Target Markets for Renaissance Ag's Pasture Box

Chanden C. Westover
Utah State University

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Target Markets for Renaissance Ag’s Pasture Box

By

Chanden C Westover

Master of Science

Department of Applied Economics

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Abstract:

*Renaissance Ag is an agricultural company that is committed to trying and increase productivity. Using the Pasture Box, they believe they can grow a feed source that uses less water and land than conventional agriculture. To better understand the benefits of their product, they have allowed Utah State University to conduct research on beef cattle by feeding their fodder. This paper will look into this research and its implications. It also explores various target markets and the benefits of targeting them.*

Introduction:

Renaissance Ag (RA) is an agribusiness company headquartered in Vineyard, Utah. Their Utah background has familiarized them with the complexities associated with agriculture in an area with constrained amounts of land and water. This motivated them to research and invent their novel technology, the Pasture Box.

The Pasture Box is made from a shipping container that is modified to grow grain fodder on the inside. This fodder is grown from seeds such as wheat, barley, rye, etc. Each day new seed is placed in the box where it is watered. It then takes one week to reach maturity. The result is fodder, a grass-like feed that is a couple of inches high. Fodder can be used as a supplement to hay feed, or it can also be used as a substitute for corn silage. The boxes are designed with seven levels to provide feed for each day of the week.

RA believes Pasture Box can produce feed using less water and land than conventional production. One Pasture Box can grow the equivalent of 15 acres of hay a year with 93% less water used. A box will produce 3,000 pounds of fodder daily. (Renaissance Ag, 2022). There are other companies like them which presents the challenge of determining where they should target
their efforts to be able to compete with the other companies. As a new company with limited resources, creating a successful strategy and generating profit before the money runs out is imperative. Identifying and selling to the market that receives the highest benefit from their technology should translate into reaching profitability quickly. Their main questions surrounding choosing a target market are: which type of market should they choose? Is it dairy farms, hog farms, chicken farms, goat farms, beef farms, or something different altogether? The other side of picking a market is where this market should be located. So many different geographic regions and agricultural sectors could benefit from this technology.

Lit Review:

Fodder has been cultivated for centuries. (Fazaeli1, Golmohammadi, Shoayee, Montajebi, and Mosharraf, 2011). While fodder was consumed by humans in the past today the interest in fodder is driven primarily by its potential as a livestock feed source. With land and water becoming more limited, hydroponically grown fodder has garnered significant interest. A 2011 study to see if there were benefits to feeding fodder took 24 beef calves on a feedlot. These calves were then separated into two groups. One group was fed fodder, and the other was fed conventionally grown feed. Throughout the study, both groups’ rations were tested and monitored. The fodder had more sugars and starches but a slightly lower protein content than the dry grain. Results from the study showed little difference between the two groups’ weight. This conventionally grown fodder's extra labor and cost made it less cost-effective than dry matter grain. (H. Fazaeli1, H. A. Golmohammadi, A. A. Shoayee, N. Montajebi, and Sh. Mosharraf, 2011)

In 2015 several hydroponic greenhouses were being tested to grow fodder worldwide. Many were for university studies; others were privately owned operations. They all had the same purpose of seeing if this was a realistic feed option (Prafulla Kumar Naik, 2015). The downside
of these greenhouses is that they require a designated area, and have a significant operating cost. Transforming dry matter grain seed to fodder changes the overall nutrients of the crop. Grain has a high protein concentration, while fodder has more starches and sugars. The problem is that while fodder can be used as a hay or corn silage substitute, it would not replace the barley or wheat needed in a dairy cow’s diet. With grain seed being needed for both the fodder and the grain feed, farmers would be spending most of their feed cost on these products. The lack of differentiation in feed purchasing would put an over-reliance on grain.

For years, fodder was seen as a feed option with high potential. The use of hydroponics to grow a substitute for hay was highly appealing. The ability to use less land and water created a desire to pursue this possibility further. A formidable setback for fodder being a viable livestock feed is the cost of production. Both conventionally and hydroponically produced fodder require large amounts of seed and labor. Hydroponically grown fodder also has high mold potential. This mold lowers the nutritional value. It is also difficult to get animals to eat moldy feed. These considerations have incentivized farmers from using fodder within production. (Sneath and McIntosh, 2003).

**Background of the Pasture Box:**

RA is not the only company to offer this kind of product. Given the competition they need to be able to prove the benefits of their box. There is little room for error and a need to get their name out there. The best way is to prove that there are benefits to the pasture box. They face an uphill battle with there being only a sample of data on the Pasture Box.

Water has always been an issue for the agricultural world. With a growing population, the problem has increased. Agricultural uses an average of 70 percent of the available freshwater
globally. The strong belief is that this is unsustainable. With the population and income growth, the demand for food will continue to rise. The ties of food to water will continue to put a strain on the global water supply. (Khokhar, 2017). Although the way agriculture has been performed in the past has worked, it has become clear that changes must be made. This is where RA comes into the picture. They plan to use the Pasture Box as a central piece to help farmers provide the necessary feed with less water.

The biggest obstacle they face is entering a market where change has yet to be openly received. Farmers are known to find a way that works for them and then stick with it. Renaissance Ag feels that its product can greatly benefit farmers. As a result, they have put a significant amount of time and resources into evaluating the quality of feed produced with their product. They feel there have been good results and hope to prove the benefits of their technology further.

**Cost of the Pasture Box:**

Pasture Boxes, like other hydroponic fodder systems, will be expensive to manufacture. RA figures that one of the larger units can be built for around $120,000. The original plan was for the boxes to be sold at a price of $250,000. This would be for a fully assembled and functional pasture box. Once the boxes were up and running, RA would offer maintenance for a fee. With farmers already having several expenses requiring their finances, RA felt this was not a realistic plan. With the goal of lowering input costs, it felt counterintuitive to have such a high upfront cost. This led to the creation of the subscription plan.

The subscription is a monthly payment of $2,500. This is under a yearly contract that is renewed at year’s end. RA will also come and get the box if there is a time that the farmers are
not using it, allowing them to pause their subscription if they are not using the box. This $2,500 covers the machine and does not include the seed or other operating costs. At $2,500 a month, it would take RA four years to cover the cost of the individual units. Any revenue from the subscription after this will be considered a profit. The subscription will include the needed maintenance and troubleshooting for the unit at no additional charge. The subscription requires the customer to pay for transportation costs. The customer is also responsible for finding their own seed. It is estimated that 580 pounds of grain per day is needed to run at total capacity.

To help their customers, RA has purchased wheat from a company in Canada and is willing to sell it at a loss. They hope that if they can provide seed at a lower cost, it will further incentivize the use of their product. They figure they can sell it at $0.19 cents a pound which would be $7.91 a bushel and $380 a ton. Using the 580 pounds a day would be an estimated cost of $110.20 per day to run a full size box. Per month it would be around $3,306 for the seed to run the box without the cost of shipping the seed. With adding the cost of the seed and services into the equation RA figures it would take seven and a half years to cover cost instead of four.

**Utah State University Experiment Data:**

In the fall of 2022, Utah State University allowed RA to bring a pasture box to their south farm. This pasture box was used to conduct a controlled study. For this study, twenty beef cows with their calves were split into four groups of five. Once the groups were made, they began a ninety-day trial. In this trial, two groups received alfalfa in their ration. The other two groups’ alfalfa ration was cut in half, and fodder was used to supplement the other half. Over ninety days, they were examined five times. On day zero, day ten, day forty-five, day fifty-five, and day ninety. On each of these days, they observed the cow and the calves weight. In addition they took a sample of the cow’s milk to measure the protein, the fat, and the lactose within it. For each
metric, simple charts were made to compare the alfalfa-fed animals to the fodder-fed ones. There were also regressions run for each statistic to see whether they were significant. The result of these regressions are represented in Table 1.

The main reason for this study was to look for differences in the calves. In cow-calf operations, most of the income comes from selling calves. If Renaissance Ag plans to be relevant in the beef industry, it must be able to add value to it. The best way to do so is by directly affecting calf growth. The Utah State University study is critical to see the difference between the different feed rations. Aside from the nutritional differences, a key element is a financial difference. The best way to calculate this is to see if there is a difference in the cost per pound gained.

In the below graph, the blue line illustrates the average weight of the alfalfa-fed calves over ninety days. The red line represents the fodder-fed calves over ninety days. There is very little difference between the two options. Alfalfa-fed calves show higher weights until day 55, then fodder and alfalfa were even. If we were only to use these graphs, we would have the assumption that there is no meaningful difference in growth to note between the two. To fully understand the data, we will need further statistical analysis.
Figure 1 illustrates the difference in the average weights of fodder-fed calves vs. alfalfa-fed calves over 90 days.

Another significant part of the analysis was the study of beef cow’s milk. This study was conducted for two reasons. First, cow’s milk plays a prominent role in the calf’s growth. Checking the fat, lactose, and protein is the best way to see if there is a difference in milk quality. Further investigation allows us to see if the milk was an altering factor. For beef calves, the milk they get from their mothers early on is critical to their growth. If RA can prove there is a significant difference in the milk that increases calf growth and health, it could be a game changer for their company. If farmers knew that changing their feed slightly could increase calf growth, they would be willing to do it.
Figure 2: Illustrates the difference in the milk fat levels for cows fed alfalfa vs. those that had fodder supplemented into their feed.

As with the weight graph, the blue line shows the alfalfa result, and the red line shows the fodder in the following three charts. The above graph shows the milk fat averages. These averages stayed very close to each other over the ninety days. There was a drop in both products from day ten to forty-five due to the pregnancy cycle of the cows. All the cows that were used in the experiment had been bred previously. There were expected drops in their production due to the energy needed for the new calves. Both had a significant jump from day forty-five until day ninety. Even with a substantial increase, the two feeds stayed close to each other. The overall result from this graph is that there are minor differences in milk fat production.
The lactose for the cows had a very different result. The alfalfa had several changes over the ninety days. There was an increase in the first ten days. This started with a sharp decline around day fifty-five and then a slight decline till day 90. The fodder had a slight increase over the first period, and they kept with a slight decline until day fifty-five, then there was a slight jump up and a steadier decrease. Even with the jumps in the alfalfa fed, the two options are close. Overall, alfalfa is higher, and fodder is more consistent. The difference is minimal however and could have little to no true effect on the calves.
There is very little difference in protein levels for the two feed types. This could be because there is little difference in feed quality between alfalfa and fodder. The alfalfa and fodder could have similar levels of nutrients that contribute to milk protein. This would make the most sense.

With butter fat and lactose having so much variation between the different periods, it would be difficult to deem one better. However, the weight and proteins minimal variations are essential.

For milk production, a high protein level decides whether a producer receives bonuses. Putting weight on beef calves quickly is the primary goal of beef producers. The slight difference in fodder and hay feed in the two products makes it hard to deem one better than the other.

Table 1: Regressions, this table show the different result for each statistic. The subscript (a) shows it is not significant. (b) represents a significant statistic.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment</th>
<th>Day 0</th>
<th>Day 10</th>
<th>Day 45</th>
<th>Day 55</th>
<th>Day 90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Alfalfa</td>
<td>497.8a</td>
<td>518.2a</td>
<td>620.6a</td>
<td>614.6a</td>
<td>629.6a</td>
</tr>
<tr>
<td></td>
<td>Fodder</td>
<td>471.4a</td>
<td>497.2a</td>
<td>587.2a</td>
<td>595.8a</td>
<td>629.9a</td>
</tr>
<tr>
<td>Milk Fat</td>
<td>Alfalfa</td>
<td>3.98a</td>
<td>1.99a</td>
<td>1.4a</td>
<td>6.36a</td>
<td>5.82a</td>
</tr>
<tr>
<td></td>
<td>Fodder</td>
<td>4.33a</td>
<td>1.7a</td>
<td>2.59a</td>
<td>6.75a</td>
<td>5.87a</td>
</tr>
<tr>
<td>Lactose</td>
<td>Alfalfa</td>
<td>4.25a</td>
<td>4.92a</td>
<td>4.86a</td>
<td>4.58a</td>
<td>4.53a</td>
</tr>
<tr>
<td></td>
<td>Fodder</td>
<td>4.65a</td>
<td>4.82a</td>
<td>4.71b</td>
<td>4.64a</td>
<td>4.43a</td>
</tr>
<tr>
<td>Protein</td>
<td>Alfalfa</td>
<td>3.12a</td>
<td>3.67a</td>
<td>3.84a</td>
<td>3.76a</td>
<td>3.51a</td>
</tr>
<tr>
<td></td>
<td>Fodder</td>
<td>3.34a</td>
<td>3.51a</td>
<td>3.53b</td>
<td>3.59a</td>
<td>3.35a</td>
</tr>
</tbody>
</table>

Means within variable rows and a day column followed by different superscripts (a,b). Those with a b are significantly different (P-value<0.05)

**Hay Substitution Study:**

Table 2: This table shows the cost per each pound gained in the fodder fed calves vs the alfalfa fed ones.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Fodder Fed</th>
<th>Alfalfa fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of each pound gained on both Alfalfa and Fodder fed calves</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Number of Calves</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Average starting Weight per Calf</td>
<td>471</td>
<td>498</td>
</tr>
<tr>
<td>Average ending Weight per calf</td>
<td>630</td>
<td>630</td>
</tr>
<tr>
<td>Days on Feed</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>LB’s of Feed per Day per calf</td>
<td>35</td>
<td>22.7</td>
</tr>
<tr>
<td>Total Alfalfa Price</td>
<td>$220.50</td>
<td>$286.02</td>
</tr>
<tr>
<td>Seed Cost</td>
<td>$54.41</td>
<td></td>
</tr>
<tr>
<td>Water Cost</td>
<td>$1.48</td>
<td></td>
</tr>
<tr>
<td>Power Cost</td>
<td>$0.59</td>
<td></td>
</tr>
<tr>
<td>Total Fodder Expense</td>
<td>$65.97</td>
<td></td>
</tr>
<tr>
<td>Pasture box subscription</td>
<td>$42.53</td>
<td></td>
</tr>
<tr>
<td>Total feed cost</td>
<td>$328.99</td>
<td>$286.02</td>
</tr>
<tr>
<td>Average pounds gained per calf</td>
<td>159</td>
<td>132</td>
</tr>
<tr>
<td>Cost of each pound gained</td>
<td>$2.02</td>
<td>$2.17</td>
</tr>
</tbody>
</table>

The next goal was to explore the financial feasibility of the overall project. To do this, the four groups of calves were separated into two groups. The first group was ten fodder-fed calves, and the second was ten alfalfa-fed calves. From there, the average starting weights of both groups were taken. Then the average weight on day 90 was taken for both groups. These weights are put in the average ending weight per calf. The 35 pounds of feed per day for the fodder fed calves was the total pounds per day fed to a single calf and its mother. The mother was included due to the age of these calves. With them receiving a large portion of their nutrients from their mothers. The alfalfa fed calves and cows received 22.7 pounds per day. The difference in poundage comes from dry matter. With alfalfa being over 80% dry matter and the fodder being only 12-15% they translate very differently upon digestion. This dry matter difference makes it so the pounds fed of each feed are very different. As a result we got a very different number of pounds needed by each group.

The next step was setting up the financial cost for the two feed methods. This was to be done for a single calf. The 22.7 pounds needed for the alfalfa-fed calves was taken and multiplied by 90 days. 2043 pounds of alfalfa was needed for a single calf. Because alfalfa is sold by the ton
the 2043 was divided by 2,000, it would take 1.0215 tons for a single calf. This was then multiplied by the average cost of over 20 years by using the monthly price and averaging it to get a cost of $280 a ton (NASS, 2023). It would take $286.02 of alfalfa to feed a single calf over 90 days. Next, the difference between the calves starting and ending weights was calculated. The results were 132 pounds. The $286.02 was then divided by the 132 pounds to give us a cost-per-pound gain of $2.17.

For the fodder-fed calves, there was a 50% ration of fodder with 50% alfalfa. Taking the 35 pounds of feed needed and multiply it by 90 days you would need a total of 3150 pounds of feed. A single calf would then require 1575 pounds of fodder and 1575 pounds of alfalfa over 90 days. Again because hay is purchased by the ton we converted the 1575 pounds to tons by dividing it by 2,000. This gives us a need for 0.7875 tons of alfalfa. This was multiplied by $280 to get a cost of $220.50. The fodder cost was calculated by dividing the total of 1575 lbs by 5.5. This was done using Renaissance Ag’s calculation that a ratio of 1 pound of seed would be 5.5 pounds of fodder. This gives a total of 286.36 lbs. of seed needed. The 286.36 lbs. of seed was multiplied by the $0.19 per pound to find the seed cost of $54.21. The water cost was found by taking RA calculation that it takes 0.625 gallons of water per pound of fodder and multiplying it by the number of pounds needed for a total of 984.375 gallons. This was multiplied by 90 $0.0015 per gallon to get a water cost per calf of $1.48. Power was calculated by taking the 14 hours per day and dividing it by the 3000 pounds of feed a box can grow. Giving us 0.004666 kwh/lb this was then multiplied by the 1575 to get a total of 7.35 kwh needed. Taking the hours needed and multiplying it by the cost per hour of $0.08 gave us a cost of power of $0.59. The numbers for the gallons of water, the cost for water and the kilowatt hours and the cost per hour all came from RA’s personal pricing configuration. The monthly subscription for the Pasture Box was also
added to the cost of fodder. RA figured it that with the monthly of subscription of $2500 your cost for the subscription for each pound gain would be $0.027 per pound. Multiplying this by the pounds gained we would get a cost of $42.53 per calf. With the subscription, alfalfa, and the cost to grow the fodder, the total cost would be $328.99 for the ninety days. The difference in the starting and ending weight for the fodder-fed calves was 159 pounds. The $328.99 is then divided by the 159 pounds to get a cost of $2.02 per pound gained.

Alfalfa had a $2.17 cost per pound gained on the calves. The fodder total cost was $0.15 cheaper at $2.02. With a lower price fodder would gain significant attractiveness. With alfalfa price on a trend that looks like they will continue to rise lower fodder prices could be very attractive. In order to get a clear idea of how these prices compare a sensitivity analysis would need to be ran. In the base scenario, the 20-year average of monthly alfalfa prices was used to get $280. To better understand the cost, the highest and lowest prices in those 20 years were used to see how the cost per pound changed. The break-even price was also found. The results are shown in the table below.

Table 3: This table displays the change in cost per pound gained as alfalfa prices change.

<table>
<thead>
<tr>
<th>Prices</th>
<th>Fodder Fed Cost Per Pound</th>
<th>Alfalfa Fed Cost Per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Year Average Price: $280</td>
<td>$2.02</td>
<td>$2.17</td>
</tr>
<tr>
<td>20 Year Maximum Price: $421</td>
<td>$2.72</td>
<td>$3.26</td>
</tr>
<tr>
<td>20 Year Minimum Price:$170</td>
<td>$1.46</td>
<td>$1.32</td>
</tr>
<tr>
<td>Break-Even Price:$225</td>
<td>$1.74</td>
<td>$1.74</td>
</tr>
</tbody>
</table>

The above table shows that holding all else constant if alfalfa prices were to reach $421 a ton, fodder fed would be $0.54 cheaper than the alfalfa fed. This would make it easy to go with feeding fodder. The contrast would happen if prices hit their low. Hay would be $0.14 cheaper
than fodder making it the clear option to go with. At $225 a ton for alfalfa, a producer would be indifferent to growing either option. These numbers were used because they were historic numbers given by NASS. They also helped illustrate the model in the clearest way. It is important to note that alfalfa, which was closer to the $170 price, was used in the USU study. This would be closer to the typical farmer’s plan with beef cows. Feeding your beef cattle a cheaper and lower quality feed is very common. The important part of beef cows is that they have enough feed to gain weight. This does not have to be as high of a quality. Because of this, the lowest price would be the best representation of feed cost for beef cattle.

Table 4: Sensitivity of cost per pound as grain prices change.

<table>
<thead>
<tr>
<th></th>
<th>Fodder Fed Cost Per Pound</th>
<th>Alfalfa Fed Cost Per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base of $0.19</td>
<td>$2.02</td>
<td>$2.17</td>
</tr>
<tr>
<td>High of $0.24</td>
<td>$2.10</td>
<td>$2.17</td>
</tr>
<tr>
<td>Low of $0.14</td>
<td>$1.92</td>
<td>$2.17</td>
</tr>
</tbody>
</table>

Just as we did look at how changing alfalfa prices changed the price per pound gained, we will do the same with seed prices. If prices were to rise by $0.05, the cost per pound gained there would now be a $0.07 difference. At that price producers would still be more likely to feed the fodder option. If the price were to drop by $0.05, fodder would be $0.25 cheaper. This is a large enough difference that you would save by feeding fodder. With such a large difference farmers would be very likely to feed fodder.

The overall result of this study shows that alfalfa prices would need to be high to really make fodder the clear choice. Even with a high base assumption of $280, alfalfa was cheaper. As was stated earlier, this would not be a common price for the producer to pay for feed. The lower assumptions would give us a clearer representation of the price.
Target Markets:

Utah Beef Producers:

Utah is the third driest State in the United States. Aside from northern counties like Cache and Box Elder, the state is a desert (Curtis, April 2021). Alfalfa, corn, and grains are the most common land crops. Alfalfa supports the state’s primary agricultural product, livestock. Over 70 percent of Utah’s agriculture is in livestock, with 78 percent of the livestock in beef production (Curtis, April 2021). The dry climate of Utah has made it, so there is more range land than crop-producing ground. This range land lets the beef cows graze at a low cost to the producers. The key to success is spring and early summer rains. Receiving this free moisture is a primary factor in a successful cow production year. In 2019 Utah beef cattle sales had 450 million dollars in cash receipts. (Curtis, April 2021).

With rain playing a vital role in beef production success, the recent drought has been a cause of concern. The importance of beef cattle success affects not only the producers but all those who have an interest in the industry. The American Farm Bureau Federation is one such company. In 2022 they conducted a study on the current drought. The purpose was to understand how the current drought-affected crop and livestock production (Munich, 2022). The study was conducted by sending a survey to farmers in the western states. The results show that forage and crop yield rates are down compared to previous years. The lack of snowpack and rain has made forage less productive. With less forage, farmers have to supplement their grazing by purchasing feed. The lack of water has made hay production decrease significantly. This lower feed supply and a shift in the demand for hay has caused a price increase. Livestock producers are forced to pay a higher price or sell their herd. Several farms have been selling part of their herd to buy feed
for the remaining herd. This selling of animals has caused herds sizes in the western states to decrease by 36% (Munich, 2022).

As a land grant University, Utah State University has had a historical interest in Utah beef. An extension paper written during the drought said, “Drought conditions would have to be very serious and long-term for livestock producers in Utah to transition out of livestock production. They are more likely to purchase feed or lease additional pasture and reduce the herd than change livestock type or transition out of livestock production” (Curtis and Ward 2021). This mindset limits the available options to the farmers. The commitment of these producers could be enough to get them through this drought. If these high prices and lack of water continue, one has to wonder when farmers will reach their breaking point. Will the producers be willing to accept the changes that are a result of this drought, or will they be too stubborn and watch their operations go under.

Water is not the only concern in Utah agriculture. The decrease in agricultural land in Utah has changed how producers farm. With 1.2 million acres of Utah agricultural land transformed into housing, the number of arable acres is decreasing (Larsen, 2022). The loss of land also factors in with the water. This land has been transformed into housing, factories, and commercial buildings. All of which still use water. Even though there is less agricultural land, available water has not increased. Less land has meant less crop production inside the state. Beef producers who are unable to successfully feed their cows on forage and grow their own feed must buy it. With less being grown in the state, they are forced to buy from other states. By buying out of state, there is an additional shipping cost. This, combined with the already high cost, can put the producers in a financially difficult situation.
The apparent decline of land and water was a significant factor in the creation of RA. For Utah it has become clear that there will continue to be a decrease in land and water. The pasture box is the perfect solution for both. It can produce the feed equivalent of fifty acres of land in a single shipping container. This cuts land use and provides a year-round feed production option. Farmers could cut their demand for alfalfa by feeding 50% fodder with their alfalfa ration. While the cows are on forage, fodder would not be needed, at these times RA would take the pasture box back no additional cost to the producer. This ability to have the box only when needed has excellent potential in drought years. You would be able to have it when grazing feed was exhausted, and you would not need to purchase as much feed for the winter. The pasture boxes’ ability to use 93% less water than irrigated alfalfa fields has significant potential in drought years. (Renaissance Ag 2022). The added need for grain would cause a shift in the producer’s feed plan. Those producing their own feed, they would begin growing larger amounts of grain. With grain needing less water, there would be more available for those fields with alfalfa. Those who buy a large amount of their feed would purchase more grain and less alfalfa.

**California Dairies:**

California is a leading state in agriculture. Its year-round warm climate is ideal for most crops and livestock to flourish. With warm summers and very mild winters, plants and animals do not receive the setbacks cold weather brings. This ideal weather and large agricultural footprint are a large reason why California is the leading state in the dairy industry. As of 2021, California had 1.72 million head of dairy cows (USDA, 2021). This was nearly 50 million more cows than the number two state. This seemingly perfect environment and strong dairy markets do not come without challenges. California weather is both a great strength and a significant hindrance. With
years of drought and the state population growing, California has an abundance of obstacles to agriculture.

Shrinking agricultural land has been happening in California since the 1940s. 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 Conversion, 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 ten years in length. This act has been very effective, with nearly one-half of the agricultural land enrolled in the program. (California Department of Conversion, 2022). Even with the success of this act, there are still land obstacles that California must overcome. The limited land makes it so that farmers must decide the optimal crop to grow. Due to the climate, they can grow about anything that they want. With a high return on fruits, vegetables, nuts, and other crops, it is hard for the local farmers to take a loss and grow hay for their local dairies. This makes hay-needy farms willing to purchase hay from other states in the country.

Water is the most significant limitation of California agriculture. Even during years of good snowpack and sufficient water, predictions of when the next drought will occur begin. “California’s warm Mediterranean climate and expansive water infrastructure support a thriving agricultural industry, with annual revenue exceeding $30 billion. The state is also prone to multi-year droughts” (Mall and Herman, 2019). The hot California summers can add extra stress to the water availability. These hot days will cause irrigation water to evaporate. As a result, more water is needed to keep the plants from drying up. “Evaporative demand during April-October 2021 was the highest since 1895 and four inches more than the late 20th-century average”
High evaporation and lower water levels are testing the limits of California producers.

The dairy industry has not been exempted from the effects of limited water. California has had such a boom in its urban areas, such as Los Angeles and Sacramento, that pushed dairy farms towards central California. As this happened, the small operation began to be dissolved, and the large mega-dairies that dominate the state market came to be (Cross, 2006). These large dairies have made California the leader in milk production in the US for decades. However, this comes with several unique challenges. Most of these dairies are well-established in size and do not need more land to operate. Regardless, they do need a constant and ample supply of feed. Some large dairies own land and grow a portion or all of their feed. Even those with land still find themselves purchasing feed.

In 2021 feed prices for alfalfa, corn silage, and grain increased. These crops are all primary dairy inputs (Josué Medellín-Azuara, 2021). For the California dairies, high input cost is their most felt impact of water shortages. This is a crucial reason why California’s dairy market would be a good fit for RA. The enormous amount of feed these large dairies need makes them prime candidates to have several boxes on their farms. These boxes would allow the dairies to grow their own feed with lower water input. State regulations are the most significant obstacle to making this RA’s strategy. Being aware of the state-specific laws and regulations and adequately navigating they will be key to RA’s success in California.

Spain Hog Market:
“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). The demand for meat, especially pork, is mainly met by its supply in the European Union. However, they are not afraid to import goods to meet this demand. After domestic production has hit capacity, they import the meat needed to satisfy demand. The European Union is the world's largest importer of livestock feeds. This imported feed covers one-fourth of the livestock feed demand (Hasha, 2002).

For the European Union, the largest livestock sector is the hog industry. In 2018, there were 148 million hogs in the European Union (Augère-Granier, 2020). In Europe, Spain is the largest pork producer, supplying over 20% of the total pork grown in the European Union. The methodology that Spain uses in hog production is unlike that of any other country. Most countries keep their pig in tight confinement throughout their whole life. In Spain, once the sows are bred, they are kept in pastureland. This cuts feed costs and has shown improved health in the Spanish sows (García-Gudiño, January 2020). Spain, however, still has feed costs and needs land to grow the hog feed not covered by the pastures. This feed demand is difficult for local producers to meet in a country that produces 1.23 million pigs per year (García-Gudiño, January 2020).

In 2018 pork was the most significant agricultural commodity produced in Europe. Pork was over 8% of the total agricultural production (Augère-Granier, 2020). Driven by the strong demand inside the union, pork is a critical element of agriculture. A significant stumbling block has been the increased feed needs. Hogs are grown in a feedlot requiring all feed inputs to be shipped on-site (Gene Hasha, 2002). This puts a strain on feed producers to produce more and limits the uses for pastureland. This issue has not been significant in Spain. With their current
production model using the pasture land to raise their hogs, they have been better prepared for the increased demand.

Spain is known to have a dry, hot climate. This climate can be beneficial to growing crops and animals. It gives a more extended growing season for the crops. The warm climate is not only ideal for crops but is preferred for livestock. Not having to deal with the harsh environment and sicknesses that come with winter, animals can avoid growth-halting issues. Despite the benefits of its environment Spain still has a significant climate challenge. “Water availability problems have been a historical issue in Spain” (López-Gunn et al., 2012). Spain’s hot, dry climate gives it a similar problem to California. The hotter growing season calls for more irrigation. The loss of water through evaporation has the crops demanding more water. Spain is not new to the stress of water and has been a leader in water conservation and building dams (López-Gunn et al., 2012). Despite this efficiency, Spain is always unsure when their next drought will come. This constant worry of drought makes water a very coveted resource.

Since the end of World War II, Europe has had an abandonment of Agricultural land. The reasons for this vary from the hardships of growing crops to low income and farmers finding better opportunities in urban areas. With available land decreasing and no way to get more, it has become an irreplaceable commodity (European Union, 2015). Spain has been affected just like any other nation, if not more. Spain’s soil and land have been ideal for studies on agricultural abandonment (Castillo, 2020). A growing population and abandonment of land has increased the price of agricultural land. Irrigatable land is more costly due to the ability to grow higher yields and the water rights that come with it (Eurostat, 2021). The shifting of land use and importing large amounts of feed could put considerable stress on hog producers.
For RA, their most considerable benefits of targeting Spain would be land and water. The Pasture Box has great potential in aiding the farmers in this country. Allowing hog producers to grow heavy feed on-site could help cut their costs. Fodder having a much higher weight index than dry-fed grains could enable the farmers to get the same outcome. By transforming smaller amounts of dry feed into fodder, they could cut expenses and quantities of feed shipped in and have the same effect as before.

**Arizona Dairies:**

Arizona is known to be a dehydrated desert state. However, most plants can be grown there almost year-round due to their warm environment. The year-round growing season gives them a solid agricultural influence in many field crops. Another powerful part of their economy is their dairy sector. The dairy sector in Arizona has 196,000 head of cows, making it significantly smaller than the 1.7 million in California (USDA, 2021). Even with a small size, it still has a significant purpose. Dairies are major purchasers of feed even if they have land and grow some of their own. When they buy, these dairies want to do so close and generally do not care about price as much. The dairies in Arizona have gone from more minor, less than 100 cow farms, to 200-300 cow farms (Teegerstrom, 2010). These dairies keep the local milk production facilities in business. Most of the slaughtered beef in Arizona are old dairy cows or steers from the dairies. Though the dairy influence in Arizona is small, the influence of the dairies on Arizona is significant.

Not just in dairies but all agriculture in Arizona, there is one typical constraint: water. The climate of Arizona makes year-round agriculture very feasible. Being able to grow year-round increases the revenue potential. Those on dairy farms that produce their own feed can grow more in a year than other states, cutting the quantity that must be purchased. However, the low water
does not make this as feasible as farmers desire. The driest parts of Arizona have been known to receive less than 4 inches of water per year (Ford, 2022). Nearly 41% of the state’s annual water comes from groundwater. With the majority being used in urban areas. However, the issue comes from the fact that there is no accurate measurement of this water use. No one knows what percentage of the available groundwater is being used. They also do not regulate it (Pereira, 2022). This lack of knowledge about the amount of groundwater used is alarming for the state. With some years having low rainfall, meaning less water in the rivers, they will pull more water from the groundwater. With the high demand for water in agriculture and everyday living, one must wonder if they will run out.

Agriculture land in Arizona has challenges, but they differ significantly from the other target markets. The amount of available irrigated agricultural land has not changed in the last decade. Regardless, the type of crops grown in these areas has changed. With hay being one of the most grown crops and one of the highest water demands, there is cause for worry (Ford, 2022). Arizona is the perfect climate for growing hay. With the warm, dry climate, hay grows unbelievably well with enough water. The hot climate also allows it to dry quickly and stay at a high quality until it is baled. This near-perfect climate is also a significant issue like that of California and Spain in that the water used for irrigation tends to evaporate. This calls for high water application. Putting even more pressure on the water issue in Arizona. Arizona does not have a significant land problem, but they have a problem irrigating its agricultural land.

The dairies are most affected by the water shortage in the local feed market. Small dairies like the ones that are in Arizona rely on local feed. The larger dairies in California have the volume to purchase all the feed that they need. The smaller dairies in Arizona cannot compete because their size does not allow them to have the same purchasing power. The local feed allows them to
buy hay without the shipping cost. In an industry known for operating on the margin, the additional shipping cost can be the difference between success or failure.

RA’s water-saving abilities have real potential in Arizona. The Western United States are in the worst drought we have seen in the last 1200 years (Ford, 2022). For an already water-needy state like Arizona, this increases the pressure of water needs. If RA could get their boxes into the Arizona dairy industry, it could be of immeasurable benefit. The dairies would be able to grow feed that required less water while still remaining high quality. For those dairies who buy feed, it would lower their cost, and those who grow crops such as hay would be able to cut their production. Allowing them to grow a less water-needy crop such as wheat. This would allow them more water for their cows or other crop production.

**Historic Feed Prices:**
Figure 4: Average prices of feed.

Above, we went over why the Pasture box would benefit these markets. Now we will shift and go over the feed prices in these areas. Due to the different livestock, fodder would be used in these four markets to replace different crops. For the dairy cows in Arizona and California, it would be used as a supplement for the hay they are already receiving. For Utah beef, fodder would also be used as a supplement for hay. Due to hay not being an input in the Spain hog market, fodder would substitute corn. The goal of the dry grain corn fed to hogs is to help them put weight on quickly. Using grain such as wheat or barley and changing it to fodder gives you feed that can substitute corn. The water weight of the fodder helps quickly add weight, similar to dry corn. Although it is not as good of a substitute for dry matter corn as corn silage or alfalfa, it still is a viable substitute. With hog markets not using silage or alfalfa, fodder would be best used as a substitute for dry matter corn.
The above chart shows that even though these prices are in different states and countries, there is still a pattern. With the three markets using hay, this would be expected. Due to how close they are, it is unsurprising that they are closely related to rises and spikes. For the corn, the pattern is more of a surprise. Due in large part to it being in a different country. This graph illustrates that all feed markets are connected. With the change in the price of one crop, the others generally follow suit because more of them will be bought to substitute the other product. However, there can be some lags with prices changing after the other prices.

Over the last twenty years, Utah hay has been the cheapest market, with hay in California and Arizona following closely together. These markets would be tied closely together because of the dry climates and the potential to grow other crops instead of alfalfa. Corn in Spain is the highest because of the high quantity of imported feed. Because corn is used in different markets than hay, it is also priced and sold differently. Overall, in the last two or three years, the gaps between these prices have shifted, with relatively little to no difference in the price. This gives RA the prime time to pick a market and begin higher product distribution than in recent years.

With the limited data of RA and their short period of time as a company, there is no historical data for them. However, by adding up their cost per pound of fodder and using it over 20 years, fodder is cheaper than other feed options. It is important to remember that it requires more than one pound of fodder to replace a pound of alfalfa. Even considering that, if RA can keep its prices consistent, fodder would still be competitive during times of high alfalfa prices. With only a few periods where prices were close to them and even less that other prices were lower. With low prices, RA would be attractive to any livestock market that is consistently watching feed prices.

Conclusion:
As was stated earlier, a lot is riding on RA, picking the correct market to focus on. Focusing on one market does not mean they will not have their product available to other markets. They want their product to be available to all who are interested and need it. A target market is simply an ideal place for them to put their effort where a profit can be made. At the same time, giving the pasture box a place to prove its worth to the agricultural world.

After looking into the four markets, I decided California dairies would be the best target market. California’s mega-dairies would have a significantly greater revenue stream than the smaller dairy market of Arizona. The constant need for high-quality feed daily would allow this market to use the full potential of the Pasture Box. Whereas the Utah beef farmers who only needed it during the winter months would rarely use it in the summer. Even though there would be shipping costs to California, they would be nowhere near the price of sending the boxes across seas to Spain.

The reason for sending to California goes beyond the advantages it has over the other markets. The large dairies would need several boxes. This would give RA the opportunity to make large profits. California’s advantage in using its agricultural resources for higher profit crops than cow feed is also a factor. Dairies taking a much smaller demand on a feed from local farmers would allow the farms to send their crops out as exports or grow a new mixture. The ability of the Pasture Box would give a state that is consistently stressing about its water an easy way to use less but stay productive. By selling the Pasture Box in California, not only would RA be profitable, they could target a market that would truly benefit from their technology.
Works Cited


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