Technical Work Paper
A Description of Animal Agriculture in Minnesota

Prepared for
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on Animal Agriculture
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Technical Work Paper
GEIS on Animal Agriculture

Major Historical Trends

Introduction

This technical work paper, the Description of Animal Agriculture, is intended to compile the information that has been gathered by other technical work papers for the GEIS and to weave these individual pieces together in such a way that the reader can see the interrelationships between these pieces, and develop a view of the whole landscape of animal agriculture as it exists in Minnesota. The paper cannot possibly include or recreate the many technical details that are presented in the technical papers. Rather than providing technical details, it is intended to help the reader take a step back and look at the big picture of what is happening in agriculture, why it is happening, and what the consequences are.

The source materials for this paper are primarily the technical work papers and the literature review that are part of the GEIS. Where possible, these have been cited in the text, so that the reader is able to refer to the relevant technical work paper or literature review for more detailed information. In addition, a series of technical publications were used and personal interviews were conducted to provide information on trends and on animal production systems in use in Minnesota. These are listed in the References section at the end of the paper.

The paper begins with a discussion of the major recent historical trends in animal agriculture, focusing mainly on the fifteen-year period from 1982 to 1997. It then contains a statewide statistical description of animal agriculture. This is followed by descriptions of the typical production systems for hogs, dairy, beef, turkeys, and chickens. It concludes with a discussion of issues and opportunities raised by the changes taking place in animal agriculture.

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Major Historical Trends

Major Historical Trends

The following is a discussion of major historical trends in animal agriculture, over the fifteen years between 1982 and 1997. Particular attention is given to trends that occurred in the 1990s. Data for much of the discussion is from the Census of Agriculture; it is for this reason that the fifteen-year timespan was chosen for examination. Most of the data was supplied by the Land Use Team, and much of the text was adapted from the Land Use Conflicts and Regulation Technical Work Paper.

Number and Size of All Farms

Number of Farms Decreasing

The number of farms has decreased significantly since 1982. In 1997, there were 47,281 farms in Minnesota with over $10,000 in gross sales as reported in Table 12 of the Census of Agriculture. This number declined by 29% from 1982, when there were 66,966 farms. The decrease in the number of farms is true across the State. All counties lost farms between 1982 and 1997, with the exception of Itasca and Ramsey Counties which had minuscule increases. Central Minnesota and the Red River Valley in northwestern Minnesota had the largest percentage decreases.

Average Farm Size Increasing

Average farm size has been steadily increasing in Minnesota. Average farm size in the State increased by 23% from 1982 to 1997, from 374 acres to 486 acres. The increase in average farm size is true across the State. Outside of the seven-county metro area, average farm size increased in all counties except Cook between 1982 and 1997. Increases in average farm size were highest in the central and south central counties, with increases from 40% to 63%. Some of the counties that gained the most in average farm size were also those that lost the highest percentage of farms between 1982 and 1997.

Change in farm size can be seen in more detail by looking at the number of farms in various size classes. The most dramatic change between 1982 and 1997 was in the farms that had from 100 to 259 acres. The number of farms in this class decreased in every county between 1982 and 1997, and in many counties it decreased by 50% or more. This is especially striking because of the fact that in most counties this was the predominant farm size in 1982. Similarly, the number of farms with between 250 and 499 acres decreased in all counties between 1982 and 1997. In several counties, the number of farms with 500 acres and up increased while the total number of farms in the county decreased.

Farm Tenure of All Farms

Farm Operators Working More Days Off Farm

Farm operators across the State are increasingly engaged in off-farm employment, implying that farming is becoming a more part-time occupation. A farm operator is a person who operates a farm, and may be the owner, a member of the owner's household, a hired manager, a tenant, a renter, or a sharecropper. Each farm has only one operator who reports information. In 1997, 50% of farm operators reported no days worked off farm, a 38% decrease from 1982. Similarly, the number of farm operators reporting farming as their principal occupation fell by 37% statewide between 1982 and 1997.

Fewer Farms Operated by Full Owner

The proportion of farms operated by the full owner is declining in Minnesota. Between 1982 and 1997 the percentage of farms operated by the full owner declined by 12%, from 45% in 1982 to 40% in 1997. Similarly, the number of farms operated by a tenant declined by 9% over the same period, from 14% in 1982 to 13% in 1997. In contrast, the percentage of farms operated by a part owner increased by 16%, from 41% in 1982 to 48% in 1997.

Increased Numbers and Acres of Farm Corporations

The number of farm corporations has increased in the State since 1982, at the same time that total farm numbers have declined. In 1982, there were 57,481 sole proprietorships, 1,323 family farm corporations, and 148 non-family farm corporations in the State. By 1997, this had changed to 40,150 sole proprietorships, 2,007 family corporations, and 186 non-family corporations. This shows changes of -30%, 52%, and 26%, respectively. It should be noted that these numbers reflect the overall decline in total number of farms in the State.

The vast majority of farms in the State are still organized as sole proprietorships. In 1982, sole proprietorships made up 86% of the farms, family farm corporations made up 2%, and non-family farm corporations made up 0.2%. By 1997, this had changed to 85%, 4%, and 0.4%. While family and non-family corporations make up a very small percentage of all farms, the rate of change in the percentage of farm corporations has been dramatic. The percentage of family farm corporations increased by 115% between 1982 and 1997, and that of non-family farm corporations increased by 78%. Rate of change may be an indicator of future trends.

Looking at the number of acres owned by each organization type gives a slightly different picture. In 1982, sole proprietorships owned 79% of the farm acres, family farm corporations owned 5%, and non-family farm corporations owned 0.3%. In 1997, this had shifted to 76%, 9%, and 0.4% respectively. This means that the percentage of acres owned by sole proprietorships fell by 4%, while the percentage of acres owned by family farm corporations increased by 68% and non-family farm corporations increased by 11%. Again, this indicates a high rate of change in the acres controlled by family farm corporations, which may be an indicator of future trends.

Average Age of Farm Operators Stable

The average age of farm operators in the State has stayed roughly the same. It fell slightly from 48.9 years of age in 1964 to 47.2 in 1982, and increased just slightly to 51.2 in 1997 (Table 1: Historical Highlights, 1997 Census of Agriculture, Minnesota State and County Data).

Animal Agriculture – General Trends

Number of Livestock Farms Decreasing

The number of farms with livestock is decreasing in the State, across all major species (hogs, dairy, beef, and poultry). Between 1982 and 1997, the number of farms with layers and pullets and those with hogs declined most precipitously; those with beef had the least dramatic declines. These changes are fairly constant across the State – the number of hog and dairy farms decreased in all counties in the State, and the number of beef farms decreased in all counties except six. County data is not available for poultry due to data suppression.

Percentage of Livestock Farms to All Farms Decreasing

In relation to all farms, the percentage of livestock farms is decreasing in the State across all major species, with the exception of beef. Between 1982 and 1997, the percentage of layer/pullet farms and hog farms declined most drastically with decreases of over 50%. The percentage of turkey farms showed the least dramatic decrease. The percentage of beef farms actually stayed the same. The percentage of hog farms and dairy farms declined in all counties in the State, whereas the percentage of beef farms actually increased in 33 counties. County data for poultry
farms is not available due to data suppression.

Increased Dominance of Beef Farms on the Landscape

In relation to other livestock farms, beef farms are increasing in dominance on the landscape. In 1982, the percentage of beef farms to all farms was highest among the major species, but the percentages of dairy and hog farms were relatively close. However, by 1997, the percentage of beef farms was by far the highest, more than twice that of dairy and hog farms. Poultry farms made up a very small fraction of all farms over the entire period.

Number of Animals per Farm Increasing

The number of animals per farm is increasing dramatically in the State. Between 1982 and 1997, increases in animals per farm were most dramatic in turkeys, layers and pullets, and hogs, all of which increased by over 200%. The exception to this is beef, where the number of beef cattle per beef farm stayed approximately the same.

Increased Specialization of Livestock Production within Minnesota

Animal agriculture in Minnesota is becoming more specialized, as shown by the change in total number of animals. From 1982 to 1997, the number of turkeys, hogs, and broilers in the State increased, while the number of dairy cows and beef cattle decreased. The number of layers and pullets stayed roughly the same. These numbers show increased specialization in hog, broiler, and turkey production in the State.

Increased specialization is also reflected in Minnesota's national market share of livestock. In 1999, Minnesota ranked third in the U.S. in the number of hogs marketed, and second in the number of turkeys raised (Hunst and Howse 2001 p. 2). The State has been gaining national market share in pork, while losing national market share in beef cow-calf and cattle feeding operations, and milk.

Concentration of Species into Particular Geographic Regions

The changes in numbers of farms and animals have not been even across all counties in the State. Livestock production has decreased in some counties at the same time that it has increased in other counties. This has resulted in the migration of the production of each species into particular geographic regions of the State. For the most part, hog production is now focused in south central Minnesota, dairy production in southeast and central Minnesota, beef production in southeast and far southwest Minnesota, and poultry production in central Minnesota. Livestock production has largely left the northern third of the State, with the exception of beef in the northwest.

Increased Consolidation

The changes described above have resulted in increased consolidation of livestock production in the State. Consolidation has occurred both in terms of fewer livestock farms and greater numbers of animals per farm. This is especially true for hogs, dairy, and poultry, although poultry consolidation started earlier in the 1970s.

Animal Agriculture – Marketing Trends

Increased Use of Contracts

There has been an increased use of marketing and production contracts in the State, particularly in hogs. Both types of contracts involve setting prices or compensation for livestock produced at some point in the future. In one analysis, between 1996 and 1999 the number of hogs sold from production contract enterprises rose from 13% to 31% (Economic Structures, Profitability, and External Costs Technical Work Paper p. II-2). Production contracting is the norm in the poultry industry.

Increased Concentration of Buyers

Nationally, the percentage of slaughter done by the top four commercial livestock slaughter firms has been rising since the mid-1980s, and was at 82% for steers and heifers, 73% for sheep, and 46% for hogs in 1994 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-76). In Minnesota, the number of butter and cheese plants fell from 845 in 1945 to just 20 in 1998 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-19).

Increased Price Volatility

Price volatility, especially for hogs and milk, has increased since the early 1980s. In dairy this is mainly due to changes in Federal dairy policy. In hogs, it may be due to the increase in contracting.

Increased Globalization of Markets

The markets for livestock products have become increasingly globalized as trade barriers have been lowered and new or revised trade agreements such as NAFTA and GATT have been adopted. International trade (as reflected by exports and imports of all products) more than doubled between 1990 and 2000 (Economic Structures, Profitability, and External Costs Technical Work Paper p. III-34). International markets are important to Minnesota livestock producers. In the late 1990s, exports amounted to around 17% of Minnesota farm cash receipts for meat animals and livestock products, 5 to 6% for dairy products, and 10% for poultry and eggs (Economic Structures, Profitability, and External Costs Technical Work Paper p. III-38). However, increased globalization means that Minnesota livestock producers face increased competition from livestock producers in other countries.

Animal Agriculture – Production Systems

Development and Increased Use of Confinement Systems

Prior to the 1960s, practically all livestock were raised in some type of outdoor system. In the late 1950s and early 1960s, indoor confinement systems were developed to provide producers greater control of the environment that housed their livestock. Indoor confinement systems usually:

- house animals at a greater density than is typical of outdoor systems;
- maintain a targeted room temperature by capturing heat radiating from the animals, and/or providing supplemental heat with furnaces in winter and providing mechanical cooling systems in summer; and
- control quality of air in the building with a ventilation system that relies on exhaust fans and/or strategic control of openings to allow outdoor air to enter the barn (A Summary of the Literature Related to Animal Health p. 21).

Producers of the nonruminant species of livestock (swine and poultry) rapidly adopted intensive, indoor confinement systems such that the vast majority of current production of these two species is now in confinement facilities. Producers of the ruminant species (dairy cattle, beef cattle, and sheep) have been slower to adopt the confinement model of production, presumably because their diets require that forages be provided. The rapid and efficient growth of swine and poultry does not require them to graze forages and they have no need for a large land base for forage production (A Summary of the Literature Related to Animal Health p. 22).

Increased Size and Scale

Since their inception, the size and scale of indoor confinement systems has continued to increase. Increased size allows these production units to spread their large fixed costs of facilities over more production units. Large-scale production units compensate for slim margins with increased output to generate more income (A Summary of the Literature Related to Animal Health, p. 24).

Increased Specialization

The phases of production in animal agriculture are becoming separated between operations, such that each operation specializes in a particular phase. For example, hog production is moving away from farrow to finish to wean to finish. This means that the gestation and farrowing takes place on sow operations, and the finishing takes place on separate finishing operations. The same kind of separation of production phases and specialization occurred in the poultry industry in the 1970s and 1980s. Now, in the poultry industry, all phases of production (breeding and laying, hatching, and finishing) occur on separate sites.

Increased Use of Growth-Promotant Technologies

The use of technologies to promote livestock growth and improve productivity have become widespread, including:

- $ Subtherapeutic antibiotic use, to increase daily weight gain and the efficiency of weight gain, and decrease morbidity and mortality. It is estimated that 60 to 80% of all cattle, sheep, swine and poultry in the U.S. receive antimicrobials at some point in time.
- $ Metabolic modifiers, such as steroid implants in beef cattle (to improve efficiency of growth and carcass composition) and bovine somatotropin (bST) in dairy cows (to increase milk yield). It is estimated that 90% of beef cattle receive a steroid implant at some point in their life. The use of bST is thought not to be as widespread.
- $ Ionophores, to provide more favorable and efficient conversion of feeds and to impart some degree of protection against parasites. Ionophores are used widely in beef cattle and poultry (A Summary of the Literature Related to Animal Health p. 81-96).

Development of New Technologies

Many new technologies have been developed and adopted in animal agriculture, including artificial insemination (used widely in swine and dairy), manure storage pits and basins, and information management systems.

Increased Productivity

Livestock production has seen a dramatic increase in productivity. For example, milk produced per cow increased threefold between 1945 and 1998 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-16).

Animal Agriculture – Government Involvement

Increased Regulation

Governmental involvement in animal agriculture has increased over the last two decades. A major portion of this involvement is in the form of regulation, including the following.

- $ Minnesota Corporate Farm Law: This law prohibits any corporation, limited liability company, pension or investment fund, or limited partnership from producing livestock and livestock products and milk and milk products. Poultry and poultry products are not included. Exemptions include family farm corporations or family farm partnerships.
- $ Feedlot Permitting: This law and associated rules include water and air quality standards, and facility design, manure storage, and manure application requirements that must be met by feedlots in order to be granted a permit to construct or remodel a feedlot.
- $ Environmental Review: As part of the permitting process, an Environmental Assessment Worksheet (EAW) must be prepared for any proposed new or total confinement feedlot with a capacity of 2,000 or more animal units or an expansion of an existing total confinement feedlot resulting in an increase in capacity of 2,000 or more animal units.
- $ Local, Township, and County Ordinances: Many ordinances have been adopted at the local, township, or county level that restrict the size and type of feedlots that can be constructed (Land Use Conflicts and Role of Government Technical Work Papers).

Increased Incentives

Government involvement has also increased in the form of incentives such as grant and loan programs. A number of grant and loan programs have come into existence, including the following.

- $ Environmental Quality Incentives Program (EQIP): Fifty percent of the funds in this Federal program are earmarked for manure management by livestock producers with feedlots of less than 1000 animal units.
- $ Agriculture Best Management Practices Loan Program: This State program provides low-interest loans to producers with feedlots of less than 1000 animal units for implementation of practices that reduce water pollution from nonpoint sources, specifically those dealing with improvements in manure collection, storage and application.
- $ Minnesota Cost-Share Program: This State program provides livestock producers with feedlots of less than 500 animal units up to 75% of the funding needed to implement improvements that protect and improve water resources, specifically dealing with nutrient run-off into surface waters (Role of Government Technical Work Paper).

Animal Agriculture – Trends by Species

Swine

Industry Structure

The swine industry in Minnesota faced increasing consolidation from 1982 to 1997, with decreasing numbers of farms and increasing numbers of hogs and hogs per farm. Between 1982 and 1997, the number of farms with hogs declined by 64% (from 20,813 to 7,512). In relation to all farms, the percentage of hog farms decreased by 54% between 1982 and 1997 (from 22% of all farms to 10%). The number and percentage of farms with hogs decreased in every county of the State, with the highest decreases in the northern two-thirds of the state.

From 1982 to 1997, the number of hogs in the State increased by 28% (from 4,473,181 to 5,722,460). Over the same period hogs per hog farm increased by 254% (from 215 to 762). However, the geographic distribution of hogs changed during this time. The number of hogs per thousand acres fell in the northern half of the State between 1982 and 1997, as well as in several of the far southeast counties. Increases were concentrated in the southwest and south central counties. Pipestone County had the highest increase in hog numbers per thousand acres, at 162%, followed by Martin (150%) and Blue Earth (124.4%).

Consolidation was most dramatic in the years from 1992 to 1997. During these five years alone, the number of farms with hogs decreased by 43% and the total number of hogs increased by 23%. Consolidation is especially evident by looking at the increase in average number of hogs per farm during this time, which was 114%.

Markets

Minnesota's national market share of hogs and pigs in inventory increased from 8.0% in 1984 to 9.0% in 1997. In 1999 Minnesota ranked third nationally in number of hogs marketed (Hunst and Howse 2001 p. 2).

Hog prices dropped from an average of $41.90 per 100 pounds in 1995 to $30.50 per 100 pounds in 1999 (Hunst and Howse 2001 p. 76). A comparison of year-to-year hog production and price changes over the past three decades shows that prices have become more volatile. In the 1970s and 1980s, a one percent change in production resulted in a price change of around one and a half or two percent. During the late 1990s, the price response has been at least twice that great.

It is unclear how much of the increased volatility is due to the increased prevalence of marketing contracts, and how much is due to other factors (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-83).

Concentration in U.S. commercial hog slaughter has been increasing. The percentage of slaughter done by the top four firms has been rising since the mid-1980s, and was at 46% for hogs in 1994 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-76).

The use of marketing and production contracts is becoming increasingly common in the hog industry. An analysis of the swine enterprises participating in the Minnesota State College University Farm Business Management Program and the Southwestern and Southeastern Minnesota Farm Business Management Associations (MnSCU-FBMA) over the four years 1996-99 shows that more hogs were transferred from the contractee enterprises in 1999 than were sold from the farrow-to-finish enterprises, and nearly as many as from the feeder pig finishing enterprises (Economic Structures, Profitability, and External Costs Technical Work Paper p. II-2).

According to a February 1999 survey of nine of the largest twelve U.S. pork packers, 64% of the slaughter hog purchases during January 1999 were priced under some contractual method other than the spot market, an increase from 57% in 1997 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-25). A more recent report found that spot market sales of hogs were down to 17% of all hogs in January 2001, which was an 8% decline from 2000 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-25).

A number of Minnesota pork producers became involved in swine production networks in the mid-1990s in response to increasing consolidation in the swine industry. Reasons for joining networks include accessing technology and systems necessary to achieve low cost production, product quality, competitive volumes, or labor simplification. Types of arrangements range from small-scale, informal farmer-to-farmer formula pricing arrangements to large-scale, jointly owned sow units directed by hired management consultants (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-29).

Production Systems

There are several new technologies and management strategies that are thought to be playing a major role in changes in the swine industry:

- feeding programs that are closely geared to animal needs during specific growth phases, and that respond more quickly to changes in ingredient availability and cost,
- health-enhancing technologies such as all in-all out rearing and early weaning that may improve performance, reduce dependence on antibiotics, and/or maintain acceptable performance in larger facilities,
- breeding systems which utilize crosses of specialized sire and dam lines to achieve desirable traits, and artificial insemination and related technologies which allow elite lines to be utilized more widely,
- more careful facility design and better information systems to improve throughput of animals from a given investment in land and buildings, and

$ networked (cooperative) selling and/or buying among groups of producers, and information sharing among producers and between producers and processors to capitalize on quantity- and quality-based premiums and discounts and identify areas that need improvement (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-27 and 28).

Hog production is moving rapidly away from farrow-to-finish toward systems where pigs are farrowed in a separate enterprise, in large, centralized sow units often located outside of Minnesota. An analysis of the swine enterprises participating in the Minnesota State College University Farm Business Management Program and the Southwestern and Southeastern Minnesota Farm Business Management Associations (MnSCU-FBMA) over the four years 1996-99 shows that in 1996, half of the hogs sold came from farrow-to-finish enterprises while only 25% were sold from that type of enterprise in 1999. The number sold from wean-to-finish enterprises tripled, from 4% to 12%, over the four years, while the number in production contract enterprises rose from 13% to 31%. Independent finishing of feeder pigs has held steady at about one-third of the total marketings, but these finishing enterprises have declined in number and increased in size. Inshipments of pigs into Minnesota were 23% of marketings in 1999. These inshipments were triple the 9% share of marketings in 1995, five years earlier (Economic Structures, Profitability, and External Costs Technical Work Paper, p. II-2).

Dairy

Industry Structure

The dairy industry declined dramatically in Minnesota from 1982 to 1997, both in terms of the number of dairy farms and the number of dairy cows in the State. At the same time it experienced consolidation in terms of average number of dairy cows per farm, although not to the extent of that experienced by the hog industry. The number of dairy farms decreased from 24,178 in 1982 to 9,604 in 1997, a decline of 60%. The percentage of all farms with dairy cows declined 49% statewide from 1982 to 1997, from 26% to 13%. All counties saw a decline in the number of dairy farms and percentage of dairy farms per total farms from 1982 to 1997. The highest declines were across the north, and in the southwest and south central areas.

The number of dairy cows (including milking cows, dry cows, and replacement heifers) decreased by 35% between 1982 and 1997, from 1,741,552 to 1,123,924. At the same time, the average number of dairy cows per dairy farm increased by 62% (from 72 to 117). It should be noted that since this number includes all dairy cows (milking cows, dry cows, and replacement heifers), it should not be confused with dairy herd size. Average dairy herd size (milking cows only) increased from 35 to 56 cows during this time. All counties lost dairy cows between 1982 and 1997. Percentage losses of dairy cows between 1982 and 1997 were highest in Traverse County at 100%, followed by Jackson (-77.7%) and Pennington (-72.3%).

The changes in the structure of the dairy industry were fairly steady over the entire period from 1982 to 1997. The decrease in the number of farms with dairy cows was slightly greater in the periods from 1982 to 1987 and 1992 to 1997, when it was about 28%, than from 1987 to 1992, when it was 23%. The statewide decrease in the number of dairy cows was slightly greater for the five year period 1982 to 1987 (15%) than for either of the other five year periods (1987 to 1992 14%, 1992 to 1997 11%). The increase in the average number of dairy cows per farm was greatest from 1992 to 1997, when it was 24%, compared to 1982 to 1987 (17%) and 1987 to 1992 (12%).

<u>Markets</u>
Minnesota's share of the national milk market declined from 8.3% in 1960 to 5.9% in 1998. Minnesota dropped in ranking from third in 1960 to fifth in 1998 (Economic Structures, Profitability, and External Costs Technical Work Paper p. II-2). The total milk produced in the State peaked at 10.8 billion pounds in 1985 and dropped to 9.2 billion pounds in 1998 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-19).

The number of butter and cheese processing plants in Minnesota has declined dramatically, from 44 plants in 1985 to just 20 in 1998, a decrease of 55% and a decrease of 77% from the 86 plants in the State in 1975 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-19).

Prices for milk have been volatile since the mid-1980s. This occurred with changes in the early 1980s in Federal dairy policy. As the Federal support price for milk moved well below the average production cost, the market price became highly volatile. Because milk is a perishable product it is highly sensitive to short range changes in the supply-demand balance (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-131).

Most milk is marketed through farmer cooperatives with informal marketing arrangements that can change at relatively short notice. The extent to which milk contracts are used is not available (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-26). In the U.S., the ten milk cooperatives with the largest milk volume accounted for half of total 1998 U.S. milk production (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-27).

<u>Production Systems</u>
Productivity per cow has been increasing steadily. It increased by 66% between 1975 and 1998, from 10,119 to 16,833 pounds of milk per cow. The largest jump in productivity since 1975 was in the period from 1985 to 1993, when productivity increased by 27% (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-16). Minnesota's average productivity per cow in 1998 was slightly less than the national average of 17,192 pounds. Minnesota ranks sixteenth nationally in production per cow (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-16).

Some major trends in production have included the introduction in 1994 of bovine somatotropin (bST), a metabolic modifier, to boost milk yield per cow, and increased use of artificial insemination, which is now used almost exclusively. There has been a substantial decline in the fertility of dairy cows, such that they often must be bred more than once.

Beef

<u>Industry Structure</u>
The beef industry in Minnesota declined between 1982 and 1997, both in terms of the number of beef farms and the number of beef cattle. However, the change was not as dramatic as that

taking place in both the hog and dairy industries. It experienced almost no consolidation over that period, and remains dominated by small operations.

The number of farms in the State with beef cattle fell from 27,411 in 1982 to 21,310 in 1997, a decrease of 22%. This was true across most counties, but unlike hog and dairy farms, six counties in the State showed slight increases in the number of farms with beef cattle (Crow Wing, Kanabec, Morrison, Pine, Stearns, and Winona). The percentage of all farms with beef cattle remained the same, at 29% in both 1982 and in 1997. From 1982 to 1997, 38% (33) of Minnesota counties had an increase in the percentage of farms with beef cattle.

The number of beef cattle decreased by 22% between 1982 and 1997, from 1,636,404 to 1,271,532. However, the number of beef cattle per beef farm stayed approximately the same at 60 head per beef farm during that period. Beef cattle declines were highest in Faribault (-63%), Grant (-60%), Lac qui Parle (-57%), Jackson (-57%), and Freeborn (-53%) counties.

Changes in the beef industry were greatest during the 1982 to 1987 time period, while the five years from 1992 to 1997 saw almost no change. From 1982 to 1987, the number of farms with beef cattle decreased by 17%, compared to 7% in 1987 to 1992 and a 1% increase in 1992 to 1997. Similarly, the change in the number of beef cattle was most significant from 1982 to 1987, when it fell by 25%. This was followed by much smaller changes in 1987 to 1992 (4% increase) and 1992 to 1997 (1% decrease). While the average number of beef cattle per farm stayed the same over the entire 15-year period, there was some volatility during that time, with a 10% decrease from 1982 to 1987, a 12% increase from 1987 to 1992, and a 2% decrease from 1992 to 1997.

Markets

Minnesota's national market share in beef cows has remained at the same level, at 1.2% in both 1985 and 1998. Minnesota does not rank in the top ten states nationally for its national market share in beef cows. With cattle on feed, Minnesota has lost some market share, falling from 3.2% in 1981 to 2.0% in 1998. Minnesota ranks tenth in its market share of cattle on feed (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-20).

Concentration in U.S. commercial beef slaughter has been increasing. The percentage of slaughter done by the top four firms has been rising since the mid-1980s, and was at 82% for steers and heifers in 1994 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-76).

Production Systems

The use of steroid implants has become widespread in beef to improve efficiency of growth and carcass composition. It is estimated that 90% of beef cattle receive a steroid implant at some point in their life (A Summary of the Literature Related to Animal Health, p. 86).

Unlike the hog and dairy industries, artificial insemination and embryo transfer technologies are seldom used in the beef industry. The most intensive users of these technologies within the beef industry are the seedstock or purebred operators, who utilize these technologies to enhance genetic progress.

Poultry

Over the last fifteen years the poultry industry in Minnesota has seen tremendous consolidation in all three areas – layers and pullets, broilers, and turkeys. The number of animals in inventory has remained stable from 1982 to 1997 while the number of farms with poultry decreased. However, while the long-term trend is dramatic consolidation, the trend slowed considerably over the most recent 5 years of data (1992 to 1997). Since each area of the poultry industry experienced slightly different trends, they are described separately below.

Layers and Pullets

The layer industry in Minnesota showed significant consolidation from 1982 to 1997, especially in terms of decreasing farm numbers and increasing numbers of layers and pullets per farm. The number of farms with layers and pullets decreased by 70% between 1982 and 1997, from 6,468 to 1,964. The percentage of layer/pullet farms decreased by 61% (from 7% of all farms to 3%). The number of layers and pullets stayed roughly the same, changing by only 1% (from 12,928,376 to 13,047,875). Layers and pullets per farm increased by 232% (from 1,999 to 6,644).

Decreases in the number of farms with layers and pullets were greatest in the periods from 1982 to 1987 and 1987 to 1992 (38% and 42%, respectively). From 1992 to 1997 this slowed considerably, with a decrease of 15%. The number of layers and pullets, while staying roughly the same over the entire 15-year period, bounced back and forth during that time with decreases in the 1982 to 1987 and 1992 to 1997 periods (-6% and -9%) and an increase of 18% from 1987 to 1992. The number of layers and pullets per farm increased most dramatically from 1987 to 1992, at 105%. This slowed greatly during the 1992 to 1997 period, when the number increased by just 7%.

The consolidation reflected in these numbers is a trend that had been underway since the 1960s. The inventory of layers and pullets in Minnesota (inventory measured at birds over 3 months of age) has not changed appreciably over the last 25 years. In 1964, the inventory of layers and pullets was reported to be approximately 14.6 million; and in 1997, the inventory was at approximately 13 million birds. Over the same time period, however, the number of farms reporting inventory dropped precipitously from almost 48,000 farms to just under 2,000. The average number of layers and pullets per farm increased dramatically from 306 in 1964 to 1,999 in 1982 to 6,644 in 1997.

Broilers

The broiler industry showed significant consolidation from 1982 to 1997, in terms of decreasing farm numbers, increasing broiler numbers, and increasing numbers of broilers per farm. During that time, the number of farms with broilers decreased by 56% (from 1,411 to 621) and the percentage of broiler farms decreased by 43% (from 1.5% to 1% of all farms). During the same period, the number of broilers in the State increased by 26% (from 22,556,750 to 28,456,532). Broilers per farm increased by 187% (from 15,986 to 45,824).

Although consolidation over the 15-year period was substantial, it slowed considerably during the last five years of the period (from 1992 to 1997). Similarly to the trends in the layer industry, the number of farms with broilers decreased most dramatically from 1987 to 1992 (by 32%) and from 1982 to 1987 (29%), but this slowed considerably during the 1992 to 1997 period, when the number of broiler farms decreased by just 9%. The total number of broilers in the State showed some volatility throughout the 15-year period, going from a 35% increase in 1987 to 1992 to a 23% decrease in 1992 to 1997. The average number of broilers per farm followed a similar pattern, with a 98% increase from 1987 to 1992 and a 16% decrease from 1992 to 1997.

Minnesota’s national market share of broilers raised annually has stayed relatively constant, at 0.7% in both 1984 and 1996. Minnesota’s market share does not rank in the top ten states nationally (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-21).

Production contracting is the norm in the poultry industry, with 85% of broilers grown under contract in 1995. Most of the remaining chickens are grown on farms owned and operated by the integrator (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-26).

Turkeys

The turkey industry in Minnesota also showed dramatic consolidation between 1982 and 1997 in terms of decreasing farm numbers, increasing turkey numbers, and increasing numbers of turkeys per farm. The number of farms with turkeys in Minnesota in 1982 was 804; this number declined by 31% to 553 in 1997. The percentage of turkey farms decreased by 12% (from 0.9% to 0.8%). At the same time, the production of turkeys increased, with the total number of turkeys increasing by 209% (from 5,255,232 to 16,220,257). The intensity of turkey farming increased even faster; the number of turkeys per farm increased by 349% (from 6,536 to 29,331) from 1982 to 1997.

Like the layer and broiler industries, consolidation in the turkey industry slowed during the five years from 1992 to 1997. The number of farms with turkeys decreased most dramatically from 1987 to 1992 (by 25%) and from 1982 to 1987 (by 10%), but this slowed considerably during the 1992 to 1997 period, when the number of turkey farms decreased by just 3%. The total number of turkeys in the State increased throughout the 15-year period, with the greatest increase occurring during the 1982 to 1987 period, at 68%. The average number of turkeys per farm also increased throughout the 15 years, but at a decreasing rate, going from an 87% increase in 1982 to 1987, to 64% in 1987 to 1992, to 46% in 1992 to 1997.

Minnesota’s national market share of turkeys raised annually has fallen slightly from 13.7% in 1980 to 13.2% in 1996 (Economic Structures, Profitability, and External Costs Technical Work Paper p. V-1-21). However, in 1999 Minnesota ranked second in the nation for its market share of turkeys raised (Minnesota Agricultural Statistics p. 2).

Statewide Statistical Description

This statewide statistical description of animal agriculture is based on 1997 Census of Agriculture data as supplied by the Land Use team. The Feedlot Inventory Data being gathered for Minnesota was examined as a potential source of data for this description. However, the Feedlot Inventory Data is available for only 39 counties, the quality of the data varies from county to county, and the data was gathered at varying points in time. In contrast, the Census of Agriculture data is consistently available statewide, has relatively uniform quality between counties, and was gathered for one point in time. Therefore, it was determined that for the purposes of this description, the Census of Agriculture data was the best available for the entire State. Data from the 1997 Census of Agriculture was the most recent available.

It should be noted that poultry information at the county level is difficult to obtain. In the 1997 USDA Census of Agriculture, 67 of the 87 counties in Minnesota had poultry data suppressed, which indicates a high concentration of animals on a few farms. Data is suppressed when one farm has 60% or more of the total animals of that species in the county. Poultry information is included where possible below.

Geographic Distribution of All Farms

Farms are located mainly in a crescent-shaped agricultural belt around the western and southern perimeters of the State, and are most concentrated in the central and southern parts of the State. In 1997, Stearns County had the highest number of farms in the State with 2,062, followed by Otter Tail (1,499), Morrison (1,075), Fillmore (1,053), Redwood (1,041), and Goodhue (1,027) Counties. Except for Otter Tail, these counties were also among those with the highest density of farms.

Numbers of Livestock Operations, Statewide

In 1997, Minnesota had 41,563 livestock operations. Beef operations were more prevalent than any other type of livestock operation. Slightly more than half of all livestock operations were beef operations, with 21,310 beef operations in the State. There were many fewer dairy and hog operations than beef operations, with 9,603 and 7,512 operations respectively. Together dairy and hog operations made up close to the other half of livestock operations in the State. Poultry operations made up less than 10% of the livestock operations in the State, with just 1,964 layer/pullet operations, 621 broiler operations, and 553 turkey operations.

The prevalence of beef farms is again apparent when looking at livestock farms as a percent of all farms. Livestock were found on over half (57%) of all farms in the State. Beef were found on 29% of all farms, dairy cows were found on 13% of all farms, and hogs were found on 10% of all farms. Poultry was found on less than 5% of all farms in the State.

Statewide, there were 0.39 beef farms per thousand acres. There were 0.18 dairy farms per thousand acres, and 0.14 hog farms. There were just 0.06 poultry farms per thousand acres.

Geographic Distribution of Livestock Farms, by County

Looking at livestock farms as a percent of all farms in each county is one way to show the geographic distribution of livestock farms. In general, beef operations are located more heavily in the far southeast and far southwest parts of the State, dairy operations are located in southeast and central parts of the State, hogs are located in south central, and poultry is located in central Minnesota.

In terms of beef, thirty counties reported beef cattle on over one-third of all farms in 1997. These thirty counties generally ran in a band from far southeast Minnesota to central Minnesota, to northwest Minnesota. They were in far southwest Minnesota as well. The highest percentage of beef farms was found in Houston and Fillmore Counties in the far southeast, and Pipestone and Rock Counties in the far southwest. Mille Lacs and Pine Counties also had high percentages of beef farms. In these counties, beef operations made up between 38% and 47% of all farms.

For dairy, seven counties had over one-quarter of all farms with dairy cows on site in 1997, and two counties (Winona and Stearns) had dairy cows on more than one-third of all farms. Counties with the highest percent of dairy farms per total farms in 1997 were located in southeast and central Minnesota.

Counties with the highest concentration of farms with hogs as a percent of total farms were located in the south central and southwest parts of the State. In these counties, between 21 and 27% of all farms had hogs.

<u>Numbers of Animals, Statewide</u>

Looking at numbers of animals statewide shows an almost perfectly reversed pattern to that seen in numbers of livestock operations. Almost all of the animals in the State were poultry in 1997. Broilers had the highest numbers, making up close to half of all animals in the State, at 28,456,532. This was followed by turkeys at 16,220,257, and layers and pullets at 13,047,875 which made up 25% and 20% of all livestock, respectively. Hogs, beef cattle, and dairy cows combined made up just 12% of all livestock. There were 5,722,460 hogs, 1,271,532 beef cattle, and 1,123,924 dairy cows. As noted earlier, the dairy number includes milking cows, dry cows, and replacement heifers.

<u>Geographic Distribution of Animals, by County</u>

In general, the geographic distribution of animals follows the same pattern as the distribution of livestock operations. The highest density of beef cattle is found in southeast and southwest Minnesota, the highest density of dairy cows in southeast and central Minnesota, the highest density of hogs in south central Minnesota, and poultry in central Minnesota.

In 1997, the number of beef cattle per thousand acres was highest in the southeast and southwest corners of the State. The counties with the highest number of beef cattle per thousand acres were Rock (110), Pipestone (97) and Houston (87), in the far southwest and southeast corners of the state.

Dairy cows were concentrated in a corridor from central to southeast Minnesota. In 1997, Stearns County had the highest density of dairy cows per thousand acres (147) with Winona County close behind (144).

Counties with the highest density of hogs in 1997 were in the southern third of Minnesota. Eight counties had over 500 hogs for every thousand acres. Martin County had the highest density of hogs, with 1,048 hogs for every thousand acres.

County data for counties with data that is not suppressed indicates that a few counties produce the majority of poultry. These counties tend to be located in central Minnesota. Four counties (Kandiyohi, Meeker, Stearns and Todd) produced nearly 50% of all turkeys sold in Minnesota. Nineteen farms in Kandiyohi County alone produced 19% of all turkeys sold in Minnesota in 1997. Six counties (Stearns, Morrison, Cottonwood, Benton, Douglas and Fillmore) produced nearly 90% of all broilers sold in Minnesota in 1997. Stearns and Morrison Counties were the leading broiler producers.

Density of Livestock Operations, by County

Looking at the density or concentration of livestock operations, as defined by the number of operations per 1,000 acres, is another way to examine the geographic distribution of livestock operations in the State. In general, beef and dairy operations are concentrated in a corridor running from the southeast to the central part of the State (not including the seven county metropolitan area). Beef is also concentrated in southwestern Minnesota. In contrast, hogs are concentrated in south central Minnesota and in the far southern border counties.

In 1997, Benton County in central Minnesota had the highest number of beef farms per 1,000 acres (1.16), followed by Houston (1.10), Fillmore (1.09), and Olmsted (1.06) Counties in southeastern Minnesota. Stearns County had the highest concentration of dairy farms, at 1.26 per 1,000 acres, followed by Carver (0.94) (both of which are in central Minnesota), and Winona (0.92) and Wabasha (0.80) Counties in southeastern Minnesota. Rock County, in southwestern Minnesota, had the highest concentration of hog farms in 1997, with 0.61 hog farms per 1,000 acres.

Livestock Operation Sizes, Statewide

As with numbers of animals, livestock operation sizes (as reflected by average animals per operation) follow a reverse pattern to number of livestock operations. In general, poultry had the highest livestock operation sizes, and beef had the lowest.

In 1997, broilers had the largest operation sizes, with an average of 45,824 birds per operation. This was followed by turkeys, which averaged 29,331 per operation. Layers and pullets had significantly smaller size operations, at 6,644 birds per operation; but this number was still significantly higher than operation sizes for beef, dairy, and hogs.

Of the other three species, hogs had the largest operation sizes with 762 hogs per operation on average in 1997. Dairy had smaller operation sizes, with an average of 117 dairy cows per operation (including milking cows, dry cows, and replacement heifers). Beef operations were by far the smallest, with just 60 beef cattle per operation.

Converting numbers of animals to animal units paints a less dramatic picture. Animal units are designed to be a way to compare numbers and impacts of animals across species. They are based on the weight of the animals; for poultry, manure handling is also a factor. They are set by both the State and the Federal Government.

In order to determine animal units, the average numbers of animals per farm reported above were converted to animal units based on Minnesota Pollution Control Agency definitions, and then averaged across different sizes of animals within the same species. This may not be an entirely accurate way to represent the number of animal units, since it is likely that there are more animals of particular sizes on an operation than others (for example, more finishing pigs than sows). But it provides a ballpark estimate of animal units for the sake of comparison.

This showed that again, broiler operations had the largest size, at approximately 626 animal units per operation, followed by turkey operations, with approximately 337 animal units per operation. Hog operations were next, with approximately 190 animal units per operation, followed by dairy operations, with 97 animal units per operation, and layer/pullet operations, with 91 animal units per operation. The lowest operation size again was beef, with approximately 46 animal units per operation.

Geographic Distribution of Livestock Operation Sizes, by County

The largest beef operations, as based on beef cattle per beef operation, are concentrated in southwestern Minnesota. One outlier to this is Stevens County, in west central Minnesota, which had 163 beef cattle per beef operation in 1997. Anecdotal information says that this high number may be due to the existence of one or two very large operations in the County. This was topped only by Renville County, which had 164 beef cattle per beef operation. These two counties were followed by Nobles (145 beef cattle per operation) and Lyon (141 beef cattle per beef operation). Smaller sized operations with an average of 4 to 47 beef cattle per beef operation tend to be clustered in a band of counties from the southeastern part of the State, up through the central part of the State, and into the northeast.

The size of dairy operations is much more varied across the State with less of a strong pattern. As with beef, Stevens County had the highest average number of dairy cows per dairy operation in 1997 (312 cows). Again, anecdotal information says that this high number may be due to the existence of one or two very large operations in the County. Otherwise, there are many counties through southeastern, central, southwestern, and even northwestern Minnesota that have 119 to 199 dairy cows per dairy operation on average. The majority of counties elsewhere in the State have between 83 and 118 dairy cows per operation on average.

The geographic distribution of hog operation sizes shows the strongest pattern. The counties that have the largest hog operations are in south central and far southwest Minnesota. The counties with the largest hog operation sizes were Martin, with an average of 2,173 hogs per hog operation; Renville, with an average of 1,639 hogs per hog operation; Rice, with an average of 1,561; Pipestone, with an average of 1,557; and Blue Earth, with an average of 1,502. These five counties have much larger operation sizes than the statewide average of 762 hogs per hog operation. Counties in a band running from central Minnesota to northwestern Minnesota have the lowest hog operation sizes, with an average of up to 152 hogs per hog operation.

Average Farm Size of All Farms

The average farm size in Minnesota in 1997 was 486 acres. Average farm size was highest along the northwest edge of the State. Kittson County had the highest average farm size at 1,317 acres followed by Wilkin and Polk Counties, where average farm size was also over 1,000 acres. The county in the agricultural zone with the lowest average farm size was Stearns, at 273 acres, followed by Wright (278 acres) and Benton (296 acres).

Farm Tenure of All Farms

Statewide, 50% of farm operators reported no days worked off farm in 1997. The counties with the highest percentage of operators reporting no days worked off farm relate strongly to counties with relatively high numbers of dairy farms per total farms. In 1997, the four counties with the highest density of operators reporting no days worked off farm were the same as those with the highest density of operators reporting farming as their principal occupation (Stearns, Brown, McLeod, and Carver.) Statewide in 1997, there were an average of 0.68 operators per thousand acres reporting farming as their principal occupation. The counties with the highest percentages of operators reporting farming as their principal occupation relate strongly to counties with relatively high numbers of hog or dairy farms per total farms.

Animal Production Systems

This sections describes typical production systems for each of the species. It also describes new production trends and alternative production methods for each species.

Determining the “typical” production system is a difficult, and probably impossible, task. Each operator and farm, and their facilities and resources, is different. This means that each adapts production technologies in ways that fit best for his or her circumstances. The result is that production systems are different on every farm.

For the purposes of this paper, the typical production system was identified by evaluating two different information sources. First, the feedlot permitting data for 18 livestock-intensive counties in Minnesota was reviewed. This data is presented in the Water Quality Impacts Technical Work Paper. According to the authors of the Water Quality Impacts Technical Work Paper, the permitting data for these 18 counties can be generalized to reflect conditions statewide, although it most likely underestimates the number of small operations, for two reasons. First, small operations are more prevalent in counties that are less livestock-intensive than the 18 counties surveyed. Second, the permitting process is prompted by a change in operation (usually an expansion), meaning that many small operations that have not made changes would not have applied for a permit and hence would not be included in the data set.

Next, field experts in each species were contacted to find their perceptions about prevalent production systems on the landscape. These experts work with many farmers across a wide geographic area every day and thus have a broad view of what production systems are found on the landscape. The field experts were usually faculty with the University of Minnesota or Extension Educators with the University of Minnesota Extension Service.

Last, these two sources were compared and a determination made as to which production system is most typical and would be included in this description. In the feedlot permitting data, it was often possible to see differences in the type of production systems used by smaller and larger feedlots. Since the data underestimates the number of small feedlots, presumably the system used by the smaller feedlots makes up a larger percentage of the operations statewide than is shown by the data. Therefore, if this agreed with the opinion of the field experts, the system used by the smaller operations was determined to be the typical production system and is presented as such.

Each description below is kept fairly general to allow for the many differences that will occur between farms. The description for each species includes a background section, general information on the production cycle of the species involved, and information on housing, feed, manure collection and storage, and manure application.

Swine – Typical Production System

Background

According to information presented in the Water Quality Impacts Technical Work Paper, the majority of swine feedlots in Minnesota are small, with less than 300 animal units (750 sows or 1,000 finishing pigs), although a significant proportion are medium-sized, with 300 to 1,000 animal units (2,500 sows or 3,333 finishing pigs). A very small proportion are considered large, with 1,000 or more animal units.

Most swine in Minnesota are raised in total confinement systems, across all sizes of feedlots. A small proportion of swine feedlots use partial housing without runoff controls, usually an open-front buildings with an outside lot. This type of housing used to be common in Minnesota. However, it is now associated with older buildings, and very few new systems of this type are being constructed. It is typically used by small feedlots with less than 100 animal units (250 sows or 333 finishing pigs). It is rarely used by larger feedlots, which use total confinement almost exclusively (Water Quality Impacts Technical Work Paper).

In the 1980s and early 1990s, many hog producers remodeled their existing buildings to adapt them to new confinement technologies. While some of these remodeled confinement systems are still in use, most of these producers stopped raising hogs in the mid- to late- 1990s when hog prices fell. As a result, many of the systems in use today are confinement facilities that were built as new structures in the early 1990s or later. This is the type of system that is described below.

Production Cycle

The swine production cycle includes the following phases:

$ Sow: Breeding of the sows and caring for them during the 16 to 17 weeks of pregnancy, plus the farrowing, which involves tending of the sows and their litters until the piglets are weaned at 2 to 3 weeks of age;

$ Nursery: Caring for the weaned pigs until they are about 8 weeks old;

$ Finishing: Feeding the pigs for about 16 weeks, or to a final weight when they are sold for slaughter at around 6 months of age.

In the past, many farms had farrow-to-finish operations. This entails managing all of the phases of the entire life cycle of the pig, as described above. However, it is becoming uncommon for farms to carry out this entire cycle on one farm. They are being divided, so that the three phases (sow, nursery, and finishing) may each take place on separate farms. In Minnesota, it is becoming more common for farms to have finishing sites only.

Housing

Sow (Gestation and Farrowing)

As indicated above, gestation and farrowing or sow units are usually on a separate farmstead from the finishing area. Or, if they are on the same farmstead, they are in a separate building from the finishing area. Gestating sows are often in the same building complex as the farrowing, but in a different room. They are most often housed in individual stalls that are about 2 feet by 7 feet. When the sows are ready to farrow, they are moved to a different area. There tends to be less automation and more individual care involved during the farrowing period. During farrowing, sows are housed in crates that are 5 by 7 feet and that consist of a 2 by 7 foot area for the sow, plus an 18-inch creep area along each side of the sow for the piglets. This allows a sow to stand, lie, eat and drink but prevents her from turning around, and allows the piglets to nurse. This arrangement reduces the risk of piglets being crushed by the sow laying on them.

Nursery

Weaned pigs are moved into a separate indoor nursery area. Nursery areas are usually in a different building, and often farm site, from the farrowing and finishing areas. In the nursery, there is a series of pens that each holds 20 to 30 piglets. Nursery pens provide 2 to 3 square feet per pig. The pens have slotted floors, typically made of plastic, coated or woven wire, and steel (not concrete).

Finishing

After leaving the nursery, pigs are moved to finishing barns. Confinement finishing buildings are usually about 40 by 200 feet. This size building will hold 1,000 hogs (300 animal units) for finishing. Many operations have two or three such finishing barns. Three groups of pigs are usually finished in each barn per year.

Each finishing building usually has two rows of rectangular pens with concrete slotted floors, and a 2-foot alley down the center of the barn. There are usually about 24 pens per barn, and each pen holds about 40 hogs. Each pen is about 16 feet by 18 feet (288 square feet), allowing approximately 7.5 square feet per pig.

Temperature Control

Confinement facilities emphasize a controlled environment to reduce temperature and humidity fluctuations and, consequently, pig stress and disease. Temperature and humidity are primarily regulated by the ventilation system. For additional cooling in the summer, circulating fans and a water drip-system are provided. Thermostatically controlled heaters are used if there is insufficient animal heat to maintain the desired temperature in the winter. In farrowing areas, supplemental heat is provided in the piglet zone only from heat lamps, electric radiant heaters, heating pads, mats and hot water floor heaters.

Ventilation

Farrowing and nursery buildings are mechanically ventilated year around in Minnesota. Curtain-sided pig finishing buildings are mechanically ventilated in cold weather, and naturally ventilated in the summer. Natural ventilation is provided by full length sidewall openings that are controlled by adjustable plastic curtains. When the temperature reaches a certain level, these curtains are automatically raised by a cable-ratchet device to allow fresh air to enter. For additional animal cooling, these barns also have circulation fans within the barns that create air movement over the pigs (but do not exchange air between the outside and the barn).

Feed

Most finishing barns store feed in bottom-unloading metal bins that are located adjacent to the building. Automated augers move this feed indoors through two feed lines (one over each row of pens) and the feed drops down to feeders along the side of each pen. Fence line feeders are most common, which form part of the partitions between pens. Each feeder has slots for 8 to 10 pigs to eat at once. Feed is available to pigs at all times and is automatically delivered to the feeders.

Water is usually in a separate area of the pen from the feeders. The waterers are automatic and are activated when the pigs push a lever or button in order to release water. A watering system that spills or wastes as little water as possible is important from a manure management standpoint, since spilled water increases the volume of liquid manure to be managed.

A typical swine diet has a corn-soybean base (corn for an energy source and soybean meal for protein). Micro nutrients are also added to the feed. Everything is combined so that the feed is a total mixed ration (generally ground) when it is fed to the hogs. If subtherapeutic antibiotics are used, they are also added to the feed.

Manure Collection and Storage

The gestation, farrowing, nursery, and finishing areas all have various types of slotted floors for manure collection purposes. Slotted floors for finishing pigs are usually constructed of concrete. These slotted floors typically have a 1-inch opening alternating with a 6- to 7-inch solid area. This means that only about 15 percent of the floor area is open. The hogs work the manure through the slots, which then falls into a concrete pit built below the building. Finishing barns usually have an 8-foot deep pit underneath them, where the manure is collected and then stored. Because the manure is a combination of urine and feces, it is in liquid form.

The slotted floors used in nursery or farrowing buildings are typically made of plastic, coated metal, or steel. Farrowing barns often have a shallow, 2-foot deep pit or gutter under the slotted flooring to collect the manure. This pit or gutter is drained or flushed every couple of weeks into an adjacent storage pit underneath another barn, for example underneath the finishing barn. Nursery areas often have either a 2-foot deep manure collection pit under them, as in the farrowing areas, or a deep manure storage pit, as in the finishing areas. Once the manure is collected or moved into the storage pit, it stays there until the pit is emptied and the manure is used for land application.

Manure Application

Periodically, manure is pumped out of the pit and loaded into a liquid tank wagon. A tractor-powered pump is often used, which agitates the manure to suspend the solids and then pumps it into the liquid tank wagon. The liquid tank wagon then carries the manure to the cropland where the manure is to be applied. The manure is usually applied to the surface of the field and incorporated into the soil in a separate field operation at a later time. More and more producers are using injection systems, which apply the manure beneath the surface of the soil, to conserve nutrients and reduce odor. Much of the manure application is now done by custom applicators rather than by the producers themselves.

Swine – New Production Trends

Some swine operations are starting to move toward wean-to-finish operations, meaning that the weaned piglets are moved right into the finishing barn. This eliminates the nursery phase, and hence reduces the number of buildings needed and the number of times the pigs must be moved.

Another new trend is the use of a tow hose system for manure application, rather than the liquid tank truck. Manure is pumped directly out of the pit, through the hose, and out to the fields. The hose is towed by a tractor in the fields for land application. This saves the time of filling the liquid tank truck, which can be substantial. Some operators have even put in more permanent hose lines which are submerged beneath the surface of the ground and thus do not need to be moved. The tow hose systems can transfer manure more than a mile from the storage basin or pit.

Swine – Alternative Production Methods

Deep-bedded systems are one alternative production method that has been developed. In a deep-bedded system, large amounts of bedding (usually straw or cornstalks) are used in a total confinement setting where hogs are housed in a group. The straw absorbs the manure and urine, creating a solid manure pack that reduces the potential of nutrient loss and odor. Consequently, the manure generated from this system is solid rather than liquid. New bedding is added frequently so that the manure and urine are continually absorbed. The combination of bedding, manure and urine decomposes in the manure pack and produces some heat, which provides some benefit in the winter but must be removed in warm weather.

In Minnesota, deep-bedding has mainly been implemented in the form of deep-bedded hoop houses for finishing. Hoop houses are arched or curved pipes covered with an opaque, polyvinyl tarp. The ends of the buildings are left open most of the year, providing natural ventilation, but are closed during extreme winter weather. Most hoop structures in the Midwest are 30 feet by 72 feet and house around 180 finishing pigs. Some producers have put in several hoop finishing barns to meet the scale of their operations. Elsewhere, deep-bedded technology is being used within large confinement finishing buildings. In this case, a group of hogs is confined to a pen, and there are several pens within the confinement building. The deep-bedding is used within each pen, but not in the alleys between the pens. This approach may be more adaptable for larger scale operations.

Dairy – Typical Production System

Background

According to information presented in the Water Quality Impacts Technical Work Paper, most dairy operations in Minnesota are small, with the vast majority having less than 300 animal units (214 to 300 mature cows, depending on cow size). A significant proportion of dairy operations have less than 100 animal units (71 to 100 mature cows). Very few have more than 300 animal units.

Most dairy operations in Minnesota use partial housing with or without runoff controls. Some use total confinement. Smaller operations seldom use total confinement, but it is the more common system for larger operations with 300 animal units or more (Water Quality Impacts Technical Work Paper).

The description below focuses on tie stall housing, a form of partial housing. This system has been the traditional system in various forms for more than 50 years, and it is still the prevalent system in use today. However, it should be noted that there are many hybrid systems in use in dairy operations across the State that utilize components of more than one system. Unlike hog production, which has become more standardized, dairy production has remained unstandardized and each farm has adapted new technologies differently, depending on their facilities, facility age and condition, and desired herd size. One reason for this may be the fact that the animals are more controlled in a dairy system than in a swine system, and thus inflict less wear and tear on the dairy buildings. This makes it more attractive for dairy producers to remodel existing buildings rather than build new buildings as with hog facilities. In any case, the non-standardization, hybrid systems, and remodeling involved in dairy operations make it difficult to identify a single prevalent production system.

At the same time, many small and expanding dairy operations are adopting a more standardized, total confinement system, called the freestall system. While this is not the prevalent system today, many people in the dairy industry predict that this type of system will be prevalent in another few years. This type of total confinement system is described below under Dairy – New Production Trends.

Production Cycle

Dairy production follows a two-year continuous cycle that includes the following phases:

- Calves: Caring for female calves until they are 2 months old;
- Replacement heifers: Caring for female calves from 2 months to 22 months old, including breeding at 14 to 15 months of age;
- Mature milking cows: Caring for cows that have had one or more calves, including breeding 45 to 60 days after calving and milking for about 10 months after calving;
- Dry (non-lactating) cows: Caring for replacement heifers (from 22 to 24 months old) and non-lactating mature milking cows for the 60 days before calving;
- Calving: Caring for replacement heifers and mature milking cows as they calf (at 24 to 26 months of age for replacement heifers, and every 12 to 15 months for mature milking cows).

In Minnesota, all phases are usually carried out within the same farm operation.

Housing

Calves

After calves are born, females and males are separated and males are sold or moved to a beef enterprise. The remaining female calves are housed individually in hutches. These are usually 4 by 4 by 8 feet, open-sided structures with a small outdoor enclosed pen. The hutches are bedded with straw, wood residue, or chopped cornstalks, with new bedding added frequently. Calves are housed in the hutches until they are about 2 months old, just after weaning at about 6 weeks old.

Replacement Heifers

Once they are 2 months old, the calves are moved into small groups of around 8 calves. These small groups help the calves acclimate both socially and physically to being around other cows. Often the small groups are housed in super hutches that are 8 to 10 feet by 16 to 20 feet with an enclosed outdoor pen. The hutches are often made of plywood and are on skids so that they are movable. Like the calf hutches, they are bedded with straw, wood residue, or chopped cornstalks.

The calves (heifers) stay in these small groups until they are 4 or 5 months old. They are then put into larger groups, usually in multiples of the smaller groups – for example, two super hutch groups would be combined into a new group of 16 heifers. These larger groups are housed in pens, which are usually in some type of partial housing such as a pole shed, with access to an outdoor lot. The pen area is bedded with straw, wood residue, or chopped cornstalks, and new bedding is added frequently. There may be more than one pen within the shed, so that more than one group is housed there, or the new groups may be housed in different facilities. The pens usually provide about 30 square feet per heifer of bedded area, but there is significant variation in this from farm to farm. The replacement heifers rest and ruminate in the bedded pen area, and are fed in the outdoor lot, usually at a fenceline feeding area. Alternatively, the replacement heifers may be kept outside all of the time, in a pasture or dry lot.

The replacement heifers are usually housed in these groups until they are about 22 months old, or 60 days before they calf the first time. These heifers will ultimately replace some of the mature milking cows in the herd.

Mature Milking Cows

For milking, cows are brought into the milking barn, which in Minnesota is usually a tie-stall barn. A typical tie-stall milking barn has two rows of stalls with a central alley between them and an alley on the outside of each row. Each stall is usually 4 feet wide and 6 feet long; the central alley is usually 5 to 7 feet wide. In most dairy barns in Minnesota, the cows face out, away from the central alley, when in their stalls. A two-row dairy barn is usually about 36 feet wide, and about 150 feet long.

The central alley is where traffic is concentrated within the barn, which helps centralize cleaning and milking activities. Between the central alley and the stalls is a gutter where manure, urine, and soiled bedding accumulate. The stall itself is slightly sloped to facilitate the movement of waste into the gutter. At the outside edge of the stall (where the cow faces) is a cement curb, which prevents the cow from trying to walk beyond the end of the stall, and outside of the curb there may be a floor-level feed deck along the outside alley. Cross alleys at both ends of the barn link the central and outside alleys and may also divide the stalls into blocks. The floors in all areas are solid concrete with a rough finish to prevent slipping. A small amount of bedding (either straw or sawdust) is used in each stall to keep the cows dry and clean, usually about 2 or 3 pounds per cow per day.

At milking time, the cows enter the barn and each goes to a stall, where it is then restricted by a fabric strap around its neck while it is being milked. Milkers (people who do the milking) access the udders of the cow from the side. Milking units are attached to the udders of the cows and a plastic hose from the milking unit is attached to high lines, a series of stainless steel pipes suspended from the tops of the stalls. The milk is then drawn by a vacuum system from the cow, through the high lines, to a bulk tank in the milk room. Here the milk is cooled and stored until it is picked up by a truck that carries it to the milk processor. The milk room, milking equipment, and barn are cleaned after each milking. Waste water from cleaning is channeled into the manure gutters. The wastewater adds significantly to the volume of manure that must be managed.

When they are not being milked, the cows are often moved outside in an open lot adjacent to the barn. Here the cows have space to rest, are fed, and have access to water. The lot is often partially paved, at least in the area where feed bunks are located. The remainder is usually dirt; it may have some mounds the cows can lie on to keep them out of the mud. In some operations, the cows may remain in the tie stall barn most of the time other than when the barn is being cleaned.

Dry (Non-Lactating) Cows

Cows that have been dried off (i.e. that are no longer being milked) before calving and replacement heifers who are 60 days before calving are housed together, since they are both not lactating. In most operations in Minnesota, the dry cows are housed and managed with the milking cows. However, in some operations, dry cows may be managed separately from the milking cows, or even divided into smaller management groups according to when they will calf ("far off" and "close up" dry cows or heifers). These dry cows would typically be housed outdoors in a dry lot or on pasture.

Temperature Control/Ventilation

Milking barns are usually insulated and ventilated such that supplemental heat is not necessary in the winter. Milking cows are adversely affected more by high temperatures than by low temperatures; thus, cooling of the cows in the summer is a more critical issue than heating in the winter. In the summer, circulation fans are used to blow air directly onto the cows, helping keep them cool. Proper ventilation also helps. Ventilation is used to remove moisture, gases, odors, heat, and dust from the milking barn. Usually, fresh air enters through special inlets which may be operated manually or automatically, and is expelled by thermostatically-controlled exhaust fans.

Feed

Calves

Calves are fed by hand in their individual hutches. They are fed cow's milk or milk replacer until they are weaned at about 6 weeks old, along with a grain starter. Hay is added to their diet when they are weaned.

Replacement Heifers

Replacement heifers are fed by hand outside in the open lot beside their shelter. They are fed a diet similar to the milking cows, consisting of corn silage, alfalfa silage, alfalfa hay, ground shelled corn, and soybean meal.

Milking Cows

Dairy cows are fed a combination of corn silage, alfalfa silage, alfalfa hay, ground shelled corn, corn distillers grain, and soybean meal. The forages are fed in the largest quantities, making up 60 percent of the cows' diet with the grain ration making up the other 40 percent. The forages are usually free-fed, while the grain ration may be fed in controlled portions.

Most milking cows are fed both inside the barn and outside in the open lot beside the barn. Typically, concrete feed bunks are located down the center of the lot. The feed is put onto the surface of the bunks by a mechanical auger, which carries the food from a silo where it is stored. The milking cows may be fed the silage and hay outside in the lot, and the grain ration inside while they are being milked.

Within the milking barn, a water bowl is shared by every two stalls. The water bowl may be in front of the curb (in the stall) or on the other side of the curb (in the outside alley). Outside, large water troughs can provide water to 8 to 10 cows at a time. These troughs are controlled by a float valve, which triggers water to be added when the water level falls. The water troughs are heated in the winter to prevent them from freezing.

Manure Collection and Storage

Calf Hutches

The calf hutches have a solid manure pack from all the bedding that is used. The manure collects in the hutch and is mixed with bedding until the calf is moved at 2 months of age. At that time the solid manure pack is cleaned out and added to the other manure that must be managed.

Replacement Heifer Shelters

Like the calf hutches, the amount of bedding used in the super hutches results in a solid manure pack. This manure pack is cleaned out when the groups are moved out of the super hutches into the larger group pens. The larger group pens also have a solid manure pack. This manure pack is cleaned out periodically, for example twice a year. The manure from both of these sources is added to the other manure that must be managed.

Milking Barn

The primary manure collection and storage system used in Minnesota is a liquid manure system. Inside the milking barn, manure and other wastes are collected in the gutters that run between the milking stalls and the central alley. The gutters are about 18 inches wide and 12 inches deep and are covered with 2 inch metal grate. Automatic gutter cleaners, usually a continuous chain in the gutter, carry the manure to the end of the barn where it is deposited into a basin. The manure is in liquid form, although it contains some bedding. From the basin, a piston pump pushes the manure out of the basin, through a pipe below the frostline, and into the bottom of the manure storage unit which is usually adjacent to the barn. In Minnesota, most dairy operations store manure in a clay-lined earthen basin.

However, many operations use a daily haul manure system. In a daily haul system, more bedding is used in the stalls which results in a more solid manure. Automatic gutter cleaners are used as in the liquid system, but they carry the manure into the box of a manure spreader rather than into a collection basin. The manure is then taken each day to a field for application. In the daily haul system, there is no manure storage.

In the Open Lot

The manure in the open lot is in solid form, since most of the liquids runoff. If the lot has runoff controls, the water flowing onto the lot is controlled by terraces, and the lot is slightly sloped so that water flowing off the lot is directed into a grass waterway or pasture or some other type of buffer strip to keep it from flowing into any surface water bodies. However, open lots without runoff controls are more prevalent than lots with runoff controls.

The lot is scraped periodically using a skid steer or tractor loader. If the operation is using a daily haul system, this manure is added to the manure that is scraped each day from the tie stall barn and that must be spread. If the operation uses a liquid system, the solid manure cannot be added to it in the storage facility. It is usually piled in a storage area, which may be an area at one side of the lot, until it can be spread.

Manure Application

The majority of dairy operations in Minnesota spread the manure, liquid or solid, on the surface of the field using a liquid tank truck or a box spreader. The liquid manure is often incorporated shortly after being spread. Some operations inject the liquid manure.

Dairy – New Production Trends

Freestall Systems

Freestall dairy housing is a new trend in dairy production that most new dairy facilities in Minnesota are using. The freestall system is different from the tie stall system in that the milking cows are totally confined indoors but are not tied or restricted, and a milking parlor is utilized that is separate from the housing area. These facilities typically house 300 to 500 cows, but may even house up to 1,400 cows. However, many smaller dairies in the State (50 to 100 cows) have remodeled their existing buildings to create a freestall-type system for smaller herds.
The free stall buildings have 2, 4, or even 6 rows of stalls. Cows rest and ruminate in the stalls, which they enter and leave at will. They are not tied in the stalls. The stalls are approximately 4 by 8 feet, and are bedded with straw, or more commonly with sawdust, sand, or special

mattresses. Because not all cows will be resting at the same time, there are usually 10 to 15% more cows than there are stalls. The cows are grouped into blocks of stalls according to their lactation schedules. This allows for closer management of the cows at each stage.

Rows of stalls are separated by a manure alley which is 10 to 12 feet wide with a grooved concrete surface. The stalls are typically 8 inches above the alley, and the stalls contain a neck rail that backs the cow toward the alley when it stands so that manure and urine go into the manure alley rather than into the stall. Feed bunks are located in a separate part of the barn from the stalls. They are along a feed alley, which is wide enough for a truck or tractor to pull a feed cart. Large watering troughs are located in the traffic alleys.

Typically, freestall buildings are naturally ventilated. They are curtain sided, and the plastic curtains are opened in the summer to provide adequate ventilation. Some circulating fans are used to blow air over the cows in the summer. The roofs of the buildings are often insulated to cut down on heat in the summer and condensation in the winter. The curtains are closed in the winter. No supplemental heating is used.

Manure and urine travel into the manure alleys that run between the rows of stalls. These are scraped twice a day (or after each milking) with a skid steer or tractor loader, typically into a collection basin at the end of the barn. Then, a pump pushes the liquid manure through an underground pipe to an earthen basin for storage. Any manure in the stalls is removed manually twice a day (or after each milking).

A cross alley in the freestall barn leads to the milking parlor, which may be in a separate area of the barn or even in a different building. Cows are moved as a group into a holding pen where a crowd gate nudges them forward into the milking parlor in groups of 8 to 24. In the milking parlor, the cows stand 36 inches above the floor where the milker stands. The cows are not tied or restricted as in the tie stalls but are very tightly spaced to control their movement. They are usually either angled (herringbone) or parallel, so that the milker can access the cows' udders from either their rear flanks or between their rear legs. The milk lines are low lines, below the level of the cows, instead of the high lines used in the tie stall barn. A vacuum system moves the milk in the lines from the cows, into a receiving jar, through a cooling system, and then into the bulk tank.

Three-times-a-day Milking

Another new production trend is milking three times a day, rather than the traditional twice a day. This does not change the management of the cows drastically as it is described above, but it changes the scheduling of the milkers. In three-times-a-day milking, less milk is collected at each milking but overall more milk is collected per day.

Dairy – Alternative Production Methods

Management intensive grazing, or rotational grazing, is one alternative production method that is being used by dairy operations. In this system, the pasture area is divided into several smaller paddocks, and the grazing cows are rotated as a herd through all of the paddocks. Cows are restricted to a paddock by movable electric high-tensile wire fences. Each time they are brought back to the pasture after milking they are moved to a different paddock by moving the electric fencing. A portable water tank is also moved to the new paddock. In this way each paddock of pasture is grazed evenly and completely and then allowed to regrow before being grazed again. Consequently, the cows are constantly grazing in rich new pasture, maximizing nutritional value, and minimizing overgrazing.

In this system the cows are outside all of the time other than during milking; they may even be kept outdoors during the winter and hand fed. Thus, the facilities needed are minimal. A milking parlor is the only building needed. Manure management is also minimal, since most of the manure and urine is distributed in the pasture. Cropping equipment needs are minimal, since the cows are harvesting most of their feed themselves. Because of its intensive nature, less pasture is needed than more extensive grazing systems.

In Minnesota, this system has been adopted by dairy operations with both small herds, such as 50 cows, and larger herds, such as 200 to 300 cows.

Beef - Typical Production System

Background

According to the information presented in the Water Quality Impacts Technical Work Paper, most beef feedlots in Minnesota are small, with less than 300 animal units (around 300 slaughter steers, 428 feeder cattle, or 250 cow-calf pairs). The majority have less than 100 animal units (around 100 slaughter steers, 143 feeder cattle, or 83 cow-calf pairs).

Most beef feedlots in Minnesota use partial housing with or without runoff controls. The use of runoff controls increases with larger operations and decreases with smaller operations. Some operations use total confinement. The use of total confinement is relatively even among all size operations, but it is not the most prevalent housing type for any of the operation size classes (Water Quality Impacts Technical Work Paper).

Production Cycle

Beef production includes the following phases.

$ Cow-calf: Caring for bulls, cows, and calves, including breeding, gestation (9 months), calving, vaccinating and deworming, castration of bull calves (which then become steers), and weaning at about 7 months of age when calves weigh 450 to 550 pounds. The calves may also be backgrounded for about another month, which includes vaccinations and introducing them to feed. Some bull and heifer calves may be kept as replacement breeding stock; the majority are raised for finishing (slaughter).

$ Stocker Calves: Caring for heifer calves and steers for about another 5 months, until they weigh 700 to 800 pounds at 12 months of age, at which point they are called yearlings.

$ Finishing: Feeding beef heifers and steers for slaughter, until they weigh about 1,100 to 1,200 pounds at anywhere from 12 to 24 months of age, depending on breed, sex, and management, although most are 16 to 18 months of age.

In Minnesota, most operations do not carry out all three phases, with the cow-calf, stocker, and finishing phases taking place on separate operations. However, there is significant variation and flexibility in the combinations and timing of these steps. For example, the stocker phase is often carried out by the cow-calf operation, or the stocker phase can be skipped altogether and the calves go directly from the cow-calf herd to the finishing feedlot. The stocker phase can also last longer than 5 months. The determining factor is often the market and prices for cattle and grain. Cow-calf operations are found more in the northern part of the State, while finishing operations are found more in the southwestern part of the State. The southeastern part of the State has both cow-calf and finishing operations.

Housing

Cow-Calf

Cow-calf herds, including bulls, cows, and calves, are mainly raised outdoors on pasture with minimal housing. Calving, which usually occurs in the spring, takes place on pasture as well. Usually 2 acres of pasture per cow-calf pair are provided, depending on management and the quality of the land. In the summer the cow-calf herds are on pasture; in the winter they may be moved to a pasture or field closer to the farmstead site. There may be an open pole shed or barn, a windbreak in the pasture, or a wooded area to provide shade in the summer and wind protection during the winter.

Stocker Calves

Similar to cow-calf herds, stocker calves are also kept outdoors with minimal housing. Their stocking rate in the pasture is based on weight, with 2 or 2 ½ stocker calves per acre initially, and fewer calves per acre as they grow.

Finishing

Most cattle finishing operations in Minnesota have an open or dry lot along with some type of shelter such as a pole shed or a windbreak. Bedding, most commonly straw or cornstalks, is used in the shelter to keep the cattle dry. The lot may or may not be paved. Often, it is a dirt lot with clay mounds or bedding packs on which the cattle can lie to stay dry. The lot also has a feed bunk where the cattle are fed and a watering trough. The feeding area is often paved. Approximately 250 to 500 square feet of space per head is provided in the feedlot. Heifers and steers are usually finished together.

Temperature Control/Ventilation

Since beef cattle spend much of their time outdoors, and any housing they have is open, the typical beef systems are naturally ventilated. There is no additional temperature control. Beef cattle perform well in cooler temperatures and can withstand cold temperatures, down to 18E Fahrenheit, as long as they are protected from the wind.

Feed

Cow-Calf

The primary feed source for bulls and cows is pasture during the late spring, summer, and fall, and good quality hay and grains (corn silage, ground, cracked or shelled corn, maybe soybean meal) during the winter and early spring. Calves nurse milk directly from their dams (mothers) until they are weaned, and start to eat from the pasture during this time as well. Calves are usually introduced to feed at weaning, including corn, oats, or barley, and sometimes soybean meal or distillers grain, by mixing the feed with hay and feeding them by hand in the pasture or at feed bunks if the operation has a feedlot. They are sometimes started on feed a month or two before weaning using creep feeders, which are usually placed in the pasture. The creep feeders have a feeder in the middle with a corral around it that only the calves are small enough to enter.

Stocker Calves

Like bulls and cows, the primary feed source for stocker calves is pasture during the fall, and good quality hay and some grain such as corn silage, barlage (barley silage), oatlage (oat silage), ground, cracked or shelled corn, and perhaps soybean meal during the winter. They are usually fed 1 pound of grain per 100 pounds of weight. The feed they are given during the winter is determined by the producer’s goals for weight maintenance versus weight gain and the nutritional requirements for each, and market prices.

Finishing Cattle

The feed bunk in the open lot is usually a large slab of concrete about 2 feet wide and 2 feet high. Finishing cattle can be fed a combination of corn silage, earlage (corn silage with the ear and cob of corn), chopped dry alfalfa or grass hay, shelled or ground corn, soybean meal, cottonseed hulls or meal, and supplemental protein and minerals. Usually their diet in the finishing feedlot will range from 60 to 90 percent grain, and 40 to 10 percent hay, respectively as they advance in the finishing stage. These feedstuffs are usually added to a feeder wagon, or truck with a mixer wagon, which mixes them together creating a total mixed ration. The wagon then drives by the feed bunk and spreads the food evenly along the bunk. The cattle are commonly fed twice a day.

Manure Collection and Storage

Cow-Calf Herd and Stocker Calves

Since the cow-calf herd and stocker calves are on pasture or in a field year round, their manure and urine are deposited throughout the pasture or field. There is no manure collection and storage system needed.

Finishing

In the shelter, the manure is in the form of a solid manure pack because of the bedding used. In the lot, the manure is also in solid form. This is because much of the liquid from manure and urine runs off of the lot. If the lot has runoff controls, the water flowing onto the lot is controlled by terraces, and the lot is slightly sloped so that water flowing off the lot is directed into a grass waterway or pasture or some other type of buffer strip to keep it from flowing into any surface water bodies. However, lots without runoff controls are more prevalent than lots with runoff controls.

The shelter is scraped periodically throughout the year using a skid steer or tractor loader. To store the manure, the manure pack is stockpiled, usually at one side of the lot or in a storage building, until it is land applied. If the lot is paved, the manure will be scraped regularly (once a day or every other day) and stockpiled in a storage area, or in a daily haul system it would be spread each day without any storage. If the lot is unpaved, some areas of the lot such as the paved feeding areas and bedding pack areas may be scraped once a year and spread on cropland without any storage.

Manure Application

The solid manure from the shelter and lot is spread on crop land using a box spreader.

Beef - New Production Trends

One new trend in beef production is better forage utilization. This includes better harvesting and storage of forages, better matching of forages to the nutritional needs of cattle, and better pasture management. Better pasture management entails rotational grazing, where the cattle are rotated to different areas of pasture periodically (such as every 30 days) to promote even grazing and hence pasture nutritional value and to prevent overgrazing. Some producers are doing this more intensively using a system called management intensive grazing. In this system the cattle are moved between pasture paddocks more often, such as every day.

At the same time, another trend in the western part of the U.S. is that cattle finishing feedlots are becoming much larger and more intensive. These large feedlots are using high tech methods such as computer systems for mixing feed rations and supply management. Such large feedlots have not yet been implemented in Minnesota, and may not be competitive in Minnesota because of the colder climate. Ultimately, however, they will affect the market and pricing for finished beef.

Another new trend in beef production is the use of electronic identification for source verification of the calf throughout its lifetime. This system makes information about the calf's background available from the cow-calf phase forward (toward feeder and packer), and back. While this identification system is primarily for marketing purposes to meet consumer demand for a safe and nutritious beef supply, it ultimately will affect production in terms of genetics and production practices.

Beef - Alternative Production Methods

An alternative production method in beef production is to finish the cattle on pasture rather than on grain. This is gaining in popularity as a result of increased consumer demand for leaner beef, which requires less grain in the cattle's diet. Another alternative is organic beef production, in which the management of the cattle would be similar to the typical system described above, but which requires the use of certified-organic pastures, forages, and feeds.

Turkeys – Typical Production System

Background

According to information presented in the Water Quality Impacts Technical Work Paper, turkey feedlots in Minnesota are mainly medium-sized, with 300 to 999 animal units (16,700 to 199,800 turkeys). Some turkey operations are large, with 1,000 animal units or more.

Almost all turkey operations use total confinement. Some of the small operations use partial housing without runoff controls (Water Quality Impacts Technical Work Paper). Since total confinement is most common, the description below will focus on that system.

Production Cycle

The turkey production cycle involves the following phases. Except for very small operations, they each take place on separate operations.

$ Breeder Flocks: Caring for breeding turkeys whose offspring will used as growers (for slaughter), including brooding of newly hatched breeding poults until they are 7 weeks old, feeding them (grow-store) until they are ready to start laying at 28 to 30 weeks of age, breeding, and laying and gathering eggs. The eggs are sent to a hatchery.

$ Hatching: Incubating and hatching the eggs from the breeding flocks, which takes about 28 days. The poults are sent off to growers the same day they are hatched.

$ Growers: Caring for grower turkeys for slaughter including brooding the newly hatched poults until they are 7 weeks old, and feeding them until they are ready for market at about 16 to 19 weeks of age for hens, and 14 to 22 weeks for toms.

The hatcheries do not house or feed the poults, and they have no manure to manage. This makes them very different from other animal production systems. Hence, they will not be discussed in this description.

Housing

<u>Breeding Flocks (Brooding, Grow-Store, and Laying)</u>

Breeding flocks utilize three different buildings: brood buildings, grow-store buildings, and laying facilities. All of them are total confinement buildings with a litter base. Most buildings are curtain-sided, with one large continuous space within them where the turkeys are housed as a group. A thick layer of litter, usually sawdust or wood shavings, covers the floor. An all-in all-out system is used, where birds of the same age are brought in at the same time, and are removed from the barn at the same time.

Newly hatched breeding poults, which are usually replacement breeding stock from primary breeders outside of Minnesota, are first housed in brood buildings from the time they are received from a hatchery until they are 7 weeks old. The brood buildings are often around 75 feet by 250 feet. Then, the poults are moved to grow-store buildings until they are ready to start laying, at 28 to 30 weeks of age. They are then moved to laying facilities. The laying facilities contain nests, either wood nests or metal mechanical nests, on the surface of the litter scattered throughout the facilities. The turkeys lay their eggs in these nests, and the eggs are gathered either by hand or automatically. The eggs are then sent or sold to a hatchery for hatching. All of the eggs produced by the breeding flocks are used to produce turkeys for slaughter – none are used as breeding replacement stock, since this comes from primary breeders in order to preserve the genetic lines.

Growers (Brooding and Finishing)
Grow, or finishing, operations utilize two types of buildings: brood buildings and grow barns. Both use the same type of litter system described above for the breeding flocks. Newly hatched grower poults are received from the hatcheries and housed in brood buildings until they are 7 weeks old. They are then moved to a grow barn, where they are kept until they are ready for market. Hens and toms are raised separately, and are usually in the grow barn for 9 to 12 or 7 to 15 weeks, respectively, until they are ready for market at about 16 to 19 weeks of age for hens, and 14 to 22 weeks for toms. The time depends on the desired final weight of the turkey. Barn sizes vary depending on the number of birds, but usually contain 3 or 4 square feet per bird and can be around 60 feet by 560 feet. Two or three flocks of turkeys are finished in a barn per year. Turkey finishing operations often have several such barns. Grow-finishing operations make up the largest part of turkey production in Minnesota.

Temperature Control/Ventilation
Turkey barns are typically naturally ventilated in the summer by full length sidewall openings that are controlled by adjustable plastic curtains. When the temperature reaches a certain level, these curtains are lowered to allow fresh air to enter. For additional animal cooling, these barns also have circulation fans within the barns that create air movement within the building but do not exchange air between the outside and the barn. The buildings are naturally and mechanically ventilated in cold weather. All turkey buildings have heaters suspended from the ceiling and spaced throughout the barn. In the brood buildings they provide radiant heat to the small poults. In the grow-store and grow-finishing buildings they blow heated air out into the barn.

Feed

Turkeys in all phases – brooding, grow-store, laying, and grow-finishing – are fed a corn-soy-fat diet. This diet is usually based on carefully mixed rations and the composition varies depending on the phase of production. In turkey barns, each barn has two or three feeding lines that are raised and lowered from the ceiling. The feeding lines drop feed into circular feeders, which sit on the barn floor. The circular feeders are on cables, so that their height can be adjusted according to the size of the birds and the litter depth. The feeders can also be larger buckets suspended from the ceiling and filled by a feed line with down spouts that extend into the buckets. The feeders are spaced throughout the barn; the number depends on the number of birds in the barn. The birds eat ad libitum (free choice) from these feeders. Waterers are also spaced throughout the barn – these are bowls or pans kept full by an automatic system. Water trickles into the waterer until it reaches a set weight, at which time the water is automatically shut off.

Manure Collection and Storage

Since all turkey buildings use litter, all the manure generated is solid. The brood buildings are cleaned out after every flock of poults, by scraping them with a skid steer or front end loader. The grow-store buildings and grow-finishing buidings are skimmed between every flock of turkeys, meaning that the wet spots are removed and extra litter is added. They are completely cleaned out about once a year. All of the solid manure collected from these buildings is either immediately spread on crop land, or is stockpiled at the headland of the field where it will be spread. Usually, there is no storage structure.

Manure Application

The manure from turkey barns spread on the surface of cropland, using a box spreader.

Chickens – Typical Production System

Background

According to information presented in the Water Quality Impacts Technical Work Paper, chicken feedlots in Minnesota are mainly medium-sized, with 300 to 999 animal units (60,000 to 333,000 chickens). Some chicken operations are small, with 100 to 299 animal units (20,000 to 60,000 chickens).

Almost all chicken operations use total confinement. Some of the small operations use partial housing without runoff controls (Water Quality Impacts Technical Work Paper). Since total confinement is most common, the description below will focus on that system.

Chicken production has two different components: Commercial layer production (for eggs), and broiler production (for meat). Commercial layers and broilers are two completely separate industries, and the chickens in each are managed differently. Therefore, each will be discussed separately in the description below.

Commercial Layers – Production Cycle

The production cycle of commercial layers (for egg production) includes the following phases.

$ Layer Breeding Flocks: Caring for and breeding chickens whose offspring will be used as layers including brooding of newly hatched breeding chicks until they are ready to start laying at about 16 to 20 weeks of age, breeding, and laying and gathering eggs. The resulting eggs are sent or sold to a hatchery for hatching.

$ Hatching: Incubating and hatching the eggs from layer breeding flocks until they hatch at about 21 days. The chicks are sent to laying operations the same day they are hatched. Male chicks are destroyed.

$ Layers: Brooding newly hatched chicks (pullets) until they start laying eggs at about 16 to 20 weeks of age (when they become hens), and then collecting their eggs until the hens are about 104 weeks old, at which time they are slaughtered or destroyed.

Except for very small operations, these phases each take place on separate operations. The majority of operations in the commercial layers industry in Minnesota are layer operations; the breeding flocks are a very small component. Consequently, layer breeding flocks will not be discussed in this description.

The hatcheries do not house or feed chicks, and they have no manure to manage. This makes them very different from other animal production systems in terms of housing and manure management. Hence, they will not be discussed in this description.

Commercial Layers – Housing

The newly hatched chicks (pullets) are first housed in pullet barns until they are ready to start laying eggs. They are then moved to layer barns. Both the pullet and layer barns typically contain wire cages, stacked 4 to 6 high, which each house 4 or 5 birds. The cages usually are sized to allow 54 to 72 square inches per bird. Eggs produced by the hens roll out of the bottoms of the cages onto a conveyor belt, which carries them to an area where they are washed and refrigerated. These barns are typically 80 by 400 feet.

In some pullet and layer barns, the cages are stacked directly on top of each other with a plastic belt running between each layer of cages. The manure falls out of the bottoms of the cages onto the plastic belt. There are usually 4 to 5 rows of stacked cages in a barn.

Other pullet and layer barns are two-story buildings, in which the first story is used for manure storage and the second story contains the pullets or laying hens. In these buildings, the cages are stacked five high but are staggered to form an inverted V, with four cages on each side and a ninth cage at the top completing the V. These are called stair-step cages. This inverted V of cages runs the length of the barn, forming a tunnel underneath. This stair-step configuration allows manure to drop through the bottoms of the cages for collection and storage, either directly to the first floor or to a platform that opens to the first floor. There are often 3 to 5 rows of cages within a barn.

Small pullet or caged layer barns house 15,000 to 20,000 birds, while large barns house up to 128,000. Laying operations can have as many as 14 or 15 barns.

Temperature Control/Ventilation

In the pullet and caged layer barns, temperature control and ventilation are automated. Computer sensors detect the temperature within the barn and adjust the ventilation accordingly. Most barns typically have fans at one end of the barn that blow air out, causing air to be drawn into the barn through vents located at the other end and through the barn. In hot weather, doors at the end of the barn can be opened to create more air flow through the barn. There is typically no heating system for cold weather; if necessary, portable propane heaters are used.

Commercial Layers – Feed

Pullets and laying hens are fed a corn-soybean based diet. A small feed trough runs the length of the row of cages and is positioned on the outside of the cages. The wires of the cages are far enough apart to allow the birds to stick their heads through the wires to eat from the trough. The feed is augered into the troughs. The pullets and laying hens are fed ad libitum, with food available at all times. Each cage contains a nipple waterer with a ball bearing, which the birds push to release water. The waterers are on a water line running throughout the barn that keeps them full at all times. In most operations, the amount of feed and water consumed is recorded by computers and closely monitored each day to detect leaks or other problems in the system.

Commercial Layers – Manure Collection and Storage

Manure is collected in different ways depending on the type of pullet or layer barn. In the type of barns that have cages stacked directly on top of one another, manure falls through the bottoms of the cages and is collected on the plastic belts that run between each layer of cages. Then, a scraper or auger moves the manure from the plastic belts to the end of the barn and into a truck. The manure is in solid form. Manure is removed 2 or 3 times a week, and typically is land applied immediately. There is usually some type of temporary storage available for times when the manure cannot be applied immediately, such as covered sheds or stacking pads. The storage typically has very little capacity and is not intended to store manure long term.

In the type of barns with stair-step cages, the manure is collected in one of two different ways. In newer barns, there is a plywood platform beneath the cages with a 6-inch slat running the length of the row. Manure falling through the bottoms of the cages is caught by this platform. In these barns, the ventilation system draws air from the roof, across the birds, across the manure on the platform, and out of the building through louvers on the first story. This ventilation dries the manure, resulting in a manure with 50 percent moisture on average. The manure is then scraped from the platform twice a day by a v-shaped draw bar pulled the length of the row on a cable, which gathers the manure on the platform and forces it through the slat to the first floor.

In older barns, the floor beneath the cages is open to the first story. Manure falls through the bottoms of the cages directly into the first story. This results in a wet manure with about 75 percent moisture.

In either case, dry or wet, the manure is then stored in the first story of the barn, which is usually cleaned out about once a year. At that time, the sides or ends of the barn are opened, and a front end or skid loader is used to remove the manure and load it into a large box spreader or dump truck.

Commercial Layers – Manure Application

The manure from caged layers (dry or wet) is in solid form, and is spread on the surface of cropland using a box spreader.

Broilers – Production Cycle

The production cycle for broilers includes the following phases.

$ Broiler Breeding Flocks: Caring for and breeding chickens whose offspring will be used as broilers including feeding newly hatched breeding chicks (pullets) until they are ready to start laying at about 25 weeks of age, breeding, and laying and gathering eggs until the layers are about 65 weeks old. The resulting eggs are sent or sold to a hatchery for hatching.

$ Hatching: Incubating and hatching the eggs from broiler breeding flocks until they hatch at about 21 days. The resulting chicks are sent to broiler operations the same day they are hatched.

$ Broilers: Feeding chicks from the time they are newly hatched until they are ready for slaughter at about 6 to 7 weeks of age.

Except for very small operations, these phases each take place on separate operations. The majority of operations in the broiler industry in Minnesota are broiler operations; the breeding flocks are a small component.

The hatcheries do not house or feed chicks, and they have no manure to manage. This makes them very different from other animal production systems in terms of housing and manure management. Hence, they will not be discussed in this description.

Broilers – Housing

Broiler Breeding Flocks

Broiler breeding flocks utilize two different buildings: pullet grow-out houses, and breeder-laying houses. An all-in all-out system is used in both, where birds of the same age are brought in at the same time, and are removed from the barn at the same time.

Newly hatched breeding pullets, which are replacement breeding stock from primary breeders, are first housed in pullet grow-out houses from the time they are received from a hatchery at a day old until they are 21 weeks old, or about 4 weeks before they are ready to start laying eggs. The pullet grow-out houses contain about 2 square feet per pullet, and are one large continuous space where the pullets are housed as a group. The concrete floors have a 4-inch layer of litter, usually sawdust or wood shavings, on the floor.

At 21 weeks, the pullets are moved to the breeder houses; they start laying eggs at about 25 weeks. Breeder houses are typically a large enclosed group building where the laying hens and cockerels (males) are housed as a group. They are often 60 by 456 feet and house 14,000 breeding hens and 1,400 cockerels. There is about 2 square feet per bird in the laying house. Part of the building, called the scratch area, has a thick layer of litter on the floor, usually sawdust or wood shavings. This area is primarily where mating takes place. The other part of the building is where feeders and waters are located, as well as the nests where the hens lay their eggs. This part of the building has a slatted floor for manure collection rather than a solid concrete floor with litter. There is free access for the chickens between the two parts of the building.

The nests are made of metal with a rubber-fingered pad that sits inside. There is about 1 nest for every 4 hens in the house. They are designed such that the eggs automatically roll from the nest onto a conveyor belt which takes them to a collection area. They are then sent or sold to a hatchery. All of the eggs produced by the breeding flocks are used to produce broilers for slaughter – none are used as breeding replacement stock, since this comes from primary breeders in order to preserve the genetic lines.

The hens remain in the breeder houses for about 44 weeks, or until they are about 65 weeks old. At this point their productivity has dropped significantly, and they are usually sent or sold for processing. A new flock then enters the breeder house, so the building is turned just once a year.

Broilers

Broilers are raised in broiler houses, large enclosed barns that have one continuous open space where the birds circulate freely as a group. The barns are often 60 by 624 feet and house approximately 47,000 broilers. Slightly less than 1 square foot of space is allowed per broiler. The concrete or clay floor is covered with a 4-inch layer of litter, typically sawdust or wood chips. Newly hatched chicks arrive when they are one day old. For the first 10 to 14 days, they are confined to half of the broiler house, which is divided by a curtain. This is known as the brooding area. After this point, the curtain is removed and the broilers have access to the whole space. Each flock of broilers is in the barn for about 6 to 7 weeks, at which time the birds weigh about 5 pounds and are ready for slaughter. There is usually 2 weeks of downtime before another flock is brought into the broiler house. About 5½ flocks of broilers are raised in a broiler house per year.

Temperature Control/Ventilation

Pullet grow-out houses, broiler breeder houses, and broiler houses are typically completely closed systems which are ventilated using static negative pressure. In this system, automatic exhaust fans turn on and off according to temperature in the buildings, causing power vents in the building to open. Because of the air being exhausted from the building, air is pulled into and circulated throughout the house equally from the power vents. This even ventilation is important to the health of the birds. The amount of air movement needed increases as the birds are older.

Broilers – Feed

Broiler pullets, breeding hens and cockerels, and broilers are fed a corn-soybean diet. Typically it includes 85% corn and 15% soybean meal, as well as a vitamin premix. The feed composition is adjusted for the various growth phases of the birds. It is usually in pellet form; these pellets are crumbled for the chicks. For both the broiler pullets and broiler breeding flocks the amount of feed they receive is regulated, since weight gain is not a goal. In contrast, the broilers eat ad libitum (free choice).

There is typically a feed storage tank on the outside of the buildings with feed lines that carry food into the feeders. Augers or chains are used to move the feed into the feeders. In the broiler breeder laying houses, feeders and waterers are in the raised area of the barn with a slatted floor. Here the feeder is a galvanized metal feed trough. Automatic, enclosed nipple waterers, which only dispense water when the birds drink from them, are also in the feeding area. This is important in order to avoid excess water falling into the manure beneath the slatted floor. In broiler pullet grow-out houses and broiler houses, the feeding lines drop feed into circular feeder pans, which are suspended above the barn floor. The feed pans are on cables, so that their height can be adjusted according to the size of the birds and the litter depth. There are about 4 pans every 10 feet along the feedline. Automatic, enclosed nipple waterers are on water lines that run the length of the building as well. The waterers are enclosed, which is important to avoid getting the litter wet.

Broilers – Manure Collection and Storage

All of the manure generated by the broiler pullets, broiler breeding flocks, and broilers is solid manure. The pullet grow-out buildings are typically cleaned out after every flock (about twice a year) by scraping them with a skid steer or front-end loader. The building is also cleaned and disinfected at that time. In the breeder buildings, the area under the slatted floor and the scratch area are scraped between flocks (once a year). In the broiler houses, the half of the barn used as the brooder area is cleaned out between flocks (every 6 weeks). In the other half of the barn, wet or caked areas of litter are removed and additional dry litter is added between flocks. It is scraped about once a year unless the litter gets wet or caked before then. The entire building is cleaned and disinfected at that time.

Once the manure is scraped, it is either applied immediately to cropland, or stockpiled on a concrete pad or headland of a field for a short time until it can be land applied.

Broilers – Manure Application

The manure from broiler pullet grow-out barns, broiler breeder houses, and broiler houses is spread on the surface of cropland, using a box spreader.

Poultry – New Production Trends

One new production trend in caged layer barns deals with egg handling. Normally, eggs are washed, refrigerated, and transported whole. The new trend is to wash the eggs, sterilize the outside, break and separate the eggs into yolks and whites, and refrigerate them, all within 12 hours of laying. The resulting yolks and whites are then transported separately in liquid tank trucks.

Poultry – Alternative Production Methods

One alternative production method in poultry that is becoming more common is free-range production systems for turkeys, broilers, and layers. In a free-range system, the birds are housed in a pole shed or other building that opens to an adjacent, fenced yard. The birds are able to go outside at will at all times. This is true even in the winter, although they may not choose to go outside in the winter. The outside yard allows them to display natural behaviors such as pecking and wallowing, and to get exercise.

There is typically about 1 square foot of space allowed inside the pole shed per bird; the space in the outside yard is in addition to this. Similar to the conventional systems, the floor of the pole shed is covered with a deep layer of litter, usually wood chips, which is cleaned out once a year. The pole shed also contains automatic feeders and waterers. Like the conventional systems, the birds' significant nutrition comes from a corn-soybean diet.

Free-range production systems have been adapted at varying scales for both small and large operations.

Issues and Opportunities Raised by the Changes Taking Place

The changes taking place in animal agriculture have resulted in many issues and opportunities. Some of these affect producers at the farm level; others go beyond the farm and affect citizens across Minnesota. The discussion below presents many of the issues and opportunities that have been raised. Issues and opportunities are explored in more detail in the Technical Work Papers; the relevant Technical Work Paper is noted for each issue and opportunity discussed below.

Issues

Economic Concerns

Farm profitability and income

Farm profitability and income is an issue that is often raised in connection with animal agriculture. Livestock producers are receiving lower prices for their products, at the same time that production costs have risen. The result has been a decrease in net farm income and profitability for many livestock operations. Ultimately, this can drive operations out of animal agriculture, resulting in further consolidation of the livestock industry. For more information on farm profitability and income, see the Economic Structures, Profitability, and External Costs Technical Work Paper.

Market access

Increased contracting, integration and consolidation in livestock markets raises concerns about market access for producers. The increased use of formula pricing by packers and retailers, the increased use of marketing contracts, and vertical integration of packers into stages of livestock production has reduced the share of the market that is traded by negotiation. This raises three main concerns about market access. First, producers in traditional cash markets may face prices that are unfairly biased downward. Second, there is some evidence that large producers receive higher prices from meat packers than do small producers. Third, if traditional cash markets continue to decline in volume, they could disappear altogether. Since traditional cash markets tend to be used more heavily by small producers than large producers, there is concern that market concentration unfairly puts smaller livestock operations at a competitive disadvantage. For more information about concerns related to market access, see the Economic Structures, Profitability, and External Costs Technical Work Paper.

Externalities

While animal agriculture produces many benefits to society at large, there is concern that the full costs of animal agriculture beyond the farm are not being accounted for. These costs, or externalities, can include damage to air, water, soil, human health, and rural communities. Because these costs are borne by society at large and not by individual livestock operations, management decisions made on the livestock operations do not adequately factor in these costs. This results in inequities between society, who ultimately “pays” for these costs, and livestock producers, who produce the damage but do not bear the cost; and can ultimately skew livestock production in directions that may not be economically efficient for society as a whole. For more information about externalities, see the Economic Structures, Profitability, and External Costs Technical Work Paper.

Environmental Concerns

Water quality

Pollution of surface and ground water with manure is a prominent issue related to animal agriculture. Pollutants from manure include nutrients (nitrogen, phosphorus, and potassium), sediments, pathogens, hormones and potentially toxic trace elements. Water that is high in nitrates (a form of nitrogen), pathogens (such as *E. coli* and *Giardia*), or hormones is unsafe for drinking, and can result in serious illness in humans, especially infants. It is also unsafe for recreational uses such as swimming. Nitrates and sediments in water can negatively affect fish, amphibians, and other wildlife. Excess phosphorus contributes to eutrophication of surface waters. For more information on potentially toxic trace elements, see the Soils and Manure Technical Work Paper.

Surface water pollution can occur as a result of runoff from animal housing units, manure storage, or land application of manure. Groundwater pollution can occur as a result of leakage from manure storage. While runoff from livestock housing areas and manure spills from storage units can have disastrous local effects on water quality, land application of manure has the greatest potential for affecting regional water quality. Phosphorus is the primary nutrient lost in surface runoff. This is exacerbated by the fact that manure application is often based on nitrogen rather than on phosphorus, resulting in excess phosphorus. For more information on manure storage, manure application, and phosphorus see the Soils and Manure Technical Work Paper.

The risk for surface and ground water pollution is directly affected by:

- the type of animal housing (open lots without runoff controls have greater potential for water pollution than total confinement);
- the type of manure storage (for solid manure, daily haul systems with no storage have greater potential than manure pack in buildings; for liquid manure, earthen basins have greater potential than above ground tanks);
- the method of manure application to land (spreading in a daily haul system has greater potential than injection);
- the timing of manure application to land (application in winter has greater potential risk than before planting in the Spring);
- the rate of manure application to land (higher application rates have greater potential risk);
- the amount of available land for manure application (operations with less land available for manure application will have to apply higher rates of manure); and
- the proximity of livestock operations to streams and ditches (the closer the proximity, the greater the potential for transport of phosphorus into surface water).

As seen in the previous section on animal production systems, different sizes and species of livestock operations are associated with different types of animal housing, manure storage, and ultimately the timing, method, and rate of manure application. This means that different operation sizes and species are more or less associated with risks to water quality. Just as the predominant operation sizes and species are changing over time, the risks for water pollution are also changing. Thus, historical trends such as increases in the size of livestock operations, the density of animals, and the geographic concentration of species are impacting water quality. For more information about water quality impacts see the Water Quality Impacts Technical Work Paper.

Air quality

Animal agriculture emits several toxic and odorous contaminants into the air which are known to have potential impacts on human health and the environment. Contaminants include gases, volatile organic compounds, odorants, particulate and particulate-bound contaminants, and pathogens. Of these, ammonia, hydrogen sulfide, and methane (gases) and particulate matter have been the most extensively studied. Deposition of atmospheric ammonia is believed to contribute to acidification and eutrophication of water and soil, potentially damaging freshwater systems, forest soils, and natural ecosystems. Atmospheric hydrogen sulfide is a concern because it is eventually converted to sulfuric acid, which returns to Earth through acid rain. Increased acid concentrations in soils and freshwater ecosystems have been shown to have damaging impacts on plant and animal life. Methane is a greenhouse gas. Particulate matter can result in reduced visibility and sunlight penetration.

Emissions of air pollutants from livestock operations depend on the species of animal, the type of animal housing, and the type of manure management. Animal manure and urine are the sources of many pollutants. Atmospheric ammonia is a form of nitrogen that is lost from livestock manure and urine. The amount of ammonia given off depends upon the digestibility and nitrogen content of the animal feed, the retention of nitrogen in meat or milk, and the species of animal. Hydrogen sulfide is produced by bacteria through the decay of sulfur-containing organic compounds in animal wastes. Methane is a result of anaerobic decomposition of animal manure and decomposition in the gut of ruminant animals. Hence, a large percentage of total facility emissions are emitted during the handling and spreading of manure.

Particulate matter emissions from animal operations include wind-blown dusts from feed, dried manure, litter, and potentially endotoxins (toxins found in certain disease-causing bacteria that are released when bacteria cells disintegrate). Sources include ventilation or escape from animal housing, or manure and litter handling.

As the size of operations, animal housing, animal feed, manure management practices, and concentrations of species in particular geographic regions change, the pollutants emitted from livestock operations will also change. Hence, the trends in animal agriculture will ultimately impact air quality. For more information about air quality impacts, see the Odor and Air Quality Technical Work Paper.

Human Health Concerns

Gases, dust, odors, and pathogens

Human health can be negatively affected by gases, dust, odors, and pathogens that are emitted from animal agriculture operations and transmitted through air, soil, or water. Ammonia, hydrogen sulfide, odors, respirable dust, allergens, fungi, endotoxins, nitrates and pathogens are high priority contaminants because they can cause serious adverse health effects in humans and can be transmitted at a significant level to humans off-site.

Ammonia and hydrogen sulfide negatively affect human health because they are respiratory and eye irritants, odorants, and can temporarily paralyze olfactory and dust-cleaning mechanisms. In addition, hydrogen sulfide can cause nausea, cramps, and vomiting, decreased hemoglobin synthesis, eye injury, and even fatality during manure pit entry. Odorants can cause tension, depression, anger, fatigue, confusion, decreased vigor, and respiratory irritation. Respiratory dust, fungi and other allergens can cause asthma, irritation, rhinitis, bronchitis, and hypersensitivity pneumonitis. Endotoxins can cause fever, malaise, changes in white blood cell counts, and respiratory distress. Nitrates can cause methemoglobinemia, or "blue-baby syndrome." Pathogens can cause a wide variety of illnesses and symptoms.

Ammonia, hydrogen sulfide, and odorous compounds are transmitted via air through off-gassing from livestock and poultry confinement, manure storage pits, lagoons, or open grazing; they are also released during land application of manure. Respirable dust, endotoxins, fungi and other allergens are transmitted via air through dust, dried litter, dried manure, fur, and feathers made airborne by wind, vibration, or natural or mechanical ventilation from animal housing. They can also be transmitted via soil through fugitive dusts from soil amended with manure. Pathogens can be transmitted via soil amended with manure through direct contact or ingestion. Nitrate, odorants, and pathogens are transmitted via water through run-off from manure-fertilized fields, direct spill of manure into water, or animals defecating in water. In addition, pathogens can be transmitted to humans from ingestion of fresh market fruits and vegetables that were fertilized with manure.

As animal housing, manure storage, and manure application practices change, the transmission of gases, odors, dust, and pathogens will also change. Thus, human health will be affected by the changes taking place. For further information on the human health effects of animal agriculture, see the Human Health Issues Technical Work Paper. For further information on pathogens transmitted via fruits and vegetables, see the Soils and Manure Technical Work Paper.

Antimicrobial resistance

Many antimicrobial agents (including antibiotics) are used in animal agriculture to reduce the likelihood of infection and to promote growth. Such subtherapeutic use has been increasing over the last half of the 20th century. There is concern that this usage is leading to an increase in bacteria or fungi with developed resistance to antimicrobials. Antibiotic resistance results from the development or transference of genes that allow bacteria to circumvent the antibiotic action of a given drug. The resistant bacteria and fungi can be transferred from animals to humans. In the event that humans become infected with resistant strains, the drugs available to fight the infection may be ineffective. Resistant pathogens may include *Salmonella*, *Escherichia coli* O157:H7, *Yersinia enterocolitica*, *Listeria monocytogenes*, and *Campylobacter jejuni*. For more information on antimicrobial resistance and related human health effects, see the Human Health Issues Technical Work Paper.

Endocrine disruptors

The increasing use of growth hormones in livestock production is raising concerns about the potential human health risks of endocrine disruptors, a broad category of agents that impact the normal functioning of hormone systems. Those that represent the most likely potential risk from animal agriculture are natural compounds that mimic or antagonize the effect of sex hormones since these are the types of compounds typically administered to animals as growth hormones. An example of a hormone used in animal agriculture is bovine somatotropin (BST), which is given to dairy cows to increase milk production. Human health effects that are suspected to be linked to endocrine disruptors include premature puberty in children and reduction in male sperm count. In animal agriculture, the most likely exposure pathway for endocrine disruptors is from runoff through contaminated manure to drinking water sources. For more information on the transmission of endocrine disruptors in water, see the Water Quality Impacts Technical Work Paper. For more information on the human health effects of endocrine disruptors, see the Human Health Issues Technical Work Paper.

Bovine spongiform encephalopathy

After outbreaks in Europe starting in the late 1980s, public concern over bovine spongiform encephalopathy (BSE), or mad cow disease, has been growing. BSE in cattle is a chronic, transmissible, and fatal disease of the nervous system caused by consumption of animal feed that contains meat and bone meal from animal carcasses. Thus far there have been no cases of BSE diagnosed in the U.S. Concern over human health arises from a probable link between BSE in cattle and Creutzfeldt-Jakob Disease in humans, which negatively affects brain tissues. For more information on the human health effects of BSE, see the Human Health Issues Technical Work Paper.

Concerns over BSE are also focused on the potential devastating effects it could have on animal health and ultimately the livestock industry. The Human Health Issues Technical Work Paper and A Summary of the Literature Related to Animal Health provide information on animal health effects.

Social and Community Concerns

Land use conflict

In some areas of the State there has been an increase in the amount of land use conflict related to animal agriculture operations. The causes of conflict are generally seen to be nuisance concerns about odor; environmental and human health concerns arising from the risk of air and water contamination from improper manure handling and storage; differing rural aesthetics; and economic and social threats to traditional rural culture, including change in the economic structure of the livestock industry.

Conflict is often reflected in the nuisance complaints that are made about livestock operations, usually by neighbors of livestock operations. The neighbors may or may not be involved in agriculture themselves. The cause of complaints is overwhelmingly odor, although other causes of complaints include heavy equipment, dust, and aesthetics. In some areas, large grassroots efforts have been organized to prevent or protest livestock operations that are perceived to be the source of these nuisances.

Odor complaints are probably a result of several factors, including increasing feedlot sizes (and animal density), animal species, meteorological conditions, animal housing types, manure management practices, public perceptions, and odor sensitivity. They may also be a result of changing demographics in rural areas, including fewer people involved in agriculture, more migration into rural areas by non-rural citizens, and increased farm/non-farm interface on the landscape. These demographic changes result in differing values between farm and non-farm people about the ways land should be used and the amenities it should provide.

For more information on land use conflict, see the Land Use Conflicts Technical Work Paper. For more information on odor complaints, see the Land Use Conflicts Technical Work Paper and the Air Quality and Odor Technical Work Paper. For more information on nuisance complaints, see the Social and Community Impacts Technical Work Paper.

Community vitality

Changes in animal agriculture have been linked to concerns about the vitality of rural communities. Concerns mainly focus on reduced quality of life and social capital in rural communities. Social capital is the trust, mutual reciprocity, and sense of shared future between individuals, and the ability to work constructively for the good of the community. It forms the fabric of family and community life.

Changes in animal agriculture have resulted in reduced quality of life for small- to mid-size producers who must often juggle off-farm work with farm work and family time to provide sufficient income for the family. Neighbors of large confinement facilities, who must deal with odors, dust, and other annoyances which interfere with the enjoyment of their property, also have reduced quality of life. Reduced social capital in rural communities is reflected in the decreasing level of individual and community trust in core government institutions at the State and local levels, in a lack of shared vision of the future for their communities, and by a break down in informal community dialogue and interpersonal relationships. For more information on the social and community impacts of changes in animal agriculture, see the Social and Community Impacts Technical Work Paper.

Animal Health and Well-Being Concerns

Concern over the health and well-being of farm animals ranges from maintaining the capacity of livestock to grow and reproduce (to fulfill their economic role in the livestock operation) to maintaining a reasonable quality of life for livestock (to fulfill their natural lives as animals). Fulfilling the economic role of livestock focuses mainly on animal health, such as preventing and treating parasites, disease, and its symptoms and providing proper nutrition. This has become more of a concern with the rise in the use of confined animal housing systems with concentrated populations of animals, since one case of sickness or disease can quickly spread to the entire population housed there. Diseases such as bovine spongiform encephalopathy (BSE) in cattle, or mad cow disease, are of particular concern because of their potential to devastate entire herds. Fulfilling the natural lives of livestock focuses on animal well-being. Animal well-being includes animal health, but also includes considerations such as the ability of animals to use their natural adaptations and capabilities; to be free from prolonged and intense fear, pain, and other negative states and by experiencing normal pleasures; and to have satisfactory health, growth and normal functioning of physiological and behavioral systems. These considerations have also become more of a concern with the rise in more intensive confinement production systems. Specific concerns include osteoporosis in crate-housed sows (downer sows) and reduced fertility in dairy cows, along with the inability of animals to move freely about and the display of stress behaviors.

Because the goals of maintaining animal well-being go beyond that of maintaining animal health, there is disagreement over what the goals of livestock treatment should be. Many people involved in livestock industries focus on animal health, while the non-agricultural public tends to have more ethical concerns based on animal well-being. This can create conflict between these two groups. However, animal health and animal well-being are closely related, and issues in one area cross over and affect the other. These issues will continue to intersect as the size, intensity, and production practices of livestock systems change. For more information about the effects of production practices on animal health and well-being, see the Farm Animal Health and Well-Being Technical Work Paper. A Summary of the Literature Related to Animal Health also includes information on these topics.

Governmental Concerns

The role of government in animal agriculture is difficult and controversial. It is difficult because livestock operations number in the tens of thousands and range from very small to very large. In addition, the impacts (such as water, air, and human health effects) are not always apparent, and significant scientific uncertainty remains for at least some of the asserted impacts. It is controversial because the livestock industry is rapidly changing, there are significant social and economic concerns related to farming (especially family farms), there is a long history of environmental exemptions for agricultural operations, there are new air pollution and catastrophic spill concerns due to the introduction of very large concentrated feeding operations, and non-farmers are increasingly brought into contact with farming operations due to new rural development patterns.

These factors have led to many concerns, especially as government has come to play a more prominent role in animal agriculture. From a public policy perspective, there are concerns about what the goals of government policies and programs should be. There are also concerns about the effectiveness of government policies and programs in meeting their intended goals.

For producers, there is a myriad of policies and agencies that administer them. Some can be overlapping or even can seem to be in direct conflict. The process of compliance or participation can also be extremely time consuming. This can be confusing and introduce considerable uncertainty into managing a livestock operation, as well as significant costs.

For citizens, which entity is responsible for enforcement of regulations is often unclear, and enforcement itself often seems sketchy and to rely too extensively on citizens as “watch dogs.” This can aggravate local conflicts and erode public confidence in government.

The ways in which agriculture is changing shape how policies are developed, the effectiveness of those policies, and ultimately the ways in which government is involved in agriculture. For more information on issues related to governmental policies and programs, see the Role of Government Technical Work Paper.

Opportunities

Quality of Life

The changes in animal agriculture have resulted in increased quality of life for some producers. Producers who have expanded their operations say they have increased flexibility in labor scheduling, an opportunity to take time off, and also an ability to remain in agriculture. For these producers, the changes in animal agriculture have created new opportunities. For more information on quality of life changes, see the Social and Community Impacts Technical Work Paper.

Stewardship

The environmental concerns outlined above have created a greater awareness of and information about environmental issues among producers, institutions, and the general public. This increased awareness and knowledge can result in improved management practices, increased incentives for better environmental stewardship (or penalties for poor stewardship), and ultimately better stewardship of natural resources affected by animal agriculture. For more information about opportunities for improved stewardship, see the Soils and Manure, Water Quality Impacts, and Air Quality and Odor Technical Work Papers.

Soil Quality

The use of manure on cropland can improve the biological and physical properties of soil in terms of soil structure, water infiltration, pH, soil respiration, bulk density, available-water holding capacity, and soil organisms. This makes the soil more productive and less erosive. Fertilizer use does not result in these benefits. For more information on soil quality effects, see the Soils and Manure Technical Work Paper.

Economics

Economic value of manure

Manure provides valuable crop nutrients such as nitrogen, phosphorus, and potassium and as such is an alternative to commercial fertilizers. The economic value of manure increases as the price of fertilizer increases. Since fertilizers are usually produced with natural gas, their price is linked to energy prices. In times of rising energy prices or energy shortages, the economic value of manure will increase. For more information on the economic value of manure, see the Soils and Manure Technical Work Paper.

Marketing alternatives

At the same time that traditional markets have shrunk, smaller niche markets have increased. Niche markets focus on particular unique aspects of the products sold, such as “free-range” or “antibiotic free” and often bring higher prices than traditional or conventional markets. These niche markets create increased marketing alternatives for producers, and also can create increased opportunities for higher income. For more information about marketing alternatives, see the Economic Structures, Profitability, and External Costs Technical Work Paper.

Education

The existence of disagreement and conflict provides an incentive for increased dialogue between the parties involved. The issues surrounding animal agriculture can present an opportunity for more discussion between producers and other community members. Ideally, this could lead to increased understanding of agriculture by the general public, and ultimately to food, environmental, and other agriculture-related policies that meet the needs of both groups. For more information on conflict resolution, pubic dialogue, and education, see the Land Use Conflicts and Role of Government Technical Work Papers.

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Introduction June 2