



**Ordway Feedyard
Manure to Energy Project**

Final Report

for

**Colorado
Department
of Agriculture**

May 12, 2009

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Project Summary

Ordway feedlot is a beef feedlot located in Crowley County, Colorado. The feedlot hosts between 40,000 to 50,000 beef cattle at any time, resulting in the production of approximately 250 million pounds of wet manure per year. The cost to dispose of this large amount is about 250,000 USD per year. The aim of this project is to evaluate various manure-to-energy technologies, and implement the one that would most efficiently help the feedlot to use the manure as an energy source, instead of a waste, with minimal environmental impacts.

As part of the CDA/ACRE grant, a feasibility report was presented to Luke Larson, manager of Ordway Feedyard, LCC. This consisted of a feasibility study, showing the current necessities of Ordway Feedyard, and a detailed description of the main technologies applicable to this case.

After this initial feasibility study was completed, the technologies that showed the most promising possibilities were digesters, incineration and gasification.

Finally, a Resource Guide to help farmers and the general public to understand more clearly what is involved in livestock waste to energy conversion was completed.

Accomplishments

FEASIBILITY STUDY

The first deliverable of this project was finished and presented to Luke Larson, manager of Ordway Feedyard, LCC. This consisted of a feasibility study, showing the current necessities of Ordway Feedyard, and a detailed description of the main technologies applicable to this case. This is a brief summary of such technologies:

- Anaerobic digesters. Manure is mixed with water and placed in a closed space where the resultant methane is captured.
 - Advantages: Low cost, very simple technology.
 - Disadvantages: Water usage. Reliability: there is a history of 50 % success with this process.
- Briquettes. Manure is dried and mixed with other forms of biomass and compressed into compact solid blocks that can be used as a fuel alternative to coal or wood.
 - Advantages: Easy and clean handling and storage, high energy content.
 - Disadvantages: Several different pieces of equipment needed. The process would not be automatic.



Figure 1. Generic Feedlot Image.

- Pyrolysis. This is a thermo-chemical process at a very high temperature in absence of oxygen used to convert manure to a liquid fuel such as ethanol.
 - Advantages: The final product is easy to handle. There is a more consistent quality compared to any solid biomass.
 - Disadvantages: This process requires a rather complicated plant.
- Gasifiers. Gasifiers convert materials with high organic content, such as manure, at high temperature in an oxygen limited environment to produce a high energy value gaseous mix known as synthetic gas or syngas.
 - Advantages: This technology is being developed by several companies and universities in this country, there are commercial products available now
 - Disadvantages: There are no antecedents of use of this technology in feedlots, or similar environments.
- Biofuel conversion to ethanol. This is a very similar process to gasifiers, with an additional conversion from syngas to ethanol.
 - Advantages: Ethanol can be widely used by several different vehicles and equipment, which opens the possibility of commercialization.
 - Disadvantages: This technology requires a plant with a high degree of complexity. So far there are no developments towards a plant simple enough to be used in a feedlot.
- Incineration. Incineration of dried manure directly is one of the oldest manure-to-energy practices that have been widely practiced across the globe.
 - Advantages: Modern developments make this a clean, simple and safe option. It might offer a relatively short return of investment period. There are commercial plants available.
 - Disadvantages: High initial investment when compared to digesters.

After this initial feasibility study, the technologies that showed the most promising possibilities are: digesters, incineration and gasification.

Mike Biggs and Rajat Srivastav met with Luke to review the options shown in the feasibility report, and to find a technology that would address Ordway's needs in the most efficient way. From this meeting, two technologies emerged as the most feasible: incineration and gasification. Digesters' 50% reliability, and the water needed to run them make this type of technology unfeasible for Ordway.

TESTING

To ensure Ordway chooses the technology that best suits its needs and adjusts to the amount of manure they'll be processing, we performed an incineration test and laboratory analysis on the manure. The test consisted on taking a sample of manure from the feedlot and burning it in an incinerator.

Incineration

The incineration test was performed by EcoCombustion, the manufacturers of Elimanure, a manure incineration system. One of the main objectives of this test was to verify the level of ash content in a representative waste sample. It is known that Elimanure has had serious problems in the past with the ashes inside the incinerator during operation.¹

The results showed that this type of technology is not feasible for Ordway feedlot due to the high ash content of the animal waste. This concentration of ash is the result of a) the extended period of time the manure rests on the ground before being collected, and b) the collection methods. Although there are a number of collection techniques that have been proven to lower the ash content in other concentrated animal feeding facilities, Ordway feedlot is not at all interested in changing their operation.

Gasification

Agricultural Waste Solutions (AWS) developed a gasification system that might be applicable to this case. It was through Kingston Energy, a supplier of AWS systems, that a laboratory test was performed on the manure. The findings of this analysis coincided with that of EcoCombustion's test, the ash content is close to 40%. However, on the case of this technology, the ash content is not a limiting factor. Still, the Ordway feedlot would benefit from a cleaner collection, since the energy content of the manure is lowered by the amount of ash in it.

What these tests show that under the current mode of operation, gasifiers are a better alternative, albeit a more expensive one, too. Ordway feedlot will have to weigh what brings more benefit to their operations: to invest more in a cleaner collection; or to have lower ash content and, therefore, a lower efficiency in their waste to energy conversion.

¹ Emily Caldwell, *Roast your compost*, Ag Nutrient Management
http://www.progressivedairy.com/anm/features/2008/0508/0508_caldwell.html

RESOURCE GUIDE

The final deliverable of this project is an educational Resource Guide. The main objective of this document is to provide a comprehensive and easy to understand guide that will help other businesses of the same nature in Colorado to develop their own solution to manure management problems.

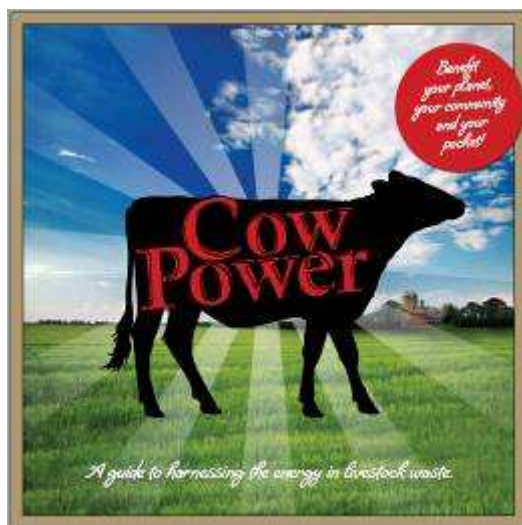


Figure 2. Resource Guide cover

In a language easy to understand, the prevailing technologies in manure to energy conversion are showcased and explained in the guide. It also help farmers to navigate the decision making process by describing each one of the steps leading to a successful implementation of a biomass utilization project.

The guide is divided in the following sections:

FAQ section: as a form of introduction, the most frequent questions regarding the basics of manure conversion into energy are asked and answered in a friendly way.

A history of biomass utilization: the use of manure as a form of fuel is nothing new. The readers are introduced in this section to the varied methods used by people of different times.

The benefits of biomass utilization: Not only the environment is benefitted from manure to energy operations. WE, at iCAST, believe in the triple bottom time. It's in our mission to foster environmental sustainability, while at the same time generating economic prosperity and social progress for every stakeholder involved. In this section, the readers will be able to understand the benefits biomass utilization technologies will bring to the people, the planet, and even their own pockets.

Biomass to energy conversion technologies: In layman's terms, the main three technologies available today to convert manure into energy—anaerobic digestion, gasifiers and

incinerators—are described in this section. This section ends with a table comparing the pros and cons of each technology.

Case studies: Three case studies are shown so that the readers learn about the experiences of other producers, and the benefits that these projects have brought to their owners.

Quick guide for a successful project: One of the main hurdles for the adoption of any technology that hasn't been widely embraced by the public is the lack of knowledge about it. This section aims at demystifying the seemingly complex process of installing a manure-to-energy converter in your farm.

Options for excess energy: In iCAST's experience, one thing farmers can do to significantly shorten the period of return of investment is to know beforehand what to do with the excess energy that is produced. Different options are presented in this section.

Finally, the guide has a glossary, a section where the sources are listed, so that people interested in this subject can learn more, and a section about the different resources they can tap into to kick-start their biomass utilization project.

The guide features a central spread that works as a map for the rest of the content. Readers can visually identify the main considerations before implementing this kind of technology, as well as some of the most common outputs. This map redirects the readers to specific pages in the guide where they can find more information.

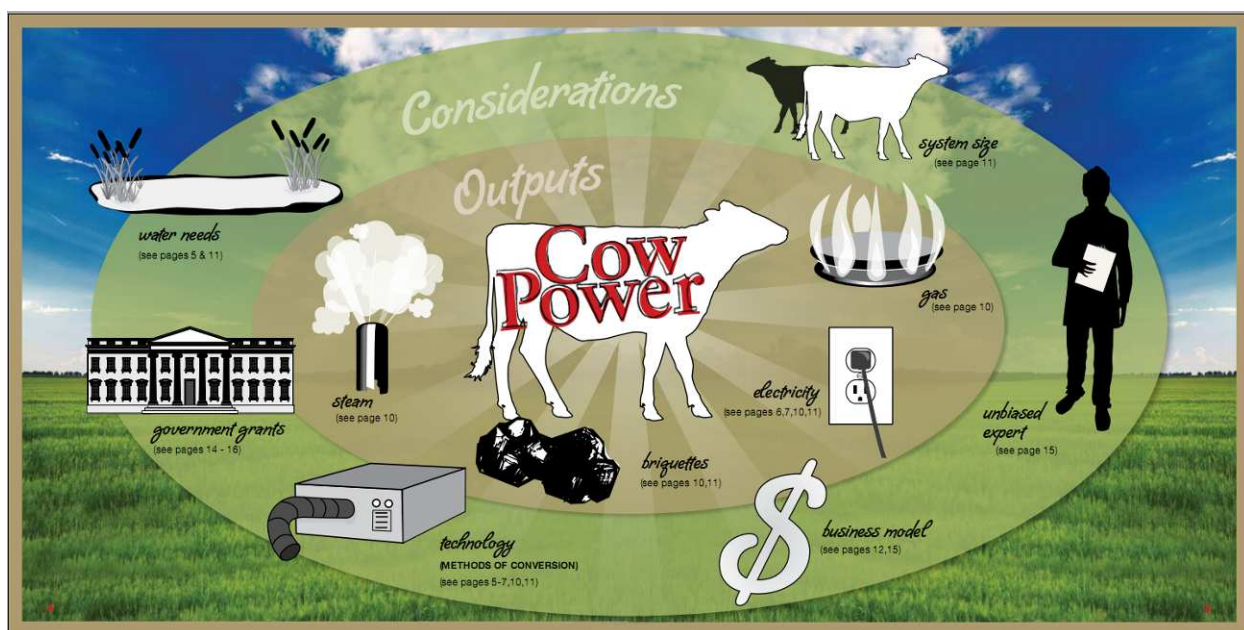


Figure 3. Central Spread.

Objectives and End Results

Task	Result
1. Complete feasibility study for the Ordway Feed Yard for bio-energy from manure. Feasibility studies will include, but not be limited to: a. Evaluation of available options and justification for the one selected; b. Process description and equipment needed; c. Costs associated with implementation as well as savings and revenues; d. Implementation plan.	The feasibility study was finished and presented to Luke Larson, manager of Ordway Feedyard, LCC. This study showed the current necessities of Ordway Feedyard, and a detailed description of the main technologies applicable to this case. Anaerobic digesters, Briquettes, Pyrolysis, Gasifiers, Biofuel conversion to ethanol, Incineration were the options described. Costs associated with implementation were presented in dollars per animal unit. Due to the unique conditions of every project, these costs can only be used as a guideline.
2. A case study on Ordway Feed Yard: a. Description of available options for bio-energy from manure with FAQs section; b. Description of opportunities and barriers for others in Colorado; c. Process of implementing a bio-energy from manure project.	Resource Guide. The main objective of this document is to provide a comprehensive and easy to understand guide that will help other businesses of the same nature in Colorado to develop their own solution to manure management problems. Available options were described in layman's terms, as well as the particular advantages and obstacles for this type of projects in Colorado. A section describes the necessary steps to implement a bio-energy from manure project.
3. An Outreach program to disseminate case study, helping other feedlots and dairies choose how to best seize the bio-energy from manure opportunity.	iCAST's educational Resource Guide was presented in Crowley County to local farmers on May 11th. Additionally, for a broader impact, the Guide has been distributed to RC&D offices covering the different rural areas around Colorado. Also, the Guide is available online at: http://www.icastusa.org/publications/CowPower.pdf

Conclusion

This project has been instrumental to understand the hurdles and advantages of implementing any of the waste-to-energy technologies in the state of Colorado. Due to unique local conditions, and the constant development of these processes, it is not easy to maneuver through the process nor is it to find the most appropriate technology for a given feedlot or farm.

The key to facilitate the adoption of this type of technology, however, is to inform farmers, the general public and local authorities about the different benefits at several levels that waste utilization brings to the surrounding communities, the environment, and the feedlot and dairy farm owners themselves.

The potential behind projects like this is two-fold: the noxious effects of manure are mitigated and the clean energy is produced locally, for a healthier and wealthier Colorado.