the system with maximum engagement. Your success is our success!

Advantages of smaXtec for farmers without herd management systems:
smaXtec secures your farm's future. Individual cow and herd management happens more location- and time-independent.

- Early detection and better cow/herd understanding
- Digital cow and herd management
- Revolutionary health monitoring
- Reduced usage of medication such as antibiotics
- No need for time-consuming routine work such as taking temperature or visual estrus and calving observation.
- Time- and location-independent monitoring of your herd
- More time for the family, hobbies and holidays

Price
The initial cost for the smaXtec Smart Sensor is $89 with a monthly data interpretation fee of $2.49 per cow. On average it costs approximately $2,000 per farm for the equipment and installation to support the sensor network.

Here's Where The Cows Are

Mike Opperman
August 20, 2019 10:41 AM

While the number of dairies in the U.S. has shrunk significantly over the past 30 years, where those dairies are located hasn't changed much. The upper Midwest and Northeast are still home to the most dairies.

In our analysis of the USDA data, we chose to include only those dairies that have more than 50 cows. With this approach, Lancaster County, Pa., has the most dairies, at 865. Four of the next five top counties are all in the upper Midwest, with three of those coming from Wisconsin and one from Minnesota. Franklin County, Pa., folds in the middle at No. 4, and two more Pennsylvania counties land at Nos. 7 and 8.

The first Western state represented is California, where Tulare county resides at No. 9. Coincidentally, Tulare county is also where the most cows are located, reflecting that Tulare county is home to more large dairies than any county in the U.S. Rockingham County, Va., rounds out the top 10.

Wisconsin dominates the remainder of the top 25 counties with eight of the next 15. Pennsylvania and California each have two more counties on the list, while Ohio, Iowa and New York each have one county.

The data also reflects another trend that has happened over the past three decades: The most cows are located in the West and Southwest. An examination of the top 25 counties for cow numbers shows that six of the top 10 counties are located in California. With Idaho, Arizona and Colorado each having a county in the top 10, that makes nine of the top 10 counties located in Western states. The only county east of the Mississippi is Lancaster County, Pa., which has the most dairies, coming in at No. 9.

Western states dominate the rest of the top 25 as follows: New Mexico and Idaho with three, California with two and Washington and Arizona each with one. Wisconsin breaks in with four counties in the top 25, and Minnesota has one.

Below is a table indicating cow numbers for the US as well as the number of farms in each state. Since the most cows are in the West, it stands to reason the biggest dairies are there, too. California and Idaho are tied with the most dairies with more than 5,000 cows at 35; Texas is listed with 25 dairies. Wisconsin and Minnesota each have nine and eight of the +5,000-cow dairies, respectively.

Milk Cows and Production – States and United States: 2020 and 2021

[May not add due to rounding]

State	Milk cows [1]		Milk per cow [2]		Milk production [2]		
	2020	2021	2020	2021	2020	2021	Change from 2020
	(1,000 head)	(1,000 head)	(pounds)	(pounds)	(million pounds)	(million pounds)	(percent)
Alabama	3.0	3.0	14,667	13,000	44.0	39.0	-11.4
Alaska	(D)	(D)	(D)	(D)	(D)	(D)	(NA)
Arizona	200.0	198.0	24,445	24,333	4,889.0	4,818.0	-1.5
Arkansas	5.0	5.0	12,800	12,000	64.0	60.0	-6.3
California	1,722.0	1,719.0	23,990	24,354	41,311.0	41,864.0	1.3
Colorado	197.0	203.0	26,142	25,966	5,150.0	5,271.0	2.3
Connecticut	19.0	19.0	23,053	22,842	438.0	434.0	-0.9
Delaware	3.8	3.0	18,553	17,333	70.5	52.0	-26.2
Florida	113.0	108.0	20,230	20,093	2,286.0	2,170.0	-5.1
Georgia	81.0	82.0	21,877	21,927	1,772.0	1,798.0	1.5
Hawaii	(D)	(D)	(D)	(D)	(D)	(D)	(NA)
Idaho	645.0	652.0	25,174	25,172	16,237.0	16,412.0	1.1
Illinois	83.0	82.0	21,530	21,634	1,787.0	1,774.0	-0.7
Indiana	183.0	192.0	23,683	23,604	4,334.0	4,532.0	4.6
Iowa	218.0	226.0	24,651	24,504	5,374.0	5,538.0	3.1
Kansas	170.0	172.0	23,682	23,826	4,026.0	4,098.0	1.8
Kentucky	48.0	46.0	19,563	19,717	939.0	907.0	-3.4
Louisiana	10.0	9.0	13,400	14,000	134.0	126.0	-6.0
Maine	27.0	27.0	21,963	21,185	593.0	572.0	-3.5
Maryland	42.0	42.0	20,976	20,833	881.0	875.0	-0.7
Massachusetts	10.0	10.0	20,000	19,700	200.0	197.0	-1.5
Michigan	430.0	441.0	27,174	27,102	11,685.0	11,952.0	2.3
Minnesota	448.0	461.0	22,694	22,881	10,167.0	10,548.0	3.7
Mississippi	8.0	7.0	16,375	15,143	131.0	106.0	-19.1
Missouri	76.0	71.0	14,276	14,225	1,085.0	1,010.0	-6.9
Montana	12.0	11.0	21,167	22,091	254.0	243.0	-4.3
Nebraska	59.0	58.0	24,746	24,534	1,460.0	1,423.0	-2.5
Nevada	33.0	33.0	23,879	24,545	788.0	810.0	2.8
New Hampshire	11.0	11.0	21,455	20,545	236.0	226.0	-4.2
New Jersey	5.0	4.0	20,200	22,500	101.0	90.0	-10.9
New Mexico	330.0	318.0	24,755	24,541	8,169.0	7,804.0	-4.5
New York	626.0	627.0	24,435	24,785	15,296.0	15,540.0	1.6
North Carolina	41.0	40.0	21,829	22,925	895.0	917.0	2.5
North Dakota	15.0	15.0	21,867	22,333	328.0	335.0	2.1
Ohio	254.0	257.0	22,118	21,957	5,618.0	5,643.0	0.4
Oklahoma	42.0	39.0	17,452	17,744	733.0	692.0	-5.6
Oregon	126.0	125.0	20,929	20,976	2,637.0	2,622.0	-0.6
Pennsylvania	482.0	474.0	21,326	21,338	10,279.0	10,114.0	-1.6
Rhode Island	0.5	0.5	21,800	20,200	10.9	10.1	-7.3
South Carolina	10.0	9.0	18,600	17,667	186.0	159.0	-14.5
South Dakota	135.0	156.0	23,111	23,096	3,120.0	3,603.0	15.5
Tennessee	30.0	28.0	18,067	18,143	542.0	508.0	-6.3
Texas	595.0	622.0	24,966	25,079	14,855.0	15,599.0	5.0
Utah	96.0	96.0	23,229	23,156	2,230.0	2,223.0	-0.3
Vermont	122.0	120.0	21,336	21,383	2,603.0	2,566.0	-1.4
Virginia	75.0	73.0	20,293	20,151	1,522.0	1,471.0	-3.4
Washington	280.0	271.0	24,346	24,000	6,817.0	6,504.0	-4.6
West Virginia	6.0	5.0	14,833	15,000	89.0	75.0	-15.7
Wisconsin	1,259.0	1,274.0	24,423	24,884	30,749.0	31,702.0	3.1
Wyoming	7.5	8.5	25,173	25,918	188.8	220.3	16.7
Other States [3]	0.9	0.9	5,333	6,111	4.8	5.5	14.6
United States	9,392.0	9,448.0	23,777	23,948	223,309.0	226,258.0	1.3

(D) Withheld to avoid disclosing data for individual operations.
(NA) Not available.
[1] Average number during year, excluding heifers not yet fresh.
[2] Excludes milk sucked by calves.
[3] Other States includes Alaska and Hawaii.

Licensed Dairy Herds – States and United States: 2020 and 2021

	Licensed dairy herds [1]	
	2020	2021
	(number)	(number)
Alabama	20	15
Alaska	1	1
Arizona	90	80
Arkansas	35	35
California	1,215	1,195
Colorado	120	110
Connecticut	95	85
Delaware	20	15
Florida	85	75
Georgia	130	110
Hawaii	1	1
Idaho	440	430
Illinois	525	495
Indiana	805	770
Iowa	965	880
Kansas	240	230
Kentucky	450	420
Louisiana	75	70
Maine	200	190
Maryland	340	320
Massachusetts	110	110
Michigan	1,200	1,140
Minnesota	2,350	2,215
Mississippi	55	50
Missouri	720	650
Montana	50	50
Nebraska	120	120
Nevada	20	20
New Hampshire	100	95
New Jersey	40	35
New Mexico	140	120
New York	3,650	3,430
North Carolina	145	140
North Dakota	60	55
Ohio	1,745	1,620
Oklahoma	130	100
Oregon	200	190
Pennsylvania	5,430	5,200
Rhode Island	10	10
South Carolina	35	35
South Dakota	180	165
Tennessee	180	160
Texas	360	340
Utah	150	140
Vermont	640	580
Virginia	475	421
Washington	340	330
West Virginia	45	35
Wisconsin	7,110	6,770
Wyoming	10	5
United States	31,652	29,858

[1] Average number of dairy farms licensed to sell milk, based on counts collected from State and other regulatory agencies.

IBISWorld

WHERE KNOWLEDGE IS POWER

INDUSTRY REPORT 11212

Dairy Farms in the US

Say moo: Government support and strong demand will likely support dairy farms

Jack Curran | October 2021

Supply Chain

SIMILAR INDUSTRIES

Beef Cattle Production in the US
Complementor

Chicken Egg Production in the US
Complementor

Sheep Farming in the US
Competitor

Dairy Product Production in the US
Complementor

RELATED INTERNATIONAL INDUSTRIES

Dairy Cattle Farming in Australia

Sheep and Cattle Farming in China

Dairy Cattle Raising in the UK

Dairy Farms in Canada

Dairy Cattle Farming in New Zealand

Raising of Animals in Ireland

Industry at a Glance

Key Statistics

$40.8bn
Revenue

Annual Growth 2016–2021	Annual Growth 2021–2026	Annual Growth 2016–2026
1.5%	0.9%	

$2.2bn
Profit

Annual Growth 2016–2021	Annual Growth 2016–2021
17.5%	

5.4%
Profit Margin

Annual Growth 2016–2021	Annual Growth 2016–2021
2.8pp	

30,610
Businesses

Annual Growth 2016–2021	Annual Growth 2021–2026	Annual Growth 2016–2026
-6.7%	-2.1%	

132k
Employment

Annual Growth 2016–2021	Annual Growth 2021–2026	Annual Growth 2016–2026
-1.8%	-0.1%	

$4.0bn
Wages

Annual Growth 2016–2021	Annual Growth 2021–2026	Annual Growth 2016–2026
-2.4%	0.1%	

Key External Drivers

% = 2016–21 Annual Growth

0.9%
Demand from dairy product production

0.3%
Per capita dairy consumption

3.6%
Price of feed

1.7%
Price of milk

Industry Structure

POSITIVE IMPACT

Industry Assistance
High / Steady

Concentration
Low

Industry Globalization
Low / Steady

MIXED IMPACT

Life Cycle
Mature

Technology Change
Medium

Competition
Medium / Increasing

NEGATIVE IMPACT

Revenue Volatility
High

Capital Intensity
High

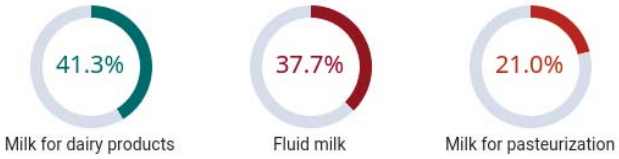
Regulation & Policy
Heavy / Steady

Barriers to Entry
Low / Steady

Key Trends

- Despite volatility, milk prices have had a net increase over the past five years
- As a result of volatile profit, many industry farms have struggled
- Farmers have sought to increase operational efficiencies through layoffs
- Government assistance and consolidation among farms will likely continue, aiding industry profit
- Dairy farms will likely attempt to save costs by merging or acquiring other players
- Reduced government support could have a significant effect on milk prices
- As the pandemic begins to pass, the milk supply is likely to remain high, permitting milk prices to fall

Products & Services Segmentation



Dairy Farms
Source: IBISWorld

Major Players

There are no major players in this industry

SWOT

STRENGTHS

High & Steady Level of Assistance
Low Imports
Low Customer Class Concentration
Low Product/Service Concentration

WEAKNESSES

Low & Steady Barriers to Entry
High Volatility
Low Profit vs. Sector Average
Low Revenue per Employee
High Capital Requirements

OPPORTUNITIES

High Revenue Growth (2016-2021)
High Performance Drivers
Per capita dairy consumption

THREATS

Low Revenue Growth (2005-2021)
Low Outlier Growth
Low Revenue Growth (2021-2026)
Price of milk

Executive Summary

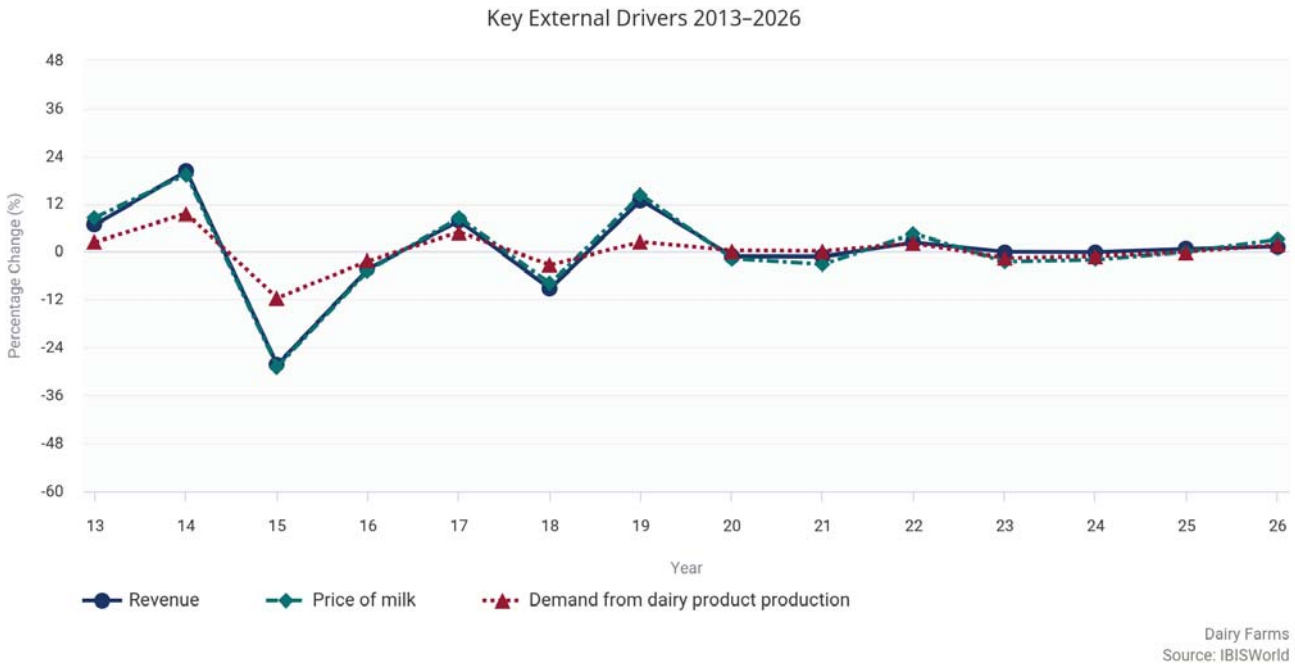
Say moo: Government support and strong demand will likely support dairy farms

In the Dairy Farms industry, the most important success factor is the price farmers receive for raw milk. Over the five years to 2021, the price of raw milk has been highly volatile, causing revenue to fluctuate. In 2018, an oversupply of dairy products caused milk prices to fall 7.9%, which led to a 9.3% drop in industry revenue that same year. However, this was immediately followed by the price of milk increasing 14.3% in 2019, and thus, revenue grew 13.0% in 2019 as well. While changing prices have caused significant volatility, the industry has experienced a net gain in revenue. Industry revenue has increased at an annualized rate of 1.5% to $40.8 billion over the five years to 2021. Despite a net increase in milk prices, profit, measured as earnings before interest and taxes, is expected to account for 5.4% of revenue in 2021.

While milk prices were strong in 2019, in 2020, a surplus of dairy products led to a decline in the price of milk. The COVID-19 (coronavirus) pandemic forced many cities and states to adopt stay-at-home orders, which forced restaurants, schools and nonessential businesses to close. Many dairy wholesalers and dairy product producers cater specifically to food service industries and schools, so with these markets closed, there were no buyers for their products. Meanwhile, demand for dairy at grocery stores skyrocketed with consumers being forced to prepare food at home. Overall, this kept demand for dairy strong in 2020. However, in 2021, as the pandemic begins to pass, the milk supply is likely to remain high, permitting milk prices to fall. As a result, in 2021, industry revenue is expected to decline an estimated 1.2%.

Over the five years to 2026, the industry will likely benefit from stabilizing milk prices and improved downstream demand. However, with a difficult start to the period, growth will likely be slow as farms are still expected to be reeling from the coronavirus pandemic. Still, with government support and strong demand for organic and raw milk, dairy farms that remain in the industry are expected to thrive. Industry revenue is projected to increase at an annualized rate of 0.9% to $42.6 billion over the five years to 2026.

Industry Performance



Dairy Farms
Source: IBISWorld

Key External Drivers

Price of milk

Downstream dairy processors and the government generally set milk prices, largely dictating revenue for dairy farms. An increase in milk prices encourages farmers to devote more resources to milk production, while falling prices causes declines in revenue. The price of milk is expected to decrease in 2021, representing a potential threat to the industry.

Demand from dairy product production

Raw milk is a key ingredient in producing cheese, yogurt and ice cream, meaning that downstream manufacturers of dairy products demand milk from industry players. A rise in demand for dairy products increases the amount of milk used as an input in dairy processing. Demand from dairy product production is expected to decrease in 2021.

Price of feed

On average, feed purchases account for slightly more than half the cost of milk production. Over the five years to 2021, rising feed costs have reduced income for many dairy farms. However, feed prices are often passed on to downstream markets, increasing milk prices and revenue. The price of feed is expected to increase in 2021, presenting a potential opportunity for the industry.

Per capita dairy consumption

Since milk and many dairy products are considered dietary staples in the United States, per capita consumption fluctuates only marginally and generally hinges on population growth. As a result, demand for dairy farms remains relatively stable. Per capita dairy consumption is expected to decrease in 2021.

Dairy Farms
Source: IBISWorld

Current Performance

Milk prices, which typically determine revenue for the Dairy Farms industry, have exhibited high volatility over the five years to 2021.

High milk prices in 2017 resulted in revenue growth that year. However, this also contributed to an oversupply of milk in 2018 that caused prices and revenue to fall. Conversely, production fell after prices declined, resulting in milk prices rising 14.3% in 2019. This resulted in revenue growing 13.0% that same year. As a result of these price fluctuations, revenue has been highly volatile. However, despite volatility, prices have had a net increase over the past five years, and therefore, revenue has grown. Industry revenue has increased at an annualized rate of 1.5% to $40.8 billion over the five years to 2021.

MILK PRICES, EXPORTS AND GLOBALIZATION

While the industry does not directly participate in international trade, dairy farms are affected by the global operations of the Dairy Product Production industry (IBISWorld report 31151).

Over the past five years, the value of dairy exports has grown as the US dollar has depreciated relative to other major currencies, making US products relatively more affordable in other countries. However, dairy exports to China have been hurt by the recent US-China trade war. In response to the United States' tariffs against Chinese goods, China has placed its own tariffs on US agricultural products, including dairy. In 2020, the US and China began phase one of a potential trade deal.

However, Dairy Farms industry is expected to benefit from North American trade policy in 2021. In 2020, the United States-Mexico-Canada Agreement (USMCA) was established, replacing the North American Free Trade Agreement and creating new trade regulations between the three countries. Most significantly for dairy exporters, under the USMCA, Canada agreed to loosen its protective tariffs on dairy imports. Previously, Canada had high tariffs on milk and other dairy products to protect its dairy cooperatives. While trade levels were limited by the COVID-19 (coronavirus) pandemic in 2020, the USMCA limited the effects of this decline on dairy farms.

PROFIT AND CONSOLIDATION

The price of feed significantly influences industry profit.

Since cattle must be fed regardless of milk output or prices, farmers typically spend at least half their revenue on feed to maintain their herds. In 2021, purchase costs are expected to account for slightly more than half of industry revenue, at an estimated 54.8%, which is still the largest share of revenue across the industry. During the first half of the period, the price of corn sharply declined despite its increased use in ethanol production. Since corn is a key ingredient in cattle feed, feed costs declined in line with falling corn prices. Overall, profit, measured as earnings before interest and taxes, is expected to account for 5.4% of revenue in 2021, up from 2.6% in 2016.

As a result of volatile profit, many industry farms have struggled over the past five years. This is partially due to the high level of revenue and profit volatility in the industry making it difficult for farms to forecast their financial performance. Additionally, the coronavirus pandemic has posed a massive threat to many dairy farms. In response to the pandemic, many states issued stay-at-home orders that require schools, restaurants and nonessential businesses to close. Restaurants and schools are two of the largest markets for milk and dairy products, so without these buyers, many wholesalers and dairy product producers have struggled to sell their products. A large number of dairy farms mainly sell to these wholesalers, and are now experiencing a surplus of milk without the means to sell it. As a result, many farms have struggled and were forced out of the industry. The number of industry enterprises has declined at an annualized rate of 6.7% to 30,610 companies over the five years to 2021.

Meanwhile, overall demand for dairy has remained high, as demand from grocery stores has grown rapidly due to people preparing food at home. However, wholesalers and farms that sell to food service industries have been unable to supply grocery stores, since this would require structural changes that require time and capital. As a result, grocery stores experienced a shortage of dairy products, causing milk prices to rise. Thus, the pandemic caused the industry to experience both a surplus and a shortage at the same time. Even as the pandemic begins to slowly pass in 2021, dairy farms are expected to continue struggling to maintain a steady supply of milk amid shutdowns and changing restrictions. As a result, in 2021, industry revenue is expected to decrease 1.2%.

In response to volatility and the new threat of the pandemic, farmers have sought to increase operational efficiencies through layoffs. As a result, industry employment has declined at an annualized rate of 1.8% to 132,480 workers over the five years to 2021. Nevertheless, wages have continued to account for a minimal share of industry revenue. This is due to much of the industry still being composed of small dairy farmers that work their own farm. For these farmers, earnings are recorded as both revenue and wages, so industry wage costs shift in line with revenue.

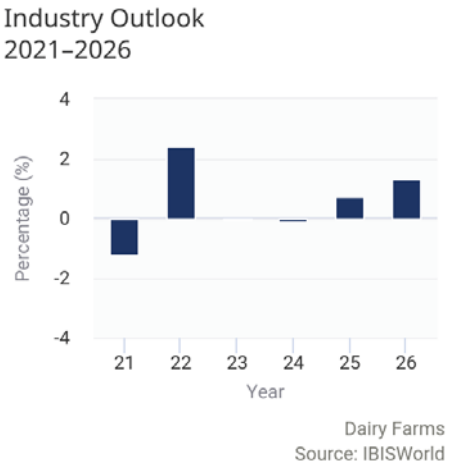
Historical Performance Data

Year	Revenue ($m)	IVA ($m)	Establishments (Units)	Enterprises (Units)	Employment (Units)	Exports (Units)	Imports (Units)	Wages ($m)	Domestic Demand ($m)	Raw Milk Price ($ per hundredweight (cwt))
2012	42,837	10,021	48,177	43,635	135,691	N/A	N/A	4,152	N/A	18.5
2013	45,753	11,966	50,736	46,161	139,389	N/A	N/A	4,462	N/A	20.1
2014	55,034	19,192	48,641	44,053	140,725	N/A	N/A	4,333	N/A	24.0
2015	39,454	9,625	50,463	45,759	146,701	N/A	N/A	4,219	N/A	17.1
2016	37,765	9,001	48,071	43,324	145,336	N/A	N/A	4,469	N/A	16.3
2017	40,710	12,482	37,922	33,171	137,295	N/A	N/A	4,543	N/A	17.7
2018	36,928	10,154	40,452	35,714	139,364	N/A	N/A	4,725	N/A	16.3
2019	41,741	9,973	37,117	32,447	135,952	N/A	N/A	4,063	N/A	18.6
2020	41,268	8,537	36,233	31,635	134,400	N/A	N/A	4,017	N/A	18.3
2021	40,773	9,702	35,122	30,610	132,480	N/A	N/A	3,961	N/A	17.8

Industry Outlook

Outlook

Demand for milk, and the Dairy Farms industry overall, is projected to grow in line with rising downstream demand from processors over the five years to 2026.



Milk is a staple food according to the US Department of Agriculture, which recommends at least three cups a day through its MyPlate program. Government assistance and consolidation among farms will also likely continue, further aiding industry operators' profit during the outlook period. As milk prices stabilize, revenue is forecast to increase slowly. Industry revenue is projected to grow at an annualized rate of 0.9% to $42.6 billion over the five years to 2026.

CONSOLIDATION

After a difficult start to the period, growth is likely to be slow for many dairy farms that have been hurt by the COVID-19 (coronavirus) pandemic.

As demand from restaurants plummeted and was replaced by demand from grocery stores, many industry farms have been challenged by increased capital costs associated with shifting markets. As the pandemic passes and the economy returns to growth, many industry farms are still likely to struggle. As a result, even with revenue growth, the industry is anticipated to move toward consolidation as farms merge to reduce costs and maintain profit. Since larger farms can save on labor and overhead costs per additionally bred cow, dairy farms will likely attempt to save costs by merging or acquiring other players. The number of industry enterprises is projected to decline at an annualized rate of 2.1% to 27,459 companies over the five years to 2026.

However, consolidation is likely to contribute to falling demand for labor, as merged farms are expected to be able to reduce labor redundancies. As a result, wages are expected to grow at an annualized rate of 0.1% to $4.0 billion over the five years to 2026. While this is an increase, industry revenue is still expected to grow at a slightly faster rate, so labor is expected to decrease as a share of revenue. Meanwhile, as labor costs decline, profit is expected to grow as a share of revenue. In 2026, profit, measured as earnings before interest and taxes, is expected to account for 5.6% of revenue, up from 5.4% in 2021.

DEMAND AND PRICE OF MILK

Milk prices are expected to stabilize over the coming years, following the large fluctuations caused by dairy product surpluses and the coronavirus pandemic.

The US economy and international economies are likely to experience slow, but steady growth as the pandemic passes, preventing wild swings in the price of milk, such as those experienced over the five years to 2021. However, high demand for milk and dairy products during the pandemic has caused the price of milk to be particularly high in 2021. As a result, the price of milk is expected to rise at an annualized rate of just 0.6% over the five years to 2026.

In addition to demand fluctuations, reduced government support could have a significant effect on milk prices over the coming years. In the 2018 Farm Bill, the centerpiece of agricultural policy that is updated every five years, the federal government removed its price support programs that previously propped up milk prices. Rather than targeting prices, the new bill targets dairy farmers' profit. Under the Dairy Producer Margin Protection Program

(MPP), farmers receive payments if the margin between revenue and feed costs gets squeezed too thin. Since the new policy targets profit rather than prices, it could continue stabilizing dairy producer profit even if milk prices fall. This decoupling could result in lower milk prices, making US dairy products more affordable for US and foreign consumers. In addition, the new MPP enables producers to tailor their coverage more accurately than previous subsidy programs. With producers able to choose their coverage more precisely, industry profit is expected to widen.

ORGANIC OPPORTUNITIES

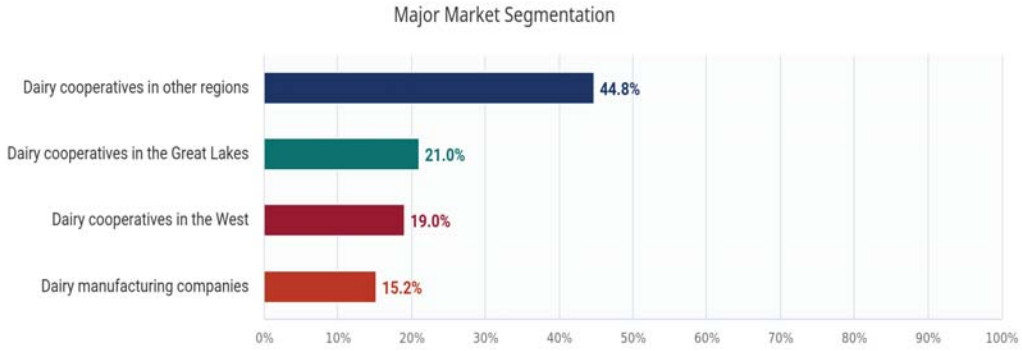
While organic milk production accounts for a small share of raw milk sales, it has grown strongly over the past decade.

Controversy regarding the injection of recombinant bovine somatotropin growth hormones to induce greater milk production has made organic milk an appealing option for some people. Consumers have increasingly turned to organic milk for added assurance that their food intake remains hormone free. Furthermore, demand for organic milk often exceeds supply. The United States has imported organic milk from New Zealand and Australia to meet growing domestic demand. Producers can charge up to twice as much as normal milk for organic milk due to the added shipping costs. However, producing organic milk typically incurs higher production costs due to the low availability of organic feed and the added difficulty of maintenance, which may deter farmers from adopting such practices. IBISWorld anticipates that organic milk will continue to gain popularity as consumers become increasingly health conscious.

Performance Outlook Data

Year	Revenue ($m)	IVA ($m)	Establishments (units)	Enterprises (units)	Employment (units)	Exports (units)	Imports (units)	Wages ($m)	Domestic Demand ($m)	Raw Milk Price ($ per hundredweight (cwt))
2021	40,773	9,702	35,122	30,610	132,480	N/A	N/A	3,961	N/A	17.8
2022	41,754	10,034	34,583	30,047	133,769	N/A	N/A	4,011	N/A	18.6
2023	41,742	10,005	33,559	29,085	132,612	N/A	N/A	3,983	N/A	18.1
2024	41,701	9,956	32,607	28,194	131,443	N/A	N/A	3,954	N/A	17.8
2025	42,005	9,994	32,301	27,894	131,609	N/A	N/A	3,964	N/A	17.8
2026	42,564	10,090	31,865	27,459	132,093	N/A	N/A	3,986	N/A	18.3
2027	43,064	10,217	31,603	27,191	132,698	N/A	N/A	4,010	N/A	18.7

Major Markets



2021 INDUSTRY REVENUE

$40.8bn

Dairy Farms
Source: IBISWorld

DAIRY COOPERATIVES

In 2021, dairy cooperatives process and market more than 80.0% of all US milk produced by the Dairy Farms industry.

The location of cooperatives is closely related to the distribution of dairy farms. It is important to note that milk prices are fixed across the board, and thus, the number of dairy farms is the underlying factor in regional revenue. In 2021, 21.0% of revenue is estimated to be from cooperatives in the Great Lakes region. Similarly, the dairy cooperatives in the West region are expected to account for 19.0% of revenue in 2021. This region includes California, the largest milk-producing state in the United States. Dairy cooperatives in other regions account for 44.8% of revenue in 2021. Over the five years to 2021, the number of dairy cooperatives has decreased, but their share of US milk production has increased as a result of major consolidation efforts.

The dairy cooperatives perform a variety of functions, including verifying weights and performing tests on milk, negotiating milk prices, manufacturing, processing, wholesaling and retailing. A key function of cooperatives is to balance supply and demand in the dairy market by deciding how much milk to put into fluid milk and how much to manufacture. A key difference between dairy cooperatives and proprietary manufacturers is that they guarantee to sell all their members' milk.

DAIRY MANUFACTURING COMPANIES

Dairy manufacturing companies purchase directly from farmers and from cooperatives.

These proprietary companies process and manufacture packaged fluid milk, cottage cheese and ice cream. Some dairy cooperatives have also formed joint ventures with proprietary companies, such as Dean Foods Company's agreement to manufacture and market almost all Land O'Lakes Inc. dairy products, blurring the line between the two markets. Exports occur at the manufacturing level among manufacturers and cooperatives. In 2021, dairy manufacturing companies account for 15.2% of revenue. This segment has declined as a share of revenue over the past five years due to the increased popularity of dairy cooperatives.

Exports in this industry are Low and Steady

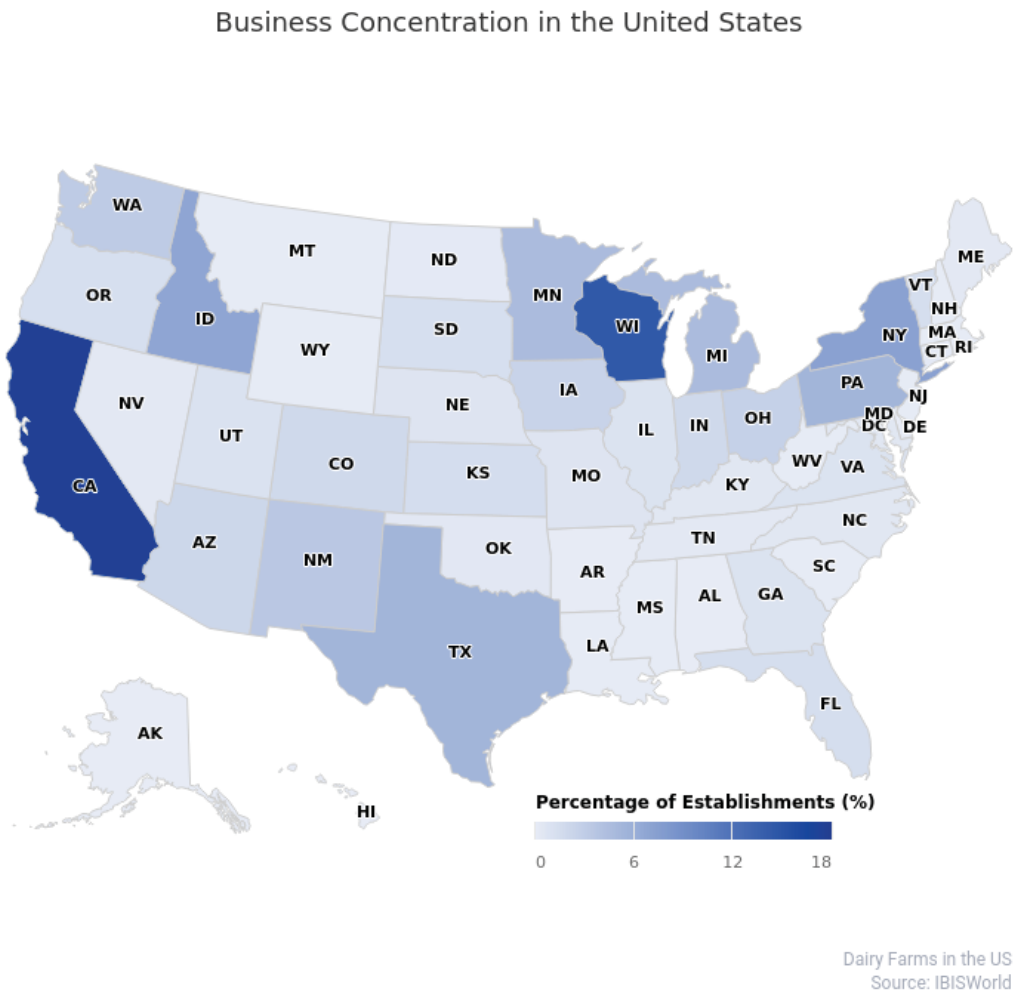
Imports in this industry are Low and Steady

The Dairy Farms industry does not participate in international trade. According to the US International Trade Commission, most of the world's raw milk is consumed domestically because raw milk and other fresh dairy products are highly perishable and expensive to transport. Even raw milk produced for fluid milk is typically homogenized or pasteurized and almost always bottled and sealed, activities that count as processing, which plant fluid milk products in the downstream Dairy Product Production industry (IBISWorld report 31151). These products can be stored and transported at relatively low cost compared with their value. As a result, international trade in dairy products is recorded downstream of the Dairy Farming industry. Dairy products made from this industry's raw milk are traded downstream by the Dairy Product Production and Ice Cream Production (31152) industries. Downstream trade in dairy products represents a small share of production and downstream revenue, but the influence of trade has increased significantly over the five years to 2021.

Trade barriers

Traditionally, the US dairy sector has been highly protected through a series of trade barriers. There is significant government intervention in domestic milk pricing and border-protection policies that have pushed US dairy prices above world prices. There are also export subsidies through the Dairy Export Incentive Program to stimulate US dairy product exports. Under the program, the US Department of Agriculture pays cash to exporters as bonuses. These bonuses enable them to sell US dairy products at lower prices and enables US dairy exporters to remain competitive in global dairy markets. Additionally, the United States-Mexico-Canada Agreement (USMCA) recently reduced Canada's protective tariffs on dairy. As a result, downstream dairy product producers are able to more easily export to Canada, thus boosting demand for US dairy.

Business Locations



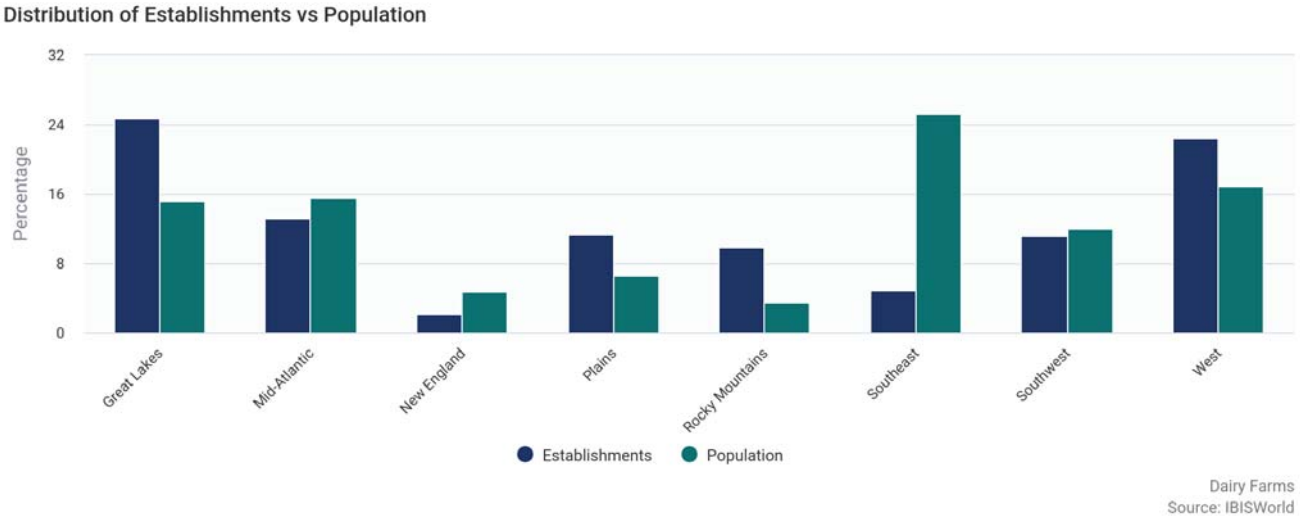
Dairy Farms in the US
Source: IBISWorld

Although milk is produced in all states, locations in the Dairy Farms industry are most heavily concentrated in the Great Lakes, accounting for 24.8% of establishments in 2021; the West (22.4%); and the Mid-Atlantic (13.2%) regions. Together, these regions account for about two-thirds of the United States' dairy farms. States with the largest share of establishments include California (17.6%), Wisconsin (14.5%), New York (7.2%) and Idaho (6.8%). These states have a longstanding tradition of dairy farming that predates the proliferation of large-scale industrialized agriculture, dating back to the early and mid-19th century. Many of the establishments in these regions are family farms that operate on a small scale. In addition, these regions' shares of dairy farms are much higher than their shares of dairy cows, further indicating the fragmented nature of the dairy farm business in these

states.

However, as the cost of running a dairy farm increases, these small family-run farms have become less economically viable. The establishments still in operation often survive by supplementing their income with other small farming or agriculture businesses. Others have folded because they could not turn a profit. As a result, the number of small-scale dairy farms concentrated in regions such as the Great Lakes, Mid-Atlantic and Plains are declining. Many are consolidating into larger operations, while some have left the industry entirely.

As an alternative to traditional small-scale dairy farms, dairy farmers in regions newer to the industry, specifically the West and the Southwest, have set up large-scale, highly automated dairy farms. The number of dairy farms in these regions is very low, but their share of dairy cows is above average. These large-scale farms have adapted to new industry conditions of high input costs and low selling prices for milk. This new business model is much more viable, and large tracts of land available in states in the West and Southwest have made starting large dairy farms easier in these regions.



Competitive Landscape

Market Share Concentration

Concentration in this industry is ✓ Low

Low market share concentration characterizes the Dairy Farms industry. US dairy farms are highly fragmented, with most farms consisting of family-owned operations. As a result, the industry is made up of many small farms that produce a minority of revenue. Industry concentration has increased as small dairy farms take losses and leave the industry. Meanwhile, the remaining dairy farmers are growing operations to take advantage of economies of scale and increase their profitability. Vertically integrated dairy cooperatives operate downstream from dairy farms to process, market and wholesale dairy products. The cooperatives enable dairy farmers to pool milk production, and the aggregate supply of milk can then be leveraged to assist in raising prices. Dairy farmers further benefit from the cooperatives' marketing and research and development efforts. Thus, cooperatives create an effectively higher industry concentration. For more information, refer to the Dairy Product Production industry (IBISWorld report 31151).

Key Success Factors

IBISWorld identifies 250 Key Success Factors for a business. The most important for this industry are:

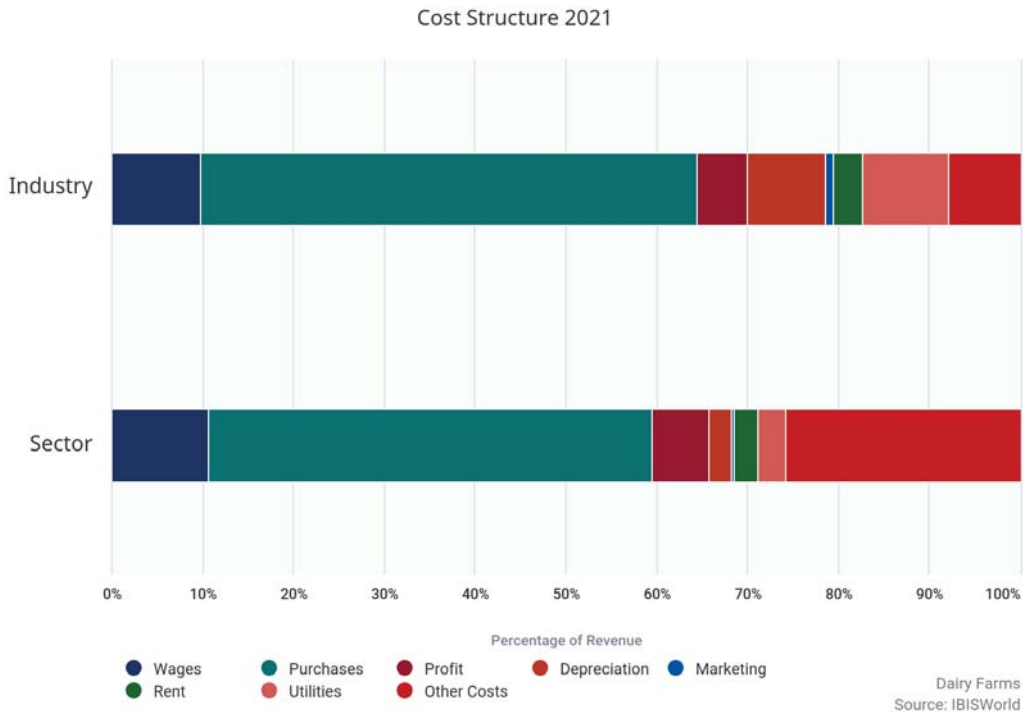
Proximity to key markets:
It is important for dairy farmers to be located in the best climatic conditions and close to dairy processors. The further farmers are located from major processing facilities, the higher the freight cost, especially in terms of refrigeration.

Superior financial management and debt management:
Superior management of debt can assist with periods of industry instability and drought conditions, especially if feed prices increase.

Use of specialist equipment or facilities:
The level of technology adopted can improve production volumes and quality of milk.

Economies of scale:
The size of the operation and the ability to obtain economies of scale, thereby spreading costs over larger production, increases a farm's profitability.

Cost Structure Benchmarks



Major Companies

There are no major players in this industry

Other Companies

Establishments in the Dairy Farms industry are overwhelmingly family-owned and individually managed, regardless of their size, so there are no major players that account for more than 5.0% of industry revenue in 2021. Most small farms operating in the industry belong to dairy cooperatives, which are owned and operated by their group members. These cooperatives do not produce any milk, and therefore, are not considered major players of this industry. Nonetheless, they have a significant influence on their member farms because they pool, process, market and distribute farmers' milk. This structure enables farmers to take advantage of the economies of scale that a larger marketing body offers, earning higher revenue through involvement in milk processing. Cooperatives also undertake research and development into milk production methods, furthering the success of this industry. Three major cooperatives account for about half of all milk produced in the United States.

California Dairies Inc.

California Dairies Inc. (CDI) is the second-largest dairy cooperative in the United States in terms of volume of milk produced by member farmers. Through its 390 California dairy farms, the company produces more than 17.0 billion pounds of milk annually, which represents about 43.0% of California's milk and about 9.0% of total milk produced in the United States. CDI also operates six plants in various cities, including Artesia, Tipton, Visalia, Fresno, Los Banos and Turlock. These plants process raw milk into dairy products such as cheese, butter and condensed milk. In fact, CDI is a major processor of nonfat dry milk and is one of the largest manufacturers of private-label butter for operators in the retail and food service sectors. These dairy products are then distributed via its two subsidiaries, Challenge Dairy Products Inc., which is responsible for butter products, and DairyAmerica Inc., which is responsible for milk powder.

Dairy Farmers of America Inc.

Dairy Farmers of America Inc. (DFA), founded in 1998 through the merger of four regional dairy marketing cooperatives, is the largest US dairy cooperative, with 14,000 members across 48 states. The cooperative markets about 63.0 billion pounds of milk annually, which represents about one-third of the United States' milk supply. DFA also owns more than 30 manufacturing plants through its manufacturing division, dairy food products (DFP). DFP processes US and Italian cheeses; cultured dairy products; canned, sterilized infant and adult nutrition products; dehydrated products; dried whey products; ground, shredded and diced cheeses; long-shelf-life dairy products; and cheese sauces. Additionally, in 2020, DFA announced plans to purchase a portion of Dean Foods Company's (Dean Foods) dairy production facilities after Dean Foods filed for bankruptcy. Lastly, DFA offers financial services, such as dairy financing and forward contracting; information services; product development research; on-farm field services; farm-focused insurance programs; and a unified voice to influence legislation.

Land O'Lakes Inc.

Land O'Lakes Inc. (Land O'Lakes) is the third-largest dairy cooperative in the United States, with more than 10,000 employees, 3,500 direct producer members and 799 member cooperatives. The company handles about 12.0 billion pounds of milk annually, which represents about 7.0% of total milk produced in the United States. Like other dairy cooperatives, Land O'Lakes produces a wide assortment of dairy products with its collected milk. The company breaks down its dairy foods segment into two groups, which include retail foods and industrial foods. The retail foods segment produces and distributes butter, spreads and cheeses to supermarkets and grocery stores through its Land O'Lakes brand. Meanwhile, the industrial foods segment distributes butter, spreads and milk powder to restaurants and public schools.