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Livestock Development in South Dakota

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It's not just about agriculture...It's a public policy debate to address the concerns of all state residents.

Relocation: the Elliot's

In February 2006 Rodney and Dorothy Elliot and their three children moved from their home in Northern Ireland to Lake Norden, South Dakota. By the end of that year they were already milking 1,400 cows in their farm, "Drumgoon Dairy". In 2013 they built a new milking parlor and half of a new cross-ventilated barn to the North of their facilities. The second half, named "Norden Dairy", brought their total capacity to 4,500 cows. The farm currently has 45 full time employees which the family enjoys assisting to enhance their farming skills. The family also farms 1,000 acres of corn and alfalfa, and owns 200 acres of pasture. Their farmland and that of their neighbors is naturally fertilized with manure from the dairy. Drumgoon and neighbor crop farmers have prospered with this arrangement and at the same time they have reduced their carbon footprint. Their top priority is to buy local, purchasing 90 percent of their feeds from farms within their county.

Dairy farms are only one segment of animal agriculture. Family farm expansions and relocations have been the norm across species all over the state.

Livestock producers and processors who deal in beef cattle, hogs, sheep, and poultry are also finding South Dakota to be an excellent location for processing plants and large-scale livestock operations. All this, makes for some general public concerns as residents in communities around the state try to chart a course that will allow for farm development while protecting the environment and dealing with nuisances such as odor.

Daniel Scholl, director of the South Dakota Agricultural Experiment Station, says that is why land-grant university research will be 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 producers that have come to South Dakota from other states and countries "would like to expand at home but they cannot in many cases because they are essentially 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 combined with numerous possibilities in South Dakota.

"Migration can be explained by 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."

Evert Van der Sluis, Professor of Economics, and a native of The Netherlands, agreed 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.

Van der Sluis noted that The Netherlands is one of the most densely populated countries in the world, and so, much of the agricultural activity there takes place near cities and towns. It is therefore not surprising to find relatively strict environmental laws and a High level of scrutiny over agricultural production methods by members of society who demand access to clean water, air, and other natural resources.

In the past, farmers who owned their land might have been able to use the proceeds from selling their capital assets in The Netherlands to invest in a South Dakota operation. These favorable differences shrunk somewhat over the past decade slowing-down the immigration of Dutch producers.

However, more recent weather and environmental-related concerns have remained relevant for agricultural producers in states along the West Coast of the United States. Ongoing drought concerns and issues associated with increased population pressures may provide opportunities for South Dakota to encourage agricultural producers in states along the West Coast to consider investing in our state.

Coming to South 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 the state. In a nutshell, the advantages are a climate suitable for livestock; 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. One example is the 2014 opening of the Bel Brands USA in Brookings, a plant that produces 1.5 million individually wrapped, Mini Babybels cheeses per day. This plant, an investment of $140 million and a 170,000 square-foot facility, which requires more than 500,000 pounds of milk daily to produce 22 million pounds of cheese, employs 250 people.

> *"In the past 15 years we have seen a lot of livestock expansion in South Dakota. The most sustainable agricultural systems are diversified, environmentally friendly operations."*
>
> **— Barry Dunn**
>
> *"We need to find a way to integrate animal agriculture back into crop farming."*
>
> **— Evert Van der Sluis**

Joe Cassady, head of SDSU's Animal Science Department affirmed: "Historically we've exported calves and corn from South Dakota. When you're doing both of those and they're going to neighboring states, someone else is taking advantage of the quality of livestock and the abundance of feed we have in South Dakota".

South Dakota is consistently a leader in the production of hay, ranking second among all states in the production of alfalfa in 2014, and fifth in the production of all hay. The top five alfalfa producing states making up 35% of all production were: California, South Dakota, Idaho, Iowa, and Minnesota. California, the leading alfalfa hay producer in the U.S., is undergoing a severe drought. South Dakota's alfalfa could become increasingly competitively priced in the future and the state needs to be prepared.

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.

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.

It might be difficult in the future to see a majority of crop farmers having a few cows, a few hogs, and that type of diversity. 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 animal farm ground and cut down on importing nutrients such as phosphorus and nitrogen. A real positive thing about having livestock operations interspersed with grain farms in a community, is that the former can use the feed and crop farms 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'."

Bigger farms

Mistry says the reason animal agriculture appears to favor 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 midsized 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 400 cows, more than four times in size compared to a few decades ago.

> *"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**

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

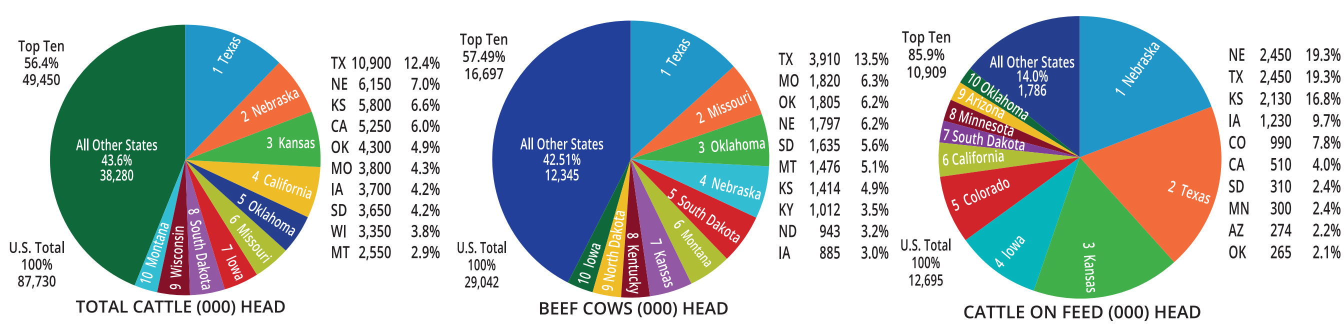
"The studies are very mixed on whether large farms, even large dairy farms, are more efficient than small farms. It's often assumed, and in public pronouncements it's often said, that the only way you can make a living is by having a large farm. But the economic literature on that is not foolproof,"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

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. 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 run-off 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 one handles the manure and effluents produced," Van der Sluis says.

"I would think that as society is demanding tighter environmental regulations, 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, more of the cost will be borne by potential emitter, whether it be water or air."



Percent and actual number of head in the 10 leading beef cattle producing states.

Community issues

From the ag producers' points of view, choosing to grow South Dakota's livestock industries is an easy decision. However, 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.

Not everyone is excited about the development of livestock operations, especially larger livestock operations that will have larger concentrations of animals.

The major concerns are with odor as well as the management of manure or nutrients from the operation and the potential for runoff. There has been a huge amount of research conducted in this area over 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.

Zoning boards and county commissions have the power and the ability to evaluate which sites are suitable and which sites are not, which plans are suitable to protect the environment and the community and which plans are not. Trust needs to be placed on them as county officials to make the right decisions for their communities.

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. These 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, as well. Probably we must strike a balance between some extremes."

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. 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.

According to the USDA's definition, family farms are those where the majority of the business is owned by the operator and his or her relatives. "As farms become larger, there's a need for more outside help", Garcia SDSU Extension Agriculture and Natural Resources Program Director pointed out. In South Dakota 98 percent of the farms are family owned.

Expansion: the Krause's

One example is that of the Krause's family. While in high school, Laron Krause partnered with his father Edwin to raise feeder pigs. He has been involved in the business ever since. In 1997 Laron and four neighbors partnered to form "Supreme Pork", a 1,650 sow farrow to finish operation, which has now 3,300 sows. As Supreme Pork partners the Krause's have 4,800 finishing spaces plus another 2,400-head barn owned by one of the other partners. Manure from the finishing barns fertilizes the corn of their operation. The Krause's also raise soybeans and wheat on their 3,300 acres. Laron and wife Jolene are very active in their community. They also give much credit to their success to their family and employees. Their two sons Adam and Brent attend SDSU and plan to return and join the family operation. They plan to build a 3,600-head contract nursery for Supreme Pork. Construction will start in the spring of 2016 as Adam graduates from SDSU. Brent will join one year later, ensuring the next generation will continue the family business.

Q. Does South Dakota have an advantage over other states in livestock production?

As of 2014 South Dakota ranked sixth in corn grain, eight in corn silage, fourth in all hay, and second in alfalfa hay among all US states. All these feeds are the basis for livestock diets. Since feed costs are the single largest cost of livestock operations, this gives South Dakota an advantage compared to other states.

The USDA uses the milk-to-feed price ratio based on the economic impact that alfalfa, corn, and soybeans have on the cost of milk production said Alvaro Garcia SDSU Director of Agriculture and Natural Resources. This ratio has been used to estimate the "economic climate" for milk production. It represents the pounds of 16% protein dairy feed mix equal in value to 1 pound of whole milk. Although all three feedstuffs used in the calculation do not constitute an entire dairy cow ration, they are the most widely used and constitute the largest feed fraction of the diet. Whenever the ratio meets or exceeds 3.0, it is considered profitable to buy feed and produce milk. During 2013 South Dakota dairy farmers were able to buy on average two more pounds of feed per pound of milk produced compared with the rest of the country.

Recently, South Dakota has seen sustained growth in value-added ventures, particularly ethanol. During 2014 there were 15 operational ethanol plants in the state that produced 1 million gallons of ethanol (6th in the US). These facilities produce close to 6.5 lbs. of distillers dried grains (DDG) per gallon of ethanol, or almost 3 million metric tons yearly. More than 70% of the bio-refineries now also extract corn oil adding to their revenue stream. Based on SDSU research DDG can be effectively utilized to feed growing and finishing pork, beef cattle, as well as dairy cows.

Q. What's the economic contribution of the pork industry to the state's economy?

There are 175,000 sows in South Dakota. These sows produce a pig crop of 3.78 million head. The 2014 estimated gross income of the pork industry was $602 million (Table 1).

In addition, the production sector accounts for 5,827 jobs and $1,365,352 million in taxes on production and imports. The impact per sow is considered to be $5,097.79.

Table 1. Pork industry output impact	
Direct	$602,150,022
Indirect	$152,104,927
Induced	$137,958,014
Total	$892,112,963
Source: G. Taylor, SDSU 2015	

Q. What's the economic contribution of the dairy industry to the state's economy?

The economic impact of dairy production was analyzed by the SDSU Agricultural Economics Department (G. Taylor. 2015). The effects 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 2). Once dairy products processing figures are included the economic impact per dairy cow is considered to be $25,707.

Table 2. Dairy industry output impact	
Direct	$426,644,988
Indirect	$145,702,854
Induced	$75,088,748
Total	$647,436,590
Source: G. Taylor, SDSU 2015	

Q. What's the economic contribution of the beef industry to the state's economy?

As of January 2015 South Dakota had 1.6 million beef cows and heifers and 385,000 head on feed. Cattle and calves were 3.7 million in 2014. As a result beef cattle create a 2.28 billion dollar impact on the economy of South Dakota, representing more than 6% of the state's economy (Table 3). Almost 12,000 people in the state hold jobs associated with beef production and the industry generates over $83 million in tax revenue for the state. The total inventory of beef cows in SD is 1.6 million with an additional 385,000 cattle being finished for slaughter in 2014. Each beef cow within the state creates about $1,755 in economic impact to the state. Ninety-five percent of the 3,176 feedlots are smaller operators, each marketing less than 1,000 head. Families involved in beef production work and live in the state and have a vested interest in maintaining a safe, clean environment for their own families, along with all residents of the state.

In 2012 the beef industry provided an estimated total economic impact of $4.48 billion, 12,571 full-time equivalent jobs, and a net positive tax impact of $613,762.

Table 3. Beef industry output impact	
Direct	$2,283,766,027
Indirect	$1,865,961,681
Induced	$334,573,916
Total	$4,484,301,624
Source: G. Taylor, SDSU 2015	

Q. Is there an advantage to finishing beef calves here in South Dakota rather than shipping them to feedlots out of state?

Beef production is often a segmented industry, with beef cows and their calves produced mostly on forages – pastures, rangelands and crop residues, while cattle intended for slaughter are often placed in more confined settings for the last few months before harvest. Overall, over 60 % of beef diets are based on forage sources that cannot be utilized by humans as food. Even during the finishing phase, the diet may contain a large proportion of feeds that arise as by-products of other uses. Calves produced within the state are considered of high quality, and are sought after by the feeding industry. Beef finishing diets typically consist 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 the state. An SDSU 2006 beef report looked at the cost of gain between cattle finished at "opportunities farm" in South Dakota and cattle finished in Kansas (Lowe et al 2006). The results showed cattle feeders in South Dakota can compete with those located in the primary cattle feeding regions of the United States, particularly because of lower feed costs.

Q. Why is eastern South Dakota especially attractive for livestock expansion?

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 is harvested east of the Missouri River. The state is second in the country in alfalfa hay production with 4.4 million tons in 2014. Alfalfa constitutes on average 25% of total dry matter consumed by dairy cows. Corn constitutes the main grain used in livestock production in the US. Dairy cow diets may include as much as 20 lbs. of corn grain and/or its co-products. During 2014 almost 800 million bushels were produced as well as 6.2 million tons of corn silage. 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 are located in eastern South Dakota.

Beef expansion would also benefit parts of SD that aren't along the I-29. Western and Central SD have some of the lowest corn prices in the US and would be particularly well suited to background and/or finish more cattle.

Q. What would be the economic impact of more livestock operations along the I-29 corridor?

Beef cattle help provide a market for other agricultural commodities such as corn, soybeans and forage. According to a recent SDSU report (G. Taylor. 2015), 508,000 head of cattle were marketed in 2012. These animals would have consumed the equivalent of 24.7 million bushels of corn, 34,544 tons of soybean meal and 2.49 million tons of corn silage. Beef cattle can make excellent use of co-products from the ethanol industry, such as DDGS. With South Dakota being a leader in ethanol production, abundant co-products exist for feeding cattle and making South Dakota a very competitive location for the feedlot industry.

SDSU Agricultural Economic Faculty (Taylor. 2015) quantified the interactions between industries (or sectors) within an economy using an input-output model (IMPLAN). A multiplier was developed per livestock sector that assessed the impact each $1 in sustained direct sales has on the local economy.

- Dairy: 1.52 ($0.52 per $1 in sales).
- Beef: 1.95 ($0.95 per $1 in sales).
- Pork: 1.47 ($0.47 per $1 in sales).

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 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 Brookings, a beef processing plant is about to be reopened in Aberdeen, and a turkey processing plant was constructed in Huron. As a result, processor demand for milk, live cattle, and turkeys increased in South Dakota. The recent exponential growth of the ethanol industry has made corn co-products available in the market at highly competitive prices.

In addition to the direct economic benefit from the sale of livestock, another benefit is the value of manure production. Crop fields require fertilization with nitrogen and phosphorus, both of which are well supplied by livestock manure. In a report from Iowa State University[4], it was estimated that it would require manure from 1,213 fed beef cattle to supply the N needed to fertilize 640 acres in a continuous corn rotation. That number drops to 674 fed cattle for a corn-corn-bean rotation and to 404 cattle for a corn-bean rotation.

Q. Do livestock farms need to be big?

The expansion of the livestock family farm has been happening for a while in the US. The reason is oftentimes attributed to the economies of scale which gives farms greater leverage with suppliers and helps them keep up with inflation. There were 1.0 million beef cow operations in 1986 which, according to the National Cattlemen's Beef Association, dropped to 619 thousand in 2012. Beef cow numbers however did not change and remained at roughly 30 million. In 26 years the average US beef cow herd increased then by 60% from an average of 30 cows in 86' to 48 in 2012.

Sucession: the Moes'

South Dakota beef farms face a similar dilemma. John Moes started from scratch in 1987, when he purchased a quarter of ground. During the next 28 years he went from 20 to 300 head total. Today the family has a 60 x 60 enclosure, complete with heated floors and a hydraulic chute. With an expansion in 2011 they are now permitted to feed 2,000 head, 1,300 of them in mono-slope barns. That space doubles as a calving area and a place to keep new mothers close during any bouts of cold winter weather. Fertility and conception rate improvements have come along with quality and performance. The first 2014 load of calves reached 64% Certified Angus Beef acceptance, compared to 27% two years earlier. Feedlot manure is managed in a holding pond and then spread on the pasture to improve production, and get the most out of each acre. Working with the South Dakota Game, Fish and Parks Department, Moes put an easement on 230 acres of his land, so that it will never be developed. For these efforts, Moes was one of four finalists for the 2014 Leopold Conservation Award.

"According to the USDA ERS the operating cost of production (including labor) for the average US dairy farm during the first 6 months of 2015 was approximately $16 per hundred lbs. of milk produced", said Alvaro Garcia, SDSU Extension Director of Agriculture and Natural Resources. Since the mid 1980's milk prices have been characterized by being highly volatile from one year to the next. During 2014 milk prices in South Dakota were $24.8 per 100 pounds. During the first semester of 2015, however prices dropped to $18.5 on average. At the present time net returns can only be positive when farms receive premiums for quality and volume, which favors larger operations. Increased leverage with suppliers due to increased scale allows dairy farmers 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.).

But South Dakota farms are bigger than those in other states. “In order to remain profitable both smaller and larger operations tend to expand,” said Alvaro Garcia SDSU Extension Director of Agriculture and Natural Resources. “The number of farms with beef cattle and calves dropped from 15,667 in 2007 to 15,582 in 2012; the number of head however increased from 3.69 million to 3.89 million during the same time period”. The number of dairy farms and cows have followed similar trends. In 2000 there were 1095 farms and 102,000 cows or 93 cows per farm. During the first half of 2015 there were again close to 102,000 cows but now in 244 dairies or approximately 400 cows per farm. In the last 6 decades the state reduced dairy cow numbers by 400% and more than doubled total milk output.

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 almost 1.2 million to 49,000 in 2013. In 1965, the average dairy herd size was approximately 15 cows. By 2000, it was approximately 70 cows, increasing to 190 in 2013, where 10,000 farms produced 80 percent of the U.S. milk. During the first semester of 2015 there were close to 102,000 dairy cows in South Dakota in 244 farms with an average of more than 400 milking cows in each.

As a result of their higher utilization of capital and management-intense technologies, larger farms have higher per-cow productivity than smaller farms. Today large South Dakota dairies utilize one employee per 100 milking cows, a figure that doubles what was the standard in the 20th century. Because of their productivity, larger farms are able to stay competitive and financially solvent even during periods of depressed milk prices.

There is opportunity to expand livestock production with a variety of enterprise sizes. A 2000 head beef feedlot would not be considered “big” compared to southern plains facilities. While it appears that many of the dairy expansion plans are relatively large, a swine finishing barn would typically have fewer animal units than many of the dairies being proposed. Expansion in the beef sector could occur from construction of new facilities, or by increased utilization or expansion of existing yards. There is also increased interest in non-traditional methods of cow/calf production, including annual forages and/or semi-confinement.

Q. What evidence is there that large dairy farms will/do increase the supply and lower the cost to the consumer of milk products?

The USDA conducted the study Dairy 2007 in 17 of the Nation’s major dairy States representing 79.5 percent of U.S. dairy farms and 82.5 percent of U.S. dairy cows. In this comprehensive survey smaller farms (less than 100 cows) produced 23% less milk than large (500 cows or more) dairy operations. Cows in smaller dairies were 21% less productive than in larger dairy operations. It can thus be concluded that land is used more efficiently by larger dairies.

According to the USDA Economic Research Service, during 2014 the value of production less total costs per 100 lbs. of milk produced was positive $2.9 for dairies with 500 or more cows and negative $9.6 for dairies with less than 500 cows. This clearly shows why smaller farms need to either expand or exit the industry. Large farms are more efficient with their capital and can afford to receive less for their product than smaller dairies. Fluid milk prices are regulated by milk processors, and not by dairy farmers.

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 1,000-cow dairy will use per year approximately:

- Yearly operating costs for this dairy amount to $3.5 million (220,000 cwt @ $16/cwt).
- Feedstuffs—115,000 bushels of corn ($400,000); 6,500 tons of corn silage ($230,000), 5,700 tons of alfalfa haylage ($430,000), and 2,700 tons of alfalfa hay ($400,000) for a total of $1.5 million in feed.
- Expenses over feed costs in this example are $2 million ($3.5 – 1.5) spent in the community in items such as: fuel, lube, utilities, equipment purchases, maintenance, and repair, veterinary services, bedding, trucking and custom services, employee salaries and owner's expenses.

A 5,400-sows operation will invest $15 million in new buildings and infrastructure, employ 14 full-time individuals, have $6 million in annual sales, and $2 million on inputs purchased locally. This operation would use.

- Feedstuffs – 206,000 bushels of corn
  1,400 tons of soybean meal (58,160 bushels)

Q. What is a CAFO? What makes it different from other livestock facilities?

Because of land use changes within the state, pasture rents have continued to increase. This increases the importance of new strategies for confinement feeding utilizing the state's available grain and co-product feed resources. On average, the state's rental rates for rangeland have increased 220% since 2010 and this increase for tame grass pasture has been 213%[3].

Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confinement. 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 pastures 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 it could potentially be considered a significant contributor of contaminants to surface water (See Table 4). Of all large farms classified as CAFOs in South Dakota 97% are family owned and operated (see map, pg 8).

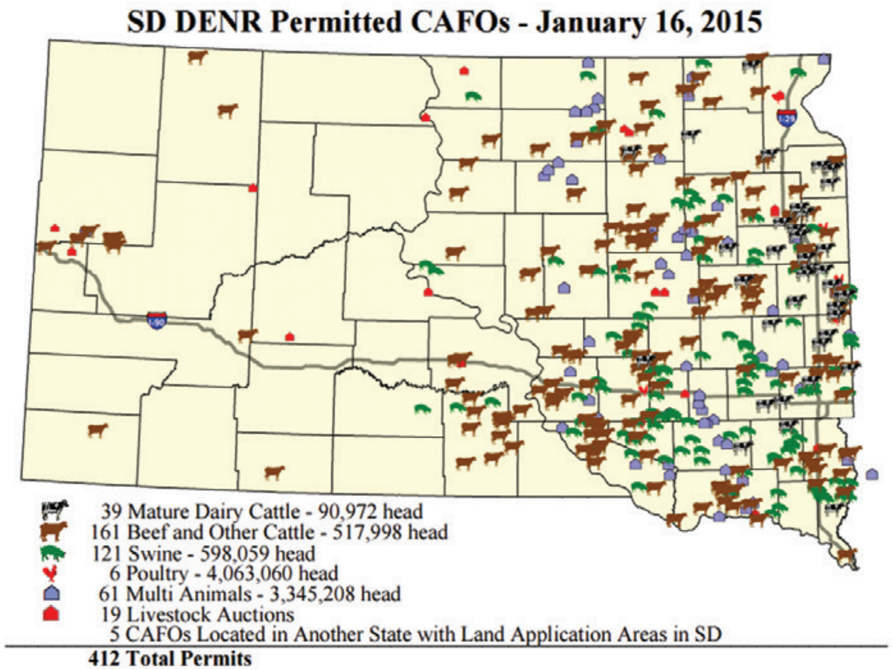
Table 4. Number of animals to define large, medium, and small concentrated animal feeding operations.

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. In this plan they need to show 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.



DENR CAFO map

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 contamination 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 http://denr.sd.gov/des/fp/fphome.aspx.

Unless the operation will be connecting to a public water supply system (for example a city or rural water supply system) a water right permit will be needed to develop a water supply for uses greater than 18 gallons per minute (on an average daily basis). To obtain a water right permit, an application is submitted to the South Dakota Department of Environment and Natural Resources. The permit application is evaluated on four criteria:

1. Is there an adequate water supply from the proposed source
2. Will the proposed use unlawfully impair existing water rights
3. Is the proposed use considered a beneficial use of water
4. Is the proposed use in the public interest

Based on the evaluation, a report and recommendation will be prepared and public notice will be given with the opportunity to file petitions of support or opposition. If approval of the permit application is recommended and the application is uncontested, a permit can be issued without a hearing. If the application is contested, a hearing will be held before the state Water Management Board, and the board will decide on approval or denial of the application. Decisions of the board can be appealed to circuit court and the state Supreme Court.

The state also administers the following permits that may be required for a livestock operation: 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 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 2014 report, 59% of assessed stream miles and 47% of lakes, reservoirs, and ponds did not support all of their uses. E. Coli, high total suspended solids, fecal coliform bacteria, salinity, and low dissolved oxygen concentrations were the most frequently observed causes of water quality problems in rivers and streams. For lakes, reservoirs, and ponds, the most common observed impairments were attributed to chlorophyll (from algal growth), water temperature, mercury, low dissolved oxygen, and pH. This statewide assessment reported 1,684 miles of rivers and streams impaired by livestock grazing or feeding operations.

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. Can livestock manure pollute surface waters?

There are an estimated 98 thousand miles of streams and rivers within South Dakota. During the most recent monitoring cycle, SD DENR sampled 6,149 miles of streams and rivers. Their analysis of monitoring data concluded that 1,684 miles of those assessed (27.4%) were impaired due to livestock grazing and feeding operations.

Manure contains four primary contaminants that can impact water quality: nitrogen, phosphorous, pathogens, and organic matter.

Organic matter in manure can be a valuable resource if properly managed, but it can become a contaminant if allowed to discharge or runoff into surface water. 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 (because livestock operations do not add the large amounts of fresh water used to dilute and transport municipal wastewater). There are cases where large discharges of manure into surface water have resulted in fish kills from oxygen depletion.

Suspended solids concentrations in South Dakota streams and rivers can often be elevated as a result of soil disturbance within the riparian corridor. Eroded soil and organic matter are deposited downstream of their entry point, resulting in degraded stream habitat for aquatic flora and fauna. Sedentary forms are simply buried by the sediment while other species are significantly stressed or depart from affected stream reaches.

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.

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.

Nutrients (nitrogen and phosphorous) and pathogens are discussed in subsequent questions.

Q. How can nutrients in manure cause water problems?

Nutrients in manure are also a valuable resource as plant fertilizer if managed properly. 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 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. In fields with tile drainage, however, the drains provide a pathway for nitrate that has leached below the root zone to outlet into surface water.

High nitrate levels in drinking water can cause health problems, especially in pregnant women and infants. The drinking water standard is 10 parts per million (ppm) 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?

Several pathogens found in livestock manure are able to cause disease in humans. However, it is not clear how important livestock wastes in environmental water are as routes of human exposure to 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 normally found within the digestive tract of most warm-blooded animals. Fecal coliforms are simply indicators, and do not generally cause disease, but the probability of contracting a water-borne disease is considered to be higher if the water is contaminated by fecal material. High fecal coliform counts can be found in streams, lakes, and groundwater sources throughout the nation. Traditional monitoring techniques only indicate the presence and amount of coliform bacteria. New bacterial source tracking techniques are currently under development which would help water managers identify the source animals contributing this fecal material.

Q. What levels of hormones and antibiotics are released in livestock manure?

Over the past 15-20 years there has been increased interest in the levels of naturally occurring and synthetic hormone levels in manure, as well as antibiotic levels. Hormones are excreted by all animals into the environment at levels that vary depending on sex, reproductive status, and hormone administration for production. Production benefits are classified as growth benefits (implants), increased milk yield (rBST injections), or to manage the reproductive cycle (injections, indwelling vaginal devices, etc.). Antibiotics are excreted from animals either unchanged or as metabolites (broken down sub-units) that vary in their effects on bacterial life, some can limit growth or kill, others have no effect. Both hormones and antibiotics are broken down in the environment at variable rates, but the compounds tend to bind/associate with clay or organic materials in the soil, limiting discharge potential. Antibiotics in stockpiled manure can be measured at rates that range from undetectable to several parts per million (ppm or mg/L), and hormones can be measured in the range of parts per billion (ppb or ng/L). Antibiotics and hormones are sometimes detected in surface water, but at very small concentrations (parts per trillion to parts per billion). At these levels, the antibiotics and hormones do not pose any immediate human health concerns. However, the impacts of long term exposure to very low environmental levels of antibiotics, and hormones on human health are largely unknown. Research continues to be performed to attempt to define any potential risks. Best management practices that limit runoff reduce these potential risks.

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. 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.

Q. Does South Dakota have air quality rules and regulations for livestock facilities?

South Dakota does not have any state-specific air quality rules and regulations for livestock facilities. However, the South Dakota Department of Environment and Natural Resources (SD DENR) is charged with maintaining National Ambient Air Quality Standards (NAAQS) established through the Federal Clean Air Act.

There are three federal air quality rules to be aware of, with varying degrees of application to livestock facilities:

- The Clean Air Act is unlikely to directly affect animal feeding operations in South Dakota, because we are considered an attainment area (our state meets the NAAQS). However, large operations should stay informed on policy changes by the Environmental Protection Agency (EPA), especially related to fine particulate matter.
- The Emergency Planning and Community Right to Know Act requires livestock operations over specific capacities to evaluate ammonia and hydrogen sulfide production potential, and file a report with the SD DENR if the peak emission of either gas exceeds 100 lb per day or more.
- The Greenhouse Gas Reporting Rule requires livestock operations over specific capacities to evaluate greenhouse gas production from the manure management system. The EPA is not currently collecting reports from farms that exceed the 25,000 metric tons of carbon dioxide equivalents per year threshold; however, for the limited number of farms that meet the capacity and emission thresholds, producers are advised to maintain sufficient inventory records to facilitate future compliance, if necessary.

More specific details and compliance guidance is available in Cortus (2012).

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. What are the gases that contribute to odor from livestock facilities?

An odor results from a complex mixture of many odorous compounds. Volatile organic compounds (VOCs) are a group of odorous compounds, most of which register individually at very low concentrations in livestock facilities. When combined with the more prevalent gases, such as hydrogen sulfide (H_2S) and ammonia (NH_3), the mixture is what causes the sensation of odor. The significant VOCs differ between sites and species, and the change in odor composition as it moves away from a barn is not clear.

Q. Can odor be measured by measuring the gas concentration?

In several studies of swine and dairy barns in the Midwest, strong correlations or relationships were found between hydrogen sulfide, ammonia and VOC concentrations relative to odor concentration. This suggests that the variability, in particular, of odor may be predicted by the variability of these other gases. However, the correlations were site specific and may not apply to all swine and dairy systems or geographic locations.

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 odor is measured based on the ratio of clean air to odorous air to the point where it can be either detected (different from clean air) or recognized (as a specific type of odorant) by a human nose.

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.

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.

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 a lesser concern under most situations for South Dakota farms. Dry and windy conditions, particularly for feedlots, promote more dust release. Moisture addition and surface management can reduce dust release.

Since the majority of service and township roads are gravel, dust generated from vehicles traveling over these roads can also be considerable. Water, salts or other additives can be 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?

A summary by O'Connor et al. (2010) of peer-reviewed literature that evaluated respiratory, gastrointestinal and mental health effects for individuals living near animal feeding operations (excluding livestock producers) concluded:

1. A weak and inconsistent association between self-reported disease in people with allergies or familial history of allergies
2. No consistent dose-response relationship between exposure and disease.

Q. What technologies can a producer use to reduce odor and gas emissions?

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. Odor sources include animal housing, manure storage and land application sites.

Reducing generation

- Dietary changes – may also impact the quality of meat, egg, or milk products.
- Solid-liquid separation of manure – facilitates nutrient concentration but requires both solid and liquid manure handling.
- Additives – may enhance or control chemical, biological or physical reactions within the manure.
- Aerobic treatment – adding extra oxygen to the manure storage.
- Anaerobic digesters – 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 – includes rigid concrete, wood lids, lightweight roofs (fiberglass, aluminum, etc.), flexible plastic membranes, or a floating cover, which can be made with a variety of natural or artificial materials.
- Biofilters – reduce odor and hydrogen sulfide emissions. Used in conjunction with a mechanical ventilation system.
- Oil sprinkling - reduces the airborne dust concentration and may also lower odor and gas emissions.
- Injecting liquid manure and incorporating solid manure – reduces surface area of manure exposed to the environment and retains nutrients in the soil.

Enhancing dispersion

- 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 odor from a livestock production site on the surrounding community be predicted before the facility is constructed?

The South Dakota Odor Footprint Tool (SDOFT) provides an estimate of the odor annoyance frequency around a livestock production site. SDOFT considers historical weather data, along with the surface area and type of livestock housing and manure storage.

The impact of certain odor control technologies can also be investigated using SDOFT.

- SDOFT does not take into account all site specific or topographic factors, but provides a starting point for discussion on acceptable odor annoyance frequencies around livestock production sites.
- SDOFT is a spreadsheet-based tool and available at http://www.sdstate.edu/abe/research/structures/odor-modeling.cfm.

Q. How can flies and rodents be controlled in and around livestock facilities?

Good farm facility management and sanitation overall – cleanup of spilled feed, bedding, manure, and removal of standing water – are essential for controlling flies. The housefly 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 houseflies are primarily a nuisance, stable flies can inflict an annoying bite to humans.

Birds and rodents are attracted to livestock facilities for food and shelter. Building modifications to exclude these pests (rat and bird proofing) will reduce the appeal of a site to the pest. Good facility management and sanitation are also essential for reducing bird and rodent problems.

Various chemical control options also are available and can be effective if used according to manufacturer or specialist instructions.

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