Case Study

Renaissance Ag: Identifying the Who, How, and Where of Marketing a New Technology

Chanden Westover[a] and Tanner McCarty[a]
[a]Utah State University

JEL Codes: Q12, Q13
Keywords: Feed, hydroponics, marketing, strategy, target market

Abstract
This case study explores the marketing decisions facing an agricultural technology company in Utah. Renaissance Ag recently developed a technology that converts shipping containers to hydroponic feed production systems. One shipping container produces 1.5 tons of livestock feed per day and requires less water compared to conventional agriculture. This technology has promise in a world food system being constantly forced to produce more with less. However, promoting adoption of new technologies in agriculture is always challenging. Renaissance Ag's long-term viability is dependent upon efficiently channeling its limited marketing budget toward regions and agricultural sectors likely to receive the largest benefit from their technology. This case study challenges students to conceptualize and quantify the trade-offs associated with selling in different markets. It also has them consider impacts of different payment structures on equipment sales. The intended audience for this case is freshman and sophomore students in agribusiness and agricultural economic programs.

1 Introduction

Brady Blackett, the head of the sales team at Renaissance Ag, takes in the views of the Wasatch Mountains on his drive home from work. On the drive, he reflects on the day's meeting with the leadership team. Renaissance Ag has developed a hydroponic system that produces livestock feed using less land and water than conventional production. The problem is that the company needs to start making sales in a market that is in its infancy. It is up to Brady to identify the target market and the strategy that will lead Renaissance Ag to profitable sales as quickly as possible. This will be challenging, but if he can pull it off, Renaissance Ag will gain the resources they need to continue growing and maybe even revolutionize the livestock industry.

This technology is called the PastureBox, a system that offers several benefits. First, each shipping container-sized PastureBox can grow the feed equivalent of 15 acres of hay a year. It does so using 93 percent less water than conventional production. This attribute would be valuable for any livestock producer who is either land- or water-constrained. Second, experiment data from the engineering team looks promising. A pilot-scale PastureBox reliably produces fodder, and most engineering challenges are resolved.[1] Third, experiment data from the animal science team also looks encouraging. When compared to entirely alfalfa-based rations, 50-50 rations of a fodder-alfalfa mix produced similar weight gain in cattle and milk nutritional composition. This suggests that PastureBox fodder could be a close substitute for a portion of alfalfa rations in the cattle or dairy industries.

[1] For the PastureBox to work, engineers needed to develop effective systems for lighting, timing, insulation, piping, and input use. All of these factors have been addressed. The only remaining engineering challenge includes making improvements to the water recycling system.

The PastureBox does have one major drawback, which is its cost relative to conventional agriculture. The PastureBox's cost of production can make it more expensive than the alfalfa equivalent in certain regions and times. Also, the box itself is expensive for Renaissance Ag to produce. Each unit costs Renaissance Ag over $100,000 to manufacture. Based on these considerations, Brady has three primary questions he needs to resolve before pitching his marketing strategy to management at the end of the week.

1. What industry should this technology be sold in? Brady feels that this technology should be geared toward either the dairy or the cattle industry since those are the two areas for which the technology has been tested. Each of these industries has potential benefits and costs associated with it, and it is not immediately clear which sector would be best.

2. What region should this technology be sold to? This technology will be most successful in areas that will benefit from it most (e.g., areas of scarce water, scarce land, high feed cost, etc.), but the degree to which each of these factors matters relative to the other must be carefully considered.
3. How should this technology be sold? A single PastureBox would be a large investment for a small- or mid-size business.

1.1 Learning Objectives of This Case Study

i. *What industry should this technology be sold in?* Students should gain an understanding of the trade-offs associated with technological adoption across various industries. These trade-offs will include costs, benefits, and changes in risk exposure associated with the technology in each industry.

ii. *What region should this technology be sold in?* Students should gain insight into the specific external factors (e.g., market, policy, natural resources, etc.) that influence the advantages and disadvantages of a given technology across different regions.

iii. *How should this technology be sold?* Students should learn how transactional structure (e.g., payment size, financing options, payment plans, etc.) influence the desirability of adopting a new agricultural production technology.

2 Background of Renaissance Ag and the PastureBox

Renaissance Ag is a young agribusiness company headquartered in Vineyard, Utah. Having a management team familiar with production agriculture in this region has acquainted them with the agricultural problems associated with limited land and water availability. This motivated them to invent the PastureBox. The PastureBox is made from a shipping container that is modified to grow grain fodder. This fodder is grown from seeds such as wheat, barley, or rye. Each day, new seed is placed in the box where it is watered. It then takes 6 days to reach maturity. The result is fodder, a grass-like feed that is a few inches high and can be used as a partial substitute for hay.

The PastureBox produces feed using less water and land than conventional production. One PastureBox can produce 3,000 pounds of fodder daily. The PastureBox also has the potential to cut down on hay storage costs. It creates a continuous stream of feed rather than being tied to the growing season. The controlled nature of this production also means that production cost of fodder produced in the PastureBox will be much more predictable than alfalfa or other hay sources that are subject to variations in rainfall, sun, pests, and any other factor that affects yield.

Figure 1: Picture of a PastureBox Unit (Renaissance Ag, 2024)[2]

Renaissance Ag is one of only a few companies that offer this kind of product. This status comes with both benefits and costs. On one hand, they face limited competition, which could give them a sizeable market share for hydroponically produced cattle/dairy feed. On the other hand, this market is in its infancy, and producers have yet to widely adopt hydroponic technology for livestock feed. Renaissance Ag first needs to build the market and associated supply chain for their product. With no existing road maps for hydroponically produced feed, they will need to develop all of their relevant strategies from scratch. They also have to win over producers who are unfamiliar with their product.

2.1 PastureBox Experimental Data

In the fall of 2022, Utah State University partnered with Renaissance Ag to bring a PastureBox to their south research farm. Researchers conducted a study where 20 beef cows with their calves were split into four groups of five. In this trial, two groups received alfalfa in their ration. The other two groups received a 50-50 (by weight) ration of alfalfa and fodder. On days 0, 10, 45, 55, and 90, researchers recorded observations such as the cow's weight, the protein and the fat in the cow's milk, and the calves' weight. For each metric, data was charted to compare the outcomes of alfalfa-fed rations to mixed rations. The results from this study were used to gauge the substitutability of fodder for alfalfa and calculate the cost per pound gained of both feed rations. In Figure 2, the blue line illustrates the average weight of the alfalfa-fed calves over 90 days. The orange line represents the fodder-alfalfa mix fed calves over 90 days. Alfalfa-fed calves started out a little heavier, but both groups ended at similar weights. Weight gain was slightly higher for the mixed ration. This study also collected data on beef cow milk attributes. This was done for two reasons. First, cow's milk plays a prominent role in a calf's growth. Checking the fat, lactose, and protein is the best way to see if there is a difference in milk quality. Second,

[2] For a demonstration of this technology see, https://www.youtube.com/watch?v=E-fNbNplqLc

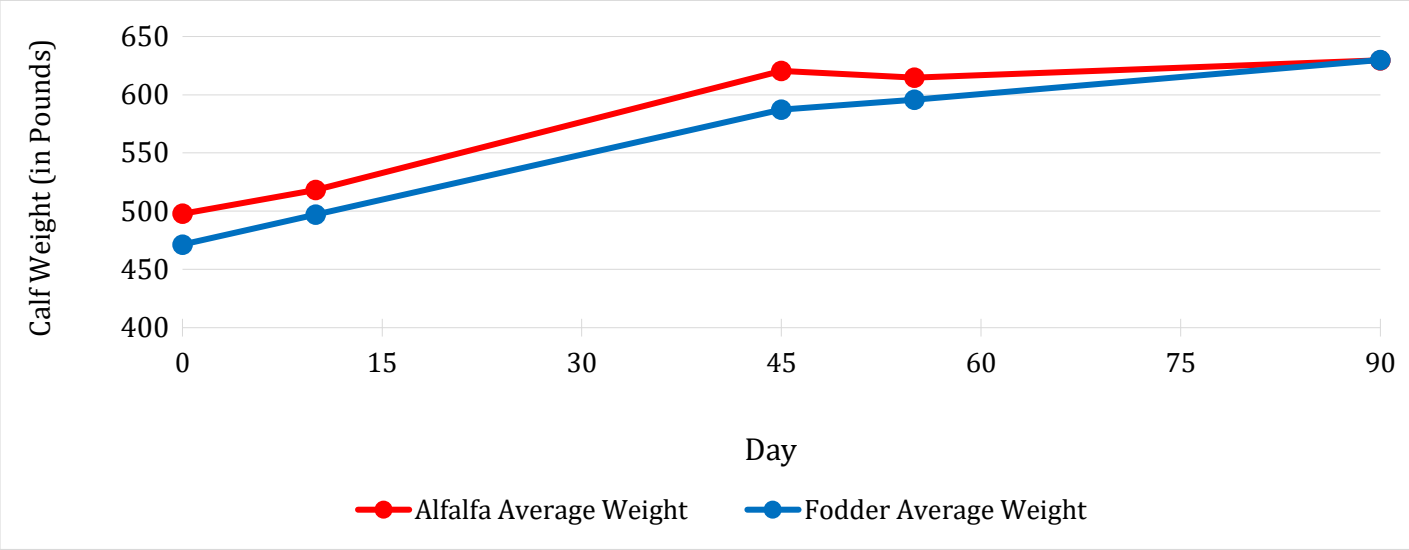

Figure 2: The Average Weights of Alfalfa-Fed Calves vs. Those Fed Fodder-Alfalfa Mix over 90 Days (Renaissance Ag 2023)[3]

Renaissance Ag is still deciding where their technology would be the most beneficial. The milk was tested to see if there was any difference in milk quality. If milk produced with the mixed feed had superior or similar qualities to milk produced with alfalfa-only feed, Renaissance Ag will also consider marketing their technology to dairies. The results of this study are displayed in Figure 3.

Figure 3 compares the resulting nutritional composition as a percentage of milk from cows fed the alfalfa ration (blue) and the fodder-alfalfa mixed ration (orange). Lactose, protein, and fat levels were similar across feeds for the duration of the study. The effect of feed composition was not found to be statistically significant for any of the milk nutrient levels over the duration of the study. This takeaway from the Utah State University study is corroborated by a second study Renaissance Ag completed with researchers at Cornell University. That study compared a control ration to one that

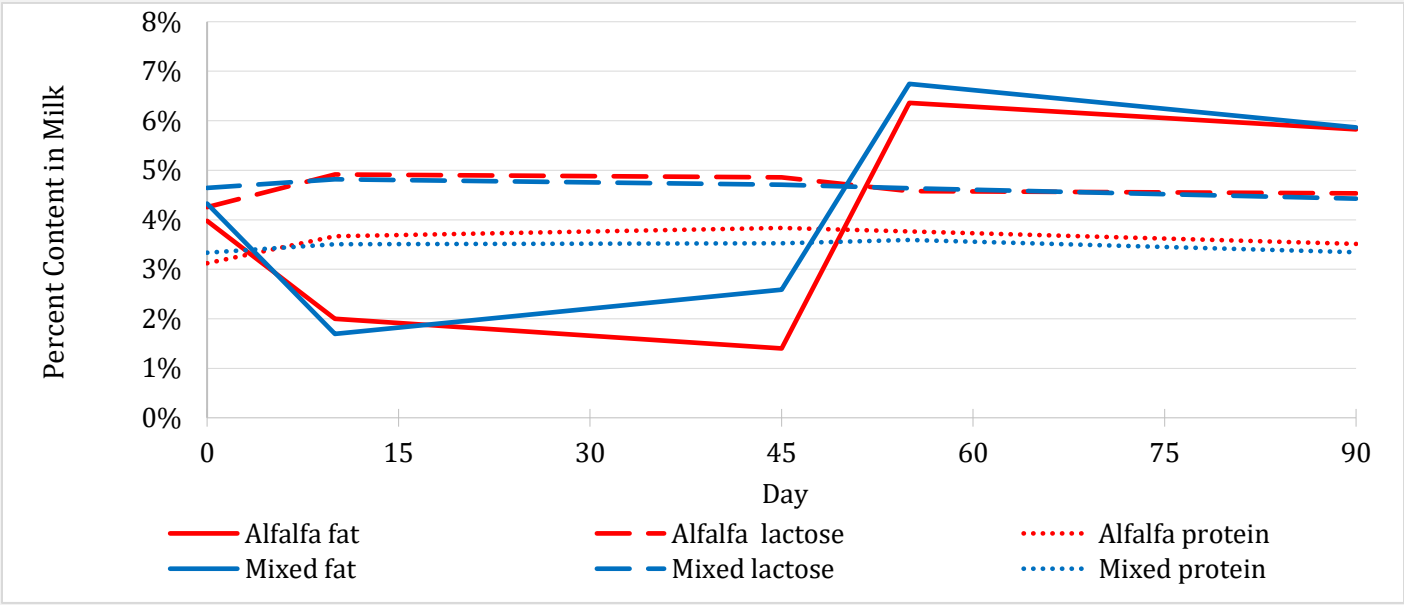

Figure 3: Measured Fat, Lactose, and Protein Percentages in Milk for Cows Fed Alfalfa vs. Fodder-Alfalfa Mix over 90 Days (Renaissance Ag 2023)[4]

included 10 percent wheat fodder and another that compared 10 percent barley fodder. Milk attributes were the same between both fodders and the control group. The barley fodder ration had a 7-percent higher feed efficiency compared to the control diet.

2.2 Economic Comparison of Different Feeds

While these feed sources may produce similar outcomes in terms of calf weight gain or milk composition, they may have different costs associated with them. Table 1 shows a budget for the costs required to produce fodder from a standard-size PastureBox and the associated per ton cost of producing fodder from the box.

Table 1: Estimated Cost of Producing Fodder from the PastureBox

Item	Parameter	Units	Source
Daily output	1.5	Tons of fodder per day	(Renaissance Ag 2023)
Monthly output	45	Tons of fodder per month	(Renaissance Ag 2023)
Monthly water cost	$84.38	Total cost per month	(Logan Municipal Council
Monthly electricity cost	$33.60	Total cost per month	(Electricity Local 2023)
Monthly seed cost	$3,109.09	Total cost per month	(Renaissance Ag 2023)
Monthly rental cost	$2,500.00	Total cost per month	(Renaissance Ag 2023)
Total monthly cost	$5,727.07	Total cost per month	(Author Calculations)
Cost per ton of fodder produced	$127.27	Cost per ton	(Author Calculations)

Costs for the table were estimated using numbers provided by Renaissance Ag. Each PastureBox is supposed to produce 1.5 tons of fodder daily. Each pound of feed produced requires 0.625 gallons of water at an assumed price of $0.0015/gallon. The system requires an average of 14 kWh of electricity per day with an assumed electricity price of $0.08/kWh. The system requires 545.45 pounds of new fodder seed each day, which was assumed to sell at a price of $0.19/pound. Finally the cost of renting a PastureBox was assumed to be $2,500/month.

Researchers then combined results from the calf weight gain study and the PastureBox budget to calculate the average cost of weight gain across both diets. Average weight gain for each group was divided by total feed fed to each cow-calf pair over 90 days. Each pair in the previous study was allowed to consume as much feed as they wanted. Cow-calf pairs on the alfalfa ration consumed an average of 22.7 pounds of alfalfa daily. Cow-calf pairs on the mixed ration consumed an average of 15 pounds of alfalfa and 15 pounds of fodder daily. More pounds of feed were consumed in the mixed ration due to fodder having a higher water content per pound than alfalfa does. Table 2 displays the results and costs associated with the 90-day study.

The total feed consumed for a cow-calf pair over the duration of the study was multiplied by the price of the feed to calculate the total cost of feed. The fodder production cost was recovered from Table 1 ($127.27/ton), and the alfalfa price was assumed to be the Utah alfalfa price in 2023 ($303/ton; U.S. Department of Agriculture, National Agricultural Statistics Service 2023). Total feed cost for each ration

[3] The mean feed treatment effect on cattle weight was not statistically significant, at a 5-percent level for any weigh day.

[4] The mean effect of feed treatment on milk fat, lactose, and protein percentages was not found to be statistically significant at the 5-percent level for any measurement day of the study with the exception of day 45 for lactose and protein.

Table 2: Feed Cost per Pound Gained Over 90 Days for Alfalfa-Fed Calves vs. Mix-Fed Calves

	Alfalfa ration	Mixed ration	Units
Cow-calf daily alfalfa consumption	22.7	17.5	pounds
Cow-calf 90-day alfalfa consumption	2,043	1,575	pounds
Cow-calf daily fodder consumption	0	17.5	pounds
Cow-calf 90-day fodder consumption	0	1,575	pounds
Total cost of feed over 90 days	$309.51	$338.84	total cost
Average calf weight gain	132	159	pounds
Cost per pound gained	$2.34	$2.13	$ per pound

Note: The feed rations in this experiment represent a realistic scenario but are by no means a one-size-fits-all strategy. Feed requirements will be affected by cattle breed, age, climate, and final market. Factors such as caloric needs, digestibility, and feed:grain ratios will vary across application. The implications of changing feed requirements are explored in the attached corresponding budget.

was divided by the average calf weight gain for each ration to recover the cost for each pound gained. Based upon these assumptions, the alfalfa fodder mix was estimated to be a cheaper alternative to alfalfa feed by $0.21 per pound gained. If the results for feed intake and weight gain from the nutrition study hold across larger samples and in years/regions where alfalfa prices are high, then the PastureBox would pass a cost-benefit analysis for farmers.

Researchers also recovered the break-even alfalfa price for the PastureBox under several assumptions. Under expected baseline assumptions (experiment results from Tables 1 and 2), the break-even alfalfa price for a producer adopting a PastureBox is $226/ton. Under a worst-case scenario assumption, where calf weight gain is equal across feeds but still requires 3.365 tons of fodder to replace 1 ton of alfalfa (feed substitution remains the same as Tables 1 and 2, but there is no difference in calf weight gain) the break-even alfalfa price becomes $428/ton. As a comparison, alfalfa prices in Utah were $303/ton in 2023 and averaged $228/ton between 2014 and 2023. Based upon these considerations, PastureBox is expected to be an economically attractive feed source for markets in which traditional feed cost is relatively high.

3 Decisions Under Consideration

Renaissance Ag will base their marketing strategy on Brady's recommendation. Brady believes there are three key questions to resolve to come up with the best marketing strategy. They include: what industry should this technology be targeted toward, what region should this technology be marketed toward, and what payment structure should Renaissance Ag adopt in selling this technology?

3.1 Target Industry

Fodder produced from the PastureBox could be used as a partial replacement feed in many different livestock industries. While it has been most rigorously tested for its substitutability for alfalfa, there are preliminary results suggesting it could also have some substitutability with dried grains. While dairy, beef, hogs, goats, or sheep could all be potential options, Brady thinks that either the dairy or beef industry would be the best fit due to the existing nutritional research being applied to dairy cows and beef cattle. The PastureBox could have uses for cow-calf operations, grazing operations, dairy operations, or feedlots. While every single farm/ranch is unique, each of these industries would have certain benefits and drawbacks associated with adopting the PastureBox.

3.1.1 Cow-Calf Operations

Cow-calf operations represent the first link in the beef supply chain. These cow-calf operations specialize in birthing calves and giving them a combination of cow's milk and feed for 6–9 months after

which they are weaned and moved or sold to grazing or finishing operations. These weaned calves are typically sold at weights between 400 to 700 pounds. Prescribed feed rations for the cows and calves in these cow-calf operations vary across farms, with some operations including inputs such as corn silage, sunflower meal, or distillers grains within a given ration (Tobin and Hoppe 2023). Having said that, most rations for cow-calf operations rely heavily on some mix of pasture forage, hay, straw, and/or stover. Cow-calf operations are further broken down into drylot and pasture/grazing enterprises. Drylot operations feed cow-calf pairs on a feedlot for most or all of the year (Tobin and Hoppe 2023). Pasture and grazing operations typically graze cow-calf pairs during the grazing season and move them to a drylot when forage is no longer available due to snow or drought (Myerscough et al. 2022). The important thing to remember for either scenario is that the cost of fodder is driven by the fixed cost of the PastureBox, and running a box for only half of the year could raise the average total cost of fodder considerably. For a drylot system, use of the PastureBox would be straightforward. Each day, fodder is produced and added to ingredients within the ration. It would be used the same way for the pasture/grazing system whenever the cows and calves are brought back to the feedlot. It could also be used during the grazing season to augment forage and allow grazing to occur over a smaller area; however, transporting each day to the grazing area would add cost to production and would be unrealistic for distant fields.

3.1.2 Grazing Operations

Once calves are weaned, they are sent to either grazing operations or feedlot operations. Grazing can be further segmented into practices in which the weaned cattle are kept with their mothers for a few additional months to graze (referred to as a cow-calf-yearling operation) or separated and sent to graze individually (stocking operations). In either grazing scenario, cattle are put on a range or pasture where they graze and add weight until they are sold to a feedlot for finishing once they reach somewhere around 800–900 pounds (Forero et al. 2017). While grazing operations focus on adding weight through forage, it is not uncommon to add a small amount of feed supplement such as alfalfa into production to either help weight gain, round out nutrition, feed cattle as they are received or shipped, or make up for forage shortfalls.

Due to alfalfa playing a more minor role in grazing operations, the only ranchers likely to be interested in a PastureBox would be those with large herds involved in unique situations. Fodder could be interesting for ranchers dealing with nutritional deficiencies in local forage or responding to local drought conditions. Forage availability, particularly in drier climates, is highly correlated with precipitation. Low precipitation decreases forage growth in the following months. If forage availability falls enough, ranchers can be forced to buy supplemental feed to make up for the shortfall. This problem gets exacerbated by drought conditions reducing water availability for water-intensive crops like alfalfa, spiking supplemental feed cost when ranchers need it the most. Having access to a PastureBox could substantially reduce this risk. With the recent droughts experienced by the western half of the United States, there could be interest from ranchers.

3.1.3 Finishing Operations

Finishing operations purchase weaned, yearling, or feeder cattle. These cattle are sent to a feedlot where they are fed a grain-heavy ration consisting of a mixture of corn silage, alfalfa, minerals, grains, and salts (Lee et al. 2023). Once these cattle reach a weight of 1,100–1,400 pounds, they are sent to slaughter plants. The constant feed demand associated with a feedlot would lend itself well to fodder.

The downside to targeting this industry is the lack of research testing the impact of partially substituting fodder for alfalfa in feedlot cattle. Without experiment data showing the impact of fodder on feedlot weight gain, feedlot owners may hesitate to adopt a technology that has been untested for their specific industry.

3.1.4 Dairy Operations

Dairies have different feeding options for cows. Feed for dairies can follow a total mixed ration, grazing, or any combination of the two (Haan 2023). Since dairies produce milk for human consumption, the nutrition of the cow's rations is generally more strict than rations fed to cows in cow-calf operations. Operations that have a constant demand for feed, could be particularly attractive to sell to as they would allow the PastureBox to run constantly and spread out fixed cost. Additionally, Renaissance Ag has the most experimental data for the impact of feed on milk attributes. Both the Utah State University and Cornell University studies found that milk nutritional content remains similar across feeds. On the other hand, dairies are generally more rigid with their feed choices than other sectors; thus, they may require more convincing to try something new.

3.2 Target Region

Land scarcity, water scarcity, local policy, transport cost, and alfalfa price are all likely to be important factors when considering the adoption of the PastureBox. However, the individual importance of these factors is unclear. Thus, it is necessary to identify cattle-producing or dairy-producing regions where these factors are present and then compare them holistically. In the following section, Brady considers the merits of two domestic and one international region with marketing potential for the PastureBox.

3.2.1 Utah

Utah is the second driest state in the United States (Burgueño Salas 2023). Aside from a few northern counties, the state is mostly dry and rocky. These climactic and land attributes make crop production difficult but also mean that a lot of land has remained in public hands and is available for grazing. The Bureau of Land Management in Utah manages 22 million acres of grazing land (U.S. Department of the Interior, Bureau of Land Management 2017). These attributes have pushed Utah's agricultural economy toward cattle and dairy production. Utah's largest industries by share of total agricultural commodity revenue are cattle and calves (25.1 percent), dairy products (20.5 percent), and hay (14.4 percent; U.S. Department of Agriculture, Economic Research Service 2023a). The total value of Utah's agricultural sector production in 2021 was $2.25 billion (Economic Research Service, 2023a).

This rangeland lets cows and cattle graze at a low cost. The key to success is precipitation. The recent decline in forage availability caused by drought has been a cause of concern. In years of poor forage availability, ranchers have to supplement their grazing operations by purchasing feed. Increases in demand for alfalfa increase local prices and squeeze grazing margins. This increase in alfalfa prices also gets passed on to cow-calf, feedlot, and dairy operations. All of these producers are forced to either pay a higher price for feed or sell their herd.

Utah and other western states are experiencing the region's worst ongoing drought in 1,200 years (O'Donoghue 2022). Years of drought have created friction between agricultural producers and a growing urban population. In Utah, about 75 percent of the water supply is used by agriculture. While this use was not problematic under historical precipitation levels, regional precipitation over the past two decades has declined. This has caused water levels in lakes and dams around the region to fall considerably. This is particularly problematic for the Great Salt Lake. Mining companies extract over $1 billion worth of minerals from the lake each year (Larsen 2022a). There are also concerns about arsenic beneath the lake that could be released into dust if the lake continues to dry out (Turner 2023). This dust could cause health problems for residents of Salt Lake City and the surrounding metro area. State policy makers are currently grappling with how to prevent the Great Salt Lake from completely drying out.

Water is not the only concern in Utah agriculture. Since 1997, Utah has lost 1.2 million acres of agricultural land to urban growth (Larsen 2022b). Reduction in arable land has hampered crop production inside the state. Producers who are unable to successfully feed their livestock on forage must either grow or buy feed. With less feed being grown in the state, they are forced to buy from out of state. This requires additional shipping costs, which raises final feed prices.

In addition to these environmental factors, Utah would be the easiest region to market the PastureBox logistically. Renaissance Ag is located in Vineyard, Utah, so selling locally would help minimize transportation costs. Renaissance Ag also plans on providing guaranteed maintenance and upkeep to their customers, which would be easiest to do if their customers were close to the main office.

3.2.2 California

California is the second domestic market with great potential for the PastureBox. Agricultural commodities produced in California were valued at $51.3 billion in 2021 (U.S. Department of Agriculture, Economic Research Service 2023b). Its year-round warm climate and rich soil are ideal for many different crops and livestock. California is the leading state in the dairy industry and accounts for 18.1 percent of all dairy revenue in the United States. Dairy is also the largest agricultural commodity produced within California (14.8 percent of all agricultural commodity revenue; U.S. Department of Agriculture, Economic Research Service 2023b). As of 2021, California had 1.72 million head of dairy cows (U.S. Department of Agriculture, National Agricultural Statistics Service 2021). California is also a major cattle producer. Cattle and calves accounted for $3.1 billion in revenue in 2021 (U.S. Department of Agriculture, Economic Research Service 2023b).

This seemingly ideal environment for agriculture is not without challenges. Water is a significant limitation of California agriculture. The state is also prone to multi-year droughts (Mall and Herman 2019). Hot California summers can exacerbate shortfalls in precipitation. This combination of heat and dryness reduces forage availability. High evaporation and lower water levels are testing the limits of California producers.

Sustained drought in California has also contributed to friction between agricultural producers and urban centers. Agricultural producers in California have been feeling the squeeze on water access from multiple fronts. The Sustainable Groundwater Management Act passed in 2014 requires that local agencies develop and implement groundwater sustainability plans that limit the amount of groundwater being pumped. Additionally, producers in many watersheds such as the Sacramento and San Joaquin have had their water rights curtailed by the state the past few years (James and Greene 2022). This decline in water availability has forced farmers across California to leave increasing amounts of land fallow. Between 2019 and 2022, an estimated 752,000 acres were pulled out of irrigation (James 2022). Droughts have a disproportionate effect on lower value crops such as alfalfa. When water becomes scarce, farmers re-route it to fruit and nut orchards, which provide higher returns per gallon of water and are more costly to replace if they dry out. This decimates local feed availability.

Cattle and dairy operations within California must also contend with a shrinking amount of agricultural land. After World War II, people moved to California and bought agricultural land to build homes on. This depletion of land pushed the government to establish the Williamson Act (California Department of Conservation 2022). This act aimed to make it harder for landowners to sell their land out from under farmers. It proposed that a rental agreement between a farmer and landowner must be at least 10 years in length. This act has been effective, with nearly one-half of the agricultural land enrolled in the program (California Department of Conservation 2022). The limited land and favorable growing conditions contribute to California's agricultural land having the highest value in the country. The average agricultural land value in California in 2022 was $15,410 per acre compared to the national average of $5,050 per acre (U.S. Department of Agriculture, National Agricultural Statistics Service 2022). With a high return on fruits, vegetables, nuts, and other crops, it is hard for the local farmers to justify hay production. This forces many dairies to pay a premium to truck hay in from areas outside the state.

The aforementioned factors highlight the potential benefits of selling the PastureBox in an area with high feed demand, high feed prices, scarce water, and scarce land. On the other hand, prioritizing sales to Californian producers would require a regional office in California where Renaissance Ag employees could locate to help promote sales and provide any future maintenance to the boxes.

Additionally, selling in the California market would require an increase in transportation costs to get the boxes from Utah to California.

3.2.3 Italy

"Wealthy, and with 100 million more people than the United States, the European Union (EU) has a prodigious demand for meat and other livestock products" (Hasha 2002, p. 2). The demand for meat is mainly met by its supply in the European Union. However much of the feed required to support those livestock is imported. This importation covers one-fourth of the livestock feed demand (Hasha 2002). Within the European Union, Italy is a key producer in the beef and dairy industries. They represent 11.3 percent of beef production (the third largest producer behind France and Germany) and 8.9 percent of milk production (the fourth largest producer behind Germany, France, and the Netherlands; Eurostat 2022). Italy is broken down into two agricultural regions: the northern mountainous region where livestock, dairy, and grains are the primary agricultural outputs, and the southern region, which specializes in fruits, vegetables, wine grapes, and olives.

What makes Italy an especially interesting region as a target market compared to other E.U. countries is that both the climate and land values within Italy lend themselves better to hydroponic technology adoption than would be the case with some of Italy's neighbors. The average value of agricultural land in Italy in 2020 was valued at just over $15,000/acre. The average value of agricultural land in France in the same year was just under $2,700/acre. These high land values can limit the availability of cheap grazing access and/or make it difficult to justify the production of feeds such as alfalfa. Reducing dependency on expensive feed imports could be advantageous in this region. Relatively high agricultural land prices in Italy can be attributed to declines in agricultural land over past decades. Between 1960 and 2020, agricultural land in Italy decreased from 206,830 square kilometers to 129,990 square kilometers (World Bank 2023).

Italy has also been experiencing its own problems with drought. Last year, the northern region saw its worst drought in 70 years. This reduction in precipitation was reported to have done over $1.1 billion in damage to Italy's entire agricultural economy that year (Amante 2022). Even worse, the drought has continued into this year with the Alps accumulating less snowpack than they typically do. This snowpack is crucial for feeding Italy's rivers, which provide both irrigation and electricity generation. Policy makers are concerned that later this summer, Italy may not have sufficient flow in the Po River to run its electric dams (D'Emilio 2023). It is unknown what policies will be implemented to respond to this drought, but it appears likely that agricultural producers will have less water access than usual to prevent grid blackouts.

There are several key benefits to marketing the PastureBox in Italy. High land values limit hay and pasture availability. Alfalfa and other types of hay are relatively bulky and low value, which makes importing expensive. Being able to produce a large amount of feed on a small geographic footprint could be a game changer for local producers. Additionally, the PastureBox seems consistent with the overall "Common Agricultural Policy" of the European Union, which emphasizes sustainability, environmental protection, and risk management. On the other hand, Italy is a long way away from Vineyard, Utah. Shipping costs would be considerable. Opening and operating an international branch would also be expensive and difficult. Specifically, it would require learning to navigate Italy's national and local laws, working across language and cultural barriers, coordinating across different time zones, and paying for the costs associated with opening and maintaining a second office. Finally, the beef and dairy industries in Italy are less consolidated and industrialized than those in the United States, meaning that careful attention would have to be paid to finding producers who are large enough to justify the purchase of a PastureBox.

3.2.4 Historic Feed Prices

One final key consideration is regional alfalfa prices. If the PastureBox cannot produce fodder at a competitive price relative to alfalfa, then producers will not be interested in the technology. Figure 4

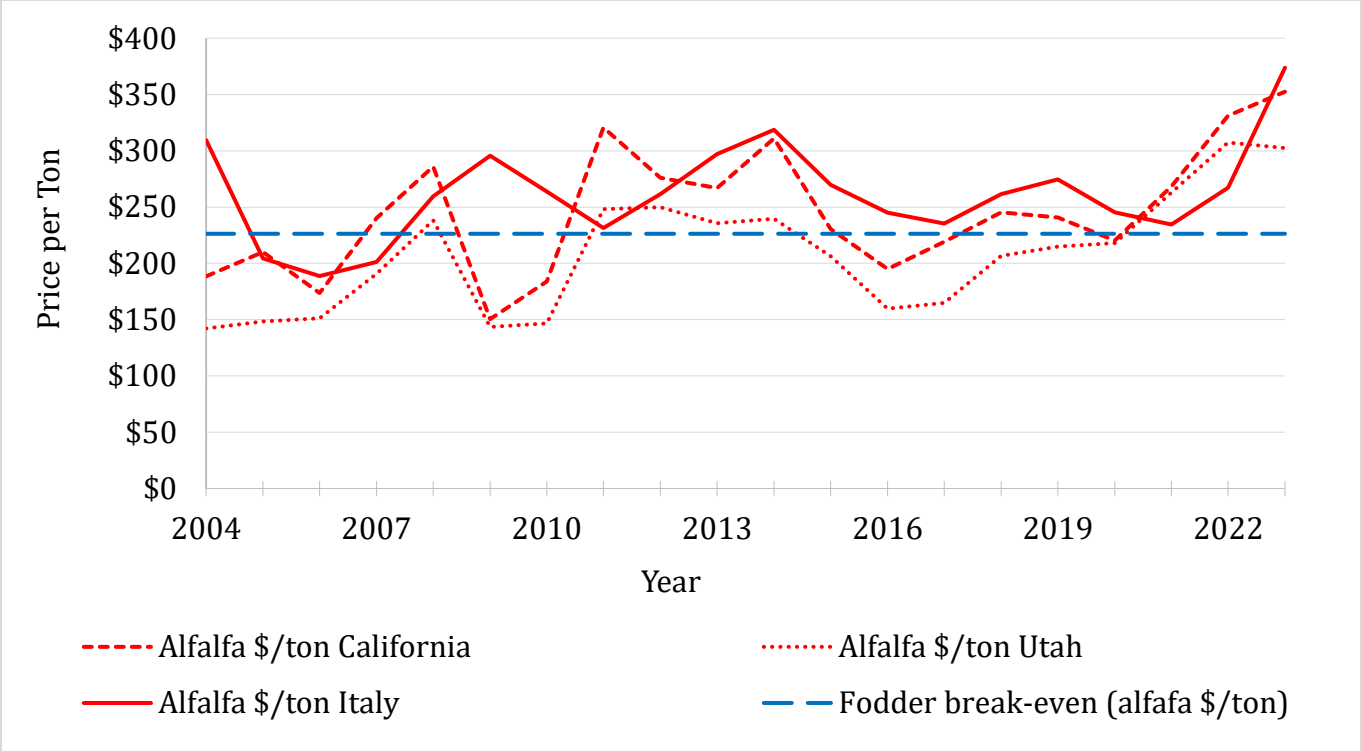

Figure 4: Historical Real Prices of Alfalfa (Inflation Adjusted for All Years with a 2023 Base

highlights the historical prices of alfalfa in Utah, California, and Italy. These are compared with the price of alfalfa that makes the cost per pound of calf weight gain equal across the previously discussed rations (under baseline assumptions). The figure shows that under baseline assumptions, fodder is more expensive than hay most years in Utah and cheaper for most years in Italy. California falls in the middle with alfalfa prices being lower than the fodder alternative about half the time.

There are several important caveats to consider. First, alfalfa prices have increased in real terms considerably over the past 20 years. The real rate of price growth has averaged almost 3 percent per year on average across these three markets. If alfalfa prices continue to grow at that pace, fodder could be even more competitive in the future. On the other hand, while Renaissance Ag would be an early entrant into this market, they do not have a monopoly on hydroponic technologies. If they are successful, there will likely be additional entrants to the market over time, which would introduce competition and put a cap on prices. As land and water in these regions continue to become increasingly scarce, there is good reason to assume alfalfa prices will continue to climb. Second, hydroponically produced fodder also has the ability to be used as a risk management tool. Farmers do not need to worry about purchase price or production volatility with a PastureBox, making returns more predictable over time. Fodder also does not need to be stored since it is produced every day. This should save labor hours usually required to put hay in and take hay out of storage.

While alfalfa is a key feed crop to compare fodder against, there are other popular feedstuffs to consider as well. While the experimental study used an alfalfa ration, there are many operations that use cheaper feed than alfalfa, such as forage or grass hay. That would lower the cost of a conventional ration. The average national price per ton of all types of non-alfalfa hay for 2023 was $90/ton below alfalfa-only hay prices (U.S. Department of Agriculture, National Agricultural Statistics 2023). Additionally, historical alfalfa price is based upon average alfalfa prices from a regional level (Milan Chamber of Commerce 2023; U.S. Department of Agriculture, National Agricultural Statistics 2023). While average or even high-quality alfalfa is common for a dairy, a cow-calf operation may purchase lower quality alfalfa or non-alfalfa hay. Either of these would trade at a discount to the average alfalfa price and make fodder

adoption more difficult.

3.3 Transaction Structure Between Producers and Renaissance Ag

Any firm within the agricultural supply chain that sells big ticket items is familiar with the premise that how one sells something can be as important as the price tag. Farmers often do not buy tractors, combines, or irrigation equipment in cash because of the nature of agricultural production. Costs are incurred on the front end, and revenue does not happen until later. This incentivizes suppliers to work with banks to provide financing to their customers or provide other options to postpone payments. The possibilities for transaction structure are endless, but any potential transaction will have to satisfy several key considerations.

First, it costs Renaissance Ag more than $100,000 to manufacture each PastureBox, so they need to charge enough to be profitable. Second, most farmers are going to prefer a structured payment plan over a large cash investment in a new technology. Third, while Renaissance Ag does have a few million dollars' worth of liquidity to help their potential customers get started, they need to start producing a revenue flow in a relatively short period of time to continue growing.

3.3.1 Transfer Ownership to Farmer Through Sale

Renaissance Ag could try to sell their PastureBox as a one-time purchase. They would either sell the box to large operations for cash or work with mid- and small-size operations to obtain funding from banks. If this strategy works, it would provide Renaissance Ag the quickest path to positive cash flow and grow their liquidity. The downside to this strategy is that it would be the hardest one to convince customers on. The technology is new, so producers may not be willing to put down a six-figure investment on a technology they are unfamiliar with. Additionally, banks often frown on making loans for newer technologies. Even if a bank were willing to make a loan, high interest rates will raise the final cost of a PastureBox. A $200,000 loan with a 7-percent interest rate paid back over 10 years means the farmer would actually pay almost $285,000 over the life of the loan.

3.3.2 Rental or Leasing Agreement

Renaissance Ag could instead rent out or lease their technology to interested parties. Renaissance Ag would charge either a monthly or yearly fee to their customer in order to rent a PastureBox and produce feed in it. The producer would pay for it as long as they use it, and ownership would revert back to Renaissance Ag if the farmer ever wanted to terminate their rental agreement. The advantage of this strategy is that it neutralizes the two greatest hurdles to farmer technology adoption: the perceived risk of a new product and liquidity constraints. If producers do not have to worry about paying for this technology all at once and only risk a rental fee testing this new product, they will be much more likely to try it out. However, Renaissance Ag would be forced to cover a higher share of upfront costs, capital that could take years to recoup. Additionally, it puts them in the unenviable position of having to police subscription payments. They also would have to deal with the possibilities of higher transportation costs if farmers adopt PastureBoxes when feed prices are high and send them back to headquarters when prices are low. Finally, there could be the potential for moral hazard in this arrangement if the renters do not maintain the PastureBox and return it with damage to Renaissance Ag, claiming it was just regular wear and tear.

3.3.3 Installment Plans

Installment payment plans would strike a balance between the first and second options. The farmer would acquire the technology and pay it back over a predetermined number of years in installments. Farmers would be exposed to a larger upfront cost than a rental but not as large as buying the machinery all at once. Renaissance Ag would still provide a fair amount of liquidity upfront but could dictate how much by the period of time the repayment plan covered.

3.3.4 Lease to Buy

In a lease-to-buy plan, the farmer would be given the technology and make monthly payments in the same way that they would under the rental agreement. However, they would also pay an upfront fee that would allow their rental payments to go toward purchasing the equipment outright at an agreed upon date in the future. It would provide the farmer with a fair amount of liquidity while keeping risk exposure low and reducing the level of potential moral hazard in maintaining the technology. It would however still expose the farmer to more upfront cost and risk than renting would.

3.3.5 Combinations of Plans or Multiple Plans

Payment plans are infinitely modifiable, and the above plans act as a jumping-off point rather than a comprehensive list. It would be possible to offer each of them separately to allow potential consumers to self-select into what works best for them or to make some type of a hybrid payment plan (e.g., 20 percent down payment with yearly installments after that). The important thing is that the plan is attractive to the farmer and that Renaissance Ag can be profitable with it.

4 Reflection

Developing and testing a new technology is only half the battle. Forming a successful marketing strategy to support this product will present its own challenges. Deciding who to sell to, where to sell, and how to sell are all difficult questions in well-established markets. They are considerably harder in nascent industries where information is incomplete and the situation in terms of prices, policy, and competition evolves daily. Developing a solid marketing strategy will allow Renaissance Ag to build upon their previous success and continue growing. Answering these questions will not be easy, but Brady feels that he is up to the task. After all, if he wanted things easy, he would not have gotten involved in agriculture in the first place.

5 Discussion Questions

1. List the two largest advantages and two largest drawbacks associated with each type of market the PastureBox could be sold in (cow-calf, grazing, feedlot dairy).

2. Based upon your answers to question 1, which industry would you market the PastureBox to and why?

3. Conduct a brief PESTEL[5] analysis for each of the considered target regions (Utah, California, and Italy). Think in terms of how the external factors associated with operating a PastureBox in these regions would affect its viability for feeding beef cattle or dairy cows.

4. Based upon your answers to question 3, explain which of the three regions you feel would be the best to market to and why?

[5] For background information and the definition on PESTEL analysis see, https://blog.oxfordcollegeofmarketing.com/2016/06/30/pestel-analysis/

5. Your answer to question 4 depended upon a narrowly defined set of regions. Utah, California, and Italy are hardly the only regions that are interesting within the entire world. For instance, Saudi Arabia is more water-constrained than any listed region, and Bangladesh is more land-constrained. Australia and Mexico both have limited water and relatively high production costs. Come up with one additional region you feel would be economically interesting to sell the PastureBox to and give at least four reasons defending why it would be a good region. Be sure to back up your solution with data and at least two citations.

6. Based upon your answer to question 5, would your answer to question 4 change? Explain why or why not?

7. What two payment factors do you think would be most important to a farmer for being willing to purchase a PastureBox and why?

8. What two payment factors do you think would be most important to Renaissance Ag for being able to successfully sell a PastureBox and why?

9. Based upon your answer to questions 5 and 6, develop a payment plan that you feel would be successful in incentivizing farmers to adopt a PastureBox while keeping Renaissance Ag profitable and solvent. Be specific on what the details of this plan would be (payment levels, timing, etc.).

10. As mentioned, depending upon the payment plan, a PastureBox can be a large upfront cost for a farmer or rancher to incur. This money would not be able to be invested into other parts of the operation. What would the opportunity cost be for a farmer or rancher adopting the PastureBox be, and how would that cost change under different financing options?

11. If Renaissance Ag can successfully roll out their technology in a profitable market, what can they do to maintain market share over time as additional hydroponic feed companies attempt to enter the same market?

12. How would changes in the interest rate effect either the farmer's decision to adopt the PastureBox or Renaissance Ag's marketing strategy to the farmer?

About the Authors: Chanden Westover is a Masters Student at Utah State University. Tanner McCarty is an Assistant Professor at Utah State University (Corresponding Author Email: tanner.mccarty@usu.edu)

References

Amante, A. 2022. "Drought Threatens Northern Italy's Crops, Lobby Warns." Reuters, June 17. Retrieved from https://www.reuters.com/business/environment/drought-threatens-northern-italys-crops-lobby-warns-2022-06-17/.

Burgueño Salas, E. 2023. "Annual Precipitation in the United States in 2022, by State." Statista, May 16. Retrieved from https://www.statista.com/statistics/1101518/annual-precipitation-by-us-state/.

California Department of Conservation. 2022. "Williamson Act Program Overview." Retrieved from https://www.conservation.ca.gov/dlrp/wa/Pages/wa_overview.aspx.

D'Emilio, F. 2023. "Italy, France Confront 2nd year of Western Europe Drought." AP, March 1. Retrieved from https://apnews.com/article/drought-europe-italy-france-agriculture- 1e789a5b782ee951a17ba37d7f189900.

Electricity Local. 2023. "Electricity Rates in Utah." Retrieved from https://www.electricitylocal.com/states/utah/#ref.

Eurostat. 2022. "Agricultural Production—Livestock and Meat." Eurostat, September. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=427096#Meat_production.

Forero, L., Stackhouse, J., Stewart, D., & Sumner, D. (2017). *Sample Costs for Beef Cattle*. Retrieved January, 2024 from https://coststudyfiles.ucdavis.edu/uploads/cs_public/28/34/2834f4a4-c487-4359-bea0-4e891a8b6639/2017beefyearlingstockerssacvalfinaldraft_71917.pdf

Haan, M. 2023. "8 Things You Need to Know Before Starting Your Own Dairy Farm." PennState Extension. Retrieved from https://extension.psu.edu/8-things-you-need-to-know-before-starting-your-own-dairy-farm.

Hasha, G. 2002. *Livestock Feeding and Feed Imports in the European Union—A Decade of Change*. Washington DC: U.S. Department of Agriculture, Electronic Outlook Report from the Economic Research Service, FDS-0602-01, July. Retrieved from https://www.ers.usda.gov/publications/pub-details/?pubid=36458.

James, I. 2022. "'It's a Disaster.' Drought Dramatically Shrinking Californian Farmland, Costing $1.7 Billion." *Los Angeles Times,* November 22. Retrieved from https://www.latimes.com/environment/story/2022-11-23/drought-cost-california-agriculture-1-7-billion-this-year.

James, I., and S. Greene. 2022. "California Deepens Water Cuts to Cope with Drought, Hitting Thousands of Farms." *Los Angeles Times,* July 7. Retrieved from https://www.latimes.com/california/story/2022-07- 07/california-deepens-water-cuts-amid-drought-hitting-farms.

Larsen, L. 2022a. "How the Great Salt Lake Soon Could be Powering Your Phone, Computer and Car." *Salt Lake Tribune,* April 17. Retrieved from https://www.sltrib.com/news/environment/2022/04/17/how-great-salt-lake-soon/.

Larsen, L. 2022b. "Don't Blame Farms for Drying Up the Great Salt Lake. Why They Could Be Key to Its Survival." *Salt Lake Tribune,* May 21. Retrieved from https://www.sltrib.com/news/environment/2022/05/21/dont-blame-farms-drying/#:~:text=Farms%20also%20provide%20a%20slew,help%20recharge%20aquifers%20and%20tributaries.

Lee, H., T. McCarty, A. Thayer, and R. Larsen. 2023. "Milner Ranch: Is the Grass Greener in Processing?" *Applied Economics Teaching Resources* 5(1). Retrieved from https://www.aaea.org/UserFiles/file/AETR_2022_021RManuscriptFinal.pdf.

Logan Municipal Council. 2020. "A Resolution Adopting Revised Water Rates." Retrieved from *https://cms9files.revize.com/loganut/Water%20Rates%20Res%2020-29%20July%202020.pdf*.

Mall, N.K., and J.D. Herman. 2019. "Water Shortage Risks from Perennial Crop Expansion in \California's Central Valley." *Environmental Research Letters* 14(10):104014.

Milan Chamber of Commerce. 2023. "Prices of Livestock Foods: Fodder and By-Products." Teseo. Retrieved from https://teseo.clal.it/en/?section=conf_foraggi.

Myerscough, M.E., L.T. Neira, K.H. Sexton, L.S. Hofer, K.M. Trennepohl, W.T. Meteer, W.P. Chapple, J. McCann, and D.W. Shike. 2022. "Effects of Housing Beef Cow-Calf Pairs on Drylot or Pasture in the Midwest on Production Parameters and Calf Behavior through Feedlot Receiving." *Journal of Animal Science* 100(1):skab357.

O'Donoghue, A. 2022. "How Bad Is the Western Drought? New Study Says Worst in 1,200 Years. You Read That Right." *Deseret News,* February 14. Retrieved from https://www.deseret.com/utah/2022/2/14/22933560/how-bad-western-drought-new-study-says-worst-1200-years-utah-great-salt-lake-lake-powell.

Renaissance Ag. 2023. PastureBox Feed Experiment [unpublished experiment data].

Renaissance Ag. 2024. The Future of Livestock Feed is Here, January 23. Retrieved from https://renaissanceag.com/

Tobin, C., and K. Hoppe. 2023. "Drylot Beef Cow-Calf Production." Fargo: North Dakota State University Extension, AS974. Retrieved from https://www.ndsu.edu/agriculture/extension/publications/drylot-beef-cow-calf-production#:~:text=A%20minimum%20of%200.5%20pound,a%201200%2Dpound%20cow).

Turner, B. 2023. "Utah's Great Salt Lake Is on the Verge of Collapse, and Could Expose Millions to Arsenic Laced Dust." LiveScience, January 10. Retrieved from https://www.livescience.com/utah-great-salt-lake-verge-of- collapse.

U.S. Department of Agriculture, Economic Research Service. 2023a. "State Fact Sheets: Utah." Retrieved from https://data.ers.usda.gov/reports.aspx?StateFIPS=49&StateName=Utah&ID=17854.

U.S. Department of Agriculture, Economic Research Service. 2023b. "State Fact Sheets: California." Retrieved from https://data.ers.usda.gov/reports.aspx?StateFIPS=49&StateName=California&ID=17854.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2021. "Pacific Region Milk Production." Washington DC, July. Retrieved from https://www.nass.usda.gov/Statistics_by_State/California/Publications/Livestock_Releases/Milk_Production/2021/202104MILKPROD.pdf.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2022. *Land Values 2022 Summary* (1949-1867). Washington DC, August. Retrieved from https://www.nass.usda.gov/Publications/Todays_Reports/reports/land0822.pdf.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2023. "Quick Stats." Washington DC. Retrieved from https://quickstats.nass.usda.gov/.

U.S. Department of the Interior, Bureau of Land Management. 2017. "Utah Rangeland Management and Grazing." Retrieved from https://www.blm.gov/programs/natural-resources/rangeland-and- grazing/rangeland health/utah#:~:text=Utah%20Rangeland%20Management%20and%20Grazing,BLM%20land%20in%20the%20State.

World Bank. 2023. "Agricultural Land (sq. km) – European Union." Retrieved from: https://data.worldbank.org/indicator/AG.LND.AGRI.K2?locations=EU.

6(2) DOI: 10.22004/ag.econ.343482