

Mono-Slope Beef Barn Open House

Managing Mono-Slope Barns to Improve Cattle & Environmental Performance



Tuesday, August 30, 2011
10 a.m. – 3 p.m.
Goodwin Heritage Cattle Inc.
Goodwin, SD

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

Mike Gibson, Barn Manager

Station 2: Managing the Pack for Animal Comfort and Reduced Emissions

Mindy Spiehs, USDA Meat Animal Research Center

Station 3: Cattle Performance and Economics for Different Housing Systems

Ben Holland, SDSU Animal and Range Science

Station 4: NRCS Assistance for Bedded Pack Barns

Justin Bonnema, USDA Natural Resource Conservation Service

Station 5: The Air Quality Project and Air Quality Regulations

Dick Nicolai, SDSU Agricultural and Biosystems Engineering

Station 6: Analyzing the Gases and Particulate Matter

Erin Cortus, Steve Pohl & Scott Cortus, SDSU Agricultural and Biosystems Engineering

Station 7: Value and Nutrient Management of Mono-slope Manure

Ron Gelderman, SDSU Plant Science

Eric Barnsness, USDA Natural Resource Conservation Service



South Dakota
Cooperative Extension Service



IOWA STATE UNIVERSITY
University Extension



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Sponsors

Goodwin Heritage Cattle Inc.

47068 173rd Street
Goodwin, SD 57238
605-795-4425

Watertown Ag Chamber of Commerce

20 S Maple
Watertown, SD 57201
605-882-8480
Email: coc@watertownsd.com
Web: <http://www.watertownsd.com>

Glacial Lakes Energy LLC.

301 20th Avenue Southwest
Watertown, SD 57210
605-882-8480

South Dakota Farm Bureau

Wayne Smith, Director of Field Services
PO Box 1426
Huron, SD 57350
E-mail: marsha@sdfbf.org
Web: <http://www.sdfbf.org>

Banner Associates, Inc.

Sara Pankonin, PE
2307 W. 57th St. Suite 102
Sioux Falls, SD 57108
605-977-6342
E-mail: sarap@bannerassociates.com
Web: <http://www.bannerassociates.com>

USDA Meat Animal Research Center

E. John Pollak, Center Director
PO Box 166, Spur 18D
Clay Center, NE 68933-1066
402-762-4109
E-mail: E.John.Pollak@ars.usda.gov
www.ars.usda.gov/main/docs.htm?docid=2340

Coteau Hills Cattlemen's Association

16743 458th Ave.
Watertown, SD 57201
605-882-3546

SPN & Associates

2100 N. Sanborn Blvd.
Mitchell, SD 57301
605-996-7761
Web: <http://www.spn-assoc.com>

Landmark Builders Inc.

320 1st Ave. NE, ste. 1
Watertown, SD 57201
605-886-7176

Ag United for South Dakota

Steve Dick, Executive Director
PO Box 507
Sioux Falls, SD 57101
605-336-3622
E-mail: steve@agunited.org
Web: <http://www.agunited.org>

South Dakota State University

Ag and Biosystems Engineering
Steve Pohl, Ag Engineer Specialist
121 Ag Engineering, Box 2120
Brookings, SD 57007-1496
605-688-5662
E-mail: stephen.pohl@sdstate.edu
Web: www.sdstate.edu/abe/

Iowa State University Extension

Beth Doran, Beef Program Specialist
400 Central Ave. NW, Suite 700
Orange City, IA 51041
712-737-4230
E-mail: doranb@iastate.edu
Web: www.iowabeefcenter.org

Form-A-Feed Inc.

740 Bowman Street
Stewart, MN 55385
320-562-2413
<http://www.formafeed.com/>

Station 1

How We Manage the Barn

Mike Gibson, Farm Manager

47068 173rd Street

Goodwin, SD 57238

Office: 605-795-4424

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 2000.
 - Better cattle performance
 - Can produce cattle year around - Not at Mother Nature's mercy!
 - Best option for the Goodwin locale
 - Less labor
3. **One-time feedlot capacity:** 3,200 head; 250 to 300 head per pen
4. **Cost per head space:** \$325 per headspace in 2000
5. **Kind and amount of bedding used:** Wheat straw bales work best. Corn stalks do not keep as well so we tend to use them up every year. Bean vines are also used as a third choice, since they tend to create more dust. Typically bed each pen with 4 bales per week, but bed 2 more bales per week in the moist spring months.
6. **Special management we have for:**
 - a. **Feeding** – Feeding is done twice a day, morning and night. Feed is divided between the north and south bunks depending on season. In the summer, more feed is distributed to the north bunk in the shade, but in the winter more feed is distributed to the south bunk in the sun.
 - b. **Manure handling** – We try to haul manure once a week. During the summer all manure and bedding is removed and land-applied. In the winter, we leave a manure pack in the middle of the pen and blow fresh straw on top. The outside 20 feet of the pen is scraped and land applied, except when the manure is frozen.
 - c. **Animal handling** – During feeding, someone walks the pen to health check the animals. Problems are easier to detect as animals move toward the feed bunk. Every animal has an ear tag. An animal is tagged on its back if it needs to be removed so that the animal is easier to find after feeding is finished. Each pen has its own gate. Cattle are sorted in alleyways.
7. **Environmental regulations we have:** This operation has a South Dakota General Permit.
 - It is inspected once a year
 - We work with an agronomist to collect annual soil and manure samples for land application
 - The manure management plan is reviewed and updated semi-annually
 - No EQIP money was used
8. **If we were expanding our feedlot again, here is what we would consider:**
 - Slat flooring versus solid concrete

Station 2

Environmental Conditions in Beef Deep-Bedded Mono-Slope Facilities

M. J. Spiehs¹, B. L. Woodbury¹, B. E. Doran², R. A. Eigenberg¹, K. D. Kohl³, V. H. Varel¹, E. D. Berry¹,
J. E. Wells¹

¹USDA-ARS Meat Animal Research Center, Clay Center, NE; ²Iowa State University Extension, Orange City, IA; ³Iowa State University Extension, Storm Lake, IA

Mindy Spiehs, 402-762-4271

Mindy.Spiehs@ARS.USDA.GOV

Summary

Ammonia (NH₃), 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 NH₃ 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 NH₃ 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 where 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 NH₃ 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 facilities¹

	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
<i>E. coli</i> O157:H7, % positive	30.0a	33.0a	50.2b
Avg generic <i>E. coli</i> , 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 3

Cattle Performance and Economics for Different Housing Systems

Ben Holland
 Assistant Professor, SDSU
 605-688-5460
ben.holland@sdstate.edu

What we've learned about cattle feeding facilities at the Opportunities Farm

Facilities:

Each facility contains 4, 80-head pens. Each pen contains an individual automatic water trough and 80 ft of bunk space (12 in./head). A description of the facilities is below:

- **Open (OPN)** – Open, mounded, soil-surfaced feedlot pens (80 x 275 ft). Mounds are approximately 7 feet tall with 30 ft²/head space on the mound. Total pen space is 275 ft²/head. A concrete bunk pad extends 15 ft from the feedbunk into the pen.
- **Open with Shelter (OS)** – Mounded, soil-surfaced feedlot pens (80 x 215 ft) partially covered within a monoslope barn. The barn covers the feed alley, feedbunk, and 20 ft of pen. Concrete extends an additional 12 feet beyond the end of the roof. Mounds are 3 ft high.
- **Monoslope (MON)** – Concrete surfaced feedlot pens (80 x 40 ft) completely enclosed in a monoslope barn. Deep pack bedding is used in the back half of the pen. Bedding is applied once weekly, and the areas near the feedbunk and water trough are cleaned weekly.

Performance:

From 2004 to 2009, 28 comparisons between facilities have been made with the same cattle, diets, management, and environment.

- Performance was similar for cattle fed in **OS** and **MON** facilities.
- Compared to **OPN**, **OS** and **MON** had 0.9% advantage in final weight, 2.5% advantage in ADG, and 3.1% advantage in feed efficiency.
- These differences are due to cattle that finished in the 1st and 2nd quarters, when the feed efficiency advantage of buildings was improved 3.5 to 9.5% compared to **OPN**. No differences between facilities occurred when cattle finished in the 3rd and 4th quarters.

Economics:

	OPN	OS	MON
		\$ per head space	
Construction Costs	\$550.76	\$767.96	\$687.06
		\$ per head per day	
Non-Feed Operating Costs			
Equipment	\$0.089	\$0.111	\$0.186
Bedding	\$0.023	\$0.023	\$0.115
Labor	\$0.012	\$0.015	\$0.025
Total Operating Costs	\$0.125	\$0.149	\$0.326

Considering building costs, operating costs, and animal performance, feed costs must be greater than \$121.74/ton of dry matter for **OS** to be a more cost effective system than **OPN**, and \$488.80/ton of dry matter for **MON** to be a more cost effective system than **OPN**.

Summary:

- When open feedlots have adequate wind protection, mounds, and drainage, animal performance is only slightly improved for cattle are fed a confinement building.
- If considering building or expanding cattle feedlots in the Northern Plains, improvements in cattle performance in confinement barns must be balanced with feedlot construction expense, manure quality and quantity, and labor and bedding requirements of different facility designs.

Station 4

NRCS Assistance for Bedded Pack Barns

Justin Bonnema, Animal Nutrient Management Team
USDA Natural Resource Conservation Service
605-692-2344 ext 101
justin.bonnema@sd.usda.gov

Engineering Assistance

- The Natural Resources Conservation Service (NRCS) provides engineering assistance to producers in South Dakota that are under the 1,000 animal unit threshold. This assistance is for development of a waste management system for an animal feeding operation that can include confinement barns, open lots, or a combination of facility types for housing animals.
- For confinement barns, the NRCS engineering assistance applies to the storage of the manure and bedding that is generated by the animals in the confinement barn.
- The timing of NRCS assistance is available on a revolving system. Projects often take 6 months or more to go through the design process, therefore, if you are interested in assistance, apply as soon as possible by visiting your local NRCS field office.
- To be eligible for NRCS engineering assistance, waste management systems for animals that are all under a roof must store at least 270 days of the manure, bedding, and other waste produced by the animals in the barn. This typically includes installing manure bays under the roof for manure stacking or installing an outdoor stacking area with a control system that provides containment of the wastewater in a holding facility or has the wastewater released to a vegetative treatment area.
- NRCS engineering assistance applies to a complete waste management system. When open lots are part of the system, the barn must replace the open lots or a containment system for the open lots will also be required as part of the waste management system.
- South Dakota Department of Environment and Natural Resources permitting can be included as part of the NRCS engineering assistance. Permitting is required for all operations that exceed 1,000 animal units in size (large CAFOs) and may be required for smaller operations depending on other criteria, such as county zoning, proximity to water bodies, etc.

Nutrient Management Planning Assistance

- The NRCS has agronomists that can provide assistance with preparation of comprehensive nutrient management plans (CNMPs). A CNMP helps producers manage nutrients that are generated by an animal feeding operation.
- Components of a CNMP include feed management, manure and wastewater handling and storage, nutrient management planning, land treatment practices, record keeping, and consideration of uses of manure beyond crop production.
- Nutrient management planning assistance can include calibration of spreaders and assistance with determination of actual land application rates of manure and wastewater.

Financial Assistance

- The Environmental Quality Incentives Program (EQIP) is a potential source for NRCS financial assistance that may be available to producers installing a waste management system.
- The program rules and payment rates for the EQIP are set each year. The payment rates for a fiscal year are typically set in the fall with contracts for projects being awarded in the spring of the year.
- For confinement barns, the cost share rates can vary depending on the type of barn constructed.
- There are also 319 Water Quality projects that may be available to provide cost incentive payments to producers installing waste management systems, including buildings.
- Visit a local NRCS field office to obtain more information about the available cost share programs for your area.
- To be eligible for financial assistance, the roofed structure and all structural components that are part of the building must be certified by a professional engineer that the roof is designed to meet all criteria for structures as outlined in NRCS practice standards.

Contact Information

For more information, contact your local NRCS field office or the NRCS Agricultural Nutrient Management Team at:

Nutrient Management Staff
John Lentz, Resource Conservationist
Jason Gilb, Agronomist/Soil Scientist
1820 North Kimball
Mitchell, SD 57301
(605) 996-1564

Engineering Staff
Joy Cordier Jensen, Civil Engineer
Justin Bonnema, Agricultural Engineer
520 Third Avenue
Brookings, SD 57006
(605) 692-2344

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Station 5

Monoslope Beef Barn Emission Study

Dick Nicolai
Associate Professor, SDSU
Dick.Nicolai@sdstate.edu

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 6

Analyzing the Gases and Particulate Matter

Erin Cortus, Steve Pohl and Scott Cortus
South Dakota State University
Erin.cortus@sdstate.edu 605-688-5144
Stephen.pohl@sdstate.edu 605-688-5662
Scott.cortus@sdstate.edu 605-688-5668

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:

$$\text{Emission} = \text{Airflow} * (\text{Outlet concentration} - \text{Inlet concentration})$$

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 (NH₃)
- Hydrogen Sulfide (H₂S)
- Methane (CH₄)
- Nitrous Oxide (N₂O)
- Carbon Dioxide (CO₂)

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, N₂O, & CO₂



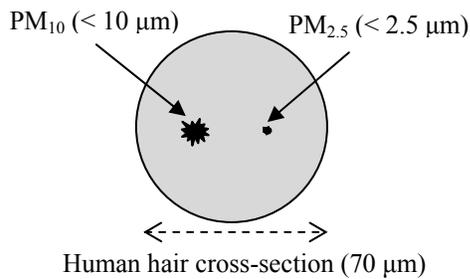
Gas Sampling System

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 – PM₁₀ 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.



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.

Station 7

Value and Nutrient Management of Mono-slope Manure

Ron Gelderman
Professor, SDSU Plant Science
605-688-4770
Ronald.gelderman@sdstate.edu

Eric Barnsness
Agronomist, USDA NRCS
605-692-2344 ext 103
Eric.barnsness@usda.gov

Manure Value

What is the value of manure?

We can quantify the value of manure in terms of nitrogen, phosphorus and potassium content, if we know how much of these nutrients are in the manure. Other benefits of manure, including organic matter, are more difficult to attach a dollar sign to. However, the full value of the manure is only realized when the nutrients in the manure match those required by the crop. Soil testing, manure testing and nutrient management planning all go hand-in-hand in effectively and efficiently turning manure into money.

Nutrient Management

How will calibrating my spreader help me?

- Knowing Application Rates
- Savings on Commercial Fertilizer

By calibrating your manure spreader and using manure tests from your operation the amount of nutrients being applied can be determined. With these figures, expensive commercial fertilizer application rates can be adjusted, saving you money.

Why would I want to calibrate my spreader?

- Apply nutrients to crop needs
- EQIP/DENR Requirements

Spreader calibration is an essential step for proper record keeping. Record keeping is required for both Permitted operations and for producers with EQIP contracts.

How do I get calibrated or Nutrient Management Assistance?

Contact Your Local NRCS Field Office or the Nutrient Management Team at 605-996-1564. Calibration only takes about an hour of your time and can save you money, while protecting the environment. Manure sampling assistance can also be provided. These services are free to producers.

Mono-Slope Beef Barn Open House - August 30, 2011

Please help us better serve you in the future.

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: