Livestock Development in South Dakota

Frequently asked questions, with answers for you and your community

Q&A

The purpose of this publication is to answer — with science-based land-grant university research — questions frequently asked by the public about issues and needs affecting agricultural growth, urban expansion, and rural community development in this state.

It's not just an agricultural issue... It's a public policy debate requiring decisions that balance between extremes

A dairy producer from the Netherlands, looking for a way to expand his farming operation in the mid-1990s, hit on a novel solution: Sell the land, the cows, and the equipment, and start from scratch in South Dakota.

It proved to be a sign of things to come. Since then a steady trickle of dairy producers from Europe, Canada, and other parts of the U.S. have been relocating to South Dakota.

And dairy farms are only one segment of animal agriculture. Livestock producers and processors who deal in beef cattle, hogs, and sheep are also finding South Dakota to be a base for processing plants and large-scale livestock production areas – called "concentrated animal feeding operations" (CAFOs). All that makes for possible conflicts as South Dakota residents in communities around the state try to chart a course that will allow for development of livestock operations while protecting the environment and dealing with nuisances such as odor.

Kevin Kephart, director of the South Dakota Agricultural Experiment Station, says that is why land-grant university research will be so crucial to South Dakotans as producers, cooperatives, and local governments make decisions about how to proceed with safe, science-based agricultural development.

Go west, young man: the 'push' factors

Vikram Mistry, head of SDSU's Dairy Science Department, says these people from other states and countries "are progressive producers who would like to expand but they cannot in many cases because they are essentially touching shoulders with the next producers. They are landlocked. What's available here is open land, but it's also reasonably priced." Rural Sociologist Dave Olson of SDSU's Rural Life/Census Data Center says that, as Mistry suggests, the choice to relocate often has to do with decreasing opportunities elsewhere.

"One theory of explaining migration is the 'push/pull theory.' In other words, people migrate because there are factors that push them out of one place and pull them into another," Olson says.

"Push factors might include lack of employment, undesirable living conditions, personal interests, and limited opportunities for success. Pull factors might include the opposites—better jobs, safer or better living conditions, personal opportunities, and better or different recreational amenities."

Agricultural Economist Evert Van der Sluis, acting head of the SDSU Economics Department, says South Dakota just happens to be the current beneficiary of factors that are pushing some producers in other states and other nations to look elsewhere for places to do business. Van der Sluis, a native of the Netherlands, agrees with Mistry that two major "push" factors that are making producers in his part of Europe look elsewhere are tough environmental laws and limited agricultural land that is costly and increasingly hard to find.

"There's no doubt that the environmental laws in northern Europe are a lot tighter than they are here," says Van der Sluis. "It's almost impossible in the Netherlands to find places where you would be more than half a mile from a village or from a neighbor. In such crowded places, it's only expected that good policies should include environmental laws, and oversight of these operations."

It's also been quite lucrative for producers who own their land in countries like the Netherlands to sell out in recent years. With land selling for tidy sums and with additional cash in hand from the sale of cattle, equipment, and the quota that allows them to market milk, those producers can reinvest in a dairy in South Dakota.

"In the past 15 years we've seen a lot of livestock leave eastern South Dakota. The most sustainable agricultural systems are diversified, sustainable operations."

— Don Boggs

"We need to find a way to integrate animal agriculture back into crop farming."

— Evert Van der Sluis

Van der Sluis notes that those interested in settling in South Dakota are not easily discouraged by rising land values, because they generally do not need much land for for their operations. On the other hand, rising land values could make it easier for existing South Dakota farmers to borrow the money needed to expand their own dairy or livestock operations.

Mistry points out that is already happening, although it's perhaps less visible than the immigrants arriving from other nations or other states.

"We have South Dakota producers who have successfully expanded their operations."

Coming to Dakota: The 'pull' factors

Whether they're from other states or countries or whether they've lived here all their lives, producers agree on some inherent advantages for animal agriculture in South Dakota. In a nutshell, the advantages are a climate that is suitable for dairy producers and manageable for those in other livestock industries; abundant, affordable feedstuffs, including distillers grains produced as a co-product from ethanol plants; and a growing number of state or regional processing plants for dairy and livestock industries that are reducing the distance farmers must take their products for processing.

"Historically we've exported calves and we've exported corn from South Dakota. When you're doing both of those and they're going to neighboring states to the south, it's obvious that somebody else is taking advantage of the quality of livestock we have in South Dakota and the abundance of feed that we have," says Don Boggs, head of SDSU's Animal and Range Sciences Department.

"With the evolution of the ethanol industry, we're not exporting nearly as much corn as we used to,

(continued on page 8)

SDSU

economics...

IMPACTS

Q&A

comparative advantages

I-29 corridor

farm size

CAFOs

employment

local communities

Q. What are the first things people ask about new livestock operations?
Will the community accept the operation? Is size a factor? Is expansion of an existing facility by local farmers more acceptable than construction of one by newcomers? Why are livestock producers considering new construction and expansion?

Communities vary in what is considered an acceptable size for a new or expanded livestock facility. This is not unique to South Dakota. A majority of Wisconsin farmers in the mid-1990s did not support expansion; 26 to 28% viewed dairy, beef, and sheep expansion more positively.

Increases in family living expenses concern all South Dakota families. Farm families generally have two options: increase the size of the operation to generate more income or find off-farm income. Some communities understand this and accept growth. Other communities do not.

Q. Does South Dakota have an advantage over other states in livestock production?
South Dakota ranks seventh in corn for grain, fifth in all hay production, and third in alfalfa hay production among all states. All these feeds plus corn silage are the basis of dairy cattle diets. Because feed costs are on average 50% of the total costs of feeding dairy cows, this gives South Dakota an advantage compared to other states.

Recently, South Dakota has seen tremendous growth in value-added ventures, particularly in the ethanol industry. According to the Renewable Fuel Association, 10 operational ethanol plants in the state produce 404 million gallons of ethanol. These facilities also produce approximately 6.5 lb of dried distillers grains (DDG) for each gallon of ethanol produced, or 1.32 million tons of co-product total.

Based on research from several universities, including SDSU, DDG can be effectively utilized in the diets of growing and finishing cattle. According to the 2002 Census of Agriculture, South Dakota maintains a herd of approximately 1.7 million beef cows and heifers and markets 737,000 fed cattle annually. If every beef animal in the state was fed at recommended feeding levels, the fed cattle and cow herds combined would utilize only 60% of the ethanol co-products produced in South Dakota.

On the hog side, South Dakota pork producers currently market approximately 2.6 million head per year, and these pigs consume approximately 875,000 tons of feed. While people typically think of corn and soybean meal when it comes to pigs, ethanol co-products like DDG also can be a valuable ingredient in swine diets.

Q. Is there an advantage to finishing beef calves here in South Dakota rather than shipping them to feedlots out of state?
Research reported by SDSU in 1992 suggests that beef cattle can be fed in South Dakota as profitably as in Texas. Although cattle required a little less feed in Texas than in South Dakota, the same feed could be purchased for less in South Dakota, more than offsetting the difference in feed efficiency. Feed prices need to be 4.5% less in South Dakota to offset this difference. A finishing diet typically consists of 80% corn, and corn prices typically are 10 to 15% lower in South Dakota than in the lower Great Plains, making it more economical to feed cattle in South Dakota.

A 2002-2003 study at SDSU showed that "proper" feeding strategies in the winter can help reduce costs and improve cattle performance. The research showed that if South Dakota producers would implement such feeding strategies, they would be able to winter feed more efficiently and become more competitive with feedlots in southern states.

The study was based on an earlier observation that cattle use their feed more efficiently if fed in the afternoon; the heat production that occurs as a result of the fermentation also keeps the animal warm during cold winter nights. Morning-fed animals have lost that edge and must call on stored reserves in their bodies to generate heat, thus reducing the amount available for growth. Average daily gain during the study was 3.12 lb for the morning-fed group of feedlot steers and 3.42 for the afternoon-fed group.

Q. Why is the I-29 corridor especially attractive for dairy expansion?
Because corn constitutes the main grain used in livestock production, it makes economic sense to raise cattle where corn is produced. Dairy cow diets may include as much as 20 lb of corn grain and/or its co-products. In the 20 counties along the I-29 corridor, 14 counties produce in excess of 9,500,000 bushels of corn each, and the remaining six counties (Marshall, Day, Clark, Codington, Grant, and Deuel) produce between 5,000,000 and 9,499,000 bushels per year.

Most of the state's ethanol plants, which produce DDG, are located in the I-29 corridor. In addition, all the state's milk processors with the exception of one are located in eastern South Dakota.

Corn silage and alfalfa constitute nearly 50% of the dairy cow diet on a dry matter basis. Nearly three-fourths (72.5%) of corn silage produced in the state in 2003 was harvested east of the Missouri River, and 11 of the counties along I-29 produced 80,000 tons or more. Twelve counties in eastern South Dakota produce at least 100,000 tons of alfalfa hay. Alfalfa constitutes on average 25% of total dry matter consumed by dairy cows.

Q. What would be the economic impact of more dairy operations along the I-29 corridor?
Research at SDSU shows the answer depends on the region in question (see map), but economic impacts are generally positive. In the three different regions, potential dairy production units were analyzed for effects that were direct (changes in the industry itself from more animals), indirect (changes in feed, animal health, and other related industries, "business-to-business" transactions), and induced (changes in household spending as a result of additional income). For purposes here, all are lumped together. Construction costs and employment were analyzed but not reported here because they are one-time effects.

Table 1. Annual impacts of added dairy facilities (post-construction) in the I-29 corridor.*

	Northeast		*East Central*		*Southeast*	
	1.44*		***1.49***		***1.32***	
cows	*dollars*	*employees*	*dollars*	*employees*	*dollars*	*employees*
100	439,279	3.8	453,011	3.7	401,647	3.2
300	1,317,837	11.2	1,359,035	11.2	1,204,946	9.7
1,000	4,392,789	37.5	4,530,119	37.1	4,016,487	32.1
2,500	10,981,962	93.7	11,325,296	92.8	10,041,271	80.3

* Production level target is 20,000 lb/cow/yr. Targeted value of all outputs (milk, calves, cull cows, other) is $15.23/cwt.
** Multiplier, total of direct, indirect, and induced effects.

Source: G. Taylor, SDSU Economics Commentator 442.

The multiplier for sustained economic activity in the northeast is 1.44. That means each $1 of direct sales from the dairy operation generates an additional $.44 of economic activity. In the central area, the multiplier is 1.49, the result of higher population levels and employment, a larger number of industries, and higher incomes. In the Southeast the multiplier is 1.32, implying there are "leaks" of money outside of the area and that employees possibly commute into the area.

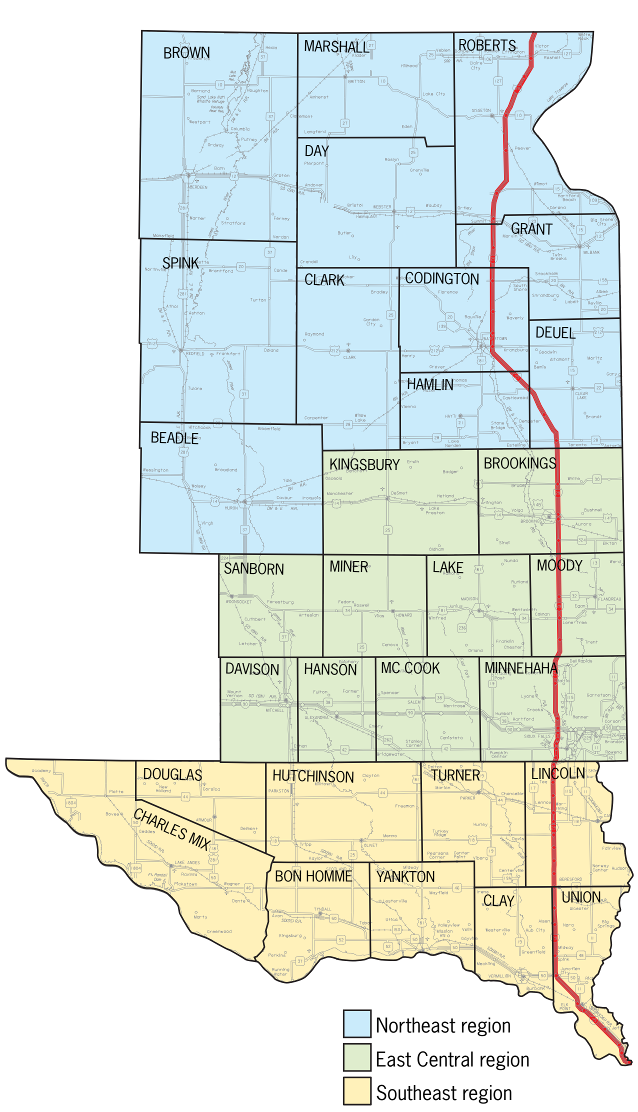
The multipliers are not exceptionally high, but they fall in about the middle of the range of those for other industries in the area and are similar to other agricultural livestock enterprises. Highest multipliers are meatpacking in the Northeast and Southeast and soybean processing (2.26) in the Central region.

Q. Are there economies of size in livestock production?
Economies of size imply that average costs go down as farm size increases. This may happen for several reasons. The farm may be able to make better use of available labor, buildings, or equipment. In addition, large operations often have better access to capital, making new, more efficient technology affordable.

While new technology may lower production costs, it generally has large initial capital costs. To decrease costs per unit of production, it often makes sense to increase production.

Increased size also allows for the hiring of more specialized labor. In the case of a dairy farm, this may entail hiring herdsmen, milkers, or a nutritionist. The

The I-29 corridor in eastern South Dakota.



specialized skills these employees possess allow the operation to increase its efficiency and create additional opportunities. Other incentives for increasing the size of an agricultural operation may be associated with buying large amounts of inputs and price premiums for larger output volumes.

Q. Are there economic relationships that favor livestock development?
In recent years, new opportunities for processing agricultural commodities have been developed in the state. A cheese plant has been built in Lake Norden, and beef and turkey processing plants are being constructed in Huron. As a result, processor demand for milk, live cattle, and turkeys will increase in South Dakota in the immediate future.

Q. Do livestock farms need to be big?
Based on Iowa State University Estimated Livestock Returns from 1994 to 2003, the average return for feeding beef calves from weaning to finishing was $12.38 per head, and finishing yearlings returned $20.01 per head. On average, to support a family living expense of $40,000 annually, an operation that only feeds cattle would have to finish approximately 3,230 calves or 2,000 yearling cattle each year.

On the dairy side, the Wisconsin Center for Dairy Profitability estimated the cost of milk production in 928 dairies at $10.96 per hundred lb produced. Dairy farms are being paid premiums for quality and volume. Milk prices are characterized by being highly volatile from one year to the next. Since 2000, for example, the 4-year average milk price that one South Dakota processor paid to the average 600-cow dairy was $13.6 per hundred lb; $12.4 per hundred lb in 2000; and $15.6 in 2001. Net returns for a 600-cow dairy operation went from $1.4 in 2001 to $4.6 per hundred lb of milk in 2001, with an overall average of $2.6 between 2000 and 2003.

Considering that the average South Dakota dairy produces close to 17,000 lbs per cow per year, during 2001 net returns per cow would have been $238 or a yearly total of $23,800 for the average 100-cow dairy. Assuming a debt-free family operation, with two people working 10 hours a day, 365 days a year, their wage would have been $3.26 per person per hour.

Q. How do dairy operations of different size affect an area's economy and employment opportunities?
Since 1965, the number of dairy farms in the U.S. has fallen by nearly 90%, from almost 1.2 million to 120,000. In 1965, the average dairy herd size was approximately 15 cows. By 2000, it was approximately 70. Increased leverage with suppliers due to increased scale allows dairy producers to capture significant cost savings and improve profitability. Increased scale has also made it possible to spread out overhead costs (facility investment, especially parlors; tractors and other large equipment; consultants; manure management, etc.).

As a result of their higher utilization of capital and management-intense technologies, larger farms have higher per-cow productivity than smaller farms. According to the Wisconsin Center for Dairy Profitability, the more profitable farms averaged more cows (34 vs. 31) per worker and more milk sold per worker (729,591 lb vs. 594,911 lb). Because of their productivity, larger farms will be able to stay competitive and financially solvent even during times of depressed milk prices.

During 1997, large (average 582 cows per herd) dairy farms in New York state produced 11,750 lb of milk per acre compared to 4,870 lb per acre for small farms (average 47 cows per herd). In this survey, it was concluded that land was used 251% more efficiently by large dairies. To achieve similar efficiencies and milk production with smaller dairy farms, there is a need for more cows per acre. This would have a greater impact on the environment.

Q, What evidence is there that large-scale livestock operations will/do increase the supply and lower the cost to the consumer of milk products?
Large farms required $25 of farm assets per hundred weight of milk produced, compared to $50.37 for small farms. Hence, large farms are 201% more efficient with their capital and can afford to receive less for their product than smaller dairies.

Q. What is the impact of livestock enterprises on our economy in terms of local and regional purchasing?
A 1,000-head beef feedlot operating at 85% of capacity will use per year approximately:

- Feedstuffs—113,000 bushels of corn, 775 tons of hay, 390 tons of supplement.
- Veterinary supplies—$6,000 of implants, $12,000 of vaccines, $7,000 of dewormers, $2,500 of medicines.

A 700-cow dairy will use per year approximately:

- Feedstuffs—80,000 bushels of corn at $160,000, 4,500 tons of corn silage at $99,000, 4,000 tons of alfalfa haylage at $160,000, and 1,900 tons of alfalfa hay at $152,000.
- Veterinary supplies and services—$260,000.

Other inputs and services would include trucking, utilities, water and electric, and equipment maintenance and repair.

Q. What is a CAFO? What makes it different from other livestock facilities?
Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production facilities on a small land area. Feed is brought to the animals rather the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland. Animals are confined for at least 45 days in a 12-month period, and there's no grass or other vegetation in the confinement area during the normal growing season.

Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet Environmental Protection Agency (EPA) regulatory definitions. A large AFO is always a CAFO. A medium AFO is defined as a CAFO if there is drainage running through the confinement area or if there is a man-made conveyance to surface water. A small AFO is designated as a CAFO if it meets the criteria for a medium CAFO and is a significant contributor of pollutants to surface water. (See table 2.)

Table 2. Number of animals to define large, medium, and small concentrated animal feeding operations.

Type of Animal	Large	Medium	Small
cattle	1,000+	300-999	less than 300
mature dairy cows	700+	200-699	less than 200
veal calves	1,000+	300-999	less than 300
swine (over 55 lbs)	2,500+	750-2,499	less than 750
swine (less than 55 lbs)	10,000+	3,000-9,999	less than 3,000

Source: South Dakota Department of Environment and Natural Resources

Q. Are there controls that would limit the number of CAFOs and/or concentration of animals in a geographic area?
Indirectly, yes. To obtain a state permit, livestock operations must have an initial nutrient management plan showing they have adequate land under their control to properly spread manure according to typical nitrogen and phosphorous soil tests, estimated soil erosion from each field, expected manure analysis, and nitrogen and phosphorous recommendations for their crop rotations. In effect, this limits the number of livestock operations that could be permitted in a given area. There also may be local discretion, from county to county, in determining livestock operation densities.

Contributors

Animal and Range Sciences Department
Bob Thaler, Extension swine specialist
Kent Tjardes, Extension beef feedlot specialist
Cody Wright, Extension beef specialist

Dairy Science Department
Alvaro Garcia, Extension dairy specialist
Ken Kalscheur, assistant professor
David Schingoethe, distinguished professor

Economics Department
Marty Beutler, Extension ranch management specialist
Don Guthmiller, Extension educator—marketing and farm management, North 5 Field Education Unit (Hamlin Co.)
Gary Taylor, assistant professor

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environment and health...

WATER QUALITY

Q&A

regulations and permitting

water pollution

surface water quality

groundwater quality

nutrient management

manure application

Q. Are there state regulations that farmers must follow when building or operating a large livestock confinement facility and applying manure?

Large livestock confinement facilities in South Dakota must have a state water pollution control permit to operate. This permit establishes the minimum environmental standards for livestock operations defined as concentrated animal feeding operations to ensure protection of the state's surface and ground waters.

An operation is considered large if it has a capacity of at least 700 dairy cows, 1,000 feeder cattle, 2,500 feeder pigs, or equivalent numbers of other animals. Smaller operations may also be regulated if they are posing a pollution hazard to waters of the state. The South Dakota Department of Environment and Natural Resources is responsible for developing and enforcing the state permit for livestock operations.

To obtain a state permit, livestock operations must present engineering plans for the building site that show how manure will be collected and stored to prevent environmental degradation. In addition, they must have an initial nutrient management plan showing they have adequate land under their control to properly spread manure according to typical nitrogen and phosphorous soil tests, estimated soil erosion from each field, expected manure analysis, and nitrogen and phosphorous recommendations for their crop rotations.

Before operations can be permitted, the operator must attend an approved training workshop that clarifies the regulations and gives details that need to be in a nutrient management plan. Once an operation is permitted, it must test manure intended for land application each year. In addition every field must be soil tested each year prior to manure application to determine the correct rate of application for the crop to be grown. The South Dakota Department of Environment and Natural Resources regularly inspects permitted facilities to ensure manure is being properly stored and land-applied to prevent environmental degradation.

The water pollution control permit for livestock operations allows local governments and planning and zoning commissions to concentrate on land-use and zoning issues instead of water pollution control issues. The permit does not regulate odors or local land use planning. A copy of the permit for large livestock operations can be obtained from the South Dakota Department of Environment and Natural Resources and from their web site at www.state.sd.us/cafo.

The state also administers the following permits that may be required for a livestock operation: water right, storm water construction, dewatering, and ground water discharge.

Q. Are county governments in South Dakota involved in regulating livestock operations and manure applications?

Counties in South Dakota often make local regulations concerning livestock operations that must be followed in addition to the state regulations. For example, counties may require a state permit for operations with fewer livestock than are required under the state permit.

A county may have rules restricting the location of livestock operations or where manure can be applied, such as within certain distances of occupied buildings or over shallow aquifers. Since county regulations are specific for each county, residents must check with their local county officials for local rules that pertain to them.

Q. Does anyone make sure that producers follow the rules once a CAFO is established?

Complaints can be filed with the South Dakota Department of Environment and Natural Resources (DENR), which is responsible for investigating and monitoring compliance.

Q. What is the status of our water quality?

Water quality is defined based upon the intended uses for water, and most of the water resources in South Dakota are managed simultaneously for multiple uses. Drinking, swimming, fishing, irrigation, livestock watering, and other uses each have different water quality standards.

Water quality criteria have been defined to support each of these uses and all of the criteria for all uses assigned to a water body provide a set of standards. Water bodies that do not meet these standards fail to support one or more of their designated uses.

The State of South Dakota is required by federal legislative mandate to monitor water quality within the state and report the status of the state's waters every two years. In the most recent report, 44% of monitored stream miles did not support all of their uses. High total suspended solids, high fecal coliform bacteria counts, high specific conductance, high sodium adsorption ratios, high total dissolved solids, high water temperatures, and low dissolved oxygen concentrations were the most frequently observed water quality problems. Sixty-six percent of monitored lake basins (excluding the Missouri River reservoirs) did not support one or more of their designated uses and most of the observed impairments were attributed to nonpoint sources of dissolved salts, nutrients, and organic matter from associated watersheds.

Q. What is a TMDL?

The total maximum daily load (TMDL) is the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Assessment projects are conducted to evaluate the quality of a water body and define the loads of pollutants entering. An assessment uses field data and computer modeling to estimate the load contributions from many sources. This is called load allocation.

Once the load has been estimated and allocated to different sources, a total maximum daily load is defined. This TMDL is the maximum quantity of that pollutant that the water body can receive and still stay within the water quality standards (support all of its uses).

TMDL studies are required through Section 303 of the Clean Water Act. The results of a TMDL study are used by water resource managers to identify critical areas within a watershed in need of best management practices.

Once a TMDL has been defined for a water body, state and local agencies can work with landowners to implement best management practices designed to bring the average daily load within the TMDL limit.

Partnerships generated between landowners and state and federal agencies include cost-sharing and monitoring to evaluate the success of implementation projects.

Q. Livestock makes manure. Can manure pollute surface waters?

Aquatic life depends on oxygen dissolved in the water just as we depend on oxygen in the air. Manure contains high levels of organic matter (20-30% by weight). This organic matter is decomposed by bacteria within streams and lakes, using available oxygen in the process. The amount of oxygen required for this decomposition is called the biochemical oxygen demand (BOD).

The Nebraska Extension Service states that BOD levels in livestock manure average 20,000 mg/L or 50 times that found in municipal sewage. Fish kills resulting from depressed dissolved oxygen in lakes and streams resulting from manure entry have been reported in neighboring states. These problems can be prevented by fencing livestock away from lakes and streams and through construction of waste containment facilities. Cost sharing may be provided for the construction of these systems.

Many streams within South Dakota suffer from high suspended solids concentrations. In fact, high suspended solids concentrations are the most frequently observed cause of water quality standards violations. Suspended solids are the small particles within a water sample that are not able to pass through a filter. Some streams within South Dakota have naturally high levels of suspended solids (e.g., Badlands streams). Others have elevated levels resulting from inputs of suspended materials from erosion within the watershed and locally along stream banks. Eroding and sloughing stream banks can be prevented through grazing rotations and eliminated by fencing off the stream channel. Many landowners use pasture pumps to provide water to livestock that are fenced away from the channel.

Q. How can nutrients in manure cause water problems?

Manure contains many different nutrients but nitrogen and phosphorus have the greatest potential to cause water quality problems. After manure is applied to the soil, nitrogen in it is converted by soil microbes to the nitrate form. Nitrate is the dominant form of nitrogen used by plants.

The key issues here are that nitrate does not attach to soil particles and is completely soluble in water. Therefore the nitrate is not in the soil itself but rather in the water that is in soil. If water in soil moves below the root zone of crops, nitrate in the water also moves below the root zone and likely will continue its downward movement until it reaches the ground water. The movement of water and nutrients through soil is called leaching.

Although water can move through any soil, it moves much more rapidly through coarse textured sandy soils and gravels than through heavy clay soils. Therefore the likelihood of moving water and nitrate below the root zone and into the ground water is much greater on the coarse textured soils. These coarse textured soils are often above the aquifers that supply drinking water. Because nitrate moves into soil so easily, it normally doesn't run off the soil surface into surface water.

High nitrate levels in drinking water can cause health problems, especially in infants. The drinking water standard is 10 parts per million nitrate nitrogen.

Phosphorus in manure acts differently than nitrogen when applied to soil. It attaches tightly to soil and is not very soluble in soil water. Because of these properties it does not move through soil like nitrate and does not readily end up in ground water.

However, because phosphorus stays on or near the soil surface, it is subject to runoff into surface waters with sediment that is eroded off fields or dissolved in the runoff water.

Unlike nitrogen, phosphorus itself is not a major health hazard in water. However, it promotes algal growth in surface waters. Algal growth makes recreational activities less desirable and can cause fish kills.

Q. Does livestock manure in water constitute a human health concern?

The jury is still out on this question. Several pathogens found in livestock manure are known to cause disease in people. However, it is not clear how important livestock wastes are in transmitting these pathogens.

Wastes entering a water body may come from many sources (e.g., people, livestock, wildlife). State water quality agencies use fecal coliform bacteria as an indicator of animal waste contamination in water resources.

These bacteria are found within the digestive tract of all warm-blooded animals. They are simply indicators, not disease causing organisms, but the probability of contracting a water-borne disease is higher if the water is contaminated by fecal material.

High fecal coliform counts are found in streams, lakes, and groundwater sources throughout the nation. These bacteria may have originated from any warm-blooded animal.

Traditional monitoring techniques only tell us that the indicator is present and how abundant it is in the water sample. New bacterial source tracking techniques are currently under development which would help water managers identify the source animals contributing this fecal material.

Q. Is manure more likely to cause environmental problems than other sources of nutrients such as commercial fertilizer?

Nutrients in manure are converted in soil into the same compounds as nutrients in fertilizers, legumes, and crop residues. Therefore, when applied at equal rates of nutrients, manure is generally not any more likely to cause nutrient losses to the environment than other sources of nutrients. The key issue here is "applied at equal nutrient rates."

In the past, manure was sometimes applied at rates that supplied much more nitrogen and phosphorus per acre than was normally applied as commercial fertilizer. Because high rates of manure were being applied, regulations were put in place to ensure farmers used application rates that are closer to the nutrient needs of the crop to be grown. The price of commercial fertilizer is the incentive for farmers to apply only the amount needed by the crop, minimizing the need for commercial fertilizer application rate regulations.

Q. Can manure be applied to soil without significant risk of nitrogen leaching or phosphorus runoff?

The major cause of leaching losses of nitrogen is applying more nitrogen than the crop can use. The excess nitrogen remains in soil after crop harvest and is subject to leaching before the next crop uses it. South Dakota State University, through research in soil fertility, has calibrated a two-foot deep nitrogen soil test that determines the amount of nitrogen that needs to be added to soils to meet crop needs.

In addition to soil testing to determine the amount of nitrogen needed, manure testing determines the amount of nitrogen in manure that is available to the crop. When the two-foot nitrate test is used in combination with manure analysis, manure rates can be applied such that little nitrogen is left in soils after harvest, minimizing the risk of nitrogen leaching losses before the next cropping season.

The major cause of phosphorus runoff is soil and manure losses by erosion. Reducing erosion by implementing good soil conservation practices minimizes losses of soil and the phosphorus attached to it. Knifing in liquid manure and incorporating solid manure dramatically reduce manure runoff losses.

When manure is applied to meet the nitrogen needs of the crop, often more phosphorus is applied than removed by the crop. The additional phosphorus raises the phosphorous content of soil. Soil testing is needed to measure the phosphorous levels in soil. Increased phosphorous soil test levels have been shown to increase phosphorous losses in runoff water. Regulations, however, have been implemented to restrict phosphorous applications to rates no greater than crop removal once phosphorous soil tests rise to critical levels, therefore minimizing runoff potential.

Contributors

Biology / Microbiology Department
Nels Troelstrup, professor, aquatic ecology

Plant Science Department
Ron Gelderman, professor and manager of soils lab
Jim Gerwing, professor and Extension soils specialist

Resources

Environment and Natural Resources Surface Water Quality Program / Joe Foss Building / 523 East Capitol / Pierre SD 57501-3182
Telephone: (605) 773-6707
Website: www.state.sd.us/cafo or www.state.sd.us/denr/DES/Surfacewater/feedlot.htm
Contacts: Kent Woodmansey (kent.woodmansey@state.sd.us) and Jeanie Votava (jeanie.votava@state.sd.us)

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Telephone: (605) 688-6171
Website: http://anserv.sdstate.edu
Contact: Nancy Thiex (nancy.thiex@sdstate.edu)

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Nutrient recommendations for crops: SDSU Soil Testing Laboratory / Box 2207A / South Dakota State University / Brookings SD 57007-1096
Telephone: (605) 688-4766
Fax: (605) 688-4667
Website: http://plantsci.sdstate.edu/soiltest
Contacts: Jim Gerwing (james.gerwing@sdstate.edu) and Ron Gelderman (ronald.gelderman@sdstate.edu)

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environment and health...

AIR POLLUTION AND NUISANCES

Q&A

regulations

odor and gases

dust

odor reducing technologies

setbacks

flies, birds, and rodents

Q. Does South Dakota have air quality rules and regulations for livestock facilities?
Currently the state of South Dakota does not have any air quality rules or regulations governing emissions from livestock facilities.

EPA, under the Clean Air Act, sets limits on how much of a pollutant is allowed in the air anywhere in the U.S. The Clean Air Act establishes two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has classified the six principal pollutants (or criteria pollutants as they are also known) in their primary standards. None of these six (carbon monoxide, nitrogen dioxide, lead, ozone, particulate matter, and sulfur dioxide) is a major factor in emissions from livestock facilities.

Local governments in South Dakota may set air quality standards for their respective communities. Often these rules or regulations take the form of set-back distances.

Q. How do other states regulate odor from livestock facilities?
As of 2002, 31 states have some type of odor regulation. Many of these regulations are written as general nuisance laws. Those that are more specific usually define some frequency of complaint or an exceedance of a dilution threshold at the property line. For example, North Dakota Administrative Code 33-15-16-02 reads "no person may discharge into the ambient air any objectionable odorous air contaminant which is in excess of two odor concentration units." In North Dakota odor concentrations are measured with a scentometer by a certified odor inspector.

Minnesota feedlot regulations Chapter 7020.0505 require feedlots with 1,000 animal units or more to submit an air emission plan. This air emission plan must address odor specifically but may also include ammonia and dust. Minnesota also has an ambient air quality standard limiting hydrogen sulfide emissions (Rule 7009.0080).

Q. What are the gases that contribute to odor from livestock facilities?
An odor results from a complex mixture of many odorous compounds; there are at least 168 different gases that contribute to swine odor. The three most researched gases are hydrogen sulfide, ammonia, and methane. Other odorous gases have not been found at any concentrations to impact the natural environment or human health.

Hydrogen sulfide gas has the characteristic odor of rotten eggs. However, that can be deceiving. The odor is first detected by most people at concentrations below 1 ppm by volume. Above 6 ppm, the odor will only increase slightly, although the concentration of hydrogen sulfide increases significantly. A concentration of 50 ppm can cause dizziness, irritation of the respiratory tract, nausea, and headache. At 150 ppm, the gas can have a deadening effect on the sense of smell, making detection difficult. Death from respiratory paralysis can occur with little or no warning in concentrations exceeding 1,000 ppm.

Compared to ammonia, hydrogen sulfide is usually very low in animal houses. It was measured at 0.09 ppm in a normally ventilated confinement building and 0.28 ppm after the ventilation was shut off for 6 hours.

Ammonia from livestock husbandry emanates from buildings, slurry and manure storage, pastures (grazing), and during manure application to fields. Among these sources, livestock housing and manure storages contribute about 40 to 60% of the total emissions. Urine is the primary source of ammonia.

Ammonia gas is an irritant, colorless, lighter than air, and highly water soluble. It has a sharp pungent odor, becoming detectable at levels as low as 5 ppm. Typical ammonia levels in well ventilated confinement buildings are 5 to 10 ppm with liquid manure systems and 10 to 20 ppm where manure and urine are deposited on solid floors, especially in poultry units. Levels can exceed 25 ppm with lower winter ventilation rates and reach 40 ppm in poorly ventilated buildings. Very high levels of ammonia concentrations, such as 2500 ppm, may even be fatal.

Methane is a nontoxic and odorless gas. Its contribution to global warming is believed to be second only to carbon dioxide. Methane is emitted from both natural and man-made sources, including animal agriculture. Anaerobic decomposition of animal manure contributes about 5% of the total methane emissions and another 15% comes from the gut of ruminant animals.

Q. Can odor be measured by measuring the gas concentration?
No analytical standards have been agreed upon, although much research has been done. No single gas concentration has been found to correlate with or to be an indicator gas found in livestock odors. (An indicator's concentration would correlate well with the human olfactory system—in high concentration, it would indicate a high concentration of odor.) At present there is no specific gas identified that can be used as an indicator of odor from livestock facilities.

Q. How are odors measured?
There are five parameters that provide a fairly complete description of an odor. Odor concentration and odor intensity are the two most common. The other three odor parameters—persistence, character descriptors, and hedonic tone—are more subjective parameters not lending themselves to science or regulatory purposes.

Concentration of odors is measured as the amount of clean air needed to dilute a sample of odorous air to the point where it can just be detected or recognized by a human nose. This is the point at which a person can describe the odor by applying a character descriptor to it.

Intensity describes the strength of an odor and is measured at concentrations above the detection threshold. Intensity changes with concentration and can be measured at full strength or after dilution with clean air. Intensity measurements are determined by comparing an odorant to the intensity of a reference gas. This gas is most often n-butanol.

Persistence describes the relationship between odor concentration and perceived intensity. It is a calculated value based on the intensity at full and the intensity of diluted samples. Odors with high persistence include livestock manure and smoke.

Character descriptors are used to describe what an odor "smells like." Some terms used are sweet, sour, pungent, mint, citrus, and earthy.

Hedonic tone measures the pleasantness or unpleasantness of an odor, typically recorded in a scale of –10 to +10 with neutral odors being recorded as zero. Unpleasantness usually increases with odor intensity.

Field measurements of odor using intensity measurements have been used by several researchers and communities to monitor odor emissions and odor plume transmission. This method is currently being used at SDSU to determine the effect a natural windbreak has on reducing odor.

Q. Do livestock facilities add dust to the atmosphere?
Dust and other particulates, such as microorganisms and endotoxins, are a real indoor air quality concern for both animals and humans. The emissions of these contaminants from animal production units are much less of a concern, although only a limited amount of research has been done to document emissions levels and their impact on the environment and people near these areas.

Particulates can transport odor and thus cause nuisance concerns. It does seem from existing data that poultry units emit the highest levels of dust and endotoxins, followed by swine units and cattle facilities in that order. Since the majority of service and township roads are gravel, dust generated from vehicles traveling over these roads can be considerable. Currently, calcium chloride is spread on these roads in short strips where dust is considered a problem such as in front of a residence or around animals that could continuously breathe the dust.

Q. Are odors and gas emissions from livestock facilities a risk to human health?
No evidence showing a direct impact of airborne emissions from animal operations on human health has yet been reported in science journals, but quality-of-life factors for those living near animal facilities have been documented. Human health concerns can be both psychological and physiological.

Psychological responses have been reported by a number of studies (North Carolina and Iowa) that have documented higher levels of human "stress" when exposed to airborne emissions from livestock and poultry operations. Also quality-of-life factors like not wanting to open windows or go outside during pleasant weather were similar in the control (non-livestock) and cattle areas but much lower for residents living in a community near a hog operation.

Some physiological responses or disease "symptoms" like headaches and nausea have been found in people living near animal production sites, but the occurrence of actual diseases has not yet been documented. Certain respiratory and gastrointestinal health symptoms (runny nose, sore throat, excessive coughing, and diarrhea) were reported more often in the communities located near livestock (mostly hog) facilities.

Airborne dust, gases, and biogenic particles can negatively impact human health. Similar studies around animal production facilities are limited. Clearly, more research is needed to relate emissions from animal facilities to airborne concentrations and the health effects on individuals living near animal production facilities.

Q. What technologies can a producer use to reduce odor and gas emissions?
Odor emissions from an animal production site originate from three primary sources: animal housing, manure storage units, and land application of manure.

In general, odor control can be achieved by reducing or interrupting odor generation, by reducing or interrupting odor emissions, or by increasing dispersion from every source.

Reducing generation
- Dietary changes—possible, but the change also impacts the quality of meat, egg, or milk products.
- Solid-liquid separation of manure.
- Chemical additions to control sulfides in manure by chemical oxidation, pH control, or precipitation. Other chemicals work as masking agents or absorbents.
- Biological treatments to accelerate the natural process.
- Aerobic treatment—adding extra oxygen to the manure storage. Costs associated with this practice are too high for widespread adoption of the technology.
- Anaerobic digesters to optimize bacterial decomposition of organic matter under controlled conditions. Odor reduction from anaerobic digestion system is variable depending on the type of digester and its management.

Reducing emissions
- Covers—rigid concrete or wood lid over an outside concrete pit until the storage is agitated and emptied. Or lightweight roofs (fiberglass, aluminum, etc.) and flexible plastic membranes. Or a floating cover on the surface of the manure for open manure storage facilities. Floating covers can be made with a variety of materials. Natural floating covers are those formed by the fibrous material in the manure (e.g., crust). Artificial floating organic covers, also called biocovers, include straw, chopped cornstalks, saw dust, wood shavings, rice hulls, etc.
- Biofilters can reduce odor and hydrogen sulfide emissions from livestock and poultry facilities by 90%. A biofilter is a layer of organic material that supports a microbial population in front of an exhaust fan. The microorganisms break down the odorous gases to carbon dioxide and water.
- Oil sprinkling inside an animal housing facility reduces the airborne dust concentration and may also lower odor and gas emissions.
- Injecting liquid manure and incorporating solid manure will significantly reduce odor emissions during land application.

Increasing dispersion below the detection threshold
- Increasing distances between the livestock facility and neighbors.
- Siting the livestock facility where wind can help disperse the odors and gases.
- Adding natural windbreaks such as rows of trees and other vegetation.
- Placing windbreak walls near exhaust fans to direct more exhaust air upward or slow forward momentum.

Q. Can the impact of odors from a livestock production site on the surrounding community be predicted before the facility is constructed?
Animal agriculture encompasses a unique set of air pollution challenges that differ in many respects from industrial and urban air pollution cases. The modeling parameters that require special treatment for animal agriculture cases include:
- Rural meteorology (throughout the day and night).
- Facility design and features (natural and forced ventilated structures and open manure storage basins).
- Pollutants generation from animals (compared to processes in industry).
- Pollutants generation from biological activity in manure storage basins.
- Pollutants release from manure storage basins (large area sources).
- Receptor (population) density surrounding facilities.
- Receptor "sensitivity" and "tolerance" to selected pollutants (air toxics, odor, and pathogens).

The University of Minnesota has developed a modeling tool "Odor From Feedlots Setback Estimation Tool (OFFSET).

OFFSET is designed to estimate average odor impact from a variety of animal facilities and manure storages. The model combines odor emissions with odor reducing technologies to estimate the strength and frequency of odor events at various distances from a given farm. (See Figure 1.)

Q. Livestock facilities breed flies and attract birds and rodents. Can these nuisances be controlled?
The house fly and stable fly reproduce in large numbers in decaying organic matter and manure. Favorable breeding areas can be found around homes (compost piles, pet droppings, and mulch) as well as livestock facilities. While house flies are primarily a nuisance, stable flies can inflict an annoying bite to humans. These flies can routinely move 5 miles from their breeding site and, in some cases, much farther. Fly populations can be significantly reduced by sanitation.

Birds and rodents are attracted to livestock facilities for food and shelter. Building modification to exclude these pests (rat and bird proofing) will reduce the attractiveness of a site.

Good farm facility management and sanitation overall—cleanup of spilled feed, bedding, manure, and removal of standing water—are essential for controlling flies. Various chemical control options also are available. Good facility management and sanitation also are essential for reducing bird and rodent problems.

Contributors

Agriculture and Biosystems Engineering Department
Dick Nicolai, Extension farm machinery and safety specialist
Steve Pohl, Extension structures and environment specialist

Plant Science Department
Mike Catungui, Extension entomologist
Jim Wilson, Extension pesticide education coordinator

Resources

Livestock and Poultry Air Quality. SDSU Cooperative Extension Service, South Dakota State University. Contact: Dick Nicolai Dick_Nicolai@sdstate.edu

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The following four strategy papers by the SDSU Extension Service are on the SDSU Cooperative Extension website. Go to http://agbiopubs.sdstate.edu and search by ESS number:
- Odor management information for livestock operations. ESS803-A.
- Recommended strategies for odor control in confinement swine operations. ESS803-B.
- Recommended strategies for odor control in confinement beef cattle operations. ESS803-C.
- Recommended strategies for odor control in dairy operations. ESS803-D.

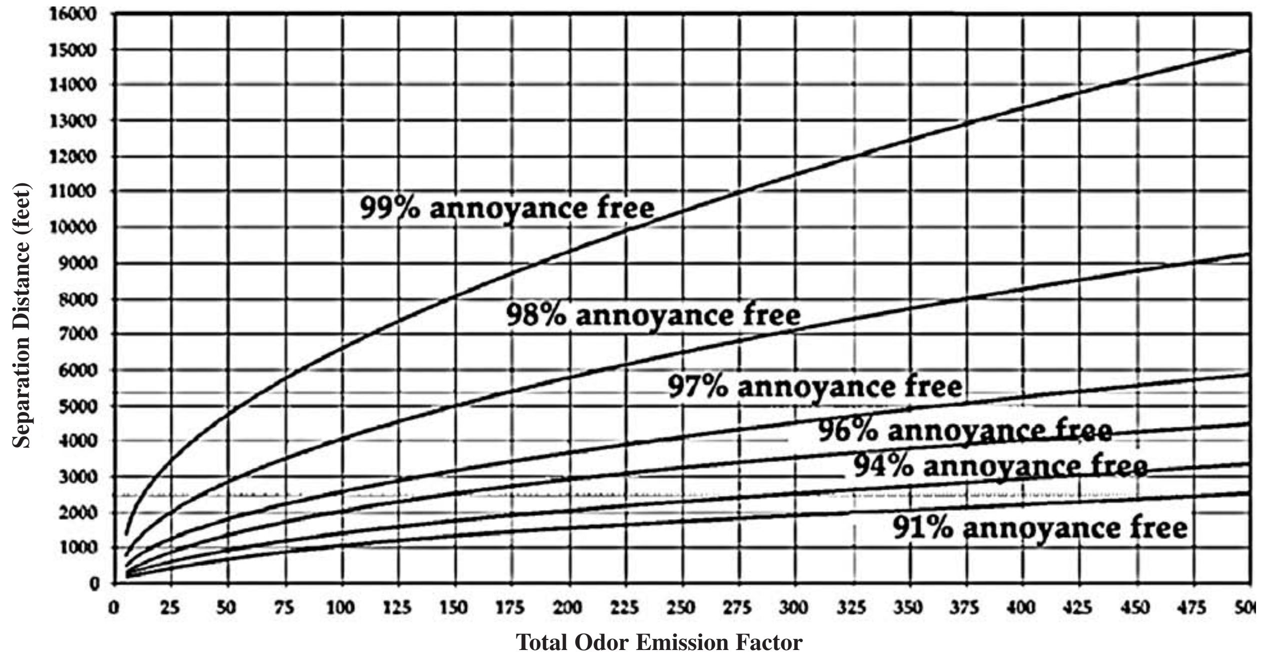
University of Minnesota manure and odor education and research website. www.manure.umn.edu

Environmental Quality Board. Generic Environment Impact Statement on Animal Agriculture. http://www.eqb.state.mn.us/geis/

For more information...

South Dakota Cooperative Extension Service fact sheet series 925 available at county Extension offices and on the Web at http://sdces.sdstate.edu offers additional information on all the subjects in this tabloid and includes individual publications for dust, fly control, odor, economics, water quality, and the specific species of livestock.

Figure 1. OFFSET estimates setback distances at different odor annoyance-free frequency requirements. Weather conditions strongly influence movement and dilution of odors. Total Order Emissions Factor (TOEF) is the sum of odor emissions from all sources. The curves represent the percent of time odors are possibly detected but at an intensity level that is considered less than annoying. Example: For 97% annoyance-free odors from a facility with a TOEF of 150 requires a 5,000-ft. setback from the nearest neighbor; at 94% a setback of 1,800 ft. is needed. This chart is based on Minnesota farms and climatic conditions; adjustments would have to be made for other localities. Several counties in Minnesota determine setback based on this model. For example, Nicollet county requires 94% annoyance-free.



Source: L. Jacobson et al. OFFSET, University of Minnesota

(continued from page 1)

and we're being left with the co-product, distillers grains. Some of that is dried and shipped to California and Texas and other places, but some of it is available for feeding locally."

South Dakota consistently is a leader in the production of hay, ranking third among states in the production of alfalfa in 2003, and fifth in the production of all hay. Boggs sees that as another reason it makes sense to grow South Dakota's ruminant livestock industries.

"Ruminant livestock production creates a need and a market for perennial forages. A lot of the farm ground across South Dakota, both east and west, is probably better suited environmentally to perennial forage production than for annual cash crops. Having a healthy livestock industry should help create markets for those forage crops," Boggs says.

He adds that on a community basis, growing South Dakota's livestock industries will help restore some of the diversity to the state, since farmers in some parts of the state have switched entirely away from animal agriculture and now grow only cash crops.

"In the past 15 years, we've seen a lot of livestock leave eastern South Dakota. The most sustainable agricultural systems are diversified, integrated operations," says Boggs.

"I don't think we'll ever go back to seeing all the crop farmers having a few cows, a few hogs, that type of thing. But as we develop more livestock-feeding operations in our region, they will be able to make agriculture in those communities more sustainable. We will be able to recycle nutrients from the feeding operations back to the farm ground and cut down on importing of nutrients such as phosphorus and nitrogen. I think that's a real positive about having livestock operations interspersed with grain farms in a community. The livestock operation can use the feed and in return the farming operations can use the nutrients."

Van der Sluis agrees that such diversity in a farming community would give it a broader economic base of support.

"Most of us would agree that crop agriculture only is not a very complete kind of agriculture. We need to try to find a way to integrate animal agriculture back into crop farming," says Van der Sluis.

"That's the argument that's sometimes used by groups involved in this new type of agriculture. They say, 'Yes, we do need animal agriculture again. It's just on a larger scale than it used to be'."

> **"It's a public policy debate that we have to try to help resolve by including science-based facts...we all come with values.... This is not just an agricultural issue.... Probably we must strike a balance between some extremes."**
>
> — Evert Van der Sluis

Bigger farms

Mistry says the reason animal agriculture favors larger operations is one of economies of scale–in a typical scenario, more cows can better return a producer's investment in land and facilities. But that doesn't mean there's no room for the small- to mid-sized producer, he adds. However, it's a fact that dairy farms are adapting to their changing industry by expanding. The average dairy herd in South Dakota is now 110 cows, or probably twice what it was a few decades ago.

Van der Sluis adds that studies by economists are inconclusive on whether bigger farms are a better vehicle for doing business, however.

"The studies are very mixed on whether large farms, even large dairy farms, are more efficient than small farms. It's often assumed, and in public pronouncements it's often said, that the only way you can make a living is by having a large farm. But the economic literature on that is not foolproof," says Van der Sluis.

Boggs adds that one of SDSU's own studies shows that a large cow-calf operation is not necessarily more profitable than a small one.

"It showed the profit per cow is not as dependent on economies of scale as we once thought it was," Boggs says. "The medium- and smaller-sized herds can be as profitable on a per-cow basis as the really large herds. What you run into, though, is family living expenses and what it costs to raise a family. Livestock margins are not that high, so it takes quite a few animals to provide for a family's living expenses."

Throwing a new wrinkle into discussions of whether big is more efficient, Van der Sluis says, is the question of who should pay for regulations designed to protect the environment from potential damage due to agricultural pollution or in a worst-case scenario, who should pay for cleanup.

"It's not necessarily going to hold anymore that larger farmers are going to be more efficient than smaller farms. It depends on how you account for pollution," Van der Sluis says.

"I would think that as society is demanding tighter environmental regulation, more of the cost will be borne by potential polluters, whether it be water pollution or air pollution. That would increase the cost of doing business."

Community issues

From ag producers' points of view, choosing to grow South Dakota's livestock industries is an easy decision. But Boggs says the expanding livestock industries also affect communities. That's where SDSU can play a role by providing sound, science-based information on topics related to animal agriculture. That information helps inform the public but also helps producers who want to build or expand livestock enterprises to do it in a way that causes as little concern as possible to their neighbors.

"Obviously not everyone is excited about the development of livestock operations, especially larger livestock operations that will have larger concentrations of animals," Boggs says.

"I think the major concerns are with odor as well as the management of manure or nutrients from the operation and the potential for runoff pollution. There has been a tremendous amount of research conducted in this area in the last few years. Through this research, livestock facilities have been or can be developed that alleviate many of these concerns and greatly improve the safety and security of these larger livestock operations."

Boggs says South Dakotans also must place trust in their local officials.

"Zoning boards and county commissions have the power and the ability to evaluate which sites are suitable and which sites aren't, which plans are suitable to protect the environment and the community and which plans aren't. I think we need to trust them as county officials to make the right decisions for their communities," he says.

Van der Sluis says in addressing local issues about agricultural expansion, South Dakotans can perhaps take a lesson from the way economists teach agricultural policy.

"It's not enough to say that science will answer the questions. It's a public policy debate that we have to try to help resolve by including science-based facts, but we also have to realize that we all come with values, even a mathematical scientist. His values need to be entered into the debate," says Van der Sluis. "This is not just an agricultural issue. I think it has to do with property rights. These are very important issues that we as a society must make decisions about, not just for our generation but for future generations, with an eye toward the future. Probably we must strike a balance between some extremes." ☐

South Dakota State University
College of Agriculture & Biological Sciences
Brookings, South Dakota 57007

President / Peggy Miller
Interim Dean / Chuck McMullen
Associate Dean, Director of Academic Programs / Don Marshall
Associate Dean, Director of Agricultural Experiment Station / Kevin D. Kephart
Associate Dean, Director of Cooperative Extension Service / Gerald Warmann

PUBLICATIONS TEAM
AgBio Communications Unit
Director, Executive Editor / Barbara Hartinger

Contributors / Reviewers... faculty and staff from the following:
South Dakota Agricultural Experiment Station
Kevin D. Kephart, director

Cooperative Extension Service
E. Kim Cassel, ag and natural resources program leader

Agriculture & Biosystems Engineering Department
Van Kelley, professor and head

Animal & Range Sciences Department
Don Boggs, professor and head

Biology / Microbiology Department
Tom Cheesbrough, professor and head

Dairy Science Department
Vikram Mistry, professor and head

Economics Department
Evert Van der Sluis, professor and acting head

Plant Science Department
Dale Gallenberg, professor and head

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SOUTH DAKOTA STATE UNIVERSITY
College of Agriculture & Biological Sciences
Ag Hall 135 / Box 2207
Brookings, SD 57007-0191