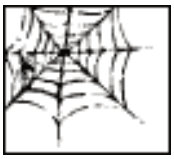
Archived Publication

This information provided in this document is for reference. Please be aware that the information in this document may be outdated or superseded by additional information.



EPA promulgated regulations for Concentrated Animal Feeding Operations (CAFOs) in February 12, 2003 that expanded the number of operations covered by the CAFO regulations and included requirements to address the land application of manure from CAFOs. The rule became effective on April 14, 2003. NPDES-authorized states were required to modify their programs by February 2005 and develop state technical standards for nutrient management. On February 28, 2005, in response to litigation brought by various organizations, the Second Circuit court issued its decision in *Waterkeeper Alliance et al. v. EPA*, 399 F.3d 486 (2d Cir. 2005). EPA has updated the CAFO rule to reflect the changes requested by the Court. Visit www.epa.gov/npdes/caforule to view the 2008 CAFO Final Rule and supporting documents.

APPENDIX B

ANIMAL SECTOR DESCRIPTIONS

APPENDIX B. ANIMAL SECTOR DESCRIPTIONS

The poultry, swine, dairy, and beef industries constitute the principal sectors of animal agriculture in the United States. The majority of animal feeding operations (AFOs) that are defined as concentrated animal feeding operations (CAFOs) are in one of these four sectors. In addition to operations in these four principal sectors, there are also a number of veal calf, sheep, duck, and horse animal feeding operations that may meet the definition of a CAFO and be subject to NPDES permit requirements. The text that follows provides a general overview of the principal sectors, including descriptions of production and waste management practices to provide a general understanding of the nature of each of these sectors. The production and waste management practices described are those most likely to be encountered on CAFO-size operations. It is not intended for this document to describe all the possible practices and combinations of practices that may be encountered, since that number is sizable.

Poultry

The poultry sector has three principal segments: chickens - broilers, chickens - laying hens, and turkeys. In each of these segments, production and waste management practices are probably more uniform than in the swine, dairy, and beef industries.

Chickens - Broilers

Broiler refers to a meat-type chicken typically slaughtered at about 7 weeks of age at a live weight of about 5 pounds. This size of bird is the principal product of the broiler sector within the poultry industry. However, there is also some production of younger birds, identified as squab broilers, Cornish game hens or Rock-Cornish crosses, as well as older birds known as roasters. Squab broilers are typically slaughtered at about 4 weeks of age at a live weight of about 2.25 to 2.5 pounds. Roasters are generally slaughtered at about 8 to 10 weeks of age at a live weight of 6 to 8 pounds. Typically, 5 to 6 flocks of broiler chickens will be produced annually. Because squab broilers and roaster boilers differ in the length of their grow-out cycle (the time to reach slaughter weight), more flocks of squab broilers and fewer flocks of roasters are produced annually. All broilers are typically fed corn-soybean-based diets, which may also include various cereal grains and a variety of other ingredients. Grain sorghum may be substituted for corn. Essentially all broiler-type chicken production is vertically integrated; that is under contract with the grower, the integrator supplies the birds, the feed, and any pharmaceuticals required. The grower supplies the production facility and labor. With vertical integration, the integrator retains ownership of the live birds, but disposal of the manure and dead birds generated is the responsibility of the grower.

Confinement Facilities

Almost all broiler chicken production occurs in either totally or partially enclosed structures. Partially enclosed structures have partially open side walls that can be covered by curtains during periods of cold weather. A combination of natural and mechanical ventilation is used to remove heat and moisture from partially enclosed facilities. Mechanical ventilation is used with totally enclosed structures, known as controlled environment housing, or, more commonly, tunnel-type housing.

Broiler houses are normally divided into three chambers. One chamber, referred to as the brood chamber, is used to house day-old chicks (biddies). Until the age of about 2 to 3 weeks, chickens are unable to maintain a constant body temperature and require supplemental heat. Thus, brood chambers are heated at the beginning of the grow-out cycle. As the birds grow and heating requirements are reduced, the second and third chambers are opened sequentially to provide more floor space per bird. In cold weather, broiler houses are heated throughout the grow-out cycle to maximize feed conversion efficiency and the rate of weight gain.

Manure Management

All broiler-type chickens are raised unconfined within the production facility on litter, which has the primary function of absorbing the moisture in the excreted manure. Litter materials vary depending on availability and cost, but they are usually sawdust, wood shavings, peanut hulls, or rice hulls.

Normally, litter and accumulated manure, also commonly called litter, are only removed from the entire house every 1 to 3 years after 5 to 15 or more flocks of birds have been produced. The industry refers to this as a total clean-out. When total clean-outs do not occur on a yearly basis, litter and accumulated manure may be removed annually from the brood chamber. This is known as a brood chamber clean-out. Following both total and brood chamber clean-outs, the litter is replaced.

During each production or grow-out cycle, a material known as crust or cake will form along feeder and waterer lines. In these areas, the amount of manure excreted is higher than in other areas of the house, and moisture from the manure and waters tends to bind the mixture of litter and manure together, forming large clumps. As watering systems have improved, the amount of crust formed during each grow-out cycle has decreased. Crust is usually removed after every flock of birds produced. The remaining litter and accumulated manure may be covered (top dressed) with a relatively thin layer of new litter if the amount of crust removed is high.

Historically, total and brood chamber clean-out litter and crust have been either applied to crop land immediately, if crop production activities permitted, or stored in uncovered piles until land was available for disposal. Over the last several years, structures have occasionally been used to store crust. However, construction cost has generally precluded the use of such storage structures for litter generated by total and brood chamber clean-outs some producers use. The timing of these clean-outs has shifted somewhat from late fall and early winter, as the industry has become more sensitive to the impact on water quality of litter stored in uncovered piles. It is acceptable for litter to be stored under a tarp as long as rain and runoff is diverted around the pile in lieu of constructing covered storage facilities. Temporary short-term stacking of litter (i.e., 2 weeks) on or near a field where it will be applied may also be an acceptable handling provided manure is applied in a timely manner. For example, Maryland Agriculture Extension allows litter stacked at the field for no longer than two weeks.

Mortality Management

With broilers, the highest rate of mortality normally occurs during the first 2 weeks of the grow-out cycle, but continues at a lesser rate throughout the rest of the cycle. Typically, about 4.5 to 5 percent of the birds housed will die during the grow-out cycle although the typical mortality for roasters is about 8 percent. To prevent the possible spread of disease, dead birds must be removed at least daily, if not more frequently. As mentioned earlier, the disposal of dead birds is the responsibility of the grower. Several options are available for dead bird disposal. Composting is one of the more desirable approaches and has been heavily promoted by the industry. As an alternative to composting or burial, at least one integrator has been distributing freezers to preserve carcasses for subsequent disposal by rendering.

Catastrophic losses of broiler chickens also occur, especially during periods of extremely hot weather but also during weather events such as hurricanes, tornadoes, and snow or ice storms. Catastrophic losses of broilers from excessive heat are usually more severe with older birds. There are also several options for disposal of catastrophic losses, with burial being the most common practice. (Note, that burial is prohibited or highly regulated in some states.) Large-scale composting is another, and probably more desirable, option from a water quality perspective.

Chickens - Laying Hens

A laying hen is a chicken maintained for table egg production. The production cycle begins with the placement of young birds, normally 14 to 16 weeks of age, in the production facility and ends 11 to 12 months later when the birds are removed. These birds, known as spent hens, may be slaughtered for meat for human or pet foods or disposed of by rendering. More than three-fourths of layer farms molt their birds followed by a second period at egg production. Routine molting by withholding or restricting feed is the most common method. Placement and removal of birds are on an "all in—all out" basis. Typically, laying hens are also fed corn- and soybean-based diets, which may also include various cereal grains such as wheat and barley and a variety of other ingredients.

Although the table egg segment of the poultry sector is less vertically integrated than the broiler sector, vertical integration is becoming more common. However, the egg producer is typically responsible for both manure and dead bird disposal if under contract with an integrator or an independent operator.

Slightly more than 10 percent of all layer farms have pullet raising facilities on the farm. Pullets are young chickens, usually less than 20 weeks of age, often raised for the purpose of egg production. Pullet houses are similar in construction to broiler houses.

Confinement Facilities

Most egg production occurs in totally enclosed facilities with mechanical ventilation for temperature control and moisture removal, but partially open-sided houses may be encountered in warm climates. Unlike broilers, laying hens are confined in cages and no litter or bedding material is used.

Manure Management

Manure produced by laying hens is handled both as a liquid or slurry and as a solid, with handling as a liquid or slurry being more common in older production facilities. As older production facilities are replaced, however, handling laying hen manure as a liquid or slurry is becoming less common every year. When laying hen manure is handled as a liquid or slurry, flushing or scraping is used to remove laying hen manure from the production facility. With scraping systems, a tank or an earthen structure is usually used for storage if the manure is not applied directly to crop land, while flush systems use an anaerobic lagoon for stabilization and storage. Typically, the lagoon is the source of the water used for flushing, although fresh water may be used in rare instances.

To handle laying hen manure as a solid, a two-story production facility, known as a high-rise house, is used. In a high-rise house, the caged hens are located on the second floor of the building, with the first floor used for manure drying and storage. The primary factor responsible for drying is biological heat production in the accumulating mass of manure that causes evaporation of the moisture in the manure. Ventilation systems for high-rise houses are designed to move air from intakes along the eaves of the house roof down through the caged hens and over the mass of accumulating manure before exiting the house, thus removing the moisture evaporated from the manure. Critical to the successful operation of a high-rise house is the avoidance of leaks in the bird watering system and proper exterior grading to direct surface runoff away from the building. Because of the microbial activity in the accumulating mass of manure, which is responsible for the heat generated and the evaporation of manurial moisture, stabilization occurs and storage for 1 or more years is provided. Typically, manure is removed from high-rise houses yearly between flocks of hens, but storage for 2 to 3 years is possible.

The majority of eggs marketed commercially in the U.S. are washed using automatic washers. Cleaning compounds such as sodium carbonate, sodium metasilicate, or trisodium phosphate, together with small amounts of other additives, are commonly used in these systems. Wash water is contaminated with shell, egg solids, dirt, manure, and bacteria washed from the egg surface into the recycled water. Eggs may be washed either on farm or off farm. Over three-fourths of layer farms process eggs off farm, though one-third of the largest farms are likely to wash eggs off farm. Operations that wash their eggs on farm may do so in-line or off-line. Larger operations commonly collect and store egg wash water on site in large tanks or lagoons for treatment and storage.

Mortality Management

It can be expected that about 1 percent of the started pullets housed will die each month through the laying cycle. To prevent the possible spread of disease, dead birds must be removed from cages daily, if not more frequently. As mentioned earlier, disposal of dead birds is the responsibility of the grower. Several options are available for dead bird disposal. Of these options, composting is one of the more desirable approaches.

Catastrophic losses of laying hens also occur. Loss of power and mechanical ventilation during periods of extremely hot weather is the most common cause of loss. Weather events such as hurricanes and tornadoes can also cause catastrophic losses. Several options are available for the disposal of catastrophic losses, with burial being the most common. (Note, that burial is prohibited or highly regulated in some states.) Large-scale composting is another, and probably more desirable, option from a water quality perspective.

Turkeys

Turkey production is similar to broiler chicken production in many respects. The grow-out period for female or hen turkeys is usually about 14 to 16 weeks, resulting in a live weight at slaughter of between 13 and 20 pounds. However, the usual grow-out period for toms or male turkeys is longer, ranging from 17 to 21 weeks, resulting in a live weight at slaughter of between 30 and 37 pounds. Typically, two flocks of turkeys are produced annually because of the longer

grow-out cycle and the somewhat seasonal demand for turkey. Turkeys are primarily fed corn- and soybean-based diets, which may also include various cereal grains and a variety of other ingredients.

Vertical integration is also extensive in the turkey sector of the poultry industry, with the same distribution of responsibilities between the integrator and grower as in the broiler sector.

Confinement Facilities

Like broiler production, essentially all turkey production occurs in partially or totally enclosed facilities that are divided into two or three chambers. Initially, only one chamber, also known as the brood chamber, is used; this is the area where the newly hatched turkeys, known as poults are placed. Like broiler chicks, poults are unable to maintain a constant body temperature until about 6 to 8 weeks of age and thus require supplemental heat. Brood chambers for turkeys, therefore, are also heated at the beginning of the grow-out cycle. As with broiler chickens, the second or the second and third chambers are opened to provide more floor space per bird as the birds grow. In cold weather, some heat may be provided throughout the grow-out cycle.

Some turkey producers use separate brood and growing houses and move the birds from the brooding house to the growing house after about 6 to 8 weeks. Another production practice is to use the brood chamber in a house exclusively for brooding and use the remainder of the house for grow-out after the birds reach the age of 6 to 8 weeks. These management systems are known as two-age management systems. Such systems produce more flocks each year than single-age farms.

Manure Management

As with broiler chickens, turkeys are raised unconfined in the production facility on litter, typically sawdust or wood shavings. Total clean-out of brood chambers and brood houses after each flock is common, as is total clean-out of growing chambers or houses annually. Crust removal between flocks followed by top dressing with new litter also occurs in the production of turkeys.

In the turkey sector, the use of litter sheds to store crust and total clean-outs from brood chambers or brood houses is also emerging. When land is not available for disposal, storage of these materials in uncovered piles is common.

Mortality Management

Typically, about 5 to 6 percent of hens and 9 to 12 percent of toms will die during the grow-out cycle, with the highest rate of loss occurring during the initial weeks. As with broilers and laying hens, dead birds must be removed daily, if not more frequently with dead bird disposal being the responsibility of the grower. Again, several options for dead bird disposal are available; composting is one of the more desirable approaches from a water quality perspective.

Catastrophic losses of turkeys occur during periods of extremely hot weather, but they may also be due to weather events such as hurricanes, tornadoes, and snow or ice storms. Older turkeys, like older broilers, are more susceptible to catastrophic losses during periods of extremely hot weather. There are several options for disposal of catastrophic losses, with burial being the most

common practice. (Note, that burial is prohibited or highly regulated in some states.) Large-scale composting is another, and probably more desirable, option from a water quality perspective.

Swine

The production cycle for hogs has three phases. It begins with gestation and farrowing (birth). After farrowing, the newly born pigs or piglets are normally nursed for a period of just under 3 to 4 weeks until they reach a weight of 10 to 15 pounds. The average pig weaning age is 17 days, but may approach 4 weeks at smaller operations. Over 97 percent of large farms wean at less than 21 days. The production phase after weaning is known as the nursery phase where pigs are fed a starter ration until they reach a weight of 40 to 60 pounds. At this point, they are 8 to 10 weeks of age. The average age for leaving the nursery is 63 days. The third phase of swine production is the growing-finishing phase in which the gilts (young females) and young castrated boars (males) not retained for breeding are fed until they reach a market weight, typically between 240 and 280 pounds. In this phase of swine production, hogs are fed a growing ration until they reach 120 pounds in weight, which is then followed by a finishing ration. Growing-finishing usually takes between 15 and 18 weeks. Hogs are normally slaughtered at about 26 weeks of age. After weaning, swine are typically fed a corn- and soybean-meal based diet which may include small grains such as wheat and barley and other ingredients until slaughtered.

Swine operations can be of several types. The most common is the farrow-to-finish operation that encompasses all three phases of swine production. Other operations specialize in either feeder pig production or the growing-finishing phase of swine production. Although not common, specialization in either the gestation-farrowing or the nursery phase of the swine production cycle may also occur. Larger grow-finish operations are more likely to obtain feeder pigs from off-site sources. Vertical integration is becoming more common in the swine industry.

Confinement Facilities

The swine industry uses confinement systems ranging from pasture without and with shelters to total confinement, where pigs are confined in pens or stalls. Open paved or unpaved lots with access to a building or huts for shelter are also used, but larger operations will use total confinement 99 percent of the time because of higher feed conversion efficiency and weight gain as well as lower labor costs.

Total confinement facilities for swine are similar in many respects to facilities used for broiler production, except that the pigs are confined in pens. These pens may be totally enclosed or they may have partially open side walls that can be closed with curtains during cold weather. Totally enclosed facilities are mechanically ventilated, whereas facilities with partially open side walls use a combination of natural and mechanical ventilation.

Manure Management

Four principal types of waste management systems are used with total confinement housing in the swine industry: deep pit, pull plug pit, pit recharge, and flush systems. The deep pit, pull plug pit, and pit recharge systems are used with slatted floors, whereas flush systems can be used with either solid or slatted floors.

Deep pits are normally sized to collect and store 6 months of waste. When they are emptied, the accumulated manure may be disposed of directly by land application or transferred to either storage tanks or earthen storage ponds for later disposal by land application.

Pull plug pit systems use relatively shallow pits to collect manure. These pits are usually drained to a storage tank or an earthen storage pond every 1 to 2 weeks.

Pit recharge systems also use relatively shallow pits that are drained periodically to an anaerobic lagoon. Although the frequency of draining varies, between 4 and 7 days is standard. After the pit is drained, the empty pit is partially refilled with supernatant from the anaerobic lagoon, which differentiates this system from the pull plug pit system — hence, the name pit recharge.

Flush systems use either fresh water or, more commonly, supernatant from an anaerobic lagoon to transport accumulated wastes to that lagoon daily or more frequently. Because pigs will defecate as far away from their feeding and resting areas as possible, facilities with solid floors will usually have a flush channel formed in that area. Facilities with slatted floors usually form a series of parallel flush channels in the shallow pit under the slatted floor.

Mortality Management

In swine production, the highest rate of mortality occurs in young piglets within 3 to 4 days of birth. Typically, about 10 to 12 percent of piglets will die before weaning. Between 2 to 4 percent of the pigs die during the nursery stage and during the grow-finish stage. Several approaches are used for dead pig disposal, with burial being the most common. Composting and incineration are also used but primarily for piglets. Although older pigs can be disposed of by composting, disposal through rendering is the more common alternative to burial.

Catastrophic losses of swine also occur but they are primarily due to extreme weather events such as hurricanes, tornadoes, and the like. Heat losses are less common in the swine industry, because pigs, unlike birds, possess sweat glands that help to regulate body temperature. The primary effects of periods of high temperatures on swine production are a reduced feed conversion efficiency and a reduced rate of weight gain. Burial is a practical option for the disposal of large numbers of swine carcasses, although rendering could be feasible as well. (Note, that burial is prohibited or highly regulated in some states.)

Dairy Cattle

The production cycle in the dairy industry begins with the birth of a calf, which causes the onset of lactation or milk production. A period of between 10 and 12 months of milk production is normally followed by a 2-month dry period to allow for physiological preparation for calving. At the time that milking is normally stopped, a cow will be in the seventh month of a 9-month pregnancy. Thus, a mature dairy cow produces a calf every 12 to 14 months. This frequency of calf production is necessary to maintain a cost-effective level of milk production. Average U.S. milk production is about 17,000 pounds per cow per year. However, herds with averages of 22,000 to 24,000 pounds of milk per cow per year or higher are not unusual.

About 25 percent of a milking herd is typically replaced each year, but replacement levels can be as high as 40 percent for intensively managed herds. Mature cows are replaced or culled for a

variety of reasons, including low milk production and diseases such as mastitis, which is an infection of the udder. Lameness, injury, belligerence, and reproductive problems are also reasons for culling. Nearly all culled dairy cows are slaughtered for beef used in processed foods or in higher quality pet foods.

Roughly 50 percent of the calves produced by dairy cows are bulls. Because most dairy cows are bred using artificial insemination, the industry has little demand for bull calves. Although some dairy farms will have one or more breeding age bulls for cows that will not conceive by artificial insemination, most bull calves are sold for either veal or beef production.

Because of the continuing need for replacement cows, approximately 50 percent of the female calves born are raised as replacements. Those animals selected as replacements are usually progeny of cows with a record of high milk production. Female calves not raised as replacements are also sold for either veal or beef production.

Female calves retained as replacements are either raised on-site or transferred off-site to an operation that specializes in producing dairy cattle replacements. In this second scenario, the calves may be sold to the replacement operation with the same or other animals purchased back at a later date or raised under contract. In the dairy industry, both male and female animals are called calves up to an age of about 5 months. From the age of 6 to 24 months, females are called heifers, with first calving typically occurring at 24 months of age. Replacements raised off-site may be purchased or returned either as unbred or open (not pregnant) heifers at an age of about 13 months or as bred heifers at an age usually of 22 to 23 months. Three groups of animals will be present on dairy farms that raise replacements on-site: calves, heifers, and mature lactating and dry (mature nonlactating) cows. Usually, the total number of calves and heifers present will be between 50 and 60 percent of the size of the milking herd.

Lactating dairy cows are milked at least twice per day. Milking three times a day has become more common, especially with higher milk producing herds. With the exception of young calves until weaning, dairy cattle are fed a roughage-based diet or ration composed primarily of silages and hays supplemented with feed grains and by-product feedstuffs to ensure adequate levels of energy, protein, minerals, and other essential nutrients. Citrus pulp, beet pulp, meat and bone meal, and cottonseed meal are examples of by-product feedstuffs. Young calves are initially fed colostrum, which is the milk produced during the first 4 to 5 days after calving that cannot be marketed, and then a milk replacer until weaning and a complete shift to a roughage-based ration.

Confinement Facilities

The free-stall barn is the predominant type of housing system used on larger dairy farms for lactating cows. In a free-stall barn, cows are commonly grouped by stage of lactation in large pens with free access to feed bunks, waterers, and stalls for resting. The standard free-stall barn design has a feed alley in the center of the barn separating the two feed bunks on each side. On each side of the barn is an alley between the feed bunk and the first row of free-stalls and an alley that extends between the first row of free-stalls facing the feed bunk and a second row of free-stalls facing the side wall of the structure. These are the primary areas of manure accumulation, with little manure defecated in the free-stalls. There may or may not be access to an outside dry lot for exercise or to a pasture for exercise and grazing. In warmer climates, cows may simply be confined in a dry lot with unlimited access to feed bunks, waters, and usually an open structure to provide shade.

With both free-stall barns and dry lot production facilities, milking occurs in a specialized facility known as a milking center. A milking center has three components: a holding area where cows are held prior to milking, a milking parlor where the cows are milked, and an area where milk is stored in refrigerated tanks, known as bulk tanks, until picked up for processing and the milking equipment is cleaned. Holding areas may be either enclosed or open areas depending largely on climate.

There are two predominant housing systems for unweaned calves: individual pens in an enclosed building and hutches that tend to reduce disease problems. Hutches are small, lightweight structures, typically of fiberglass or plywood construction, that can be easily moved. Individual hutches, sized for one calf, are located in a small fenced area to provide shelter from inclement weather as well as access to fresh air and sunlight. Hutches are routinely relocated to reduce disease transmission. Older calves are either housed in pens as groups in a totally or partially enclosed building or in portable super hutches in a small fenced area.

Heifers are most commonly raised on dry lots with or without shelter, but may also be raised on pasture or in dedicated free-stall barns. Dry cows may be removed from the milking herd to dry lots, pasture, or dedicated free-stall barns.

Manure Management

Manure is removed from free-stall barn alleys at least daily, and often more frequently, by either scraping or flushing. A mechanical scraper or a tractor-mounted blade is used to move the manure to a collection pit at one end of the barn. From the collection pit, manure is transferred by pump or gravity to a tank or an earthen pond for storage until disposal by land application. Milking center wastewater may be added to these collection pits to facilitate pumping or gravity flow, since scraped dairy cow manure is quite viscous with a total solids content of around 12 to 13 percent. With scrape systems, other options for managing milking center wastewater, which is generated when the milking parlor and milking equipment are cleaned, are transfer directly into the manure storage structure or transfer to a dedicated lagoon.

Flush systems are the most common in warmer climates where flush water is unlikely to freeze. Flush systems for dairy cattle operate like flush systems for swine and laying hens, with the

manure and flush water discharged into an anaerobic lagoon, which is normally the source of the water used for flushing. With flushing systems, milking center wastewater usually is transferred to the lagoon used for manure stabilization and storage.

Manure accumulations on dry lots for lactating cows are typically removed by scraping with a tractor-mounted blade and handled as a solid. Areas by feed bunks may be scraped daily, with longer intervals between manure removal in other areas of the lot. Areas by feed bunks may also be flushed. Manure accumulations in dry lots used for heifers and dry cows are usually removed by scraping and are handled as a solid. If manure removed from dry lots by scraping is not land applied immediately, it is stored by stacking on a section of the lot or at a separate site. Calf and heifer manure may be transferred from a scraped free-stall barn to the storage structure used for manure, or the lagoon used for flushed manure, or it may be handled as a solid, depending on the methods of calf and heifer confinement and the handling system used for the manure from the lactating cows.

Dry lots should have runoff collection and retention basins to prevent the discharge of manure-contaminated runoff to adjacent surface waters. The design and management of these retention basins will be discussed in a later session in this course.

Mortality Management

Although the frequency of mortality in the dairy industry is much less than in the poultry and swine industries, deaths do occur. Usually, carcass disposal is by rendering, with burial being the only other realistic option if no rendering facility willing to accept dead animals is located within a reasonable distance of the farm. (Note, that burial is prohibited or highly regulated in some states.) Carcass composting could be an option for the disposal of young calf carcasses, but it would not be feasible for older animals because of their size and the degree of carcass dismemberment that would be necessary.

Veal Calves

Veal calf operations raise calves for slaughter. Typically these operations raise male dairy calves. Most veal calves are raised to about 16 to 20 weeks of age, when they weigh about 450 pounds. About 15 percent of veal calves are marketed at 3 weeks of age, when they weigh about 150 pounds. Calves typically spend their entire growing-out period in individual stalls or pens in an environmentally controlled building with wood or plastic coated metal slat floors. Manure is typically handled in a liquid waste management system with tanks, pits, and lagoons used to store manure until it is spread on fields. Prior to weaning, a cow/calf pair counts as one animal when confined in a pen, lot, barn, or stable. Veal calves are normally separated from the cows within 3 days after birth. After being separated from the cow, the veal calf counts as one animal.

Beef Cattle

There are three different types of operations in the beef industry, with each type corresponding to a different phase of the production cycle. The first is the cow-calf operation that is the source of the heifers and steers (castrated males) fed for slaughter. Cow-calf operations typically maintain a herd of yearling heifers, brood cows, and breeding bulls on pasture or range land to produce a yearly crop of calves for eventual sale as feeder cattle. In colder climates and during drought conditions, cow-calf operations using pasture or range land will provide supplemental feed, primarily hay but also some grain and other feedstuffs. Confinement on dry lots is also an option used in some cow-calf operations when grazing will not satisfy nutritional needs. Although pasture or range-based cow-calf operations are most common, operations that exclusively use dry lots may be encountered. In colder climates, cow-calf operations may have calving barns to reduce calf mortality.

The second type of operation in the beef industry is known as a backgrounding or stocker operation. These operations prepare weaned calves for finishing on high energy rations to promote rapid weight gain. Backgrounding operations may be pasture or dry-lot based, or some combination thereof. Relatively inexpensive forages, crop residues, and pasture are used as feeds, with the objective of building muscle and bone mass without excessive fat at a relatively low cost. The length of the backgrounding process may be as short as 30 to 60 days or as long as 6 months. The duration of the backgrounding process and the size of the animal moving on to the finishing stage of the beef production cycle depend on several factors. High grain prices favor longer periods of backgrounding by reducing feed costs for finishing or fattening, while heavier weaning weights shorten the finishing process. Backgrounded beef cattle may be either sold to a finishing operation as “feeder cattle,” usually at auction, or raised under contract with a finishing operation. It is common for large finishing operations to have cattle backgrounded under contract to ensure a steady supply of animals. In some instances cow-calf and backgrounding operations will be combined.

The final phase of the beef cattle production cycle is the finishing or feedlot phase where a high energy, grain-based ration with only a small amount of roughage is fed to produce rapid weight gain and desirable carcass characteristics. The larger commercial finishing operations usually feed a complete ration that is a mixture of feed grains, roughage, and other ingredients. Smaller “farmer-feeder” operations generally feed grains and roughage separately. Usually, the finishing phase begins with 6-month old animals weighing about 400 pounds. Somewhere between 150 and 180 days, these animals will reach the slaughter weights of 1,050 to 1,150 pounds for heifers and 1,150 and 1,250 pounds for steers, and a new finishing cycle begins. Some feedlot operators will immediately start with younger animals weighing about 275 pounds or older or heavier animals. This will either extend the finishing cycle to about 270 days or shorten it to about 100 days. Beef cattle in the finishing phase are known as “cattle on feed.” Finished cattle are “fed cattle.”

Confinement Facilities

With the exception of pasture or range-based cow-calf and backgrounding operations, beef cattle are almost exclusively raised on unpaved or partially paved open lots. When feedlots and dry lots on cow-calf and backgrounding operations are partially paved, it is the areas around feed bunks and sources of drinking water that will be paved. These are high animal traffic areas and have high rates of manure accumulation. Use of partially or totally enclosed buildings for beef cattle production is rare and limited to small operations in colder climates.

A typical beef cattle feedlot is divided into a series of large pens to allow animals to be grouped by age. In each pen, there are feed bunks, sources of drinking water, and probably shaded areas in warm climates. Feed bunks located along one side of a pen are known as fence line feed bunks, and feed is delivered with specially equipped trucks or tractor-drawn feed wagons from a feed alley. Mechanical feed bunks may be located in the center of a pen or used as a divider between two pens. Although mechanical feed bunks allow cattle to feed on both sides of the feed bunk, their use is generally limited to smaller operations. Feed bunk space per head is an important parameter in beef cattle feedlot design. The large commercial feedlots will also have a feed mill and an area for treating sick animals.

Manure Management

Manure produced by beef cattle on open lots is primarily handled as a solid, with removal by scraping. Removal normally occurs only between groups of animals, but certain areas of a lot may be scraped more frequently, with the collected manure stored in mounds on the lot. The areas scraped most frequently are those around feed bunks and sources of drinking water, where the rates of manure accumulation are the highest. The complete removal of manure from open lots used for beef cattle production may only occur annually during summer months to take advantage of natural drying to facilitate handling as a solid.

Open lots for beef cattle should also have runoff collection and retention basins to prevent the discharge of manure-contaminated runoff to adjacent surface waters.

Mortality Management

As in the dairy industry, the frequency of mortality in the beef cattle industry is much lower than in the poultry and swine industries; however, deaths do occur. Carcass disposal by rendering is the primary option. Given the size of most beef cattle operations, burial cannot generally be considered a realistic alternative in the context of water quality protection.

Land Application of Manure

Livestock and poultry manures have value as sources of plant nutrients for crop production. Historically, livestock or poultry production and crop production have been integrated activities. As animal production units have been consolidated into fewer but larger operations, a decoupling of animal and crop production activities has gradually occurred. Thus, many livestock and poultry producers do not have adequate land for the disposal of the manure that is generated.

Manure handled as a solid, such as broiler and turkey manure, is surface applied to cropland using either tractor-drawn or truck-mounted box-type manure spreaders. To reduce potential pollutant transport in surface runoff, disking or plowing may follow application to incorporate the manure into the soil. Manure handled as a semi-solid or slurry, such as dairy cattle manure removed from free-stall barns by scraping, is applied to cropland using tractor-drawn or truck-mounted tanks. This type of manure typically can be surface applied and may be subsequently incorporated into the soil by disking or plowing. Manure handled as a semi-solid may also be directly injected into the soil using specially designed spreading equipment. Manure handled as a liquid, such as flushed dairy and swine manure, may be applied to cropland using tractor-drawn or truck-mounted tanks or irrigation systems. Due to the volume of manure when handled as a liquid, irrigation is a fairly common method for land application of liquid manure due to the reduction in labor requirements.

In the last 25 years, much has changed in the feedlot industry. In an analysis conducted by the USDA NRCS, animal feeding operations were categorized as to their ability to utilize nutrients from manure. In their report, *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients*, Kellogg et al. used estimates of livestock populations and land available for manure applications from the Census of Agriculture. They identified the spatial and temporal trends in the production of animal manure and manure nutrients relative to the capacity of cropland and pastureland to assimilate nutrients into plant production without excessive buildup in the soil. USDA's analysis estimated livestock populations, quantities of manure produced, and land available for manure application for 1982, 1987, 1992, and 1997. The livestock include beef cattle, dairy cattle, swine, and poultry. The analysis shows that the structure of animal agriculture has changed dramatically over the past two decades. Small and medium-sized livestock operations have steadily been replaced by large operations. As a result, the number of confined animals per operation has increased for all major livestock types. A significant shift in the mix of livestock types has also occurred as dairy cattle have decreased in number and poultry and swine populations have increased. Livestock populations have become more spatially concentrated in high-production areas. Examples of these high production areas include the concentration of pork production in the Carolinas, poultry production in southern and mid-Atlantic states, beef cattle production in the High Plains, and dairy production in western, north-central, and northeastern states. Many of these regions import significant quantities of nutrients, primarily as feed grains from the Corn Belt.

The number of animal units per acre of land available on the farm for manure application for very large operations is often high, averaging more than eight confined animal units per acre for large poultry and fattened cattle operations. As a result, the nutrients excreted by these animals can overwhelm the availability of locally grown crops to recycle the nutrients.

These changes in animal agriculture have resulted in an increase in problems associated with the utilization and disposal of animal waste. As livestock production has become more spatially concentrated, the amount of manure nutrients relative to the assimilative capacity of land available on farms for application has grown. Consequently, off-farm export requirements are increasing. In some counties the production of recoverable manure nutrients exceeds the assimilative capacity of all the cropland and pastureland available for manure application in the

county. The number of such counties has significantly increased since 1982, indicating that problems associated with animal waste utilization and disposal have become more widespread over the past two decades as the structure of animal agriculture has shifted toward fewer but larger livestock operations.