Mono-Slope Beef Barn Open House

Managing Mono-Slope Barns to Improve Cattle & Environmental Performance

Wednesday, June 22, 2011
10 a.m. – 3 p.m.
Ron & Clayton Christensen's Barn
Royal, IA

10 a.m. – 12 p.m. Open House Stations
12 p.m. – 1 p.m. Lunch
12:30 – 1 p.m. Introduction of Sponsors
1 – 3 p.m. Open House Stations

Stations listed on back side

Open House Stations

Station 1: How We Manage the Barn
Ron & Clayton Christensen, Barn Owners

Station 2: The Air Quality Project and Air Quality Regulations
Dick Nicolai, SDSU Agricultural and Biosystems Engineering

Station 3: Cost Sharing Opportunities
Dean Groenmeyer, Clay/Palo Alto County NRCS
Tony Tiogo, Iowa Department of Agriculture and Land Stewardship

Station 4: Managing the Pack for Animal Comfort and Reduced Emissions
Mindy Spiehs, USDA Meat Animal Research Center

Station 5: Stockpiling Manure
Ken Hessenius, Iowa Department of Natural Resources

Station 6: Value & Nutrient Management of Mono-Slope Manure
Jose Hernandez, University of Minnesota Agronomy

Station 7: Analyzing the Gases and Particulate Matter
Erin Cortus & Scott Cortus, SDSU Agricultural and Biosystems Engineering
Steve Pohl, SDSU Agricultural and Biosystems Engineering

Sponsors

Animal Medical Centers, Spencer
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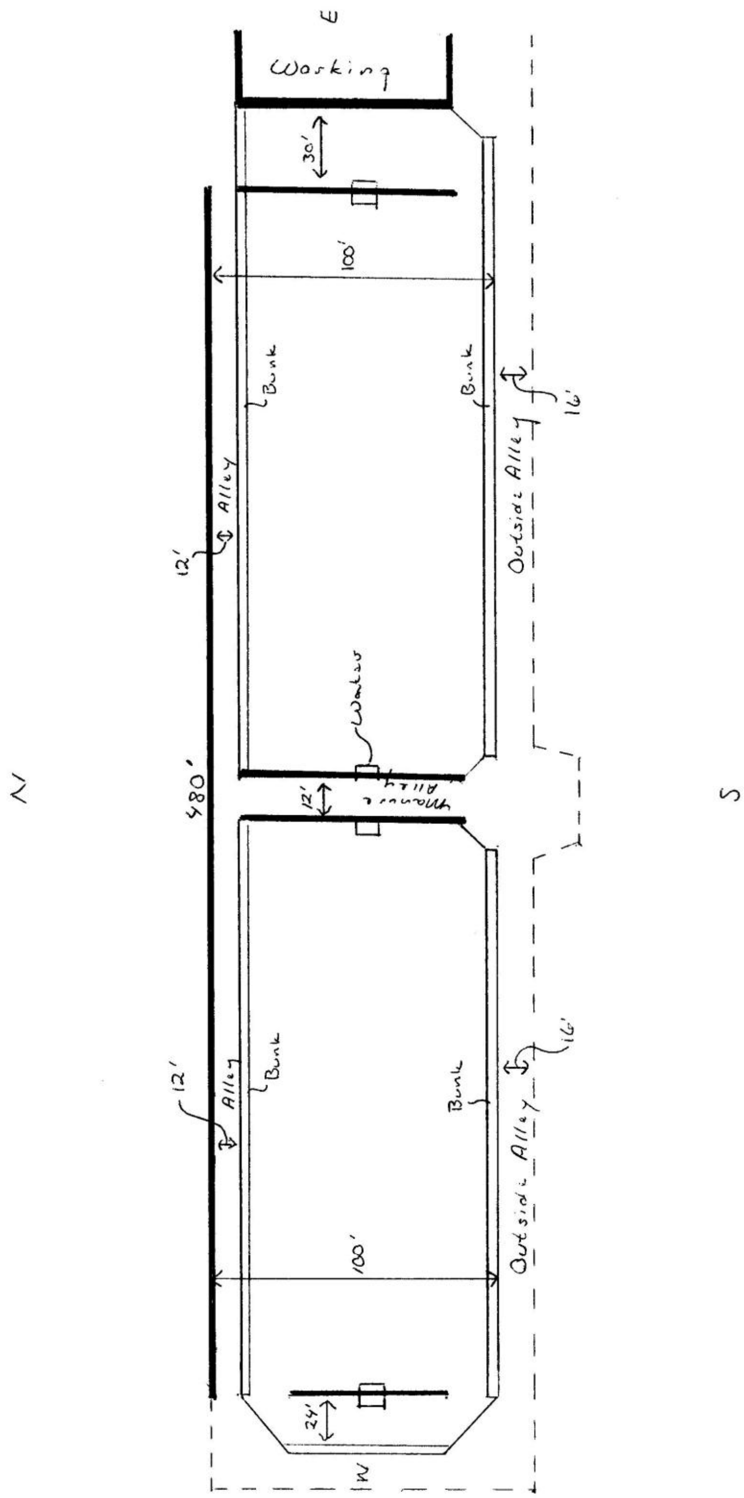
Facility Design



Station 1

How We Manage the Barn

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1. **Type of facility:** Wide mono-slope barn with solid cement floor

2. **Why we chose this type of facility:** We built the mono-slope barn in 2007.

   - Like concrete and steel for long term use and durability
   - Knew the air flow would be good all the time
   - Provides cattle comfort; seems the best environment to raise cattle
   - Ease of working cattle
   - Size of cattle lot – doesn't take up a lot of valuable farm ground
   - Manure handing is easier because of its consistency

3. **One-time feedlot capacity:** 999 head

4. **Cost per head space:** $623/head

5. **Kind and amount of bedding used:** Round cornstalk bales. Bed each pen with 4-6 bales twice a week (16-24 bales/week) on Monday and Friday. This depends on the size of the steers and number in the pens. It also depends on recent rain or snow. It takes one hour with two people working (2 hrs/week).

6. **Special management we have for:**

   a. **Feeding –** Feeding is done two times a day; 3 loads each day. The bunks are good because they prevent waste. When cattle are small, they can all get to the bunks. Also, less snow and rain gets to the bunks.

   b. **Manure handling –** We try to haul manure once a week, depending on the size of the cattle. The outside 12-16 feet of the pen is scraped. There usually are 8-12 loads per building per week. It take 5-6 hours, depending on the distance the manure is being hauled.

   c. **Animal handling –** Animal handling is easy with little stress on the cattle. They calm down very easily. We hand feed hay to get them comfortable with people. To remove sick cattle, gates open right to the sick pen. Cattle are sorted in alleyways. We have noticed, when sorting, that cattle stay at the perimeter of the pens and don't seem to like to walk on the bedpack then.

7. **Environmental regulations we have:** This is an open feedlot under DNR rules.

- 1250 feet away from the other open lot
- Stay under 1000 head
- 10% of the lot is open and at any time, any steer could walk outside for feed & water
- There is no discharge of waste into the environment

8. **If we were expanding our feedlot again, here is what we would change:**

- Make more room to get into manure alley
- Do not need as many lights
- Would put the working facility in the same building
- Do not need two doors in the end wall
- Do not need outside pens
- Open lot areas increase risk of run-off

Station 2
Monoslope Beef Barn Emission Study

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Project Goals:

- Gather baseline data for gases and dust emitted from mono-slope beef barns.
- Evaluate two manure handling systems (deep bed pack and weekly scrape).
- Report project developments to producers to reduce emissions

Project Plan:

- Monitor two pens each from two 100-foot wide barns in eastern South Dakota and two barns in northwest Iowa.
- Monitoring for ammonia, hydrogen sulfide, methane and particulate matter (dust) will occur over a two-year period.

Project Justification

Traditionally, the EPA has not required the livestock and poultry industry to comply with the federal regulations. However, recent court decisions have indicated that livestock operations are no longer exempt and must comply with these regulations, even though there is no generally agreed upon air emission estimates from most livestock and poultry facilities. In response to these court decisions, the National Air Emissions Monitoring Study (NAEMS) was funded by the federal government. The NAEMS sites investigated did not include deep-bedded beef production facilities.

Project Procedure

Air samples are being collected from two pens in the barn to assess the animal environment. Air leaving the barn will be sampled at three locations for each pen, with the sampling port located approximately in the center of each of the three sections that comprise each pen. Incoming air will be sampled at two locations for each pen on the south side of the barn and blended through a tee. The sample locations were numbered from 1 to 8, as shown in figure below. Locations 1, 2, and 3 are exhaust from Pen 1 and Location 4 is the air inlet to the pen. Locations 5, 6, and 7 are exhaust from Pen 2 and Location 8 is the air inlet for the pen. Air emission monitoring data is recorded continuously with gas analyzers located in trailer adjacent to barn. Airflow through the barn is also monitored.

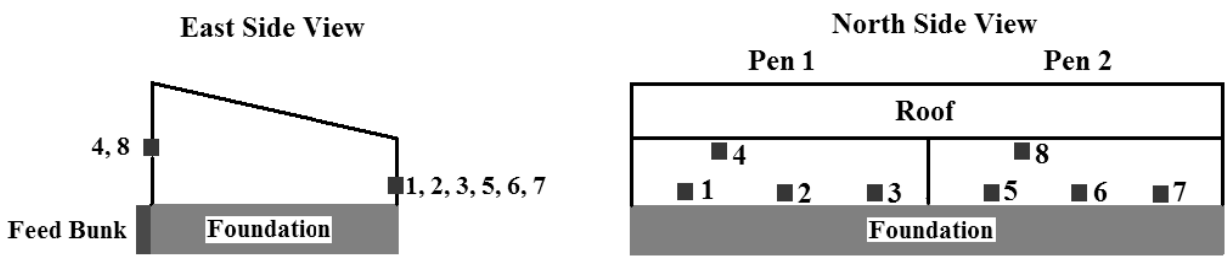

Figure 1 Barn air sampling locations

Station 3

Cost-Sharing Opportunities

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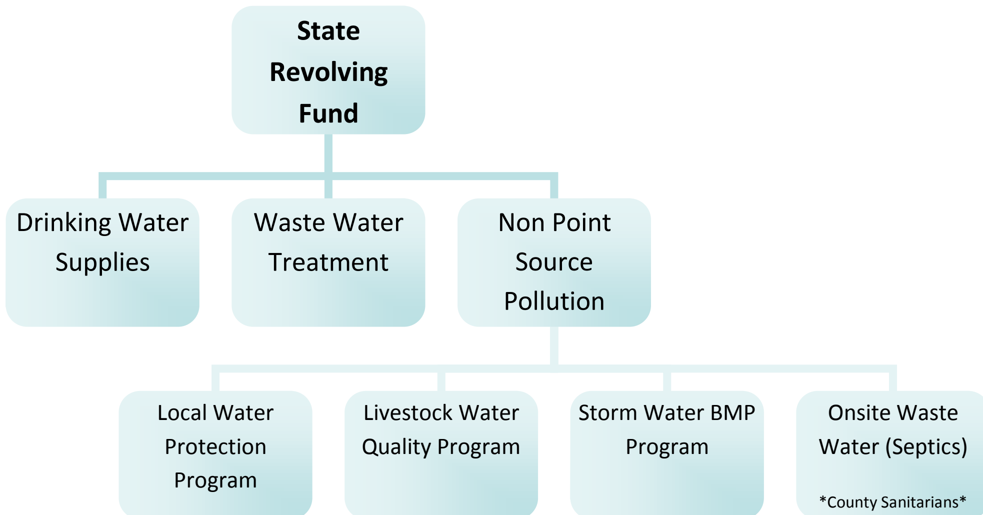

1. DNR contracts with Iowa Department of Agriculture and Land Stewardship (IDALS) to manage three of the non point source programs.
2. Local Water Protection Program
3. Livestock Water Quality Program
4. Storm Water BMP Program

- The audience for each program is different, but each has the same goal – water quality.
- Linked deposit loan structure – maximum rate to borrower is 3%
- Terms up to 15 years. $500,000 cap per borrower (this is new)
- 475+ participating lenders have a role in successfully putting these water quality projects on the ground
- Loans can be used in conjunction with federal and state programs or loans fund up to 100% of the actual cost of the practice
- Lots of things we have funded …. terraces, waterways, grade stabilization projects, **solid settling basins, mono slope or hoop buildings, deep pit confinements,** rain gardens, bio swales, permeable paving
- First point of contact for potential applicants should be local SWCD office
- SWCD point of contact various funding opportunities and technical help

A look at the numbers

Program Name	Borrower(s)	Distinct Borrower(s)	Loan(s)	Total Amount
Local Water Protection Program - All Counties	1642	1316	1642	$28,639,780.41
Livestock Water Quality Program - All Counties	323	267	323	$32,956,566.04
Storm Water Program - All Counties	7	7	7	$808,808.82
Grand Total	**1,972**	**1,590**	**1,972**	**$62,405,155.27**

NRCS Cost Sharing Opportunities

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The USDA has provided cost share assistance for roofed structured beef barns when open lots are either partially or totally closed. The funding has been made available through the Environmental Quality Incentive Program (EQIP) on a local county basis. The policy and rates for the next funding period have not been announced at this time. Interested individuals should contact their local NRCS county office to see what the rates are, and what contract limits may be established locally in the county.

EQIP funding for animal waste treatment facilities require the development of a Comprehensive Nutrient Management Plan (CNMP), and that the structure meet NRCS practice standards, including site and structure engineering requirements for the practice.

Station 4
Environmental Conditions in Beef Deep-Bedded Mono-Slope Facilities

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Summary

Ammonia (NH_3), temperature, moisture content, pH, pack depth, nutrient composition and concentration of odorous volatile organic compounds (VOC) were measured at 56 locations in each of four pens in two commercial beef deep-bedded mono-slope facilities (BDMF). Areas of high NH_3 concentration occurred randomly throughout the pens and were likely the result of recent urination of cattle. Ammonia concentration was higher when the pack and ambient air temperature increased and was consistently lower in the cold months compared to moderate and hot seasons. Therefore, priority should be given to NH_3 mitigation strategies in BDMF during the hot months.

Volatile organic compounds were more concentrated in areas with little bedding and were poorly correlated to the temperature, moisture content, pH, and depth of the bedded pack. Frequent cleaning around the bedded pack should reduce the volatilization of VOC and may improve air quality in the BDMF.

In pens were a bedded pack was removed every three weeks a cooler pack temperature and higher moisture content was measured, which may reduce NH3 emissions. The concentration of odorous compounds was higher when shallow-bedded management was used, due to less bedding material in the pen and a higher manure:bedding ratio.

Total nitrogen, total phosphorus, total potassium, and total sulfur in the manure/bedding from BDMF averaged 44.5, 14.1, 35.2, and 11.6 lb/ton, respectively. This is similar to reported values for manure from a beef earthen lot (45.2 lb/ton TN, 14.2 lb/ton TP, 36.8 lb/ton TK, and 11.8 lb/ton TS).The volatile solids content of the manure from the BDMF is 80%. This is very high compared with other beef housing systems such as soil-surfaced open feedlots which contain 21% VS in manure and pens with a pond ash surface that contained 51%VS in manure. Thus, manure from BDMF may have additional value beyond use as a fertilizer, possibly for combustion.

Both *E. coli* O157:H7 prevalence and generic *E. coli* concentrations can occur at high levels in the bedding/manure material of BDMF, and may vary with differences in ambient seasonal temperatures. Shallow-pack management may be a system that can lower barn NH_3 emissions during hot months. However, a possible negative consequence of shallow-bedded management is the increased concentration of odorous compounds in the pen surface manure.

Table 1. Concentration of ammonia and volatile organic compounds in various locations in beef deep-bedded mono-slope facilities [1]

	Bedded pack[2]	Transition[3]	Concrete[4]
Ammonia, mmol/L	68.3 ± 2.8	63.9 ± 3.9	70.2 ± 3.4
BCFA, mmol/g[5]	2.6 ± 0.2b	3.8 ± 0.3a	3.7 ± 0.2a
Aromatics, mmol/g[6]	2.2 ± 0.6b	12.8 ± 0.8a	11.7 ± 0.6a
Temperature, °F	78.3 ± 0.5a	66.2 ± 0.9b	63.0 ± 0.8c
Moisture, %	64.6 ± 0.3b	70.4 ± 0.5a	71.3 ± 0.4a

[1] N = 1257 [2] Bedded pack = area of pen having pack depth >6 inches. [3] Transition = area in pen having pack depth 3-6 inches. [4] Concrete = area of pen having pack depth <3 inches. [5] BCFA = total branch-chain fatty acids. Included isobutyrate, isovalerate, and isocaproate; [6] Aromatics included *p*-cresol, phenol, 4-ethylphenol, skatole, and indole. Different letters within a row indicate a significant difference P < 0.01

Table 2. Effect of season on pack characteristics in beef deep-bedded mono-slope facilities

	Cold[1]	Moderate[2]	Hot[3]
Ammonia, mmol/L	14.8 ± 5.4c	57.6 ± 2.3b	99.5 ± 2.9a
Pack temperature, °F	59.7 ± 0.7c	69.5 ± 0.6b	84.4 ± 0.6a
Pack moisture, %	69.9 ± 0.5a	68.1 ± 0.4a	63.4 ± 0.5b
Pack depth, in	8.7 ± 0.4a	6.9 ± 0.3a	9.7 ± .3b
pH	7.5 ± 0.04a	8.0 ± 0.04b	7.5 ± 0.04a
Total BCFA, mmol/g	3.5 ± 0.23	3.1 ± 0.21	3.0 ± 0.22
Total aromatics, mmol/g	9.7 ± 0.69b	9.63 ± 0.65b	4.21 ± 0.65a
E. coli O157:H7, % positive	30.0a	33.0a	50.2b
Avg generic *E. coli*, $\log_{10}$ CFU/g	5.99 ± 0.05a	6.41 ± 0.04b	6.47 ± 0.02b

[1] Average ambient temperature for both barns on the day of collection was at or below 32°F.
[2] Average ambient temperature for both barns on the day of collection was between 32 and 69°F.
[3] Average ambient temperature for both barns on the day of collection was at or above 69°F.
Different letters within a row indicate a significant difference P < 0.01

Acknowledgments

The authors thank the barn managers for their willingness to participate in this study. Thank you to the ARS technicians and Dordt College student workers for data collection and laboratory analysis of samples. We gratefully acknowledge the grant from the Iowa Beef Center to partially fund this project.

Station 5

Stockpiling Manure

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Dry bedded manure, as defined below, is generated by cattle or swine in a dry bedded confinement feeding operation. Specific rules for dry manure stockpiles and stockpiles from open feedlot operations are covered under separate fact sheets.

Dry bedded manure from dry bedded confinement feeding operations may be stockpiled provided the following separation distances and conditions are met:

DISTANCES TO RESIDENCES AND SPECIAL AREAS FOR MANURE STOCKPILES [1,2]	
Residence, commercial enterprise, bona fide religious institution, educational institution, or public use area (does not apply to stockpiles from SAFOs, confinements having an animal unit capacity of 500 or less)	1,250 feet
Designated area other than a high-quality water resource	400 feet
Agricultural drainage wells and known sinkholes	400 feet
High quality water resource	800 feet
Terrace tile inlet or surface tile inlet – unless methods, structures or practices are implemented to contain the stockpiled manure[3]	200 feet

[1]Manure stockpiles are prohibited on grassed waterways where water pools on the surface or in any location where surface water will enter the stockpiled dry bedded manure.

Manure stockpiles are also prohibited on land with slopes greater than 3% unless methods, structures or practices are implemented to contain the stockpiled manure, including but not limited to hay bales, silt fences, temporary earthen berms, or other effective measures, and to prevent or diminish precipitation-induced runoff from the stockpiled manure.

[2]See subparagraphs 567 IAC 65.2(3)"d"(1 -3) and subrule 567 IAC 65.2(11) for prohibitions and siting restrictions pertaining to dry bedded manure stockpiles.

[3]Separation from tile inlets does not apply if dry bedded manure is maintained in a manner that will not allow precipitation-induced runoff to drain from the dry bedded manure to the terrace tile inlet or surface tile inlet.

Definitions:

"Confinement feeding operation" means an animal feeding operation in which animals are confined to areas which are totally roofed and includes every animal feeding operation that is not an "open feedlot operation".

"Dry bedded manure" means manure from cattle or swine that meets all of the following requirements:

1) The manure does not flow perceptibly under pressure.
2) The manure is not capable of being transported through a mechanical pumping device designed to move a liquid.
3) The manure contains bedding.

"Dry bedded confinement feeding operation" means a confinement feeding operation in which cattle or swine are confined to areas which are totally roofed and which all manure is stored as dry bedded manure. Unless specifically stated otherwise, all requirements in Division I of 567 – Chapter 65 do apply to dry bedded confinement feeding operations.

“Dry bedded confinement feeding operation structure” means a dry bedded confinement feeding operation building or a dry bedded manure storage structure.

“Dry bedded manure confinement feeding operation building” or “building” means a building used in conjunction with a confinement feeding operation to house cattle or swine and in which any manure from the animals is stored as dry bedded manure.

“Dry bedded manure storage structure” means a covered or uncovered structure, other than a building, used to store dry bedded manure originating from a confinement feeding operation.

“Designated area” means a known sinkhole, abandoned well, unplugged agricultural drainage well, agricultural drainage well cistern, agricultural drainage well surface tile inlet, drinking water well, designated wetland, or water source. Designated area does not include a terrace tile inlet or surface tile inlet other than an agricultural drainage well surface inlet.

“Stockpile” means dry manure or dry bedded manure originating from a confinement feeding operation that is stored at a particular location outside a confinement feeding operation building or a manure storage structure.

Special conditions related to dry bedded manure stockpiles:

Dry bedded manure from a confinement feeding operation may be stockpiled provided:

- Stockpiling requirements provided in 567 IAC 65.2(11) are met.
- Applicable NPDES requirements pursuant to the federal Water Pollution Control Act are met.
- Dry bedded manure is removed from the stockpile and land applied in accordance with 567 IAC 65.3 (459, 459B) within six months after the dry bedded manure is first stockpiled.

Requirements for karst terrain or alluvial aquifer areas:

- A minimum of five feet of low permeability soil or rock is required between the bottom of the stockpile and underlying limestone, dolomite or other soluble rock in karst terrain or the underlying sand and gravel aquifer in an alluvial aquifer. – See 567 IAC 65.2(11)”b”(1) for details
- Stockpiles shall be placed on a reinforced concrete slab that is a minimum of 5 inches thick conforming to the requirements of 567 IAC 65.15(14)”a”(2), numbered paragraphs “1,” “3,” “4,” “6,” “8,” and “12.”

CAUTION: This document is only a summary of administrative rules contained in IAC chapter 65; it is a guidance document and should not be used as replacement for the administrative rules. While every effort has been made to assure the accuracy of this information, the administrative rules will prevail in the event of a conflict between this document and the administrative rules.
5/26/11

Station 6

Maximizing the Value of your Manure

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Livestock producers face uncertain markets and narrow margins. This situation has motivated them to optimize production methods, utilizing all resources including manure. In addition, increases in the price of commercial fertilizer experienced in the last 5 years has heightened interest in the use of livestock manure for supplying crop nutrients and has significantly increased its value.

Over the past year more producers have been considering the contribution of manure's value to their cash flow in livestock operation budgets, and seeking an appropriate market value in exchange with crop producers. More crop producers also are seeking livestock manure as a major nutrient source, either by purchasing from a livestock producer or by adding livestock to their operations.

Determining the economic value of the nutrients in livestock manure can be tricky. Nutrients in commercial fertilizer are acquired by paying for the nutrients and a small application charge. Additionally, commercial fertilizer supplies the amount and ratio of nutrients you need or ordered. With manure you, in effect, "acquire" nutrients by paying for the cost of application, even if you already have ownership of the manure. With manure, you get the amount and ratio of nutrients that it contains, which complicates the determination of a value.

Even when a rate that supplies the correct amount of nitrogen is applied, the amount of phosphorous and potash applied may not match what you would have purchased commercially, and amounts applied above crop need probably have no value. In the past, manure application costs often exceeded the value of the nutrients applied. Now, in many situations, the nutrient value in the manure exceeds the cost of application.

Maximizing the value of manure first requires understanding how economic value is gained from manure. In most cases the greatest contribution comes from the value of commercial fertilizer that manure would replace in the crop year after application. In some situations, another opportunity can come from second year credits, particularly with low fertility fields. Increased crop yield is another possible source of value created from manure application. Where it is realized, that value has increased in the past year with higher crop prices. Finally, net value can be maximized by avoiding over-application. Over-application beyond what the crop needs, or beyond what commercial fertilizer the crop producer would have purchased will usually increase application cost per acre without gaining additional income.

Management strategies to increase manure value can be looked at in the same way as how value is determined. First, for the "Value of Year 1 Fertilizer and Application Costs Replaced" (the replacement of nutrients that would have been purchased) use the following management practices:

- Apply for a nitrogen requiring crop.
- Apply to crops and fields that need P and K.
- Incorporate manure to reduce N volatilization losses.
- Use high nutrient concentration manure which requires fewer gallons or tons to haul to meet crop needs, reducing application cost.

- Avoid unnecessary dilution in liquid manures from factors such as drinker wastage.
- Consider lower rates (P based applications) with supplemental commercial N. This practice can potentially increase efficiency of nutrient use, spread yield benefits of manure over more acres, and avoid over-application of these nutrients. However, be sure that the application equipment used can apply the lower rate uniformly.
- Develop a multiyear set of manure tests for each barn to better estimate nutrient levels in manure.

To gain residual value, apply manure to low P and K soil testing fields. Value is gained by replacing fertilizer that would be purchased for the next year.

To gain yield response apply to fields that do not have a recent manure history. If possible select fields with lower organic matter.

To limit manure application costs use equipment that have a range of application levels and that can be calibrated so that application accuracy is achieved. Avoid over-application which wastes nutrients and increases application costs per acre.

Another factor regarding N management with manure is the time of application. Many times the logistics of livestock operations, with their unique handling systems, etc, determine when the manure must be applied. Fall manure applications, either injected or broadcast, allow more time for the organic portions to break down before the plant needs the nutrients as compared to spring application. In contrast, fall applications also provide more time for potential loss of N. Fall applications should be avoided on coarser-textured soils where N leaching can be an issue. If fall application is necessary, it should be done when soil temperatures are below 50 °F.

There is a useful spreadsheet, developed by Dr. Bill Lazarus at the U of MN, that considers first year fertilizer replacement value, possible residual value, and yield impacts, along with application cost, and calculates net manure value.

More information is available at http://z.umn.edu/manurevalue or http://www.manure.umn.edu

Station 7

Analyzing the Gases and Particulate Matter

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What do the terms concentration, emission and airflow mean?

In the case of air quality, concentration is the amount of gas or particulate matter (PM) in a specific volume or mass of air. The barn outlet concentration measurements provide a measure of the barn environment. The barn inlet concentration measurements provide a measure of the background amount of gas or particulate matter in the surrounding environment.
We do not have an instrument that directly measures emission. Emission values are calculated based on the airflow through the building, and the difference in the concentration of gas or PM in the air leaving and entering the building. In simple terms:

Emission = Airflow * (Outlet concentration – Inlet concentration)

Airflow through the barn is determined by multiplying the air velocity through an opening with the opening area. For a monoslope barn, we can measure airflow most accurately when the wind is from the north or south. By Law of Conservation of Mass, the mass (airflow) of air entering the barn must also leave the barn. Therefore, we measure higher air velocities through the north wall of a monoslope barn, with a smaller opening, compared to the south side with the larger opening. We use sonic and vane anemometers to measure air speed and direction.

What gases do we measure?

The gases we measure are:

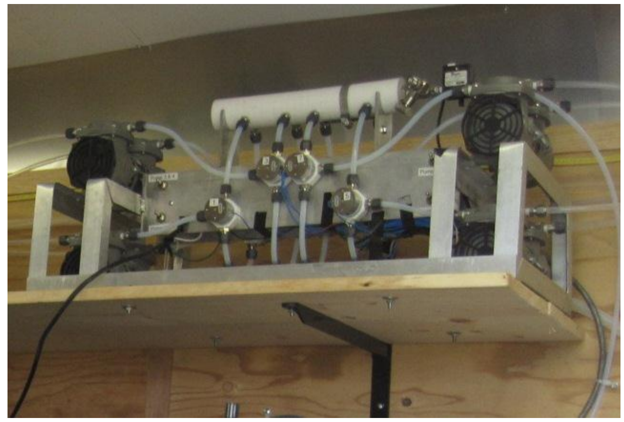
- Ammonia (NH_3)
- Hydrogen Sulfide (H_2S)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Carbon Dioxide (CO_2)

How do we measure gases?

Gas concentrations are typically measured in parts per million (ppm) or parts per billion (ppb). Detecting one ppm of gas is similar to finding one large wheelbarrow of sand (approximately 7 cubic feet) in a quarter-section of soil, 12 inches deep.

We use a Gas Sampling System to collect air samples at various points in the barn. A series of pumps continually pull air through tubes from the different sampling locations in the barn wall openings. This keeps the air in the tubes "fresh". A solenoid system connected to the computer directs the air from the different lines, one at a time, to series of sophisticated gas analyzers that use different methods to detect gases in air. This equipment is housed in a climate controlled instrumentation trailer located adjacent to the barn.

Gas analyzers for NH3, H2S, CH4, N20, & CO2



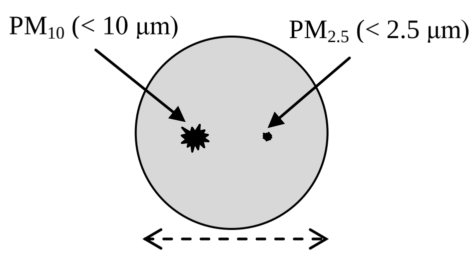
Gas Sampling System

What type of dust do we measure?

Particulate matter is a regulated pollutant under the Clean Air Act. Particulate matter can also act as a transport mechanism for gases and odor.

We measure the total amount of particulate matter that is:

- Less than 10 µm (microns) in diameter – PM_{10} or “inhalable coarse particles”. These particles can enter the respiratory system.
- Less than 2.5 µm in diameter – $PM_{2.5}$ or “fine particles”. These particles can enter the respiratory system and the bloodstream.



Human hair cross-section (70 µm)

Airmetrics MiniVol Particulate Samplers

How do we measure particulate matter?

Very simply, we weigh the amount of dust that collects on a filter. However, we use specialized instruments that control the amount of airflow through the filter. The inlets of the samplers control the size of particles that collect on the filter.

IOWA STATE UNIVERSITY
University Extension

Mono-Slope Beef Barn Open House - June 22, 2011

Please circle your occupation: Producer Agri-Business Education Government Other

Section 1 – Please rate today's information:

1. How We Manage the Barn: Very Useful___ Somewhat Useful___ Not Useful___
2. The Air Quality Project and Air Quality Regulations: Very Useful___ Somewhat Useful___ Not Useful___
3. Cost Sharing Opportunities: Very Useful___ Somewhat Useful___ Not Useful___
4. Managing the Pack for Animal Comfort & Reduced Emissions: Very Useful___ Somewhat Useful___ Not Useful___
5. Stockpiling Manure Very Useful___ Somewhat Useful___ Not Useful___
6. Value & Nutrient Management of Mono-Slope Manure Very Useful___ Somewhat Useful___ Not Useful___
7. Analyzing the Gases and Particulate Matter Very Useful___ Somewhat Useful___ Not Useful___

Section 2 – As a result of today's open house:

	Yes	No	I need more Information	Does Not Apply
8. I have a better understanding of air quality regulations and the need for this research	______	______	______	______
9. I know where to find resources for financial assistance	______	______	______	______
10. I could manage some factors in a barn to increase animal comfort and reduce air emissions	______	______	______	______
11. I plan to change how manure is stockpiled	______	______	______	______
12. I will take credit for the nutrients produced in the manure	______	______	______	______
13. I understand how gases and dust are measured	______	______	______	______

Comments: