Design Proposal Report

Spring 2010

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[In Conjunction with 3C Cattle Feeders]

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MISSION STATEMENT

Our mission at Lick of Sense Solutions is to provide our client, 3C Cattle Feeders, with innovative and affordable answers to their problems. Our goal is to allow our client to expand their business and appeal to new markets based on our solutions.

PROBLEM STATEMENT

Our task is to design, build, and test a selective entry mineral dispensing device for cattle. The mineral dispenser must restrict access to deer and feral hogs, and allow cattle to gain access and consume the product.

STATEMENT OF WORK

This project is to design, build and test a selective mineral feeder. The feeder will allow livestock to access mineral while keeping unwanted wildlife out. Along with this, a financial and competitive analysis will be completed for the project sponsor company, 3C Cattle Feeders. This financial anlysis should help give 3C a projection of how the mineral feeder will influence their buisness.We will be working in conjunction with 3C owner, Bear Runyan, along with Shea Pilgreen (Application Engineer), Kay Watson (Manufactuing Extension Agent) and OSU faculty to produce the most innovative and practical product available.

The majority of work will be performed on the campus of Oklahoma State University, and at 3C Cattle Feeders. Once a prototype is built, testing will take place at Oklahoma State cattle facilities, a working cattle ranch in Oklahoma that is currently to be determined, and Mill Creek, OK.

Work began on the project in August of 2009. An initial solution to the problem, along with a presentation of work completed was delivered on December 3, 2009. Work is continuing throughout the spring with a final product being delivered May of 2010.

Deliverable Schedule

- December, 2009
    - Financial Analysis
    - Competitive Analysis
    - Proposed Buisness Plan
    - Design Proposal Report
    - Design Proposal Presentaion
    - Team Web Site
- May 2010
    - Financial Analysis
    - Finalized Business Plan
    - Final Product Report
    - Final Product Presentation
    - Final Prototype

There are no known engineering standards that apply to our mineral feeder design. However, the product must be durable, weather resistant, corrosion resistant and safe for feed handling. The product also must be financially feasible to produce, sell and purchase.

The most important acceptance criteria for the project is that it will deter wildlife consumption of the mineral, while selectively allowing livestock to have access to it. The product should accomplish these things, while still being affordable to average livestock producers.

A couple special requirements that apply to this project are that the mineral feeder will prevent overconsumption of mineral by cattle by dispensing a specific amount of mineral while keeping other wildlife out of the feeder.

Work Breakdown Structure

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1) Financial Analysis of 3C Feeders[Complete]

1.1. *Fixed Costs: Current Fixed Costs of 3C*

1.1.1. Salary costs

1.1.1.1. 3C employees Salary

1.2. *Variable Costs: Cost's pertaining to 3C's current expansion, production, operation, and advertising.*

1.2.1. Construction Of new Building

1.2.1.1. Building Permits
1.2.1.2. Cost of dirt work
1.2.1.3. Building Material
1.2.1.4. Construction Equipment
1.2.1.5. Labor Cost

1.2.2. Utilities

1.2.2.1. Electric
1.2.2.2. Water
1.2.2.3. Gas
1.2.2.4. Telephone/Internet
1.2.2.5. Rent

1.2.3. Input Cost Current Products

1.2.3.1. Labor
1.2.3.2. Steel
1.2.3.3. Welding Supplies
1.2.3.4. Welding equipment
1.2.3.5. Other Materials
1.2.3.6. Transportation

1.2.3.6.1. Fuel

1.2.4. Advertising Costs

1.2.4.1. Website
1.2.4.2. Regional publications
1.2.4.3. Trade Shows

2) Financial Analysis of the Selective Mineral Feeder[Complete]

2.1. *Fixed Costs: Costs of 3C as a consultant resource*

2.1.1. Salary cost

2.1.1.1. 3C Employees
2.1.1.2.

2.2. *Variable Costs: Costs that will be associated with the production of the Selective Mineral Feeder*

2.2.1. Input expenses
2.2.1.1. Mineral
2.2.1.2. Steel
2.2.1.3. Plastic
2.2.1.4. Sensors
2.2.1.5. Paint
2.2.2. Labor Cost
2.2.2.1. BAE students
2.2.2.2. AGEC students
2.2.2.3. Welders and shop hands (not salary)
2.2.3. Utilities
2.2.3.1. Water
2.2.3.2. Gas
2.2.3.3. Electric
2.2.3.4. Internet
2.2.4. Advertising
2.2.4.1. Trade Shows
2.2.4.1.1. Display Booth
2.2.4.1.2. Brochures
2.2.4.2. Web site
2.2.4.3. Business Cards
2.2.4.4. Trade Publications
2.2.5. Transportation
2.2.5.1. Fuel
2.2.5.2. Room and Board

3) Proposed Communication Campaign [Complete]

3.1 *Work with Corey Dyson to construct our team website.*
3.1.1 Brainstorm various communication campaign ideas (both existing and future).

4) Competitive Analysis / Market Research [Complete]

4.1 *Revise and complete corrected competitive analysis for 3C Cattle Feeders.*
4.1.1 Determine customer requirements and desires through distributor surveys.
4.2 *Complete more literature research in order to gain a competitive edge for our client.*
4.3 *Summarize most relevant patents and communicate any existing barriers for our design with Bear and Shea.*

5) Construct a Proposed Business Plan [Complete]

5.1 *Using information gathered in competitive and financial analysis; construct a business plan draft to be completed by November 23, 2009.*

5.2 *After draft has been revised, the team will then generate a final version of the business plan due no later than November 30, 2009 to include in the final design proposal report.*

6) Generation of Design Concepts [Complete]

6.1. Research/Patent Search-Research of existing products, or any other products that may pertain to our project.

6.2. Brainstorming-Group generation of large number of solutions

7) Feeder Design[Complete]

7.1. Trough Design- Design a trough with adequate size and shape to accommodate a large variation in cattle size.

- 7.1.1. Size
- 7.1.2. Shape
- 7.1.3. Position
- 7.1.4. Material

7.2. Metering System-Design system to dispense variable amounts of mineral to different sized cattle.

- 7.2.1. Method
- 7.2.2. Speed
- 7.2.3. Location of hopper

7.3. Stand-Design stand for mineral feeder to allow the feeder to be free-standing.

- 7.3.1. Size (width, height)

7.4. Electronics

- 7.4.1. Sensors-Selection of sensors to activate dispensing system.
  - *7.4.1.1.* Type
  - *7.4.1.2.* Reliability
  - *7.4.1.3.* Range
  - *7.4.1.4.* Accuracy
  - *7.4.1.5.* Location
  - *7.4.1.6.* Power Requirements
- 7.4.2. Power-Selection of a system to power the electronics on the feeder
  - *7.4.2.1.* Charging
  - *7.4.2.2.* Storage
  - *7.4.2.3.* Computer/controller

8) Prototype/Testing-Assembly and testing of design proposal prototype[Complete]

8.1. *Assembly*

- 8.1.1. Calibrate dispensing system
- 8.1.2. Build full-scale feeder to test

8.2. *Testing*

8.2.1. Field Setup
8.2.1.1. Find testing site
8.2.1.2. Set up "game cams"
8.2.1.3. Record feeder performance
8.2.2. Evaluate Feeder Performance
8.2.2.1. Make any necessary changes

9) Finalize Design[Complete]
9.1. *Build final product*

10) Final Design Proposal Report[Complete]
10.1. *Have all deliverables completed, submitted and presented by April 30, 2010.*

TASK LIST

Fall 2009:

1. Meet with team on 11-18-09 **[Complete]**
1.1. Begin work on website
1.2. Take picture for website
1.3. Discuss date of presentation
1.4. Begin work on design proposal oral presentation
1.5. Work on revisions and research for report
1.6. Individual and group brainstorming will be done
1.6.1. The ideas will be sorted through to determine what is feasible, and what are the best options to solve our problem

2. Complete Initial Financial Analysis For 3C feeders by 11-23-09 **[Complete]**
2.1. Contact Bear or other 3C employee (via phone/email) with access to financial records and statements to cover:
2.1.1. Fixed Cost
2.1.1.1. Salary costs
2.1.2. Current Variable Cost
2.1.2.1. Construction of new Building in conjunction with Johnston County
2.1.2.1.1. Building Permits
2.1.2.1.2. Cost of dirt work
2.1.2.1.3. Building material
2.1.2.1.4. Construction equipment
2.1.2.1.5. Labor cost
2.1.2.1.6. Insurance

2.1.2.1.7. Possible date of building completion
2.1.2.2. Utilities cost incurred
2.1.2.2.1. Electric
2.1.2.2.2. Water
2.1.2.2.3. Gas
2.1.2.2.4. Telephone/internet
2.1.2.3. Input Cost Current product
2.1.2.3.1. Labor
2.1.2.3.2. Steel
2.1.2.3.3. Welding supplies
2.1.2.3.4. Welding equipment
2.1.2.3.5. All other Materials
2.1.2.3.6. Fuel
2.1.2.3.7. Man hours
2.1.2.4. Advertising Cost
2.1.2.4.1. Website
2.1.2.4.2. Regional publications
2.1.2.4.3. Trade shows

3. Contact 3C for information for feasibility template by 11-23-09 **[Complete]**
3.1. 2008 sales numbers for current products
3.2. Labor hours for each product

4. Trough Design- Design a trough with adequate size and shape to accommodate a large variation in cattle size. **[Complete]**
4.1. Trough design will include size, shape, position, material
4.1.1. This will be done based on our needs for the dispensing , metering and sensing, and will be somewhat influenced by current products
4.1.2. Trough design will not be finalized until after other engineering aspects are finalized because the trough design will be dependent on other aspects

5. Metering System-Design system to dispense variable amounts of mineral to different sized cattle. **[Complete]**
5.1. Current ideas will be tested to determine what works best for the feeder
5.1.1. Test metering wheel system
5.1.2. Test auger system

6. Stand-Design stand for mineral feeder to allow the feeder to be free-standing. **[Complete]**
6.1.1. Design and build a stand that will sufficiently support the feeder

7. Electronics **[Not completed due to a more efficient, mechanical method used]**
7.1. Sensors-Selection of sensors to activate dispensing system.
7.1.1. Test various aspects of sensor alternatives to determine what works best. This will include but will not be limited to testing of reliability, range and accuracy.

7.2. Power-Selection of a system to power the electronics on the feeder
- 7.2.1. Do research on different power systems.
- 7.2.2. Select and test a system, which may include testing of several solar panels.

8. Prototype/Testing-Assembly and testing of design proposal prototype**[Complete]**

8.1. Assembly
- 8.1.1. Assemble all parts of feeder
- 8.1.2. Calibrate dispensing system

8.2. Testing
- 8.2.1. Field Setup
  - 8.2.1.1. Find site to place and test the feeder
  - 8.2.1.2. Set up "game cams" to record the performance of the feeder
- 8.2.2. Evaluate Feeder Performance
  - 8.2.2.1. Review feeder performance and make changes as necessary

9. Complete revisions to final report by 11-23-09 **[Complete]**

9.1. Further Research into current competition
- 9.1.1. Locations of dealers
- 9.1.2. Different mineral feeder designs
  - 9.1.2.1. Do designs differ by region
  - 9.1.2.2. Costs comparison of different mineral feeders
    - 9.1.2.2.1. By dealer, region, manufacturer,
  - 9.1.2.3. List of current manufacturers and locations

9.2. Construct map of 3C current distributers
- 9.2.1. Comparison of 3C distributers and feral hog locations
  - 9.2.1.1. Possible distribution expansion

9.3. Survey current and potential distributers (with 3C's permission)

9.4. Issues on distribution

9.5. Where and how competitors advertise

9.6. List current trade shows, key gatherings, target market and possible expansion

9.7. Research into current minerals on market
- 9.7.1. Prices
- 9.7.2. Differences in mineral by region
- 9.7.3. How they are delivered
- 9.7.4. How might selective mineral feeder effect mineral market

9.8. List possible diseases that can be transferred to cattle from wildlife
- 9.8.1. Deer
- 9.8.2. Birds
- 9.8.3. Feral hogs

9.9. Complete competitive rank and market distribution sections of report

10. Provide 3C with hard copy of all current progress by 11-25-09 **[Complete]**

11. Oral presentation of selective mineral feeder Dec. 3rd or 4th **[Complete]**

11.1. Provide 3C, faculty, and class with:

11.1.1. All current financial analysis of project, and design concept for selective mineral feeder
11.1.1.1. Receive possible go ahead for project design
11.1.1.2. Feedback from 3C and faculty on project

12. Dead week: Dec. 8th to Dec. 11th **[Complete]**

12.1. Deliver the following
12.1.1. Self and peer evaluations
12.1.2. Basic project website
12.1.3. Project notebooks
12.1.4. Conduct one-on-one interview with faculty

13. Christmas Break: Dec. 14th – Jan. 9th **[Complete]**

13.1. Keep in touch with team, 3C, and faculty via phone/email
13.1.1. Cover any and all work on project being conducted over break

Spring 2010

14. January 2010

14.1. *Finalize drawings for prototype* ***[Complete]***
14.1.1. Gain drawing/design approval from Dr. Weckler, Bear Runyan, Shea Pilgreen, Kay Watson, and relevant BAE lab personnel.

14.2. *Begin construction of selective mineral feeder* ***[Complete]***
14.2.1. Rapid prototyping
14.2.2. Full-scale model

14.3. *Begin on financial analysis of selective mineral feeder* ***[Complete]***
14.3.1. Fixed Costs: costs of 3C as a consultant resource
14.3.1.1. Salary cost
14.3.1.1.1. 3C Employees
14.3.2. Variable Costs
14.3.2.1. Input expenses
14.3.2.1.1. Mineral
14.3.2.1.2. Steel
14.3.2.1.3. Plastic
14.3.2.1.4. Sensors
14.3.2.1.5. Paint
14.3.2.2. Labor Cost
14.3.2.2.1. BAE students
14.3.2.2.2. AGEC students
14.3.2.2.3. Welders/Shop Hands
14.3.2.3. Utilities
14.3.2.3.1. Water
14.3.2.3.2. Gas
14.3.2.3.3. Electric

14.3.2.3.4. Internet
14.3.2.3.5. Advertising
14.3.2.3.6. Rent
14.3.2.3.6.1. Trade Shows
14.3.2.3.6.1.1. Display Booth
14.3.2.3.6.1.2. Brochures
14.3.2.3.6.1.3. Web site
14.3.2.3.6.1.4. Business Cards
14.3.2.3.6.1.5. Trade Publications
14.3.2.3.7. Transportation
14.3.2.3.7.1. Fuel
14.3.2.3.7.2. Room and Board

15. February 2010

15.1. Order parts for prototype ***[Complete]***
15.1.1. Use part costs to analyze production costs and profits for the feeder
15.2. Complete rapid prototype of dispensing unit ***[Complete]***
15.2.1. Begin Testing of selective mineral feeder
15.2.1.1. Conduct testing at OSU, and 3C in Millcreek
15.2.1.2. Record results
15.3. February 9-11, 2010 ***[Complete]***
15.3.1. Trip to California, Cal. Poly, World Ag. Expo
15.3.2. Presentation given about LOSS' project
15.3.3. Presentation to OSU class about trip

16. March 2010

16.1. Conduct feasibility cost analysis of selective mineral feeder ***[Complete]***
16.1.1. Utilize Dr. Holcomb's finance spreadsheet to determine feasibility
16.1.2. Use information to project expected costs and profits
16.2. Continue testing of mineral feeder ***[Complete]***
16.2.1. Record data for final presentation
16.2.2. Make any changes as needed to improve the prototype

17. April 2010

17.1. Begin finalizing Spring presentation ***[Complete]***
17.1.1. Combine all market, design, testing, and research data together for presentation
17.2. Dead week: April 26- 30
17.2.1. Submit Financial Analysis and finalized Business Plan
17.2.1.1. Consult Bear about cost-effective strategies regarding the feeder in current and existing markets

17.2.1.2. Explain where and how the feeder affects other aspects of 3C's organization

17.2.1.2.1. Benefits, disadvantages, opportunites, et cetera

17.2.2. Present final product review

17.2.2.1. Final team presentation April 29, 2010

17.2.2.2. Deliver finalized prototype

INDUSTRY ANALYSIS

Economic conditions have drastically changed throughout past years. Agriculture has certainly been affected by these changing conditions, along with the feed and cattle market. The United States Department of Agriculture cattle census shows the declining cattle numbers over the last thirty years.[1] A dramatic shift occurred in the mid 70's as producers became more efficient by raising more pounds of beef per head.

> "In the 1970s the size of the average cowherd was just shy of 52 million. If the average cow resulted in the same level of beef production today as it did in the 1970s, it would have required 62 million cows to get the record beef production seen in 2002. Instead, there are only about 42 million cows in the U.S."[2]

[1] United States Department of Agriculture. "All Cattle and Beef Cows: Number of Operations." 2008. http://www.nass.usda.gov/Charts_and_Maps/Cattle/acbc_ops.asp

[2] Price, Bob. "What Happened to Cattle Cycles?" Texas Cattle Feeders Association. 2003. http://www.tcfa.org/Annual/2003/Cycles.PDF

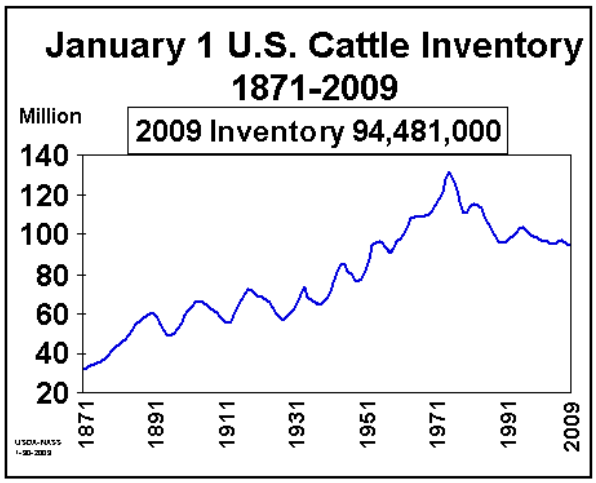


Figure 1. National Agriculture Statistics Service, USDA. "January 1, 2009 Cattle Inventory"

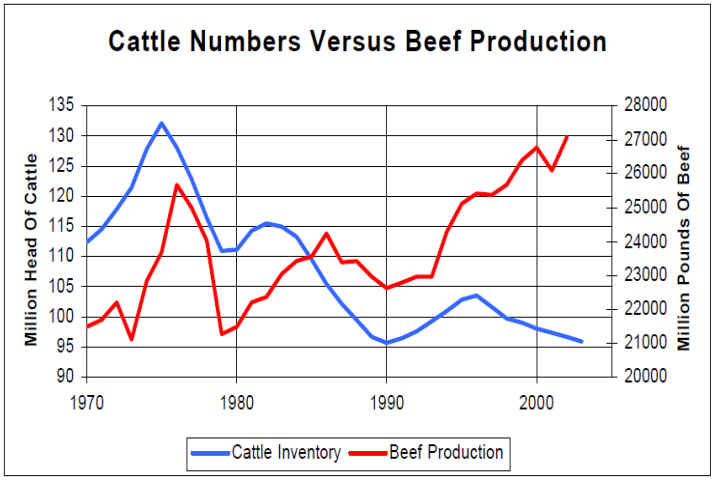


Figure 2. Price, Bob. Texas Cattle Feeders Association. "What Happened to Cattle Cycles?"

These two figures suggest that each animal is more valuable and may benefit from improved feeding practices and protection from diseases. With that being said, producers are more willing to save money any way they can without sacrificing quality (and in turn, premiums) of their animals. Moreover, ranchers are becoming more efficient in production and must supplement their cattle to the best of their ability in order to be the most profitable.

The cattle industry is an enormous part of agriculture in America. According to Dr. Dan Otto and John D. Lawrence of Iowa State University:

> Gross receipts from sales of cattle and calves in 2000 totaled $40.76 billion accounting of 21% of all agricultural receipts making the beef sector the largest single agricultural enterprise. The estimated $40.76 billion of gross output from beef production activity supports an additional $147.4 billion of economic output for a total of $188.4 billion of direct and indirect economic activity throughout the U.S. economy. Direct and indirect employment in or related to the production and processing of beef supports over 1.4 million full-time-equivalent jobs in the US as well.[3]

[3] Otto, Dan and Lawrence, John D. "Economic Impact of the United States Beef Industry." Iowa State University. http://www.beef.org/uDocs/Econ%20Impact%20Beef%20v2.doc

While there are several government regulations that apply to the livestock industry, not many rules are pertinent for the development of a selective mineral feeder. Obviously it must be humane and help cattle nutritionally without using toxic materials or hazardous mechanisms without proper attention.

Key gatherings of the cattle world vary from breed shows to equipment trade shows to public auctions. Below we have listed a select few relevant trade shows and key gatherings across the United States that 3C could choose to attend. February proved to be the most active for these shows, giving Bear and 3C representatives the opportunity to choose their preferences:

- **Cattle Industry Annual Convention & NCBA Trade Show**
    - February 2-5, 2011 Denver, Colorado
    - Put on by: National Cattlemen's Beef Association, Cattlemen's Beef Promotion & Research Board, American National CattleWomen, Inc., Cattle-Fax , National Cattlemen's Foundation
- **World Ag Expo**
    - February 8-10, Tulare, CA
- **Texas and Southwestern Cattle Raisers Association Convention & Trade Show**
    - March 19-21, 2011. Fort Worth, TX
- **Southern Plains Farm Show**
    - April 14-16, 2011. Oklahoma City, OK.
- **Tulsa Farm Show**
    - December 8-10, 2011. Tulsa, OK.
- **Sunbelt Agricultural Exposition**
    - October 18-20, 2011. Moultrie, GA
- **Oklahoma State Fair**: OKC, OK. September 17- 27, 2010
- **Florida State Fair**: Tampa, FL. February 4-16, 2010

CUSTOMER ANALYSIS

Customers of 3C are certainly a diverse group of people with the same goal in mind: to feed their cattle efficiently and conveniently, with both their creep feeder and/or 3C's digital cube feeder. Since the products have a good reputation for longevity, repeat buyers are liable to occur only when their cattle demands increase as well. Currently, no competitors have been found to sustain a feeder with the benefits that our selective mineral feeder will possess. While there are only a few producers of mineral feeders in the current market, the development of a restricted and cost-effective feeder could meet the demands and desires of all cattle producers and could potentially create its own market separate from the simple, non-restrictive and inefficient feeders being sold today.

The use of advertisement through livestock publications such as the *Oklahoma Cattleman*, *High Plains Journal*, *Showbox* and *The Purple Circle* enables the customers to find a dealer that will better inform them of all the product uses and benefits. Likewise, advertising at trade events, livestock shows and both current and potential dealers, allows qualified personnel to show the advantages of our proposed feeder and motivating buyers to try it out for themselves. Also by seeing accounts of 3C's past customers, potential new customers will see that 3C provides quality equipment. The livestock industry caters to products that are proven, and by having influential (and satisfied) customers, we can create motivation for them to spend the extra money for our selective feeder. However, economic status obviously plays a large role in potential sales. The average rancher earns $15,603 without any subsidies[4]. However, most ranchers also hold another full-time job and do not ranch as a primary income. With that being said, the range of income varies drastically throughout the target market with a large percentage of cattle producers making below the salary average of the US.

Potential dealers are more likely to buy our feeders knowing they can get volume moving through their operations while making a satisfactory profit. Products that are too complex or far-fetched would certainly scare off many buying firms. With our target market

[4] US Department of Labor, Bureau of Labor Statistics. "Farmers, Ranchers and Agricultural Managers." 2008- 2009 Edition. http://www.bls.gov/oco/ocos176.htm

catering to a simple and straight-forward customer, dealers want to make sure that's the image their operation sells. Current dealers are agricultural-based and cater to livestock producers. In the future, we would like to expand to chain stores such as Atwood's as well as other privately owned feed stores. This expansion will take place as the selective feeder is developed and its potential to help expand 3C's business to other regions of the country are explored.

The selective feeder only dispenses minerals for the desired animals of the customer. In turn, it prevents loss of minerals due to unfavorable weather, greedy stock and most importantly, to undomesticated animals such as feral hogs, deer, rats, birds and raccoons. Recently, the *USA Today* posted an article that stated, "Booming numbers of wild hogs are colliding with motorists, devouring crops, spreading disease and terrifying landowners from small towns on the Pacific Coast to the swamps of the Carolinas… 'We know that Texas has more feral hogs than any other state,' says Billy Higginbotham, a professor at Texas A&M University. 'With 1.5 million in the state, we will never eradicate them. The best we can hope for is to keep their numbers under control.'"[5] The problem with these feral hogs (as well as the other varmints) does not just lie in the loss of minerals to them but also the spread of disease. The new feeder would also be used to ensure the herds receive adequate nutritional value on top of any other medicinal products contained in the mineral solutions without any waste. Furthermore, the selective feeder offers a huge advantage in that it ensures that wild animals are not spreading disease to the cattle. Currently the available mineral feeders do not serve these purposes. The majority of mineral feeders on the market are designed with few specialty features. In fact, the most they offer is limited weather protection and some include a fly control sheet attached to the opening. Obviously this leaves 3C a huge advantage to influence the market with a new mineral feeder that not only out-performs existing feeders, but offers selective dispensing along with a recording mechanism that keeps track of cattle for the producer. As with any agricultural sector, the cattle industry creates a product with a small margin of profit and any expense that can be saved generates a considerable increase financially.

[5] Brook, Tom Vanden. *USA Today*. May 5, 2004.
http://www.usatoday.com/news/nation/2004-05-12-hogs-usat_x.htm

DEVELOPMENT OF ENGINEERING SPECIFICATIONS

From the customer requirements, engineering specifications for the feeder were developed. There are no known engineering standards that must be followed on mineral feeders. Therefore, all specifications are either industry standards for mineral feeders, or were developed by the team. We believe that these specifications must be met in order to make this feeder a successful product.

Size/Weight

The feeder must be small enough and light enough that it can be handled and moved by a maximum of two people. Mineral feeders are not typically permanently placed, so it is essential that the feeder be capable of being mobile without too much effort. Although the feeder must remain relatively compact, an adequate amount of mineral storage is still needed. The feeder must be able to contain a minimum of one 50 pound bag of mineral. This mineral feeder must also be very stable. It needs to be sturdy enough that it is not easily pushed around by cattle, and it must maintain a low enough center of gravity that it is not easily tipped over, either by cattle or hogs.

Materials

As with any outdoor product of this type, the feeder must be weather resistant and corrosion resistant. Not only resistant to corrosion from the elements on the exterior, but more importantly, corrosion resistant on the inside. Mineral is a highly corrosive material because it contains salt, so the interior surface of the feeder design must tolerate caustic materials. The feeder will most likely contain some amount of moving parts; therefore it must be designed to also be resistant to the weather. Functionality must be maintained in a snow storm, or a freezing rain event. The construction material shall not only be weather and corrosion resistant, but because it is a device used to feed live animals, it must be safe for feed handling. It cannot contain anything that could be potentially harmful to cattle if ingested.

The most important engineering specification for this project are clearly developed in our problem statement. This feeder must possess selective access. It shall allow cattle access to mineral while keeping all other wildlife out.

CLIENT COMPANY AND ITS RESOURCES

3C's management team consists of Clyde, Casey and Bear (Chance) Runyan as owners and managers along with Carl Hood as the sales manager. They represent their company by the following trademark:

Their product line consists of cube feeders that range from $2300-$2700, a creep feeder priced at $2350 and customized athletic lockers. In 2008 3C sold 357 cube feeders, 106 creep feeders, and numbers on 3C's new athletic lockers are not currently known. 3C specializes in welding and custom metal work. The main input supplier for 3C is Ryerson Steel (www.Ryerson.com) based out of Oklahoma City, OK. Marketing is mainly handled by Bear Runyan and Carl Hood and the 3C website also contributes as their main advertisement. Currently, OSU Agricultural Communication students and faculty contribute a large part of marketing for 3C through brochures, website design and ad designing for publications. Distribution of current products is done through various dealers throughout Oklahoma and surrounding states. To see a list of current dealers and map of current distributers use the following link:

http://www.batchgeocode.com/map/?i=e44ac697d03b0ed8bab60cef07ca47b5

The key distributor for our client is by far Stillwater Milling, and with three different branches they are able to reach the largest customer base in Oklahoma. Moreover, 3C has a tremendous reputation in Oklahoma. Examples can be seen by client feedback on 3C's website:

> "We have worn out every cake feeder on the market for the last 25 years. 3C Feeders are by far the best in construction and accuracy. As long as we can get them, we'll use nothing else." -Bob Jones, Reeds Cattle Co.
>
> "The 3C Cattle Feeder is the best feed dispenser on the market." -Harris Penner, Penner Ranch
>
> "My only regret about the 3C Feeder is I bought a traditional feeder first." -Steve Miles Steve & Darla Miles Cutting Horses[6]

When referencing our client's overall financial condition, our team sustains a distinct advantage through the availability of financial resources. This year we were able to do a complete financial analysis of the company with current products as well as the feasibility of the new mineral feeder.

TECHNICAL ANALYSIS

When researching other mineral feeders on the market, we found several issues as mentioned earlier. Most of the other mineral feeders we looked at were good products. They seemed to be very durable, reliable and relatively maintenance-free. All were made out of corrosive resistant materials such as plastic or rubber, and they appeared to have adequate mineral storage space. Additionally, all feeders had varying types of covers to protect the mineral from wind and rain, and many of them pivoted 360 degrees to allow the mineral to always be protected no matter the wind direction. The most advanced feeders include fly bags to help with fly and parasite control and although they are simple designs, they remain relatively effective for their purposes. The main weakness we encounter with every current mineral feeder on the market is the lack of selectivity and regulation of mineral dispensing which leads to lost minerals, spread of disease and inadequate nutrition for the cattle.

The characteristics that remain possible to improve these feeders include animal selectiveness, regulated dispensing capabilities as well as tracking and recording of each

[6] 3C Cattle Feeders
http://www.3cfeeders.com/clients.html

animal's time spent at the feeder (and hopefully, amount consumed). These characteristics have not previously been included in the past for several reasons. The recent rising cost of existing minerals and more expensive medicated minerals creates a new market. In the past, minerals weren't as expensive and customers were not as concerned about mineral loss or cattle intake amounts and therefore weren't as willing to spend more money to correct it. Another reason would be that the addition of newer precise features on feeders increases the cost dramatically. And lastly, an increasing hog population has caused drastic mineral loss to ranchers and spread of disease has risen recently. Obviously in the past these issues were present but not as relevant as they are currently.

COMPETITIVE ANALYSIS

In the current mineral feeder market there is no known selective mineral feeder being produced or in production. Research into what is currently produced has shown that mineral feeders on the market are focused on protection from weather and fly control. Below are the general designs of what is currently on the market.

 [7]

Figure 1. Current mineral feeder designs

These three designs are inefficient in that they do not:

- Regulate amount of mineral provided for each animal

[7] www.behlencountry.com/products/mineral_feeders

  - "Animal to animal variation in intake is greatest with free-choice mineral supplements. Some cattle consume no supplement while others may consume as much as four or five times the intended daily amount." [8]

- Provide complete protection from weather elements
  - Minerals subject to inclement weather, and therefore will bridge up due to moisture, or will be wasted due to wind and other elements
- Regulate against mineral consumption from wild animals(ex. feral hogs, deer, birds)
  - One of the most relevant advantages of this restrictive feeder is the protection of cattle from receiving diseases spread by wildlife. Of all concerned species, feral hogs carry and transmit the most dangerous diseases. Of these, Swine brucellosis and Pseudorabies are the most researched in the U.S. One Texas A&M Professor states that, "The spread of PRV from feral swine to domestic cattle has been observed on multiple occasions in Florida and Texas. Contamination by feral swine of supplemental feed spread on the ground for cattle is suspected as the source of infection." [9]After observing our potential distribution areas, we find that this is exactly the advantage we need. Hogs of the Southeast, Texas and California are contaminating cattle supplements, such as minerals, and thus infecting the livestock. Moreover, a scientist representing the Missouri Department of Conservation further explains the dilemmas livestock producers face by not protecting their supplement sources:

    > In addition to the ramifications of swine brucellosis . . . it causes lost reproduction and reduces profits in commercial hog operations and can be transmitted to other species including cattle. Pseudo rabies is another disease that infects wild swine and can be transmitted to hogs in commercial operations. This disease is caused by a herpes virus, does not infect people and is not related to rabies. . . Once infected, a pig is a carrier as long as it lives because there is no effective treatment. It sheds

[8] *David Lalman and Casey McMurphy.* **"**Vitamin and Mineral Nutrition of Grazing Cattle" Oklahoma State Animal Science. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2032/E-861web.pdf

[9] Davis, Donald S. Department of Veterinary Pathobiology. Texas A&M University, College Station, Tx. 1997. http://texnat.tamu.edu/symposia/feral/feral-12.htm

the virus through its mouth and nose and can transmit the disease to cattle, sheep, goats, dogs and cats where it is fatal [10]

3C plans on producing a mineral feeder that will eliminate each of these draw backs, and in doing so will give 3C a marketable advantage over what is currently on the market.

Local Competition

Through visits to Stillwater Milling, Tractor Supply, and Atwood's we were able to look at the local dealers of mineral feeders, with Stillwater Milling being the largest. Stillwater Milling provides a hood covered mineral built by Politron: $135.00, and a heavy duty poly feeder by Pride of the Farm: $142.50. Atwood's also sells the Politron Feeder: $124.99; and a poly bull feeder: $119.00. Tractor Supply sells an unknown brand hood feeder. Of the local mineral feeders being sold Politron has the most presence in the local Stillwater market. Also at another Stillwater Milling location in Claremore a Blue Prize poly bull mineral feeder: $134.00 is sold; also they sell a Priefert wind vane feeder: $132.00. At Shawnee Milling south of Stillwater the Priefert wind vane feeder: $132.00; also a poly bull feeder: $102.00.

On a side note other local competition for 3C is in the creep feeder market, Stillwater Milling: FarmStar, L-H Manufacturing, B-J Manufacturing, Bar-6, and Politron. Also a Trip Hopper (T & S MFG., Inc.) is sold at Stillwater Milling that is very similar to 3C's Digital Counting Feeder. Atwood's also sells the Politron creep feeder.

Other Competition

Research is showing that currently there is not anything on the market in the form of a selective mineral feeder. This will give 3C an advantage over other companies that produce mineral feeders. With 3C breaking into this new market they will be competing with nineteen or more companies that are already established in the market. The majority of these companies are national distributers (including Canada) while others distribute to their region of the U.S.

[10] "Feral Hogs - Threat to People, Agriculture and Missouri's Natural Resources." Missouri Department of Conservation. **Document ID: 20030924. February 2002.**

Below is a table of current major companies that are established in the current mineral feeder market.

Table 1. Manufacturers, Location, and Web Addresses, November 2009[11]

Manufacturer	Location
Behlen Country http://www.behlencountry.com	Columbus, NB
Bergman Steer Feeders http://www.bergmansteerfeeders.com	Loganville, WI
BHF Manufacturing Inc http://www.bhfmfg.com	Ontario, Canada
Easy Way Cattle Feeders http://easywaycattlecare.com	Decorah, IW
Fortex-Fortiflex http://www.fortexfortiflex.com	Unknown
H & H Farm Products Mfg Inc. http://handhmanufacturing.com	Bolivar, MO
Hastings Equity Grain Bin Mfg. Co. http://hastingstank.com	Hastings, NE
High Country Plastics http://www.highcountryplastics.com	Unknown
L-H Manufacturing http://l-hmanufacturing.com	Hastings, NE
Meyer Manufacturing http://www.meyermfg.com	Dorchester, WI
Preston DuBose http://easyopenfeeders.com	Unknown
Rotonics http://www.rotonics.com	Gainesville, TX Gardena, CA

[11] Google Searches; Research calls to Competitors

Rubberline Inc. **http://www.rubberlineinc.com**	Muenster, TX
Sioux Steel Company **http://www.siouxsteel.com**	Sioux Falls, SD
Tater Gate Farm and Ranch Equipment **http://www.tartergate.com**	Dunnville, KY
Townsend's Sales Livestock Equipment **http://townsendequipment.com**	Trafalgar, IN
Priefert Ranch Equipment **http://www.priefert.com/**	Mnt. Pleasant, TX
Poli-Tron Inc. **http://www.politron.com/**	Pittsburg, KS
Pride of the Farm **http://www.hawkeyesteel.com/products/potf/potfprod.html**	Unknown

Further information about these manufactures is in the appendix. The majority of the manufactures produce mineral feeders of the traditional design that was shown earlier in the report. The designs are the weather vane design or covered poly tub design; while others produce untraditional designs that are listed in the appendix material.

Most mineral feeders on the market have a simple design that is focused around protection from weather and fly control. But with what's currently on the market being inefficient at doing this 3C will have a competitive advantage with the implementation of a selective mineral feeder over these current established companies. The selective feeder will have an enclosed bin to hold mineral, completely shielding it from weather, while currently mineral feeders don't completely protect from weather. Also current feeders have no way of regulating the amount of mineral that a animal can consume, 3C's feeder will correct this problem and be able to monitor how much each animal consumes. Fly control is also a concept that will go into the design of the feeder, which will make 3C's innovative design even more marketable.

Advantages over Competition

The Advantage's 3C will have with the introduction of a Selective Mineral Feeder into the agriculture market:

- Already established producer of feeders in the cattle industry
- No current mineral feeder of these type being produced

- Valid reputation as Quality company among customers
- Established Dealers across target market
- Dealers located in main cattle industry region of U.S. (TX, OK)
- Able to easily supply new dealers in market (Atwood's, Orscheln's)
- High Quality durable products

Cost vs. Benefits

We have developed the costs and benefits of in order to confer the overall reason to farmers and ranchers about why they should purchase our selective entry feeder. This will help to market the feeder as well as point out its overall benefits compared to other feeders. In pointing out the costs associated with the mineral feeders currently on the market you can view the table below:

Mineral	Price 50lbs	1 year	2 years	5 years
Cow Calf CTC	$17.10	$1,560.38	$3,900.94	$7,801.88
Medicated wormer	$40	$3,650.00	$9,125.00	$18,250.00

Numbers in the table above were obtained from an excel spread sheet where we took the cost of a fifty pound bag of mineral and computed the amount of time a fifty head herd of cattle would take to consume it. These estimates were configured utilizing the fact that each cow would consume 4 ounces/day (average being 3-5 oz.). Next, we found that there are 800 ounces in a 50 pound bag of mineral which provided 200 servings of needed mineral/bag. This results in a 50 head herd consuming the 50 pound bag in four days, and thus the mineral must be replenished ninety-one times a year, and at $17.10/bag, or $40/bag, this can range mineral costs from $1560.38 to $3650.00. The most relevant point to be made is that these thousands of dollars can be considered a loss if these minerals are not going towards your operation but towards wildlife such as feral hogs in the area. So the point needs to be conveyed to customers that if they purchase the selective access mineral feeder they will not suffer this type of loss to their operation.

Competitive Position

- Quality
- Durability
- Efficiency

Viewing the competition 3C looks at a product based on the three factors above. The best example of current competition is the Trip Hopper produced by Bar-6. The Trip Hopper is very similar to 3C's Cube feeder, but the Trip Hopper doesn't handle commodity feeds as well as the digital cube feeder. Also the trip hopper is cheaper, but the quality of the design and steel are of a lower grade. Being a less efficient product than 3C's cube feeder the trip hopper is a poor choice compared to the more efficient, heavier built, and durable cube feeder produced at 3C.

Barriers to Entry

By introducing a selective access mineral feeder into the current market 3C will be ahead of competitors with the traditional designs. With this being a completely new and innovative product it will be patented giving 3C an advantage. Competitors could enter the market with a similar product to a 3C's feeder. Barriers for competitors would include development of a design that will not violate 3C's patent, analysis of current market potential for their product, and costs to obtain start up materials. Also with competitors only producing the traditional mineral feeders they would be in the position of having to train or even hire new personnel to produce something similar to 3C's selective feeder. Being the first to develop anything like this in the mineral feeder market puts forth a long term threat for 3C. Competitors will be able to take the concept of the selective mineral feeder and elaborate or design something similar with different features than that which is being designed for 3C. From our current market research the companies that would most likely be able to break through these barriers are:

- Rotonics
- Behlen Country
- L-H Manufacturing
- Priefert
- Politron
- Bar-6

This assessment was made based a competitors capabilities in engineering and distribution. By recognizing this threat 3C can plan to change and improve on the selective feeder as competition arises and develops in the current market.

Strategic Opportunities

The current market potential for the selective mineral feeder will be greatest in areas where cattle producers face losses because of wildlife consuming large amounts of mineral that is intended for their livestock. With the introduction of a selective feeder this problem should be able to be corrected. Because of this 3C has the opportunity to

- Increase employees to meet new production needs
- Become a more competitive cattle equipment manufacturer
- Increase 3C's reputation as a quality cattle equipment manufacturer
- Expand into a new market
- Introduce a product that can benefit the entire cattle industry
- Greatly expand their current business
    - Distribution potential due to hog populations

      A concern of Lick of Sense Solutions is 3C's ability to expand distribution and where to find each and every target market. We have printed three different maps: one of current 3C dealers, one of feral hog populations in the US, and one of the deer populations in the United States. By deciphering each, it becomes apparent where our target markets are located. 3C's distribution into Southern Texas, the Southeastern states and even California could be invaluable in benefits and increased sales. Not only are hogs prevalent in these areas, but deer populations have proven to be a factor as well (with the exception of California's slight deer census). The literature reviews of wildlife disease contamination would certainly add to the appeal of buyers in these areas. Moreover, after we have completed pricing factors, we can argue the advantage of saving a dramatic amount of money per head by using selective entry and regulated dispensing features.
    - Transportation of mineral feeder

      In addition, it is speculated that the mineral feeder that is ultimately designed will be easier to manufacture and transport to locations. This is due to the fact that the mineral feeder will be considerably smaller and lighter than both the cube feeders and creep feeders. With size and weight no longer constraints for 3C, distribution

is expected to expand to the regions listed above by adding more feeders per truck load and decreasing transportation cost per unit.

There is nothing currently on the market similar to a selective mineral feeder. Therefore 3C is in a unique position to become an even greater competitor in cattle equipment market by starting new trends in the industry, and having a large advantage over their competitors.

CURRENT MINERALS / MINERAL REQUIREMENTS

Dr. Jonni Rossi, an Animal Scientist for the University of Georgia explains the relevance of mineral feeder placement and durability:

> The placement of mineral feeders is a very important part of supplying minerals to the cow herd. . . A rule of thumb is to provide one mineral feeding station for 30 to 50 cows. The best areas to place mineral feeders are near water, in shaded loafing areas and near the best grazing areas. . . A good feeder should (1) keep minerals dry, (2) be portable, and (3) hold up to abuse and corrosion. Open tubs are not adequate in the Southeast. Because minerals can be corrosive to metals, wood and fiberglass; plastic mineral feeders usually last longer. [12]

Here are some tables from University of Georgia's Bulletin outlining the mineral requirements in the Southeast, and the mineral content found in common forages and feedstuffs:

[12] Rossi, Johnny. "Mineral Supplements of Beef Cattle." Extension Animal Scientist. Bulletin 895, 2006. http://pubs.caes.uga.edu/caespubs/pubcd/B895/B895.htm

Table 1. Macro mineral requirements and maximum tolerable levels for beef cattle.

Mineral	Lactating cows	Dry Cows	Growing Calves	Maximum Tolerable Level
Calcium, %	0.31	0.18	0.58	——
Magnesium, %	0.10	0.12	0.20	0.40
Phosphorus, %	0.21	0.16	0.26	——
Potassium, %	0.60	0.60	0.70	3.0
Sodium, %	0.07	0.07	0.10	——
Sulfur, %	0.15	0.15	0.15	0.40

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Table 2. Micromineral Requirements and Maximum Tolerable Levels for Beef Cattle.

Mineral	Lactating Cows	Dry Cows	Growing Calves	Maximum Tolerable Level
Chromium	——	——	——	50.0
Cobalt, ppm	0.1	0.1	0.1	10.0
Copper, ppm	10.0	10.0	10.0	100.0
Iodine, ppm	0.50	0.50	0.50	50.0
Iron, ppm	50.0	50.0	50.0	1000.0
Manganese, ppm	20.0	40.0	40.0	1000.0
Molybdenum, ppm	——	——	——	5.0
Nickel	——	——	——	50.0
Selenium, ppm	0.10	0.10	0.10	2.0
Zinc, ppm	30.0	30.0	30.0	500.0

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Table 3. Mineral content of commonly used forages and concentrate feeds

Feedstuff	Calcium %	Phosphorus %	Potassium %	Sulfur %	Copper ppm	Zinc ppm
Bahiagrass Pasture	0.46	0.22	1.45	0.21	8	20.0
Bermudagrass Pasture	0.39	0.26	1.3	0.28	9	20.0
BermudagrassHay	0.43	0.20	1.61	0.21	9.0	20.0
Fescue pasture	0.51	0.27	2.3	0.19	5.8	18.7
Fescue hay	0.51	0.37	2.3	0.18	6.0	22.0
Corn	0.03	0.31	0.33	0.14	4.8	16
Corn silage	0.25	0.22	1.14	0.12	4.2	17.7
Corn gluten feed	0.07	0.95	1.40	0.47	7.0	73.3
Cottonseed meal, 41%	0.20	1.16	1.65	0.42	16.5	74.0
Whole cottonseed	0.16	0.62	1.22	0.26	7.9	37.7
Soyhulls	0.53	0.18	1.29	0.11	17.8	48.0
Soybean meal, 44%	0.40	0.71	2.22	0.46	22.4	57.0
Molasses	1.00	0.10	4.01	0.47	65.7	21.0
Citrus pulp	1.88	0.13	0.77	0.08	6.2	15.0

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Below is a quote from High Planes Journal about the importance of mineral to a cattle producers operation:

> Providing a complete mineral supplement can greatly impact the performance of beef cattle. Marginal mineral deficiencies can easily go undetected, resulting in decreased reproductive efficiency, poor growth performance and depressed immune function. All of these factors ultimately impact your profitability. Providing a free-choice, complete mineral supplement all year is cheap insurance against the many problems associated with mineral deficiencies. [13]

[13] Miles Dabovich, "Mineral supplements for your cattle." *High Plains Journal.* April 21, 2008. http://www.hpj.com/archives/2008/apr08/apr21/Mineralsupplementsforyourca.cfm

Listed below are the average mineral makeups of common Oklahoma forages compared to the requirements of cattle in the region as provided by Oklahoma State University Extension:

Table 1. Average mineral concentration of common Oklahoma forages and dietary requirements of beef cattle.

Mineral	Alfalfa/Clover	Bermudagrass		Fescue	Native	Beef Cattle[a]
Phosphorus, %	0.27	0.21	0.23	0.08	0.15 to 0.3	
Sodium, %	0.08	0.04	0.02	0.01	0.06 to 0.08	
Iron, ppm	198	114	110 1	90	50.0	
Copper, ppm	12.4	6.3	5.0	5.7	10.0	
Zinc, ppm	23	22.4	17.8	22.5	30.0	
Selenium, ppm	0.3	0.15	0.09	0.21	0.10	
Manganese, ppm	47.6	83.9	122	51.6	20.0	

[a] Adapted from NRC, 2000.

As you can see, minerals required and minerals provided do not normally add up. This is especially true throughout the different seasons of the year when many types of forage become dormant. One option to designing a new feeder was to reformulate the mineral composition so that it wouldn't corrode metals. However, after extensive research was conducted, it appears to not be feasible to reduce Sodium levels to a non-corrosive point. Sodium, commonly referred to as salt (when combined with Chlorine), is one of the most important nutritional requirements in cattle. Dr. Johnny Rossi explains this further:

> Sodium and chlorine (salt) provide for the proper function of the nervous and muscular systems. They help regulate body pH and the amount of water retained in the body. A deficiency of these elements causes loss of appetite and inefficient weight gains or body weight loss. Sodium is commonly deficient in diets, but chlorine levels are usually adequate. Both minerals are present in soft tissues and fluids and there is very little storage of these elements, so a constant, daily source of sodium and chlorine must be provided.

An interview was conducted with Dr. Robert Kropp, the beef cattle specialist in Oklahoma State University's Animal Science Department. After asking Kropp what the most feasible way to create a mineral formulation without it being corrosive, he stated, "There isn't

one." He went on to explain that salt is used to regulate intake of minerals, which prevents overconsumption. However, even when the minimum requirement is met, the sodium is still corrosive. Dr. Kropp's "solution" to the problem would be to take salt completely out of the mineral composition and feed salt blocks, which brings up the issue of contamination from feral animals as well as waste from weather and greedy stock.

RELEVANT PATENTS

Pat # 4735171 (April 5, 1988)

Animal Feeding Apparatus

Inventor: James O. Essex

Relevance

This design has several features that may be used in the final design. One such feature is an auger system for conveying a granular type material from a hopper into a bowl, tray, or trough type structure that will allow the animal access to the material. The other feature that may be employed in this project is the control system. The control system for this device is simply a timer that operates the auger conveyor for a set duration of time. The system also has a sensor at the bottom of the food bowl that senses the weight of the food in the bowl. The patented design can be used to trigger ideas and utilize the same advantages, such as the timer, auger conveyor or the hopper.

Abstract/Description

Feeding apparatus which includes a feeding dish dimensioned for receiving a predetermined single food portion and structure for receiving a quantity of food which is at least as great in quantity as a plurality of food portions and structure for delivering a single predetermined portion from the structure for receiving into the feeding dish. The structure for delivering includes structure for sensing the weight of the feeding dish and the associated food disposed therein and a timing mechanism. The structure for delivering operates when the feeding dish is substantially empty and in addition a predetermined interval has elapsed.

Pat # 5735231 (April 7, 1998)

Automatic Dog and Cat Feeder

Inventor: Bruno Terenzi

Relevance

This device has an enclosed hopper system utilizing gravity and a flow control for the application of the product. The time interval that the solenoid retracts the stop is determined via a timer that puts a current through for a set and programmable time period. Also the design has another timer that controls the time of day that the device is triggered for dispensing. A method similar to this could be easily utilized to only allow the cattle to trigger the mineral feeder at certain times of day, as well as controlling the amount of mineral that is dispensed each time the mineral feeder is triggered.

Abstract/Description

An elongated vertically extended housing enclosed a hopper. Its lower end funnel connects to fittings extending to the exterior of housing into a feed dish. The pipe holds the dish in place. Dry feed material is controlled electrically by a solenoid operated valve incorporated into the lower fitting to hopper. Two timers will control when and how much feed should be released. The first timer activates time of day; the second timer dispenses the feed portion. The second timer will be adjustable in seconds per minute. The feed valve solenoid remains open releasing the feed material. The automatic dog and cat feeder can be used indoors and outdoors. Its exterior cabinet as well as the frame is sheet metal. The feeders as well as others are to a degree fairly waterproof, but for outdoor use an inexpensive plastic cover as an accessory provides inclement weather protection.

Pat # 5653567 (August 5, 1997)

Mobile Cattle Feeder

Inventor: Charley A. Taylor

Relevance

This device has multiple ideas that can be incorporated into the mineral feeder for metering, hopper design, and door actuating. The design uses an endless conveyor to move

material from the hopper to the ground where the cattle can consume the product. The door is actuated by using the mechanical power of the conveyor to open the door at predetermined intervals during operation. For ration control, a sliding door can be adjusted allowing only a certain amount of feed to reach the outlet at a given time. For the mineral feeder, we may incorporate the adjustable door for ration control, as well as the endless conveyance system to actively move the mineral.

Abstract/Description

A mobile batch feeder for cubed feed consisting of a supply hopper with conveyor leading to a cumulative dispensing chute. Rotational input to drive the conveyor also functions to trip open the dispensing chute periodically thereby to dispense measured batches of cube feed.

Pat # 4981107 (January 1, 1991)
Computerized Automatic Cattle Feeder System
Inventor: Gaetan Beaudoin
Jacques Cimon

Relevance

The computer system for this invention will allow the cattle to receive an individualized ration that is prescribed by the rancher.

Abstract/Description

There is a disclosed computerized automatic feeder system for feeding individualized prescribed rations to cattle confined in successive individual stalls aligned along a set path. The system comprises an apparatus capable of moving to each stall successively and having appropriate devices for preparing, at each stall, and individualized ration for the cattle head in that stall and delivering it to that animal. A computer is mounted on the apparatus for controlling the operations of moving the apparatus to the stalls and preparing and delivering the rations.

Pat # 4947796 (August 14, 1990)

Dog Feeder Apparatus

Inventor: Joseph F. Robinette

Relevance

The overall design of this device can be used as a model for the shape and orientation of the mineral feeder. This particular device cannot actively meter the food, and does not house a control system for limited access, but the hopper-dish relationship is logical.

Abstract/Description

A dog feeder apparatus is set forth wherein a plurality of tanks and associated trays are included within the apparatus wherein a water tank provides fluid to a forwardly oriented bowl assembly wherein a dog feeder apparatus accordingly provides a dry-type dog food to a forwardly oriented second bowl apparatus wherein an intercommunicating manually reciprocatable valve enables fluid from the water bowl to enter a perimeter through about the dry dog food bowl to effect moisturizing of the dry dog food.

Pat # 4782790 (November 8, 1988)

Automatic Dog Feeder

Inventor: Dalton B. Batson

Relevance

There is an endless conveyor to move the product from the hopper to the area accessed by the animal that may be used for the mineral feeder. This device meters the food by opening a gate to the conveyor for a predetermined duration. The delivery method used could be used in the mineral feeder.

Abstract/Description

An automatic dog feeding machine stores a clean and dry supply of dog food. It dispenses measured amounts into a feeding dish as predetermined intervals. It also provides water. The dispensing mechanism includes a hopper with a gates side aperture and an endless conveyor belt while within the hopper, the gate opens for a predetermined interval, and the belt

carries the food through the aperture to drop down into a chute and thence into a food dish accessible to the animal. The belt runs long enough after the gate closes to dispense all the food on the belt outside the hopper so that all the food remaining inside the machine is maintained within the hopper in protected condition.

Pat # 4363291 (December 14, 1982)

Automatic Cattle Feeding Device

Inventor: Jan H. Harmsen

Relevance

This device has an enclosed hopper design that meters a set amount of feed into an area accessible by cattle. The metering device feeds down into a tube that is inserted in the back side of the trough housing. The dispensing device is designed so that cattle may not bump the device to get more food. For conveying the feed material, an auger is used fed by gravity to pull the feed down from the hopper above.

Abstract/Description

A device for feeding cattle, comprising a housing having a head insertion opening therein and a dosing device for supplying food to the feeding device, controlled by signals generated in response to the presence of cattle at said opening, and which makes it possible to give an adapted portion to each individual. According to the invention the device is characterized by a flap disposed downstream of the dosing device and arranged for allowing the passage of one dosed quantity of food at the time. It is thus prevented that an animal can cause residues of food to fall from the dosing device by bumping against the device.

Pat # 6446574 (September 10, 2002)

Animal Actuated Feeder

Inventor: Robert Henry Bickley

Relevance

This device will allow access to an animal by requiring that animal to step on a scale. Upon being triggered the device will actuate the door which will lift up and back out of the animals way so that that animal can gain access to the food.

Abstract/Description

An animal-actuated feeder has a treadle to be tread upon by an animal desirous of obtaining food, a food compartment, a cover with closed and open positions denying and granting access to the compartment, and linkage to open the cover when the animal treads upon the treadle. A damper is coupled to the cover and dampens transit between open and closed positions. A dish having a mating lid coupled to the cover promotes the retention of the food in a palatable condition. A plurality of moat assemblies serve as legs for the feeder and inhibit crawling arthropods from gaining access to the food. A control unit and latch control the opening of the cover in response to a tag unit worn by the animal treading upon the treadle.

Pat # 4079699 (March 21, 1978)

Automatic, Timed, Adjustable Quantity Feeding Device

Inventor: Edward Glen Longmore
Betty Marie Longmore
Leonoard Bohacik
Dona Elena Bohacik

Relevance

This device is a stand-alone feeder that will be able to feed an animal for extended periods of time. The mineral feeder must complete the same job.

Abstract/Description

This invention relates to the remote and unattended control of animal feeding and is more particularly concerned with a novel means of feeding unattended animals for extended periods of time.

Pat # 4022263 (May 10, 1977)

Magnetically Actuated Cat Door

Inventor: Richard W. Beckett
Marian P. McBride
Michael B. Johnson

Relevance

There is a sensor that is used to actuate access to a particular item, in this case, the animals home. A sensor of this type can be implemented in the mineral feeder to allow access to cattle, and deny access to any animal that does not possess the appropriate tag.

Abstract/Description

A magnetically actuated cat door is provided wherein the owner's cat can wear a magnet and go freely in and out of the door while other cats are effectively barred from entering.

Pat # 6044795 (April 4, 2000)

Automatic Feeding System Having Animal Carried Transmitter Which Transmits Feeding Instructions To Feeder

Inventor: Taketoshi Matsuura
Eiji Fujii
Kazuhiro Mori

Relevance

Once again this device requires that a sensor mounted on the feeder receives a signal to an emitter worn by the animals whom are granted access. Once the animal is in close enough proximity, the feeder will begin operation. The feeder is programmed to feed each animal different amounts of food based on the owners desires.

Abstract/Description

An automatic feeding system includes a tag attached to a body of a pet; and an automatic feeding apparatus for automatically feeding the pet. The tag includes a receiving device for receiving an electromagnetic wave from the automatic feeding apparatus; an information memory device storing information on the feeding of the pet and outputting the information in response to an output from the receiving device; and a sending device for sending the information which is output from the information memory device to the automatic feeding apparatus using an electric wave. The automatic feeding apparatus includes a receiving device for receiving the electric wave from the tag; an information reading device for reading the information on the feeding of the pet in response to an output from the receiving device of the automatic feeding apparatus; a feeding device for supplying feed based on the information; and a sending device for sending an instruction to read the information on the feeding of the pet to the tag using an electric wave.

Pat # 7124707 (October 24, 2006)
Selective Animal Feeding Apparatus
Inventor: Jennifer Anne Clarke

Relevance
The apparatus is equipped with a sensor that will detect an emitter that is worn by the animal to allow access.

Abstract/Description
An apparatus for the dissemination of food to a first animal when the first animal is disposed proximate the apparatus includes a container for receipt of the food and a transmitter that is attached to the first animal and a receiver that is operatively attached to the apparatus. The transmitter emits a signal continuously according to a preferred embodiment or a signal only when it is proximate the apparatus, according to a modification. The apparatus is adapted to receive and respond to the signal to allow access to the food in the container when the signal is present. When the signal is not received by the apparatus, access to the food in the container is denied.

Pat # 7228816 (June 12, 2007)

Animal Feeding Device And Method

Inventor: Robert Michael Turner

Mark David Olcott

Relevance

This device allows access to a food supply using sensors that are programmed into the device. A sensor system such as this is needed for the mineral feeder. The idea of two animals being present and the device shuts access to all animals temporarily may also be utilized.

Abstract/Description

An automated feeding system for pets with special diets includes a feeder dish which is made accessible to a pet only when an ID tag on the pet is recognized as authorized by a receiver on the device and only for a certain time period. The appropriate amount of food is thereby made available at appropriate time intervals. If a plurality of tags is preprogrammed as authorized, each animal's tag can sequentially activate the feeding device to feed each animal, respectively. However, if more than one authorized tag is present in the feeding time set for one animal, the drawer closes.

GENERATION OF DESIGN CONCEPTS

Generation of concepts for the mineral feeder was done by brainstorming in team meetings, and also by individual brainstorming. Any and all ideas were discussed as possible solutions. All were compared against each other, and against the team's criteria. The main judging criterion was practicality. This feeder must be practical to manufacture and use. Other judging criteria were ease of use, if it involved any user defined elements, cost, effectiveness at keeping unwanted animals out, and also how the cattle would react to it. A list of desirable features was also developed that the concepts were compared against. These included limiting mineral intake by dispensing and/or metering, and recording of which cattle have eaten at the

feeder. The last mentioned feature was later removed from the list after discussion with our sponsor.

Overall Concepts

The following is a list and brief description of the possible design concepts for the selective mineral feeder. Pros and cons to each concept are also discussed.

Fenced off mineral feeder

Use fencing like that on the creep feeder to keep certain sized animals out.

Pros

- Cheap and easy to make
- Could contain desired features

Cons

- Most likely would not be effective at keeping hogs out
- Would be bulky and not very easy to handle and move around

Deer Feeder type

Bear currently make a deer feeder for personal use with a center hopper and "feeding arms" coming out on each side that allow the deer to feed at will.

Pros

- Cheap and easy to make
- Would only need to modify current design to work for cattle
- Effective at keeping hogs out

Cons

- Would not limit mineral intake
- Could not keep deer out

Kill the hogs

Use current feeder and mineral, but include an additive in the mineral that makes it poisonous or undesirable to the hogs.

Pros

- Cheap

Cons

- If undesirable or poisonous to hogs, would also most likely be undesirable or poisonous to cattle
- Not very practical
- Contains none of the desired features

Dog Feeder

Kay Watson informed us of a dog feeder that she had seen, that was essentially a dish with a half sphere on top of it. When activated by the pet's collar, half of the half sphere lid rotated back into the bowl to allow the pet access to the food. This was considered because it could easily be adapted for larger animal use.

Pros

- Simple and practical
- Would only need to modify current design
- Could be very effective at keeping unwanted wildlife out

Cons

- Contains none of the desired features
- Needs electrical power

Feeder door

Use a feeder similar to the plastic feeders on the market, and modify it to have a door that would be activated by the cattle to allow them access.

Pros

- Simple and practical
- Effective
- Would only need to modify current design

Cons

- Does not limit intake
- Needs electrical power
- Very susceptible to failure in weather conditions such, as the door freezing

Poly cone-bottom tank

Use a poly cone-bottom tank as a hopper with a dispensing system underneath it that would be activated by the cattle. Mineral would be dispensed into a trough or some other container for consumption.

Pros

- Effective
- Limits mineral consumption
- Contains desired features
- Uses existing products, which would decrease fabrication
- Limits mineral consumption

Cons

- Most poly tanks found have small openings which would cause slow dispensing
- Needs electrical power
- Dispensing system would be external, exposed to the weather

Self contained hopper and trough

This alternative is somewhat of a combination of the feeder with the added door, and cone-bottom tank concept. This feeder would also have a hopper and dispensing system that would dispense into trough. The overall design would be like that of existing feeders, but modified to contain a hopper

Pros

- Effective
- Limits mineral consumption
- Contains desired features
- All moving parts contained within the feeder, out of the weather
- Feeder, dispensing system, trough all contained together

Cons

- More complicated than many of the alternatives
- Needs electrical power

Non-electric Powered Concepts

The following is a list of the design concepts that were developed in order to eliminate the need for electrical power on the feeder.

Cattle Powered Step Plate

The dispensing mechanism would be powered by using the cattle's weight. The cattle would step on a plate, or similar device that would then move to create the movement required for dispensing

Pros

- Contains desired features
- Effective
- Does not require electrical power
- Relatively cheap to build

Cons

- Cattle may not like it, b/c of the moving plate
- Linkage system may be complex

Cattle Powered Door

Cattle would push in a door to access the mineral, the movement of the door would be used to dispense the mineral

Pros

- Contains desired features
- Effective
- Does not require electrical power
- Relatively cheap to build

Cons

- Cattle may not like it, b/c of having to push the door
- Linkage system may be complex
- Still vulnerable to deer intrusion

Recommendation

After considering all of the alternatives, the team felt there were two concepts that clearly stood out as the best alternatives to pursue. These were the hopper type feeders. These two alternatives, while being slightly more complicated than some of the other concepts, fulfill all the requirements, and allow for implementation of the desired features. We believe having the mineral storage and trough in different locations has distinct advantages. It would help in preventing the spread of disease because the hogs would not be rooting in the mineral. It also keeps the mineral out of the elements, and allows for precise dispensing and metering. Furthermore, we believe the self contained hopper and trough is the superior of the two hopper alternatives. This design will allow for better metering, faster dispensing and be an overall nicer looking product, while still maintaining all the advantages of the other hopper alternative.

Mineral Dispensing/Metering

With the generation of concepts that allow for the desired features, brainstorming was done on how to implement these features. With the hopper type design, it is critical to have a dispensing system. Since a dispensing system will already be in place, it will take minimal effort to allow the dispensing system to double as a metering system. Many alternatives were considered for dispensing and metering. These were:

- Metering wheel-like those used on grain drills
    - Easy to manufacture
    - Low power requirements
    - Can be cheaply made out of plastic, which is corrosion resistant
    - Limited amount of moving parts
    - Precise
- Metering disk-similar to metering wheel, just oriented horizontally instead of vertical
    - Easy to manufacture
    - Can be cheaply made out of plastic, which is corrosion resistant
    - Limited amount of moving parts
    - Precise
- Auger

  - Will most likely require more power
  - More expensive to manufacture than the metering wheel/disk
  - Limited amount of moving parts
  - Precise
- Conveyor
  - More complicated to implement
  - Not as precise
- Bucket conveyor
  - Complex to manufacture and implement into small space
  - Potentially expensive
  - Lot of moving parts
  - Very precise metering

Once again the pros and cons of each method were weighed by the team. The list was narrowed down to two methods that we believe are superior to the rest. We feel that either a metering wheel or an auger system will work best for our situation. Testing must be done on both alternatives to determine which one is in fact the best.

Sensors/Electronics

A scale can be used to measure the weight of the animals attempting to gain access to the mineral. Cattle are usually far heavier than that of feral hogs, and thus using a sensor such as this will allow, in most cases, the dispensing of mineral only to cattle. There is a negative side to this type of sensor however, being that feral hogs generally travel in groups, and can be quite large. If several feral hogs were to get on the scale, and be of proper weight, the mineral feeder would allow access mistaking the group of feral hogs for a cow of proper weight.

Utilizing the cattle and feral hog height differences is another option. If there were a sensor or array of sensors that can detect and measure the height of an object, and distinguish the height of a cow from that of a feral hog, the mineral feeder can be actuated with a fair amount of accuracy. Using this type of a sensor however will allow deer to continue to activate and gain access to the mineral feeder.

RFID

Passive RFID could be used for this system; however, this technology requires very expensive tags and tag readers. The passive RFID tags are usually found to be up to ten times the cost of that of a regular plastic ear tag and if the producer is to purchase new tags for new cattle, those tags must be programmed into the reader.

Active RFID would be the ideal technology for activating the mechanisms of the mineral feeder; however the cost, programming, and non-ear tag form make this type of sensor unattractive. Another downside to this technology is that each unit needs batteries which need to be replaced periodically or charged by means of solar power. Overall, this technology would be an excellent candidate for use in the mineral feeder in the future when costs are lower, and the technology is in a more practical form.

Reflectivity is another method that will allow the cattle to be outfitted with something that a sensor will be able to recognize. The ear tag of each animal can have a sticker installed that will reflect a certain wavelength of light, which the sensor will be able to read as an animal that can be allowed access. The process of changing the stickers would be simple, and easy to do given that the cattle are in a chute, and would not require any programming on the part of the rancher.

Heat signatures, or thermal imaging, could also be used effectively, utilizing the differences in the shape of cattle, feral hogs, and deer. Thermal imaging essentially takes a picture of the heat emitted by the animals, which all have a different heat signature or pattern. Processing software will be able to identify the animal by the heat signature, and make a decision to allow access to that particular animal.

Facial or shape recognition can be used in a similar way as thermal imaging, but with much more affordable sensors. Facial or shape recognition uses a simple camera, that sends the information to a computer that has a bank of allowed shapes, and the computer will make a decision based on the picture that it takes. Also with this method of recognizing cattle, the ear tags themselves can be used as the shapes of ear tags are not naturally a part of a feral hog or a deer. In other words, a feral hog or deer will not have a rectangular shape on the ear naturally, and the software can be programmed to recognize all of the possible shapes of ear tags. This method seems like a very promising technology for this feeder.

Power/Charging

For powering the sensors as well as the motor(s) on the mineral feeder, the most logical choice will be a 12V car battery. This power source is a common source and can be purchased in many locations. Another reason to use a 12V source is that it is the most common voltage on many DC electric motors and sensors.

Keeping the battery charged will require a charging source that does not require an AC power input such as household power. The units that have been considered for this job are solar panels, or a small wind turbine that will be mounted on the mineral feeder. A problem with both of these methods is that they are both susceptible to hail and ice storms that may damage the units, so a protective transparent cover will be needed for the solar unit(s). Solar power is the most likely charging method due to the lack of moving parts, as well as the lower cost of the units. A solar panel will need a diode to keep from discharging the battery during the night hours or on a cloudy day when there is no energy being captured.

Some other sensors can be employed in order to conserve energy. During the night hours there can be a light sensor that completely shuts off the mineral feeder to any operation when the battery is not being charged. Should the mineral feeder be activated multiple times with a short duration of time between activations, and the battery is discharged to a certain point, a voltage sensor can be connected so that the battery will not undergo a deep discharge period, thus compromising the life of the battery. The way that these sensors will be integrated into this system, they will each shut off the battery power from the motor and any other sensors. For instance, if the voltage of the battery is lowered to a certain amount, the low voltage switch will turn off the power to all other electronic devices, including the light sensor. If the light sensor is switched off, it will shut the power to all motors and all other sensors including the low voltage sensor to conserve as much energy as possible.

Cattle Power

Having a feeder that is powered by the cattle along with a mechanical system for keeping the hogs out could greatly simplify the overall design of the mineral feeder. It would also reduce cost, and possibly make the product more attractive to potential buyers. This would eliminate the need for any sensors to be incorporated on the feeder. It would also eliminate the need for any electrical power/electrical charging system on the feeder.

Two possible ways to make the feeder cattle powered were developed. The first was to have a step, or plate that the calf would step on that would then move, allowing for motion that could then be used to power a dispensing system. The second cattle power idea was to have a door that would be pushed open by the cattle; the door motion would then be used to power the dispensing system.

Both systems would require linkages to translate the movement of one part to another, which could be rather complex, and susceptible to failure. The door system would hold an advantage in this area because all of the parts and linkage system would be contained inside the feeder, which would keep it out of the elements, while the step/plate system would have exposed parts.

One major issue that must be addressed with these power concepts is the cattle reaction. Incorporating these will not be feasible if cattle respond negatively to them. This seems more likely in the step/plate system. If the cattle have to step on a plate that will proceed to drop, the cattle may step off. This would result in mineral being dispensed but not consumed; therefore the next animal would get a doubled amount. A negative reaction may also be encountered with the door idea. The cattle must willingly approach and push the door on the feeder open. If they are not willing to do this, they won't be able to obtain any mineral. There is less of a risk of negative reaction from the cattle with this idea because there are currently mineral feeders on the market that use a similar approach. For example there is a tub-type feeder that sits very low to the ground in which cattle must put their head under the protective rubber cover and lift up in order to gain access to the mineral. Unfortunately cattle reaction will not be able to be determined until a prototype is built and tested.

DETERMINATION OF SUITABLE DESIGNS

After discussing the design concepts developed in the fall with the project sponsor, Bear, and the applications engineer, Shea Pilgreen, it was decided that a different approach should be explored. This was decided in order to eliminate some of the electronics on the feeder, and make it more of a mechanically driven design. This would help keep the production and final product

costs down. Also, it would hopefully make the product more attractive to potential buyers, because a mechanical product would be simpler and easier to fix on site in the event of a failure.

Despite the move to eliminate, or reduce the amount of electronics on the feeder, it was important to retain the desired features in the mechanical design. Most importantly selectiveness, but also the ability to dispense a set amount of mineral. It was also believed that staying with the hopper and trough concept would be beneficial.

Many new design concepts were generated that did not require electrical power. The most challenging part of this was to find a way for the cattle to be able to power the feeder, while still excluding the hogs. It was essential to design a feeder that we believed the cattle would not be hesitant to use. All of the new concepts were variations of the hopper and trough concept, but contained many different options for powering, and dispensing.

In order to determine the most suitable design a list of criteria was developed to compare all of the concepts against. The criteria were items that were believed to be most essential in developing a quality product. The most suitable designs were the ones that not only fulfilled the requirements and desired features, but also the design criteria. This included, most importantly, reliability and durability. Mineral feeders are placed in pastures and fields and may not be checked for several days at a time. Therefore it is imperative that the design have limited chance of failure, because if it were to fail it may go unnoticed for an extended period of time, causing the livestock to be without mineral. Also, as previously discussed, because the feeder will be outside for the majority, if not all of the year, it must be durable. Not only the weather, but also cattle gathering around the feeder is another reason that it must be very durable.

SELECTION OF DESIGN CONCEPT & DESIGN IMPLEMENTATION

Criteria For Design

Simple operation

Cheap to build

Simple to build

At least a 50 lb capacity

Concepts Considered

Ratchet meter

For simplicity, the design that we have pursued must be mechanically powered. The simplest way to mechanically actuate a metering device is by using the power of the cattle that will be accessing the mineral feeder. The most useful motion that can be taken advantage of the movement of the cattle pushing a door open in order to access the mineral. As the cow pushes the door open, the ratchet will lock and mineral will be dispensed. Upon the cow pulling its head back out, the ratchet will rotate back to its original position. The metering device will be either an auger, metering wheel, or some other rotary metering device.

Weight meter

This style of system will use both the energy of the animals, and gravity utilizing a weight at the rear of the mineral feeder. As the cow pushes the door open, the metering device will dispense mineral at the desired rate. After the cow pulls its head back out of the mineral feeder, the counterweight will rotate the metering device back to the original position resetting the meter. The meter will be another rotary metering device like an auger, or metering wheel.

Cable/pulley system

A cable/pulley system will allow the door to be activated by the cattle like the other systems, and will meter mineral by using only a cable and pulley that will actuate a metering device, either linear or rotary to dispense mineral. When the animals head is pulled out of the feeder, cables on the other side of the metering device will pull the device in the opposite direction, resetting it for the next activation.

Rod Driven

This is the most direct way to transfer the forces exerted on the door into a motion that can be used for metering mineral for the animal. The rod can be attached in one of two ways, directly to the door, or it can be attached with an extension that rotates with the door as it opens and closes.

Design Decision

The method that was decided on was the use of a rod connected to the door that will be powered by the cattle. This method will allow not only allow the door to pull the metering device, but will allow the weight of the door itself to push the metering device back and reset the meter. For the metering device, we decided that the simplest method would be the best. After talking with Dr. Robert Kropp, a beef cattle specialist at Oklahoma State University, we came to know that all cattle need only a certain range of mineral per day, regardless of age and size. According to Dr. Kropp, mineral supplements are needed in the range of 2-5 ounces per head per day, depending on the source used, and there is very little variation in requirement. Therefore, there is little need to incorporate user defined amounts into the feeder. With this knowledge, we were able to make the system very simple and work with few moving parts. The mineral weight per day that cattle require was converted into a volume amount, and a simple box with a hollow cutout was designed to dispense the correct volume. Slot size was calculated after determining the density of mineral and using the density converted into a volume. Using a graduated beaker and an electronic scale, the density of mineral was empirically determined. Different amounts of mineral were poured into the beaker to a measurable volume, and weighed. The weight of the beaker was taken away from the values obtained, and those measurements were divided by the volume. The values gained were averaged to obtain an average density of .53 oz/in^3. Using this obtained density, as well as information on cattle mineral needs, a bucket was designed that would dispense approximately 4 oz. per activation.

Beaker & Mineral (oz)	**Mineral Only (oz)**	**Volume (in^3)**	**Density (oz/in^3)**
31.4	17.54	35.09	0.5
27.91	14.06	27.47	0.52
25.01	11.16	21.36	0.53
20.7	6.85	12.21	0.57
		Average	**0.53**

Detailed Description of Selected Design

The hog prevention is based off of physical differences between hogs and cattle. Hogs are generally much smaller, with larger ones reaching near three feet high at the shoulders. Hogs

also don't have as nearly as much neck reach as cattle, which was used as an advantage to keep hogs from obtaining the mineral. Hog prevention is achieved by using a system of three bars and a plate that extend outward from the stand of the mineral feeder, out in front of the feeder door. The horizontal bar, which extends across the front of the feeder is just over three feet high, and is approximately 10 inches directly out from the door of the feeder. The plate extends from the horizontal bar down to the stand, and across to each of the "hog bar arms." It is intended to keep the hogs from getting in between the bars and the feeder, and also to prevent to the hogs from getting under the horizontal bar and lifting up or moving the feeder around.

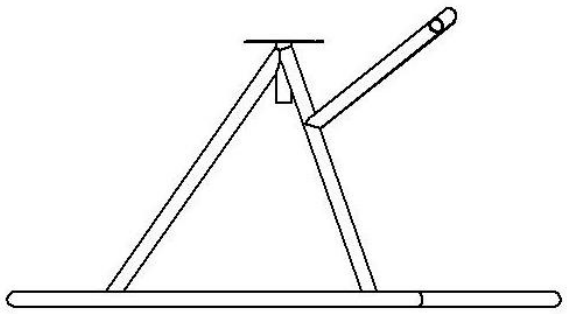


Figure 1. Feeder stand with hog bar (side view)

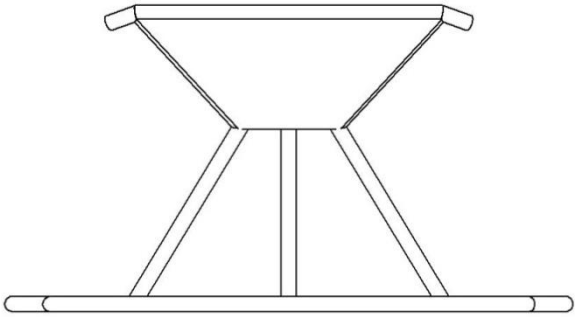


Figure 2. Feeder stand with hog bar (front view)

The dispensing device utilizes the cattle to be powered. The mineral is stored in an overhead hopper and dispenses approximately 5 ounces of granular mineral per activation. The mineral is dispensed when a calf pushes their head into the feeder, causing the door to be pushed in. The door is connected by a rod to a box that slides forward when the door is pushed open. The box has a hole cut in it that holds the mineral. When the door is closed the hole is under the hopper and is filled with mineral. The bottom of the hole is over a plate when the door is closed, which prevents the mineral from running straight through the box and emptying the hopper.

When the door is opened the box slides forward off the plate in order to dump the mineral. When the box is slid forward, it closes off the hopper opening preventing mineral from running out. The door can only be pushed open approximately 60 degrees, the mineral falls onto the back of the door then down into the trough area for cattle consumption The box is supported and slides on two rods, one on each side of the box.

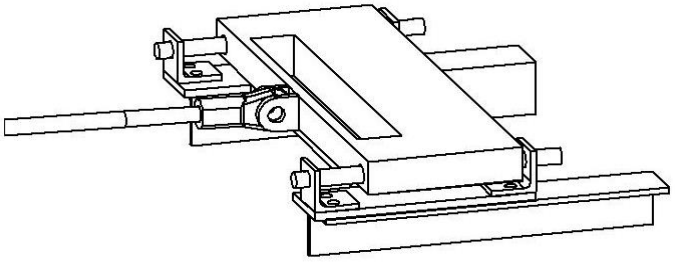


Figure 3. Dispensing system

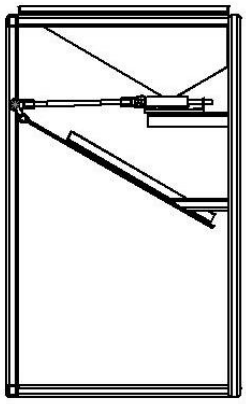


Figure 4. Dispensing system with hopper and trough

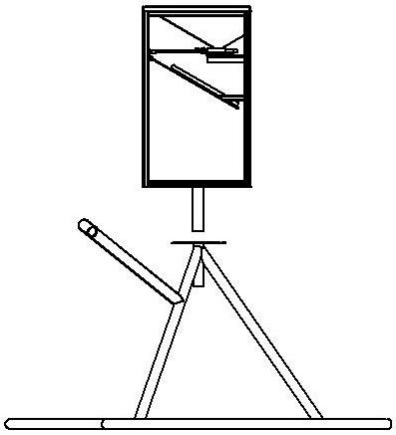


Figure 5. Entire feeder

To our knowledge, there are no selective feeders that have been specifically developed for cattle. Several types of dispensing and intake limiting feeders are on the market, but most are for small pets such as cats and dogs. Most of these also incorporate some type of electronics for selectivity, such as collars with infrared emitters for example. We are unaware of any products that incorporate selectivity and dispensing in the mechanical ways that we have.

PROPOSED PROTOTYPE BUDGET

The proposed budget for the mineral feeder is determined by looking at what materials are needed for production, labor costs, possible legal and patent fees, and possible miscellaneous costs. Estimated materials came to a total of $289.26. Labor is estimated at $84.00 for two workers at total of six man hours and $14.00 an hour. The miscellaneous section of the budget is at $65.00 for any unknown costs that may arise. This estimated budget comes to a sum of $438.26. With this being much more inexpensive than previously thought the mineral feeder will be very affordable for ranchers and farmers. Currently we are using the price of $750.00 in our feasibility sheet as the selling price of the feeder. This is more expensive than most mineral feeders on the market, but the 3C feeder will be a higher quality product than what is currently on the market.

VALIDATION & TESTING OF PROTOTYPE

Testing of this mineral feeder presented some unique difficulties. The nature of the product does not allow a majority of the testing to be done in a controlled environment. Nevertheless, several validation and testing methods were used in order to validate the design concept. Limited testing on the dispensing system was done before feeder construction began. A stand-alone dispensing system was built in order to ensure that the concept would work, and there would not be a great deal of problems with the design. This system included the angle-iron supports and the track rods along with the dispensing bucket. The system was filled up with mineral, and moved to the open and closed position many times in an attempt to determine any possible problems, such as leakage or the bucket binding on the track rods.

Shop Testing

Overall product testing began in the lab shortly after feeder completion. Once again the testing began with the dispensing system. Mineral was placed in the feeder hopper and a great deal of dispensing cycles were run, much like what was previously done with the stand alone dispensing system. There were many advantages in performing the testing after feeder completion than before with the stand-alone system. This presented the opportunity to ensure that the dispensing system worked well with the door. All clearances and movements were checked in both the open and closed positions. The door-to-bucket linkage was adjusted and fine-tuned to make sure that the door was not trying to force the dispensing bucket further than its allowable range in either the open or closed positions. During the dispensing system testing, we also verified the dispensed amount. The mineral that was being dumped out each time was caught in a container and weighed to ensure that the desired amount was being dispensed. The dispensed amount is approximately 4.2 ounces, plus or minus one-tenth of an ounce every time shown in the table below.

Mineral Dispensed (oz)	
4.2	4.2
4.4	4.3
4.1	4.3
4.1	4.2
4.2	4.3
Average	**4.2**

Mineral travel was also looked at during lab testing. The mineral needs to be placed toward the front of the trough when dispensed so that cattle can reach it, but when initially dispensed the door causes the mineral to be forced to the back.

Field Testing (Cattle)

The next portion of the product validation and testing that was performed was the first of the field testing. Dr. David Lalman of the Oklahoma State University Animal Science Department provided a pasture for the testing. The pasture is OSU property, and is located on the northwest side of Lake Carl Blackwell, just west of Stillwater. The pasture contained approximately 84 cows and 82 calves. The main intent of the testing was to determine cattle reaction to the feeder. It was desired to know if cattle would use the feeder, specifically if they could figure out how to push their heads in the door in order to obtain the mineral. The testing was also being done in order to further validate our dispensing system. It was known from the shop testing that the dispensing system did work, but it was unknown as to whether or not the dispensed amount was correct. We wanted to determine if there was too little or too much being dispensed at one time. The feeder was set up in the pasture with a motion activated game camera to monitor its performance.

Figure 1. Feeder in OSU pasture for testing

Field Testing (Hogs)

The final testing that was performed on the feeder was the validation of the hog bar. For this portion the feeder was taken to Bear Runyan at 3C Cattle Feeders in Mill Creek, Ok. The feeder was taken to Mill Creek because there are an abundance of feral hogs in the area, which are the main intruders that we are attempting to keep out. In order to ensure hog interaction with the feeder in a limited amount of testing time, the feeder was placed in a pen with six feral hogs. Whole corn along with powdered Kool-Aid drink mix was placed in the trough of the feeder. The hogs are attracted not only to the corn, but to the sweet smell of the Kool-Aid powder. A motion activated game camera was also used in this testing to record the results.

Figure 2. Feeder in pen with hogs for testing

TESTING RESULTS

Shop Testing Results

We believe that we got very positive results in all three aspects of our testing. However, we did encounter several issues with the feeder. The first being immediately after testing began with the dispensing system. It was discovered that at one point during the opening and closing of the door, the hopper was not closed off. With the door at an angle of approximately 45 degrees,

the dispensing bucket was partially in the dumping position and partially in the filling position simultaneously. This resulted in a constant flow of mineral from the hopper to the trough, rather than the desired 4 ounces. Although this was a major problem with the dispensing system, it was easily correctable. The problem was corrected by extending the lower plate by one inch. This ensured that the hopper was completely closed off by the time the dispensing bucket was in the dumping position. As a result of the plate being extended by one inch, the linkage system had to be redone in order to accommodate for the further travel. Subsequent to this problem being fixed our dispensing system performed very well, and as was mentioned with the previous data, it dispensed rather consistently as well.

As was expected for mineral travel, the mineral piled up along the back edge of the feeder trough during initial testing. Several methods were investigated in an attempt to correct this problem. Almost all included using an angled piece of material to direct the mineral toward the front of the trough. The solution that was decided upon was to use a rubber mat that would be screwed to the frame of the feeder, and go from the back to the front at an angle in order to direct the dispensed mineral to the front of the trough. This piece of rubber would serve two functions. First it corrected our problem encountered during testing of the mineral piling up in the back of the trough, and second it provides a corrosion resistant cover to the steel trough. When lined with the rubber, no mineral is in contact with the steel portions in the trough area, therefore reducing the risk of encountering problems. Once the rubber mat was in place the dispensed mineral came to rest relatively close to the door. This was believed to be desirable because it allows the cattle easy access to the mineral when using the feeder.

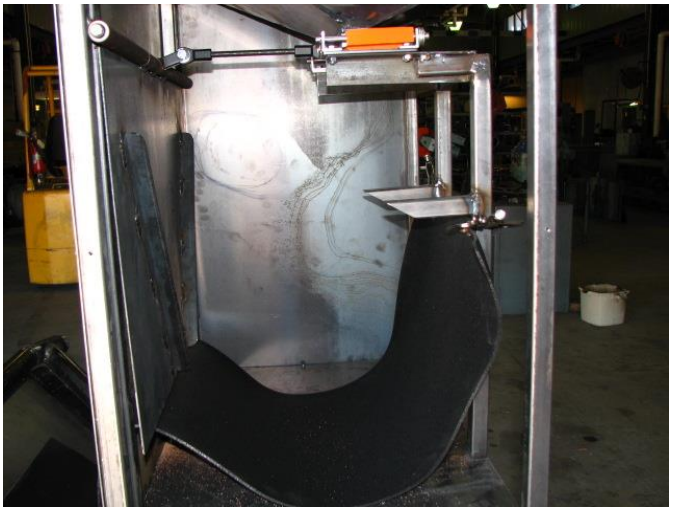


Figure 3. Rubber mat in place for lab testing

Field Testing Results (Cattle)

Some very exciting results were obtained from the first part of the field testing. Although the cattle had nudged the game camera far enough that the feeder was no longer in sight, very promising results were still recorded. After arriving at the test site for the first time since the feeder was put out, it was found that some mineral had been dispensed out of the hopper and consumed. However, because the camera had not captured any pictures of the cattle eating out of the feeder, it could not be confirmed that the cattle had consumed the mineral. Nevertheless, during our test site visit we were able to view several cows using the feeder, and we obtained many pictures of them doing so. This confirmed that cattle would in fact use the feeder, and they seemed to have little problem with determining the need to push their head into the door to obtain the mineral. Despite this, there was one major problem encountered during this portion of the field testing. During both our visit to the site, and when we went to retrieve the feeder, the mineral in the hopper was "caked" up. The cattle had dispensed all the mineral that would come out of the hopper on both occasions. It appeared that the mineral was running out of the hopper directly over the dispensing hole, and was bridging up all around the hole, therefore not allowing any more mineral to come out the hopper. So while we confirmed that cattle would eat out of the feeder, we were unable to determine how much they were using it, or attempting to use it because they had limited access to the mineral in the hopper. Another minor problem encountered was with the hog bar. Some of the cows were coming up to the feeder from the side rather than the front to get mineral out of the feeder. The mineral was easily obtainable from the front, but it appeared that they were avoiding approaching the hog bar in the front only because they were able to. This testing also proved that the young calves were unable to gain access to the feeder. This is a positive thing because although young calves may eat some mineral, they do not need it before they have been weaned from nursing the cows.

Figure 4. Cow eating mineral from feeder

Figure 5. Cow eating mineral from feeder

Figure 6. Cow eating mineral from the side of the feeder (avoiding hog bar)

Field Testing Results (Hogs)

The hog testing also produced some very positive results. The hogs did show an interest in obtaining the corn from the feeder, but were unable to do so. This is believed to be a result of the hog bar on the front of the feeder. The hogs did not even attempt to gain access to the trough of the feeder because they simply had no way to reach it.

Figure 7. Hog next to feeder in testing pen

Figure 6. Hog and feeder in testing pen

RECOMMENDATIONS/CONCLUSION

There are several aspects that we feel need to be addressed with this feeder, and several recommendations that should be made. As previously mentioned, there was a problem with the mineral bridging up in the hopper while being tested in the field. We believe this problem is easily fixable with an agitator. This could be achieved in a number of ways, but the simplest would most likely be to use a linkage system similar to what is already in use with the dispensing system, and have an agitator powered by the door. The agitator could be as simple as a rod run through the hopper with "fingers" coming off of it to keep the mineral stirred up every time the door is opened. Another recommendation we have is to make changes to the hog bar. In order to prevent the cows from attempting to get into the feeder from the side, the hog bar could be extended further around the sides of the feeder. The hog bar could also be made shorter and closer to the feeder. As a result of the hogs not being able to gain access to the feeder, we believe the bar could be reduced in size, while still preventing hog access. We also recommend increasing the capacity of the feeder hopper to hold more than fifty pounds of mineral. Further recommendations would include making the feeder lighter. The prototype was very heavy and not easily handled by two people. It is believed that the prototype is overbuilt as far as the

materials that were used in construction. By using lighter materials the overall weight of the feeder could be reduced and this may make the feeder cheaper to produce. While this feeder is not yet a market ready product, we believe that we fulfilled our goal of proving the concept of a mineral feeder that will dispense mineral and keep feral hogs out, and our prototype provides a great foundation to obtaining a marketable product for 3C Cattle Feeders.

ENVIRONMENTAL, SOCIETAL AND GLOBAL IMPACTS

There will be very limited impacts from our design solution. There are no known global impacts at this time. However, there may be slight environmental and societal impacts. By allowing mineral access to cattle only, this affects the food supply for other wildlife. Animals in particular would include feral hogs and deer, in which our feeder is specifically designed to restrict access to. By not allowing them to consume mineral, they will be forced to find alternative food sources. This could possibly be detrimental for farmers, because hogs in particular may cause damage to crops by using it as a food source rather than mineral. Any impacts caused by restricting mineral access are likely to be minimal. Deer and hogs, like cattle, are not dependent on mineral as a main food source; it is a supplement. Therefore, restricting their access should not have a great impact on their food sources.

OWNER'S MANUAL/ USER GUIDE

Finding A Location For Your Mineral Feeder

1. Look for a relatively flat location
2. Transport mineral feeder to desired location
3. Load mineral feeder hopper (see below)

Loading The Mineral Hopper

1. Release rubber latches from their slots
2. Remove lid from the top of the mineral feeder
3. Remove seal from mineral bag
4. Lift bag of mineral with your legs
5. Lift bag of mineral to the top of the mineral feeder
6. Pour entire bag of mineral into hopper
7. Replace lid on top of the mineral feeder
8. Replace latches into their slots

Checking Mineral Feeder

At first the amount of mineral should be checked regularly until a consumption pattern has been established

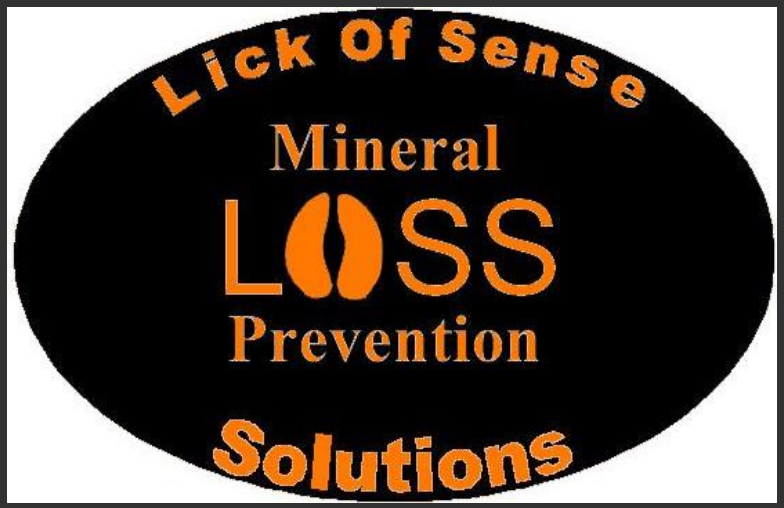
1. Release rubber latches from their slots
2. Remove lid from the top of the mineral feeder
3. Look into hopper from the top, or reach in and feel the mineral level
4. If mineral is absent from hopper, see "Loading The Mineral Hopper"
5. Replace lid on top of the mineral feeder
6. Replace latches into their slots

Replacing the Rubber Mat

1. Using a 5/16 inch nut driver, or socket, remove all screws from the side panel
2. Remove screws from the rubber mat using the same tool
3. Remove rubber mat from the mineral feeder trough
4. Cut a piece of rubber to match the size of previous mat
5. For ease of installation, drill holes in the same locations as the original rubber mat
6. Place new rubber mat into mineral feeder trough
7. Place screws into the original holes used by the screws using the nut driver or socket
8. Make sure not to over tighten screws, or the rubber mat may tear
9. Replace side panel and screws using the same tool

Spring Presentation 2010

CATTLE 3C FEEDERS



Kyle Hiner. Kevin Hufnagel. Melissa Maher. Dakota Moss.

Problem Statement

- *Our task was to design, build, and test a selective entry, mineral-dispensing device for cattle. The mineral feeder must restrict access to all wildlife while allowing cattle to gain access and consume the minerals.*

CATTLE 3C FEEDERS

- Mill Creek, OK
- Population: 330
- 14 miles Southeast of Sulphur, OK

CATTLE 3C FEEDERS

- Management:
  - Owner: Bear Runyan
  - Sales: Carl Hood
  - 11 Additional employees

Competition

- *19 current Mineral Feeder Manufacturers*
  - Regional or National Distribution
  - Manufacture multiple types of mineral Feeders

Weather Vane Feeder

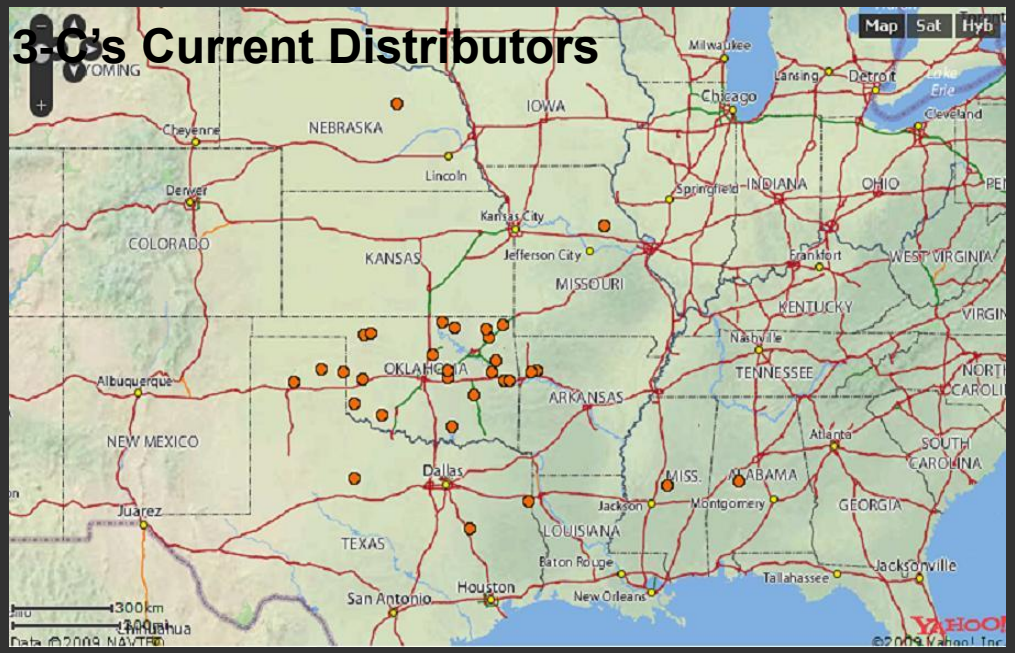
Heavy Duty Poly/Bull Feeder

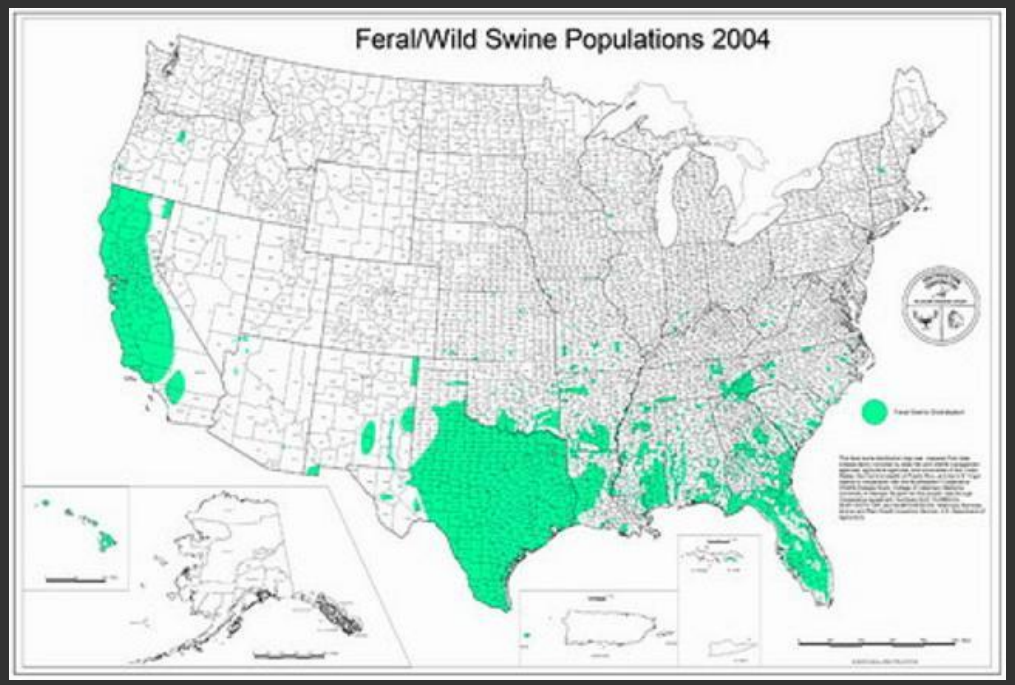
Poly Wind Vane Feeder

www.behlencountry.com/products/mineral_feeders

Competition

- **Prices on current Feeders**
  - **range from $50-$330 depending on Brand and Store**
- **Disadvantages of current feeders**
  - Inefficient
  - No weather protection
  - No wildlife protection
- **Selective feeder will correct the current disadvantages**
  - Regulating consumption
  - Providing weather protection
  - Offering wildlife protection





Possible distributor expansion into the Southeastern states, California, and additional Texas locations

Customer Analysis

- Producers cannot afford to lose costly minerals to wildlife, weather, or greedy stock
- Contamination from wildlife is a viable threat to herd health and producers' pocketbooks.

Costs & Benefits

- Current estimated price of feeder: $749.99
- Below are potential costs of minerals over time:

Mineral	Price	1 year	2 years	5 years
50 lbs Cow Calf CTC	$17.10	780.19	1560.38	3900.94
50 lbs Medicated wormer	$40.00	1825.00	3650.00	9125.00

- Estimates figured by:
  50 head/herd, 1 50/lb bag mineral every 8 days, 46 bags per year (365/8)

Financial Analysis

- Variable Costs of Production
  - Materials, Legal Costs, Distribution Costs, Labor
- Input Costs for 3C
  - Capital, Taxes, Payroll, Utilities, Miscellaneous
- Market Projection
- Expense Projection
- Return on Investment

Engineering Specs

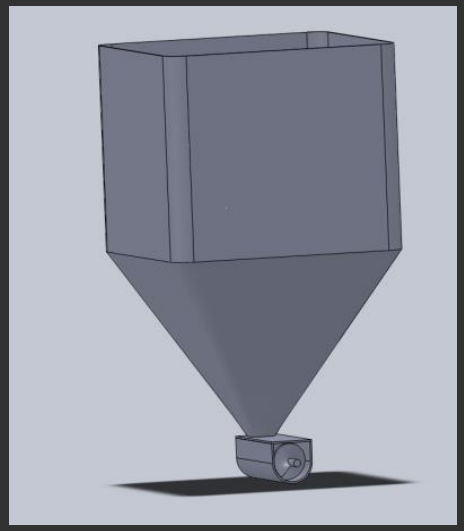
- Size/Weight
  - Minimum of 50 lb capacity
  - Stable
  - Sturdy
- Materials
  - Corrosion resistant
  - Weather resistant
  - Safe for food

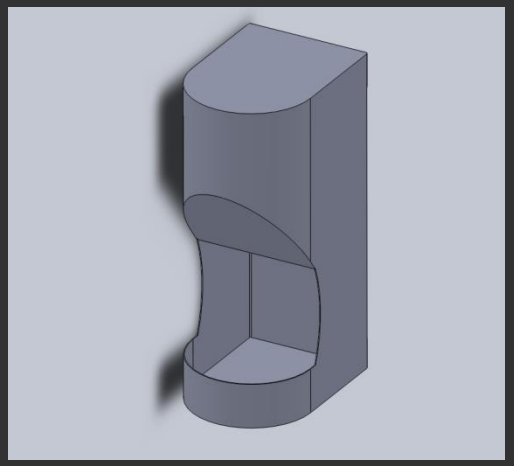
Engineering Specs

- Desired Features
  - Limit access
  - Dispense mineral
    - Limit intake/over consumption
    - Contamination control

Considered Solutions

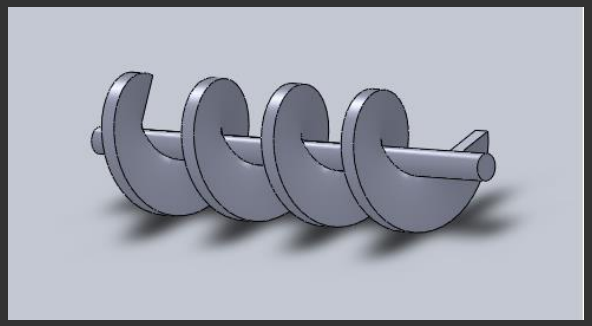
- Overall Feeder
  - Fenced feeder
  - Deer feeder type
  - Dog feeder type
  - Cone bottom hopper
  - Hopper and trough

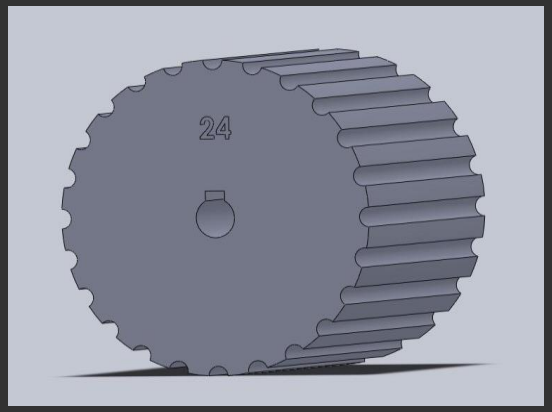


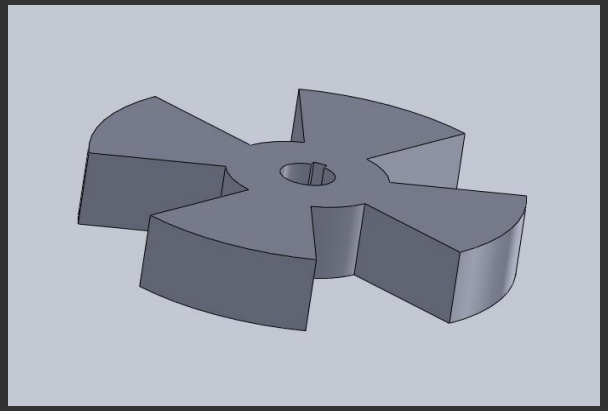


Considered Solutions

- Dispensing
  - Auger
  - Metering wheels
  - Conveyors

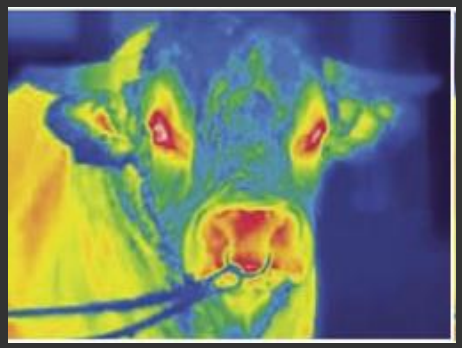






Considered Solutions

- Hog Prevention
  - RFID
  - Imaging
    - Image processing
    - Thermal imaging
  - Physical Characteristics
    - Height
    - Weight
    - Shape



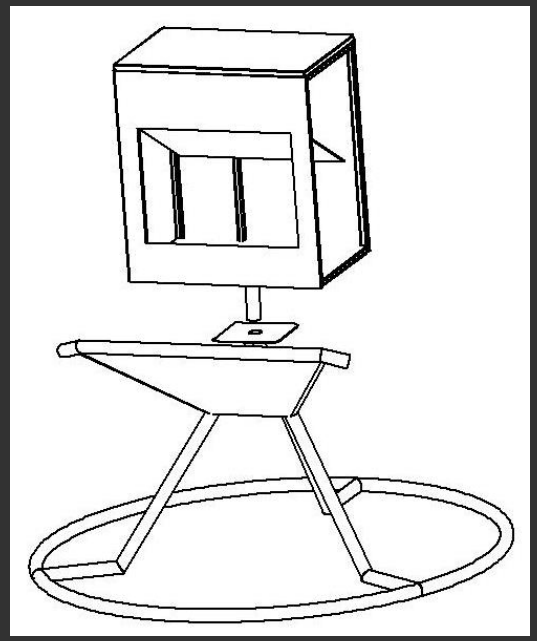
http://www.vet-ir.com/images_files/bovine2.jpg
http://www.thepigsite.com/articles/2741/use-of-infrared-thermography-for-early-detection-of-disease
http://walkingbuddies.com/home/?p=155

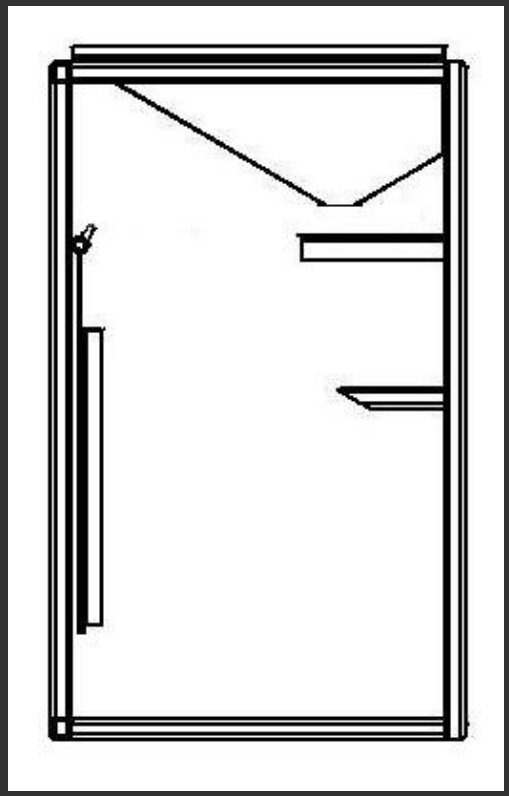
Judging Criteria

- Complexity
  - Easy to build
  - Easy to repair in the field
- Power Requirement
  - Low power is preferred
- Low Cost
  - Low man-hour cost
  - Low materials cost

Solution

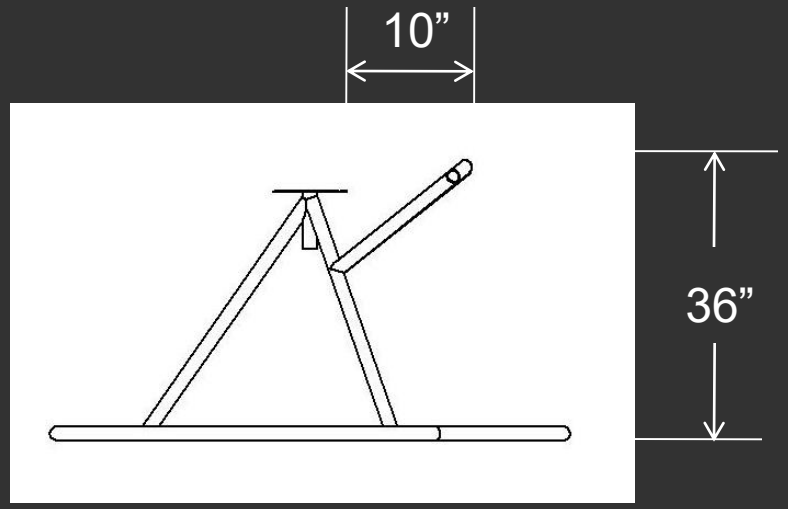
- Hopper and trough
  - Advantages of hopper
  - Fulfills requirements
  - Allows for desired features
  - Similar to look to existing feeders

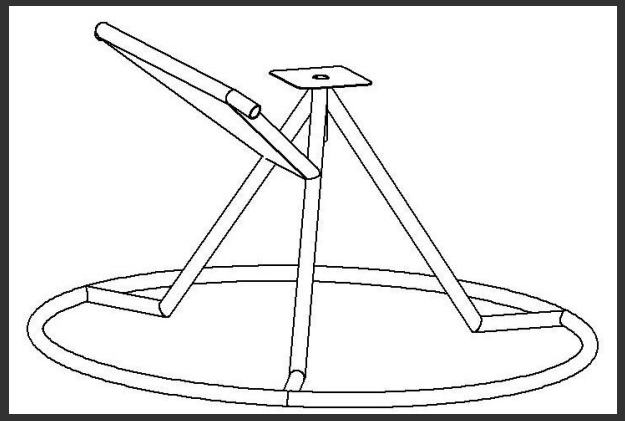


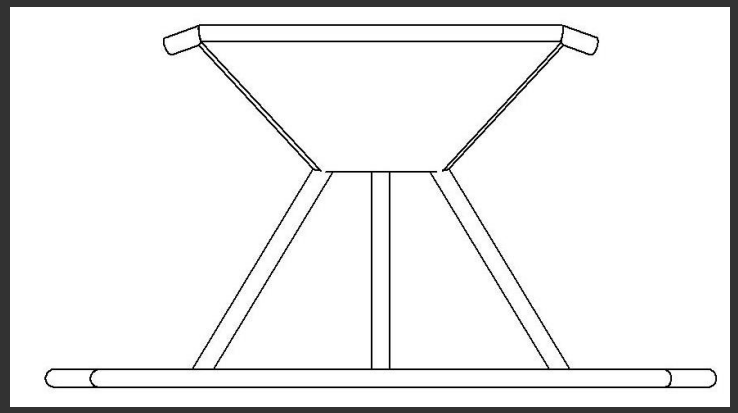


Solution

- Hog Prevention
  - “Hog bar”
  - Uses physical differences
    - Height
    - Reach
  - Hog bar design

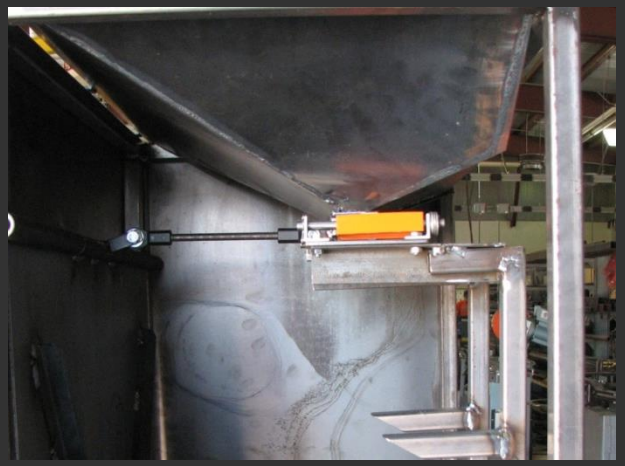


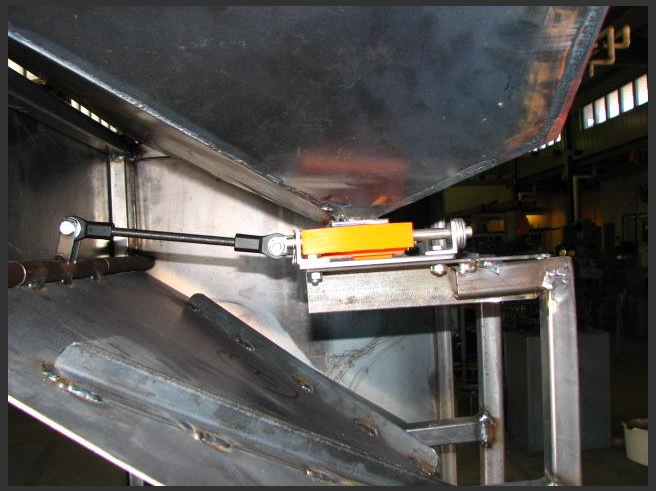




Solution

- Dispensing
  - Sliding Bucket
  - Door Actuated
    - No power requirements
  - Cheap
  - Accurate
    - Constant volume





Lab Testing

Mineral Dispensed (oz.)	
4.2	4.2
4.4	4.3
4.1	4.3
4.1	4.2
4.2	4.3

Average	4.2
Standard Deviation	0.095
Range	.3

Testing

- Cattle Use
  - Need to make sure that cattle could (and would) access the feeder

Testing

Testing

- Hog Prevention Testing
  - Done at Mill Creek, Ok
  - Feeder placed in pen
  - Hogs baited to feeder

Testing

- Hog Prevention Results
  - Hogs unable to gain access
  - No aggressive attempt at access
    - Out of reach
    - Out of sight

Testing

Recommendations

- Mineral agitator
- Updated hog bar
- Lighter
- Higher Capacity

Acknowledgements

- We would like to thank the following people for their help:
  - Bear Runyan & employees at 3-C Cattle Feeders
  - Our instructors– Dr. Paul Weckler, Dr. Dan Tilley, Dr. Rodney Holcomb
  - Wayne Kiner & BAE lab staff
  - Dr. Bob Kropp
  - Dr. David Lalman
  - Shea Pilgreen

Fall Presentation 2009

CATTLE 3C FEEDERS

Lick Of Sense
Mineral
LOSS
Prevention
Solutions

Dakota Moss. Melissa Maher. Kyle Hiner. Kevin Hufnagel.

PROBLEM STATEMENT

Our task is to design, build, and test a selective entry mineral dispensing device for cattle. The mineral dispenser must restrict access to deer and feral hogs, and allow cattle to gain access and consume the product.

CATTLE 3C FEEDERS

- Mill Creek, OK
- Population: 330
- 14 miles Southeast of Sulphur, OK
- Management:
  - Owner: Bear Runyan
  - Sales: Carl Hood

CATTLE 3C FEEDERS

- Current Products:
  - Digital Cube Feeder: $2300 - $2700
  - Creep Feeder: $2350

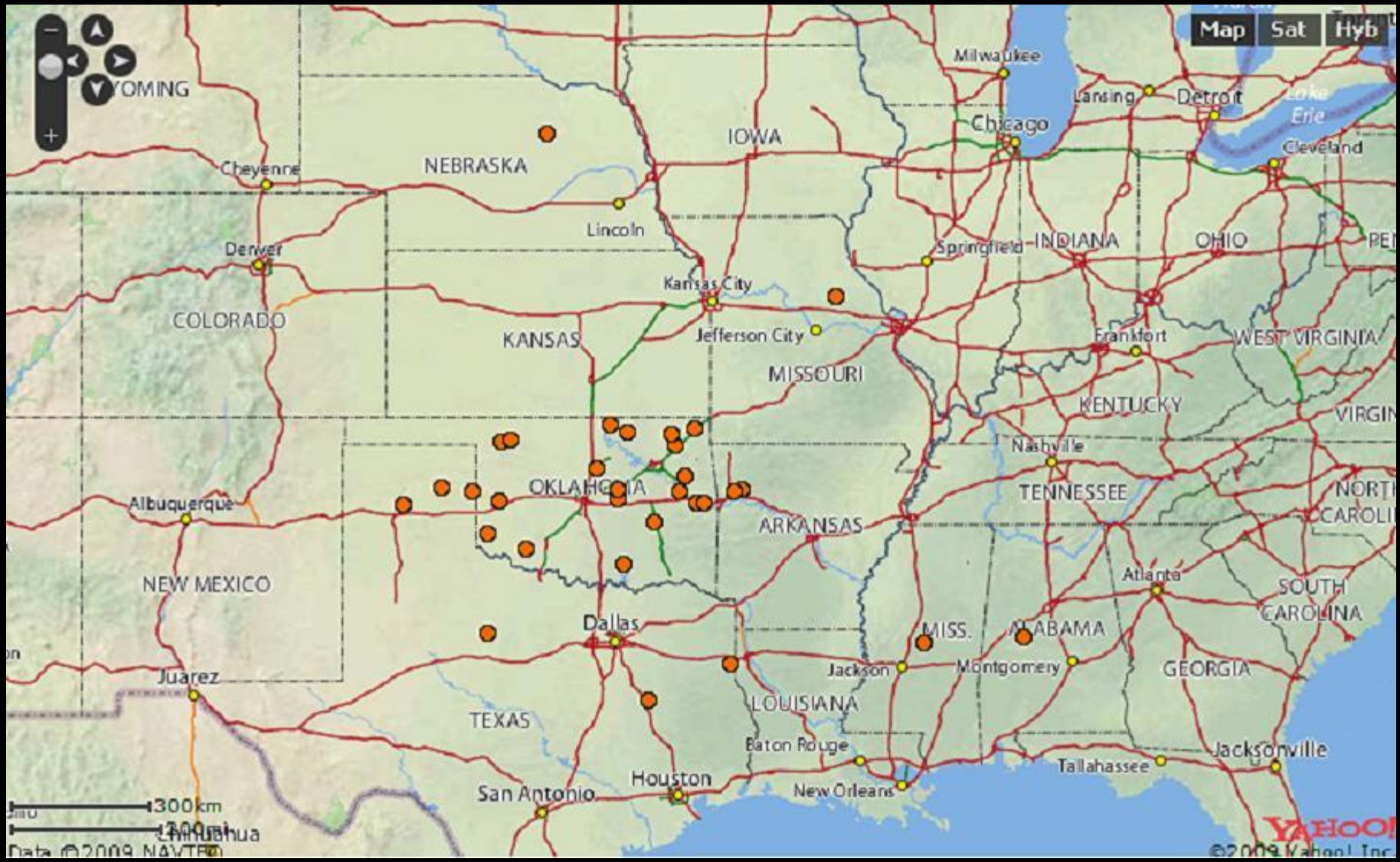
Customer Analysis

- Economic Status
  - Average US farmer/rancher yearly salary is $15,603 (not including subsidies)
  - Cannot afford to lose costly minerals to wildlife, weather, or greedy stock

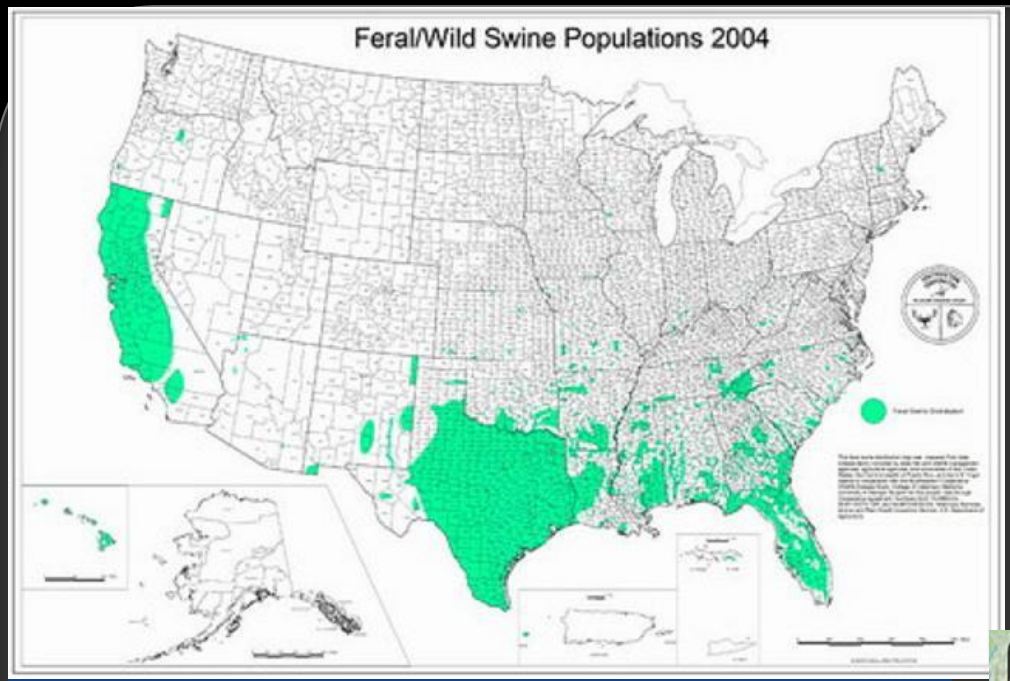
US Department of Labor, Bureau of Labor Statistics. “Farmers, Ranchers and Agricultural Managers.” 2008- 2009 Edition.
http://www.bls.gov/oco/ocos176.htm

Mineral Feeder/3C Cattle Feeders

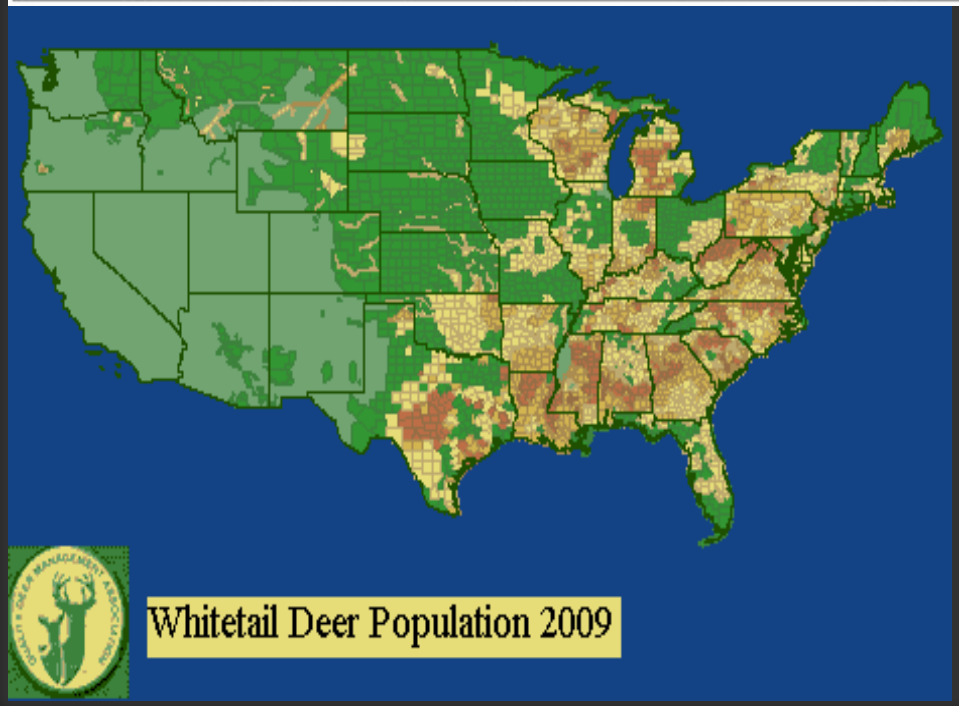
- Financial Analysis
  - Market projection
  - Expenses projection
  - Return on Investment
- Communicating to Customers
  - Operation of Feeder
    - Features
  - Costs/Benefits
    - Save money on mineral

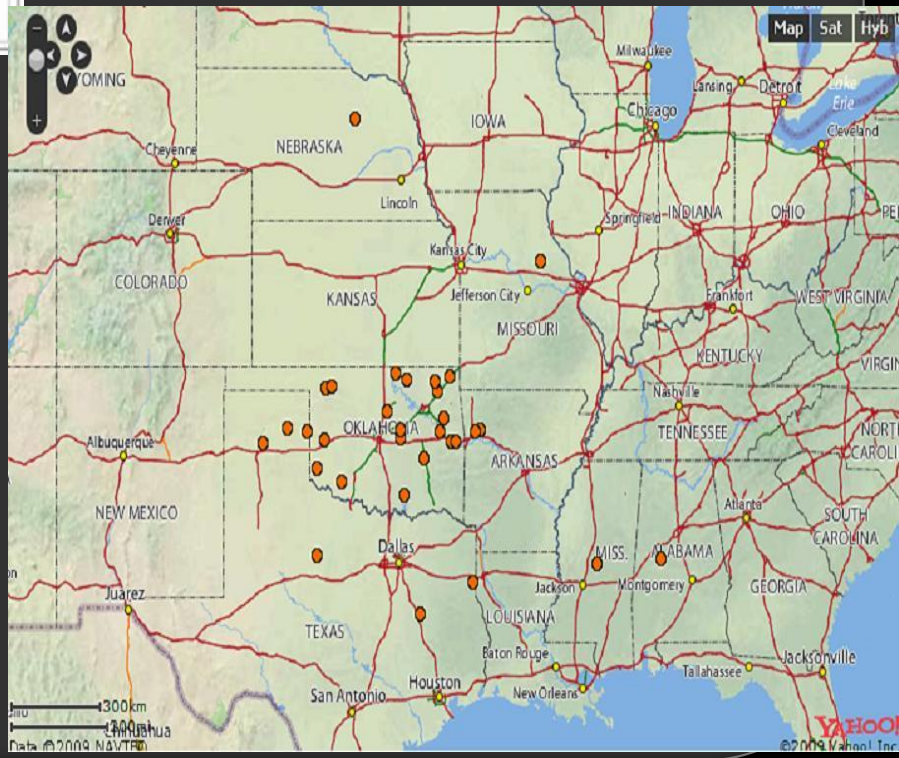


Map of 3-C's Current Dealers



Possible dealer expansion into the Southeastern states, additional Texas locations and California





Relevance of Minerals to Producers

Example of Copper Deficiency

- Mineral deficiencies can result in:
  - Decreased reproductive efficiency
  - Poor Growth Performance
  - Depressed Immune Function

www.teara.govt.nz

Current Market

Weather Vane Feeder

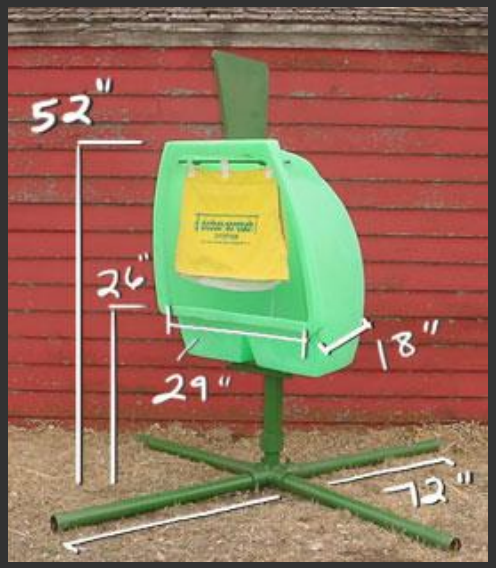
Heavy Duty Poly/Bull Feeder

Poly Wind Vane Feeder

www.behlencountry.com/products/mineral_feeders

Competition

- *19 current Mineral Feeder Manufacturers*
  - Regional or National Distribution
  - Manufacture multiple types of mineral Feeders
    - Beginning to focus towards weather protection and fly control



http://www.mineralfeeders.com/
http://www.lhmfg.com/mineral-feeders.htm

Competition

- **Disadvantages of current feeders**
  - Inefficient
  - Do not provide complete weather protection
  - Do not protect against wildlife consumption or disease

- **Selective feeder will correct the current disadvantages by:**
  - Regulating consumption
  - Providing complete protection against weather
  - Offering absolute protection from wildlife

Competitive Advantages

- 3-C is an established producer of cattle feeders
- No current selective access mineral feeder on the market
- Current dealers are located in the heart of U.S. cattle industry.
- Reputation of producing high quality, durable products

Strategic Opportunities

- Expansion into new market
- Become a more competitive cattle equipment manufacturer
- New product benefits industry

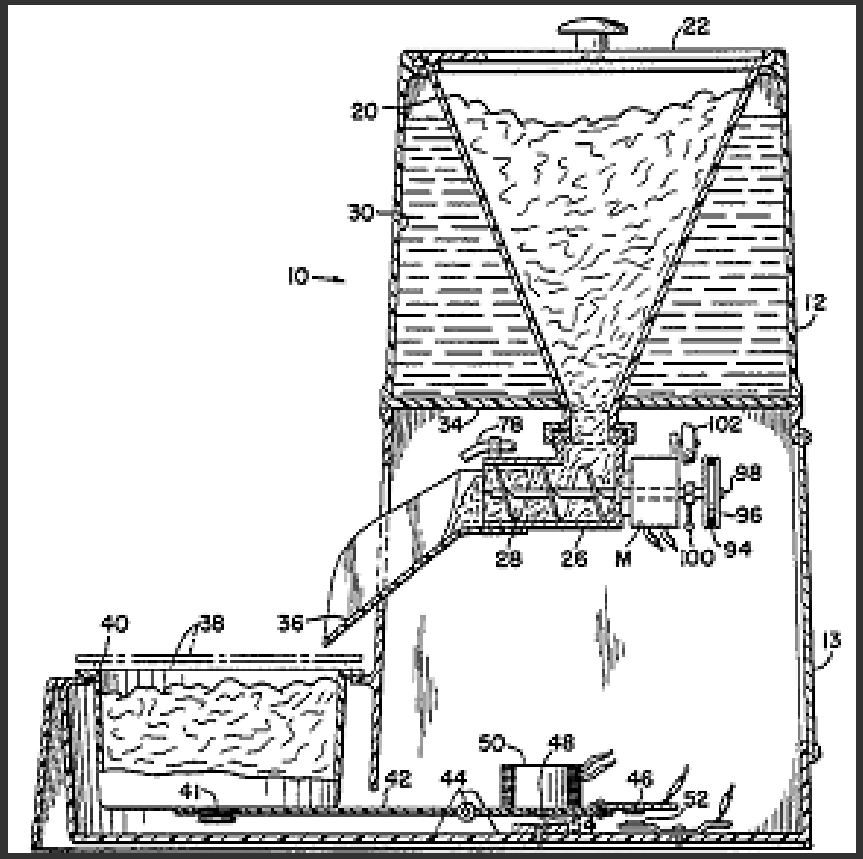
Minerals as A Design Constraint

- Reformulation of minerals' composition to prevent corrosion of metals
  - Reduce Sodium to minimum level needed by cattle, but still corrosive
  - Remove Sodium completely from mineral
    - Issues with contamination, waste due to weather and unlimited access to cattle

Relevant Patents

Pat#: 4735171-Animal Feeding Apparatus

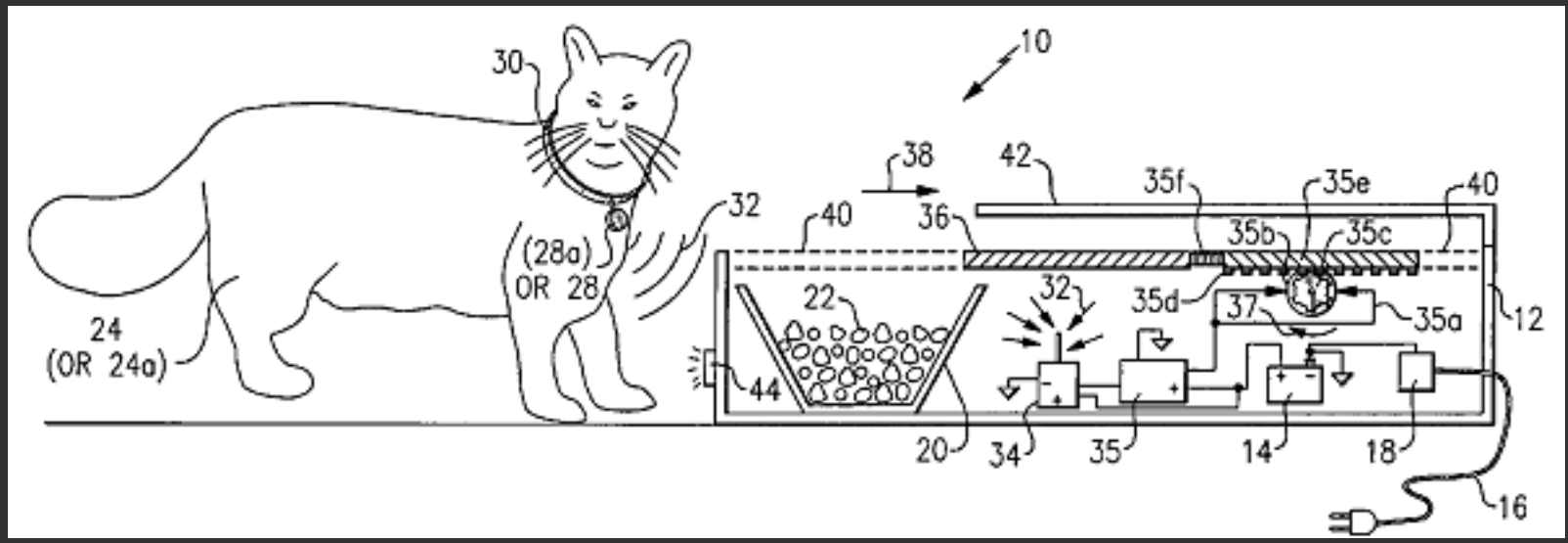
1. Contained hopper
2. Metering system
   a) Timed release.
3. Feed dish
4. Control system



Relevant Patents

Pat #:7124707-Selective Animal Feeding Apparatus

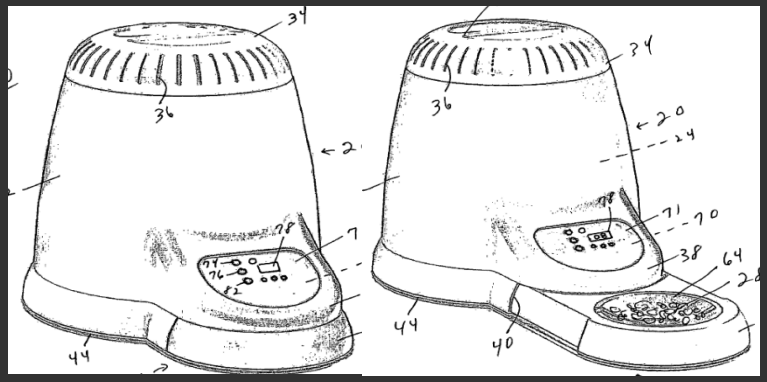
1. Signals send instructions to feeder
   a) Sensor on feeder emitter on animal
2. Door opens when signal is sensed

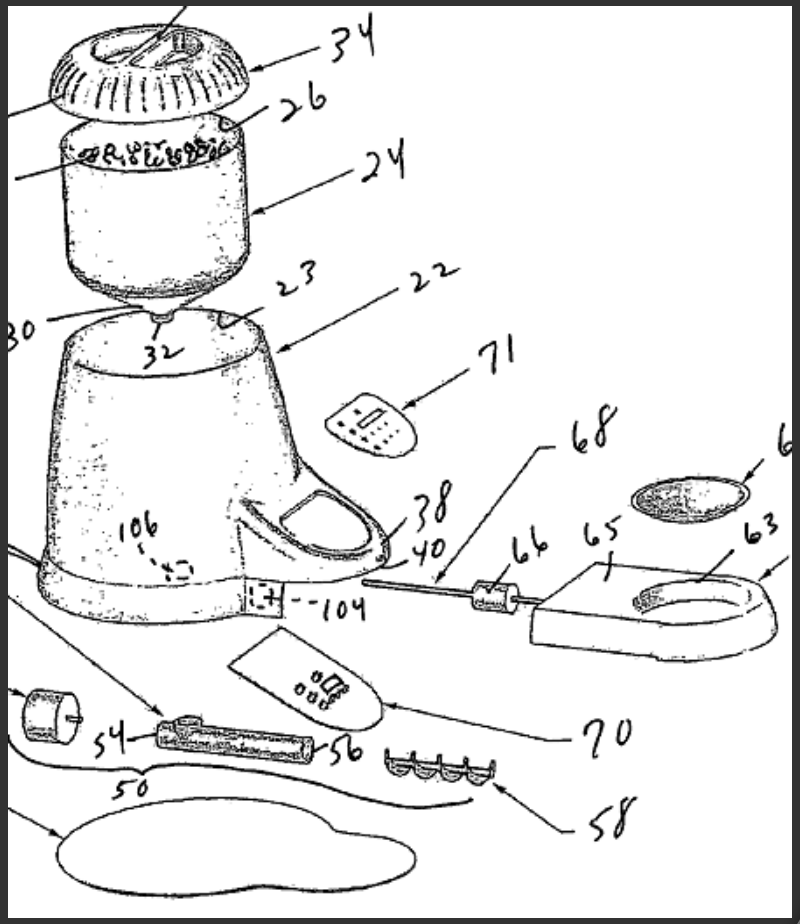


Relevant Patents

Pat #:7228816-Animal Feeding Device And Method

1. Enclosed hopper
2. Will only allow one at a time
3. Will only feed at certain times
4. Auger metering

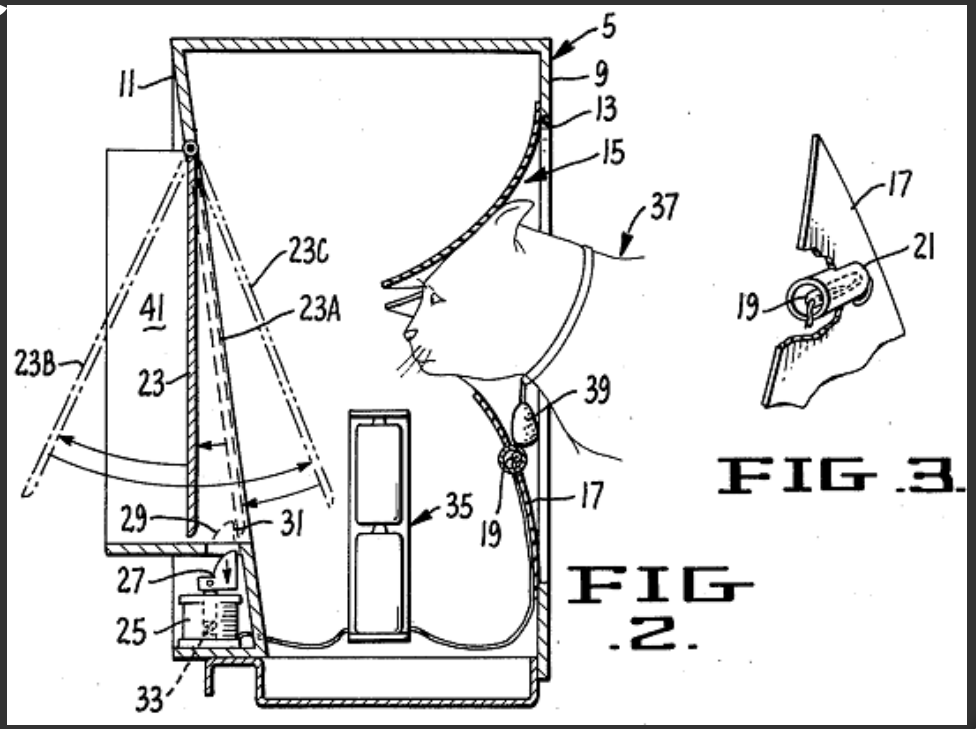




Relevant Patents

Pat #: 4022263- Magnetically Actuated Cat Door

1. Limited access
2. No need to change batteries on tag
3. Very simple



Engineering Specs

- Size/Weight
  - Easy to move
  - Minimum of 50 lb capacity
  - Stable
- Materials
  - Corrosion resistant
  - Weather resistant
  - Safe for food

Engineering Specs

- User Friendly
  - Limited programming
- Selective
  - Most important

Concept Generation

- Judging Criteria
  - Practicality
  - Effectiveness
  - Ease of use
  - Cost
  - Reaction of cattle

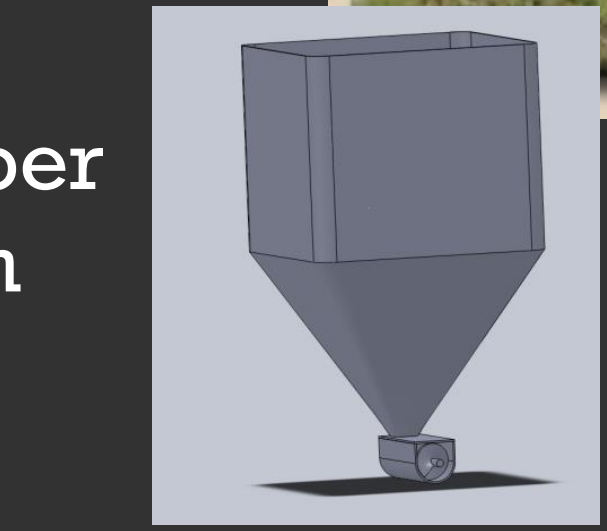
www.flickr.com

Concept Generation

- *Desired Features*
  - Dispensing/metering
  - User defined amounts
  - Tracking and recording

Design Concepts

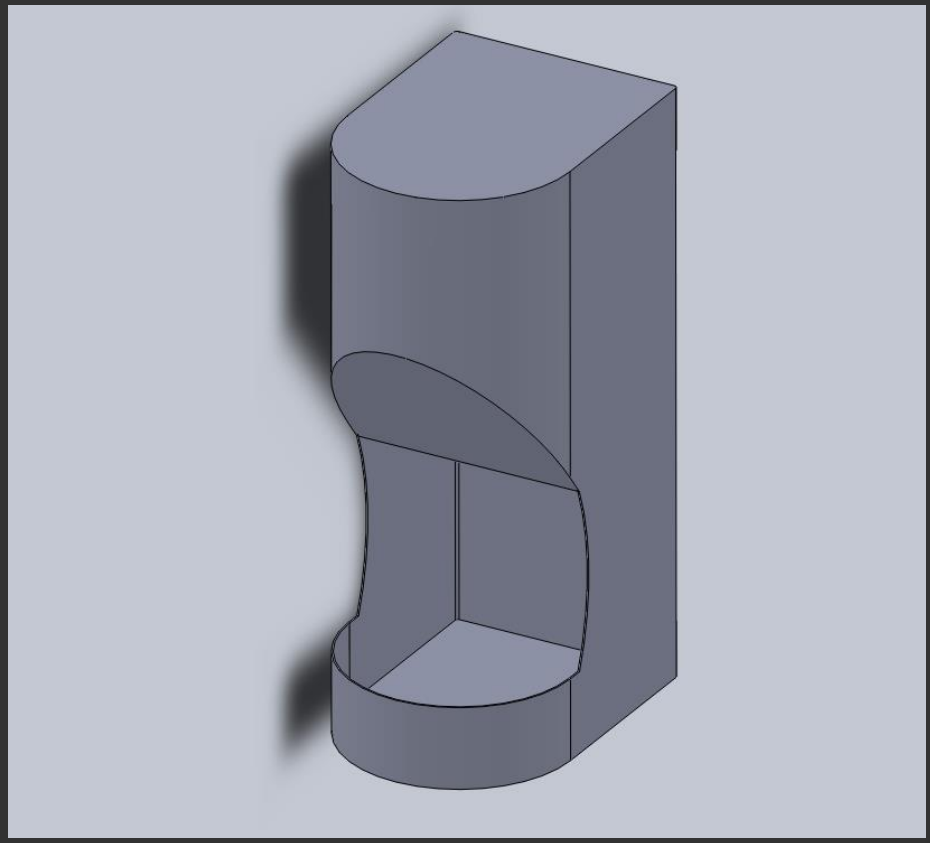
- Fence around feeder
- Deer feeder type
- Kill the hogs
- Dog feeder
- Feeder door
- Cone-bottom hopper
- Hopper and trough



http://www.3cfeeders.com/images

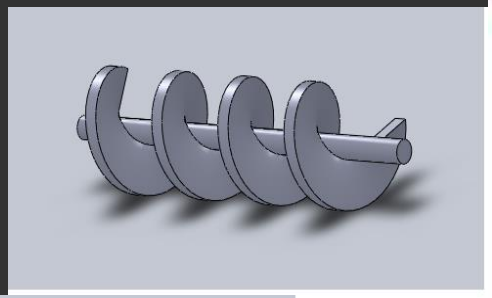
Design Concepts

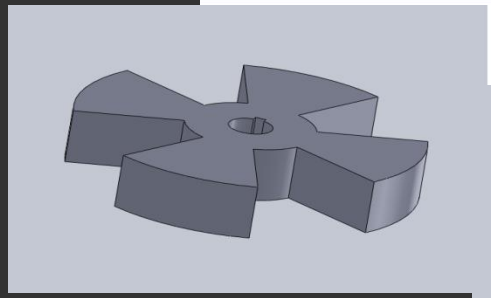
- Recommendation
  - Hopper and trough
    - Advantages to hopper type
    - Fulfills requirements
    - Allows for desired features
    - Similar look to existing products

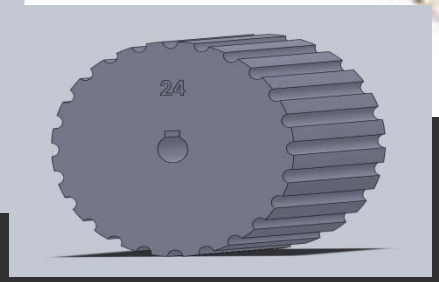


Dispensing/Metering

- Metering Wheels
- Auger
- Conveyors
  - Belt
  - Bucket







Motors

- Stepper motor ~$50
  - Can be expensive
  - High precision
    - Small degree turns (2˚ increments)
    - Immediate start/stop time

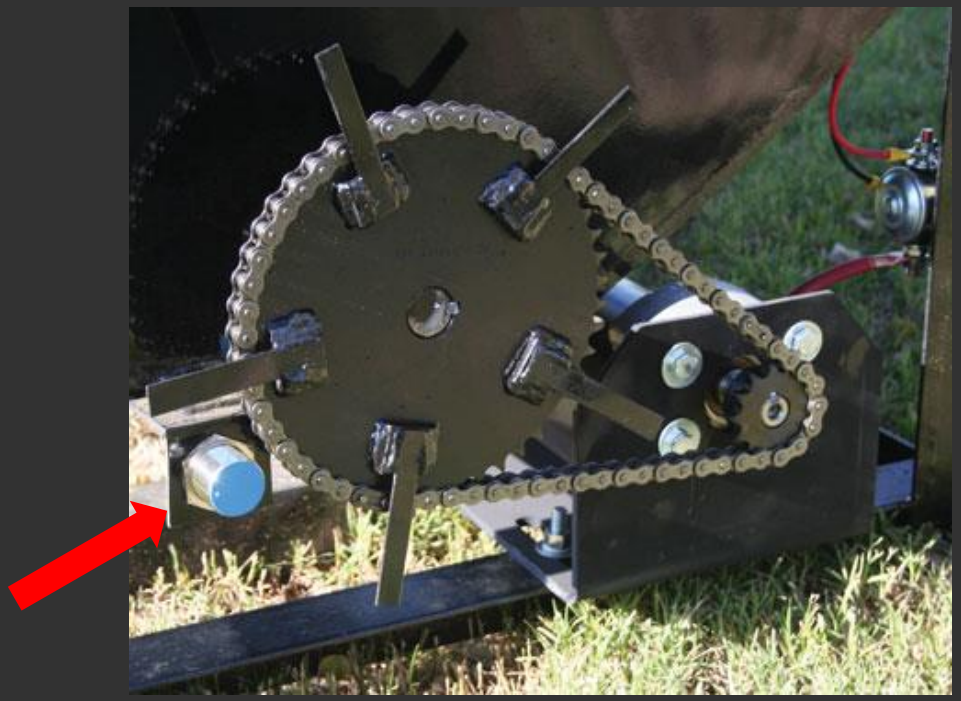
- DC-Electric motor ~$300 (1/4 HP)
  - Can be expensive
  - Low precision
    - Use timed operation not step operation
    - Start/stop lag time

http://www.anaheimautomation.com/products/stepper/stepper-motors.php?tID=75&pt=t&cID=19
http://www.electricmotors.machinedesign.com/
http://www.mcmaster.com/#dc-motors/=4resgp

Sensors

Proximity sensor (magnetic field)

- 3C currently purchases one for the digital cube feeder
- Fairly cheap (~$32)
- Feral hogs or deer will not have a magnetic ear tag



http://www.3cfeeders.com/images/chain_mech.jpg

Sensors

RFID

- ***Passive***:
  - Expensive compared to a regular ear tag (about $2 per tag as opposed to $.09-$.47 tags)
  - Each RFID tag will need to be added to a list by the user
- ***Active***:
  - Not yet in ear tag form, still under development
  - Available in collar form, but batteries need to be changed

http://www.hascotag.com/livestock.php

Sensors

Reflectivity

- We can utilize the properties of certain reflective materials that will be in sticker form that the cattle owner applies to the ear tags.
- May have interference with the sun
- May have difficulty with the cattle having ear in the correct orientation

Sensors

IR distance sensor

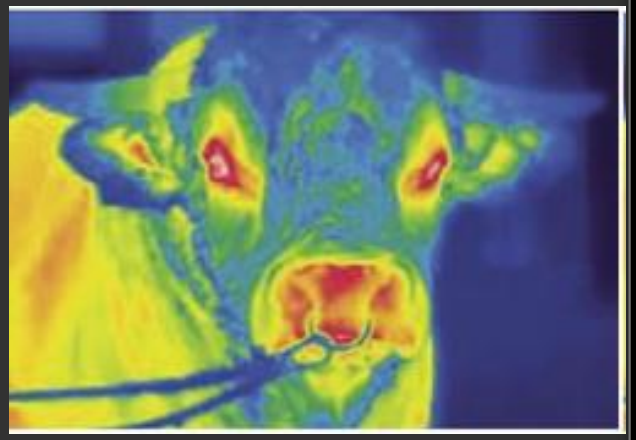
- Will not keep deer out
- Can use the cattle's height alone to trigger the feeder
- Inexpensive
  - ($13)

http://www.adafruit.com/adablog/wp-content/uploads/2009/05/sharpdist-lrg.jpg

Sensors

Thermal imaging

- Each animal involved in this project has its own heat signature (cattle, deer, feral hogs)
- Image processing can be used to activate the feeder only when a bovine heat signature is detected
- Extremely expensive to purchase hardware (upwards of $2500 per camera)



http://www.vet-ir.com/images_files/bovine2.jpg
http://www.hutchisonscientific.com/images/pig.jpg

Sensors

Image processing

- A camera captures image of the animal as it approaches the feeder
- Image processing software will make a decision based on shapes
- We can utilize the shape of ear tags or the animal
- Feral hogs or deer will not have certain shapes
- Expensive to implement

Power and Charging

- For the main power source a 12V car battery will likely be used
- To charge/maintain that 12V charge, a solar panel or wind turbine will be used

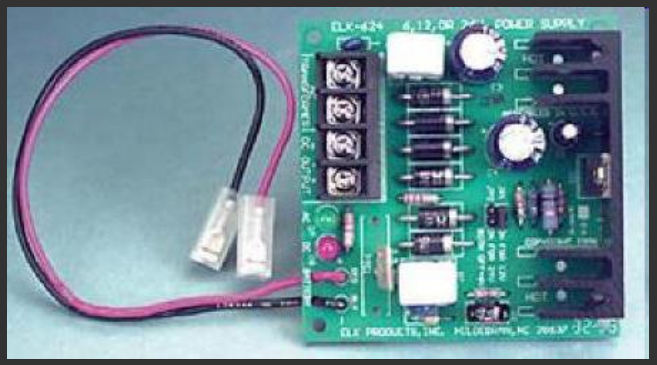
$40

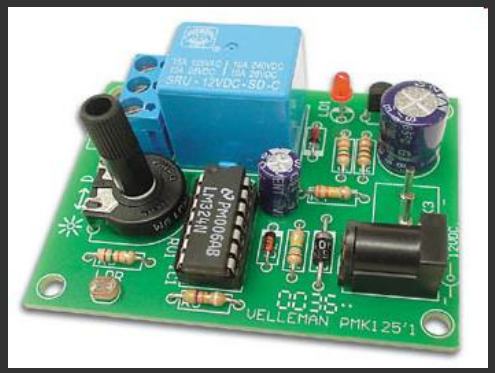
http://autosfans.com/wp-content/uploads/2009/10/car-battery.jpg
http://www.batterystuff.com/solar-chargers/2.5Wframe.html
http://www.outdoorgb.com/p/wren_extreme_micro_turbine/?utm_source=froogle&utm_medium=directory&utm_content=USA&currency=USD&country=USA

Other Electronics

Low Battery Sensor :

- Avoid any deep discharges of the battery, extending battery life





Low light sensor:

- Completely shuts the unit down at night
- Feral hogs and deer are most active at night giving another advantage

http://www.mcmelectronics.com/product/82-2165
http://www.allspectrum.com/store/product_info.php?products_id=99

Spring Testing

- Sensors
- Dispensing
- Hog Behavior?
- Prototype

Picture source: http://www.noble.org/ag/wildlife/feralhogs/MudPig.JPG

Spring Semester's Schedule

	Jan	Feb	Mar	Apr	May
Metering	X				
Motor	X				
Power/charging		X			
Sensors		X			
Required Testing				X	
Overall Design/ Build Prototype				X	
Business Plan		X			

Acknowledgements

- We would like to thank the following people for their help:
  - Bear Runyan & employees at 3-C Cattle Feeders
  - Shea Pilgreen
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  - Dr. Paul Weckler
  - Dr. Ning Wang
  - Dr. Bob Kropp
  - Wayne Kiner

We would now like to take some time to answer any questions you may have