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REPORT ON ANIMAL FEEDING OPERATIONS AND RURAL COLORADO COMMUNITIES [1]

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Introduction

Livestock are a traditional and important part of rural Colorado. Currently, Colorado shows increasing livestock numbers and decreasing livestock operations numbers. While both of these categories are dominated by beef cattle operations, large scale swine operations are primarily fueling these state level growth and concentration trends. Colorado's pig production increased 25% from 1996 to 1997 and 92% from 1992 to 1997 to about 800,000 hogs (Colorado Agricultural Statistics, 1998), but the number of farms producing pigs has decreased. Like the rest of the nation, Colorado hog production is in transition from an industry dominated by many small and diversified farms to one dominated by a few large concentrated and integrated operations.

Nationwide 55% of all hogs are produced on farms with more than 2,000 animals and 35% of all hogs are on farms with 5,000 or more hogs. From 1992 to 1996, while almost all eastern states saw hog production decline, western state production increased. Wyoming hogs increased by 134%, Utah by 270%, and Arizona by 42%. Breeding hogs increased even more markedly; from 567% in Utah to 33% in Arizona. Oklahoma has experienced the largest recent increase in total hogs (450%) (Iowa's Pork Industry - Dollars and Scents, 1998).

The emergence of corporate hog farming is both a reaction to federal, state, and local steps to regulate the industry and a catalyst for past and future

[1] Financial Support provided by Colorado Counties Inc., Colorado State University, and CSU Cooperative Extension.

[2] Although this document is submitted as a single report, both credit and responsibility for the content and tenor lie with identified section authors. Introductory and summary sections are the responsibility of the compilers/editors.

regulatory changes. Current federal legislation separates legislative treatment between Animal Feeding Operations and Concentrated Animal Feeding Operations (CAFO). An animal feeding operation is a facility that confines livestock continuously for at least 45 days during the year and does not grow feed in the area of confinement. An AFO and a Confined Animal Feeding Operation are one and the same. This often creates confusion as both confined and concentrated operations are referred to as CAFOs. However, a CAFO is a facility that confines at least 1000 Animal Units, unless there is waste discharge into public water resources or other direct contact. In the latter case, the threshold is 300 AU.

An AU allows the comparison of different types of livestock for multi-species regulatory purposes. In Colorado, 0.2 market hogs are equal to one beef cow. A mature dairy cow is equivalent to 1.4 beef cattle, or one dairy cow is equivalent to seven feeder hogs. The Colorado swine conversion is one half as strict as the Federal definition; a Colorado CAFO has at least 5,000 feeder pigs (of 55 lbs. and greater) whereas 2,500 is the federal standard (Table 1).

Traditionally, the strength and viability of Colorado's rural communities were closely associated with the health of the agricultural economy, including livestock operations. The recent structural evolution in the livestock and poultry industries and demographic change in the state have created new challenges and opportunities for rural Colorado communities. Rural community leaders are challenged to evaluate the extent to which both traditional and new animal agricultural enterprises continue to contribute to the well-being of the people they represent.

This report represents a collaborative effort between Colorado State University, Cooperative Extension, and Colorado Counties Incorporated. The report has four distinct parts: national trends in animal feeding operation policy; rural communities and animal feeding operations; innovations in odor management technology; and community or county level animal feeding operation policies. Each section summarizes essential current knowledge and contains information to assist in community decision-making regarding current and potential animal agricultural operations. In addition, an extensive reference section is included for the interested reader to find more detailed information.

Part I: National Trends in Animal Feeding Operation Policy

By Ruth Kedzior[3]

I. Introduction

The purpose of this section is to describe regulatory trends for large housed swine feeding operations at the national, state and local levels. This study has been prepared for Colorado's county commissioners because they are concerned about the issues involved in regulating large housed swine feeding operations.

Interest in this subject has been growing steadily over the last few years in Colorado because large housed swine feeding operations have been moving into the eastern portion of the state. USDA figures from 1996 show that Colorado farms have an inventory of nearly 800,000 hogs and pigs, a two-fold increase over 1990 (Steelman, 1998). The state's breeding herd stands at 160,000, a four-fold increase over 1990 (Marberry, 1998). Since 1990, eleven companies have built 17 large housed swine feeding operations in Colorado, and additional swine facilities are proposed (Steelman, 1998). As a result of this growth, Colorado is currently defining its role as a player in the swine industry.

After the last two legislative sessions ended without passage of legislation to modify Colorado's current regulations governing large housed swine feeding operations, a ballot issue was proposed to make Colorado among the most regulated states in the country. On November 3, 1998, the state voters passed this initiative, known as Amendment 14.

Colorado's political climate surrounding hog farms is not unique; rapid growth of the swine industry is a hot topic in many states across the country. As large housed swine feeding operations expand into new regions, governments have struggled with how to regulate this industry and how to respond to the competing interests at stake. Neighbors and farmers remain divided between welcoming and resisting this relatively new presence in their communities.

The future of this industry will be decided by the direction taken by the federal government, the state legislatures and the informed, growing citizenry demanding local control. The following summary highlights regulatory trends for large housed swine feeding operations.

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National Trends

On the national level, the likelihood of an even greater concentration of large housed swine feeding operations is realistic. As economies of scale give rise to large housed swine feeding operations, communities are going to have to co-exist with an increasing number of confined animals.

Regulations, in place to accommodate smaller-scale farms, are being reviewed and redesigned to reflect the impacts of large housed swine feeding operations. Tougher regulations can be expected. While expected national regulations will impact all species, large housed swine feeding operations are receiving most of the attention.

Although the U.S. Environmental Protection Agency (EPA) announced plans to tighten regulations on 6,000 of the nation's feedlots, the new standards will not be fully implemented until 2005, leaving it to state legislators and local elected officials to strengthen existing laws and enact new ones in the interim. These standards will minimize water quality and public health impacts from animal feeding operations, including large housed swine feeding operations.

In addition to the proposed EPA regulations, other national legislation is on the horizon. U.S. Sen. Tom Harkin (D-Iowa) has proposed to set national minimal environmental standards for the management of animal waste by large-scale livestock confinement facilities and poultry feeding operations. His bill would add several measures to existing clean water statutes.

In 1997, a group consisting of America's Clean Water Foundation, the EPA, USDA, state regulators and pork producers from five states met for nearly a year and to produce a set of tough recommendations for pork producers of all sizes. This framework, known as the National Environmental Dialogue on Pork Production, is outlined later in this paper.

State Trends

State trends concerning animal feeding operations are diverse. Interesting developments have occurred in the past decade in many states over the regulation of large housed swine feeding operations. Highlights of these developments in the major swine producing states are presented in this section.

The impacts of large housed swine feeding operations have generated substantial debate in several state legislatures. These impacts include declining water and air quality, health conditions, property values and concern over property rights. Common proposed state changes include: manure management plans, changing manure application rates, more stringent regulations for sensitive areas, mandatory inspections and stronger enforcement actions against "bad actors."

Local Trends

Organized proponents of the swine industry tend to support limited or no local authority over large housed swine feeding operations. However, a recent study conducted at Pennsylvania State University showed that local zoning authority slows the growth of swine industry expansion (Mo, 1997).

Opponents of large housed swine feeding operations across all the affected states are demanding more local control. Citizens want to be locally empowered to provide proper environmental controls through comprehensive plans and zoning within their jurisdictions. They are likely to feel that local government officials are more responsive than state officials. Local control may allow them to maintain their quality of life, avoid unnecessary regulatory action, and protect the ability of individual communities to determine what works in their unique local areas.

II. Federal Trends

Federal Law

Until recently, animal waste was a topic that was discussed in only a few paragraphs among the thousands of pages of state and federal environmental regulation. Animal agriculture is regulated through two federal statutes that address water pollution: the Clean Water Act and the Safe Drinking Water Act. Federal rules specifically define large "concentrated animal feedlots" (inventories greater than 1,000 cattle, 2,500 swine, 10,000 sheep) as "point sources," implying regulation under the same National Pollution Discharge Elimination System (NPDES) that issues permits for industrial and municipal wastewater discharges.

CAFOs operate under a zero discharge rule in their management of manure. All manure from a large housed swine feeding operation is required to be totally contained at the farm. When it is later applied as a fertilizer, it must be applied in such a way that it does not result in pollution of surface or groundwater.

Clean Water Act

All livestock feeding operations with CAFO designation are subject to regulation under the Clean Water Act. Swine operations with CAFO designation must comply with federal requirements for storage and treatment of manure. This Act treats point and nonpoint sources of water differently. A hog production facility is defined as a point source of water pollution, but hog waste run-off from fields into surface and groundwater is considered a nonpoint source of water pollution. CAFO owners must obtain permits from the EPA to operate manure management systems. In most states, federal permit requirements are administered by the state and federal standards are used to establish state water quality laws. Mandatory compliance with federal regulations is not required for nonpoint source water pollution. Therefore, rainwater runoff of hog waste from land application is not subject to federal regulation. However, Section 319 of the Clean Water Act says it is against the law for any discharge from a hog operation to find its way into groundwater or a stream, river, or lake. Those who do so are subject to heavy fines.

Safe Drinking Water Act

The Safe Drinking Water Act requires that the EPA promulgate National Primary Drinking Water Standards for public drinking water drawn from surface and groundwater. The standards establish maximum contaminant levels and treatment techniques. If animal waste raises these levels over the standard, the water supply must be treated - sometimes at great expense to the taxpayer (Voogt, 1996).

National Regulatory Trends

National Standards for Pork Producers

In 1997, under the auspices of America's Clean Water Foundation, the EPA, USDA, state regulators and pork producers from Indiana, Illinois, Iowa, South Dakota and Wisconsin met for nearly a year and produced a set of guidelines for pork producers of all sizes. Known as the National Environmental Dialogue on Pork Production, the group met on eight occasions and issued a Comprehensive Environmental Framework for Pork Production Operations. This Framework provides recommendations based on a set of uniform science-based guidelines designed for use by state and national regulators in determining new regulations for the pork industry.

As a result, hog farmers will likely be the first in agriculture to be covered by new comprehensive EPA regulations that should be final in 1999. These regulations will cover every aspect of farm management, including the collection, storage and application of manure and will apply regardless of operation size.

Overview of the Framework's Elements [1]

The Framework calls for the permitting of both new and existing pork production operations of all sizes. The Framework proposes: public participation procedures for permitting new or expanded operations; siting requirements, including setbacks for new lagoons and other new facilities where manure is stored and for areas where manure is applied to lands; standards for the design, construction, and operation of all facilities; restrictions on land application rates and methods; soil and manure testing; nutrient utilization plans; and, in certain circumstances, phosphorous-based application standard.

The Framework also calls for: certification of operators and training of personnel; emergency response planning; provision of financial guarantees by new or expanded operations; record keeping and inspections; and civil and criminal enforcement, with stringent penalties for "bad actors" (including permanent cessation of operations). Abandonment of manure storage facilities would be prohibited and strict closure requirements would be imposed. Various forms of financial and technical assistance are proposed to enable pork producers to comply with the Framework's recommendations. Finally, the Framework urges that additional research be conducted on certain environmental and public health questions which the participants believe have not yet been adequately answered.

National Standards for Livestock and Poultry Operations

In February 1998, President Clinton released the Clean Water Action Plan (CWAP), which provides a blueprint for restoring and protecting water quality across the nation. The CWAP describes over 100 specific actions to expand and strengthen existing efforts to protect water quality. It identifies polluted runoff as the most important remaining source of water pollution and provides for a coordinated effort to reduce polluted runoff. The CWAP calls for the development of a USDA-EPA unified national strategy to minimize the water quality and public health impacts of animal feeding operations.[2]

This long-anticipated joint plan just completed a three -month public on January 19, 1999. The plan established new guidelines for dealing with animal waste and would require the large livestock operators to develop detailed plans to store animal waste. An estimated 15,000 to 20,000 livestock operations would be required to have plans in place that describe land application of waste. Owners would be required to keep records and test soil regularly. The plan also calls for smaller operations to voluntarily adopt similar plans. The goal is for compliance of all animal feeding operations by 2008.

As noted earlier, other federal legislation has been proposed. U.S. Sen. Tom Harkin (D-Iowa) has a proposal to set national minimum environmental standards for the management of animal waste by large-scale livestock confinement facilities and poultry feeding operations. His bill would add several measures to existing clean water statutes and would leave states and local governments the flexibility to set tougher standards that reflect climatic and environmental differences, local community concerns and livestock farming needs (DeVries, 1998).

The most recent federal update concerning large housed swine feeding operations was reported November 26, 1998. According to The Denver Post, the EPA and the National Pork Producers Council reached an agreement that will allow hog farmers to voluntarily undergo environmental inspections and avoid costly fines for violations. Under the deal, pork producers who have their farms inspected under the NPPC's EPA-approved odor and water quality assessment program will be eligible for reduced penalties for any Clean Water Act violations discovered and corrected. Previously, farmers could be fined up to $27,000 per day for violations. Under the new system, participants would pay a total fine of no more than $40,000.

III. State and Local Regulatory Trends

A glance at major hog producing states

The impacts of large-scale animal feeding operations has generated debate in several state legislatures. CAFOs were among the most hotly contested issues this year, attracting the public and representatives of business and industry to legislative proceedings. The fight was the fiercest in the industry's traditional strongholds of Iowa, Missouri, North Carolina and Oklahoma (Watts Hull, 1998).

The shift West

As Eastern and traditional Corn Belt states tighten regulations on environmental and zoning issues impacting livestock operations, these facilities are moving West. The world's biggest hog operation, currently producing 600,000 hogs a year near Milford, Utah, is projected to produce nearly 2.5 million hogs each year in a few years (Tonning, 1998). Local officials sought out the company, a joint venture by four of the East Coast's largest hog producers, as a solution to the town's declining economy (Watts Hull, 1998). The company, Circle Four, hired an attorney to draft the Utah Agricultural Protection Act that prevents lawsuits against agribusiness in the state, paving the way for Circle Four to operate and expand their business.

Officials in Wyoming are also facing similar issues with quite different results. Citizen activists successfully rallied in 1997 to get a Wyoming water quality bill passed that covers hog farms. The law requires waste management plans, financial assurance, public notice, regular inspections and setbacks.

With a mild climate, a high evaporative rate, sparse populations, and vast areas of land, many counties in eastern Colorado provide an ideal location for these facilities. Colorado hog production soared from fewer than 400,000 animals in 1989 to 800,000 in 1996 mostly from large facilities that are moving into rural Colorado. This growth has led to the passage of the statewide initiative, Amendment 14, to further regulate large housed swine feeding operations at the state level.

Colorado Regulations

Prior to Amendment 14, Colorado regulations for CAFOs required manure to be stored in a properly designed, sited and constructed retention facility until it was applied to agricultural land as fertilizer at rates compatible with the crop grown on the land. Higher rates of manure application were allowed with a state approved waste management plan. Any new CAFO was required to submit a waste management plan to the state. When a CAFO site was abandoned, there was not a requirement for site restoration. Counties were able to impose additional regulations on animal feeding operations. CAFO proposals typically have been reviewed by local governments and regulated with local land use regulations. County commissioners made decisions to approve or disapprove the proposals.

Amendment 14 modifies current Colorado CAFO regulations for large swine CAFOs. Due to the passage of Amendment 14, the Colorado Department of Public Health and Environment's Air Quality Control

Commission (AQCC) and Water Quality Control Commission (WQCC) are currently in the rulemaking process. The target effective date for the new regulations is March 30, 1999.

Swine operations that house 800,000 lbs. or more of swine or which are deemed commercial under local law, will be required to obtain a state permit, and a state-approved swine waste management plan. Regular monitoring of soil and groundwater around manure holding facilities and land receiving manure applications will be conducted. Liquid swine manure-holding facilities must be covered unless improved methods to minimize odors are employed. Swine manure retention and application fields must be set back an appropriate distance to protect water quality and at least one mile from the nearest residence, school or municipality. The Colorado Department of Public Health and Environment will develop odor-control regulations for swine operations. Any spill or contamination from large swine CAFOs must be reported immediately to state and county officials. Owners of large swine CAFOs must give evidence of financial ability to clean and restore sites in the event of a spill or upon abandonment. Persons adversely affected by large swine CAFOs may seek relief by filing a civil suit. A per-animal fee will be imposed on large swine CAFOs to support enforcement of these new regulations. Amendment 14 allows local governments to impose local regulations more restrictive than state regulations.

Summary of other states

* In April, Maryland's state legislature passed the nation's strictest limits on the use of manure and other fertilizers on farms (Tonning, 1998).

* Kansas lawmakers recently drafted new regulations requiring public notice and operator training for new livestock operations (Tonning, 1998). These new regulations are to be implemented January 1, 1999. Also included are the requirements that manure applied to land must be incorporated into the soil within 24 hours and CAFOs must have an approved five-year manure management plan.

* Oklahoma Governor Frank Keating signed a sweeping bill in April that prohibits large operations from spreading manure on fields when it rains and limits the total amount of phosphorus (Tonning, 1998).

* In Iowa, the legislature is funding research and demonstration projects on odor control in CAFOs (Braun, 1998).

* In North Carolina, operators must be trained and certified in manure management (Walker, 1998). North Carolina has taken a new direction for Cooperative Extension agents that require government officials must now report any violation they see while on-site at operations. This new role for Extension agents and specialists is bound to create a relationship change with their clients.

* States like North Carolina, Kentucky, and Mississippi and counties like Goshen County, Wyoming have called for moratoria on new confined animal feeding operations to allow time to assess the impacts and to provide appropriate regulations. A few states (e.g. Minnesota) have debated whether to impose a moratorium, but opted for further study.

• Some states facing livestock issues have opted for a "good cop/bad cop" approach. Agricultural agencies provide technical assistance, training and cost-share funds while natural resources or environmental agencies issue permits, conduct inspections and issue violation notices (Tonning, 1998).

State vs. local control

Many rural communities want control over this issue and want increased regulations through zoning. CAFO regulations and other agricultural issues like right-to-farm challenges, anti-corporate farm legislation, and property rights are being defined in courts across the country.

Kentucky Attorney General Albert Chandler opined that small, family farms are not the same as large, industrial-scale hog operations in a recent decision on a Kentucky law that exempts farms from county zoning authority. Chandler's opinion cleared the way for local governments to regulate industrial-scale hog operations by zoning and other means (Watts Hull, 1998).

However, in Iowa, the largest hog producing state, a recent decision from the state Supreme Court favored state control of large-scale confinement operations. Humbolt County adopted hog operation regulations that the court ruled 6-1 illegally preempted legislative authority.

Most states recognize the importance of agriculture as a viable industry. States that have a pro-business agenda like Ohio, tend to provide an atmosphere conducive for large-scale animal feeding operations. Top producers are beefing up their lobbying efforts in an attempt to standardize regulations; thereby restricting power at the local level.

Most agricultural states have legislated agricultural exemptions to protect family farms from zoning. However, large-scale producers are also protected by these exemptions, and communities cannot implement zoning until the state passes legislation enabling them to do so. The industry has repeatedly challenged attempts at local rule over CAFOs, and several important cases are pending across the country (Barrette, 1996).

The states with laws that provide an exemption to agriculture from local zoning had greater growth or slower decline than the states without such laws. This result provides some evidence that the hog industry was more likely to expand in states with less local government role on policies affecting the livestock industry (Mo, 1997).

Corporate farming

There is a state level movement to restrict corporate farming. Minnesota, South Dakota, Iowa, Nebraska and Wisconsin have a ban on corporations from engaging in swine production. The Kansas legislature decided to allow corporations to engage in swine production in 1994. On the other hand, Colorado, North Carolina, Missouri, Oklahoma, Texas and Utah do not prohibit corporate hog producers.

Corporate farming and the future of the independent family producers are complicated issues woven into the dynamics of large-scale livestock operations. Hog producing giant Murphy Family Farms, for example, is considered by law to be a family farm.

IV. Discussion

The legal and technical aspects and implications of large-scale feeding operations are enormously involved. There are voluminous changes in regulations, legislation and data. In addition, just "catching up" with the growth of this industry is a major challenge for officials.

Local trends

It is appropriate that Coloradoans, and citizens in other affected states, be concerned about maintaining quality of life, including the protection of water resources, air quality and rural communities. Counties with suitable terrain and the need for economic development may want to foster the growth of livestock operations for the jobs and revenue they generate. Other counties may want to protect themselves from potential negative impacts. Locally approved regulation allows local people to control the kind of place their community is.

State trends

Regulations provide a framework for how we balance competing interests. Large hog producers watch state regulations (and how they are enforced) closely because they have the capital to relocate; the average family producer doesn't have that luxury. Due to the tremendous attention the livestock industry is receiving, many states are examining their regulations and often are choosing to impose more stringent restrictions. Many states, instead of fostering a state/local role, seem intent on limiting the local role and its inherent flexibility.

However, environmental requirements don't always mean less growth. This is supported by a recent study on swine expansion and environmental regulations. It tested the hypothesis that the stringency of state environmental regulations influences the growth rate of hog inventories across the states. It was expected that the more stringent the regulations were, the lower the growth rate would be in that state. The results failed to strongly support the hypothesis (Mo, 1997).

The presence of rules is only one chapter of the story. This paper does not examine which producers are exempted from regulation, nor does it explore if there is an adequate level enforcement. More differences in states' regulatory programs can be found in their enforcement efforts, which possibly impacted the growth rate of the swine industry across states (Mo, 1997). If strict regulations are on the books but left unenforced, then the community is not any better protected than the one that offers a lax set of guidelines.

In addition to state regulations and the level of enforcement imposed on operators, large housed swine feeding operations tend to locate and expand in areas that have other factors including: a drier climate, larger populations of rural people and states where there is less local authority. States that have agricultural exemptions from zoning generally see more swine expansion than states that do not exempt agriculture (Mo, 1997).

Federal trends

The biggest regulatory movement in the hog producing industry may, in fact, be taking place at the federal level. Federal standards will mean less state and local flexibility to account for special or unique situations. Federal and state policy often overlook important local issues. This creates a need to develop a multi-layered approach to legislation that authorizes flexibility for each partner to address their issues within the scope of their jurisdiction.

However, while it is important to look at this from the national perspective, it is also important for policy-makers to identify a global vision. The world population is increasing to numbers never sustained by this planet making land resources increasing scarce. The corresponding responsibility and challenge for farmers is to provide safe, affordable, high-quality food for a hungry world.

It is important to keep in mind the real issues and needs of the community. If farming is no longer isolated from the inevitable evolution of business practices in a capitalist society, then policy makers need to look at how their communities can adapt. Most laws currently in place do not recognize the natural role of the community. Thus, an important question is how to stay competitive in a global economy, provide regulations to keep the hog industry viable in rural communities, and provide a way for society to defend itself from the negative externalities from the livestock industry.

The U.S. is the world's low cost producer of pork. Does the U.S. want to continue as the market leader? If so, policymakers must decide what impediments are acceptable to achieving this goal. If the policy objective is to regulate with flexibility then the policies must reflect appropriate levels of local control. As a collective public body, those affected must in the near future decide whether or not a "one-size fits all" federal policy will work best to represent the community issues at stake.

Part II: Rural Communities and Animal Feeding Operations: Economic and Environmental Considerations

By Dooho Park, Kyu-Hee Lee, and Andrew Seidl[4]

Rural Colorado communities are deciding whether to allow and how to manage confined livestock operations to locating in or near them. Common issues surrounding the potential of livestock operations as engines of economic development include: employment and income, infrastructure and public finance, real estate, and natural resource management. In this section a question and answer format is used. Current knowledge and important considerations regarding the application of this information to specific communities are raised.

I. Jobs and income

Q: How many people does an AFO employ?

A: The direct employment effect of a swine farrowing operation is about 3-4 jobs per 1,000 sows. Cattle feedlots are thought to have similar impacts. Slaughter plants generate approximately 10 jobs per 1,000 head/day. Poultry operations generate approximately 8 jobs per $1,000,000 in sales (Musser & Mallinson, 1996). Traditional, smaller dairy operations directly employ a little more than 1-2 people per 100 head (cows and heifers). Larger, "California" style operations tend to employ about 1 person per 150-200 head (Keith Maxey, 1998, personal correspondence).

Q: What is the quality of AFO jobs?

A: There are three measures of job quality for which we have some information: salary, benefits, and turn-over. Other criteria, like independence, may be equally or more important to some decision-makers. Table 2 shows that swine industry salaries were relatively high nationwide relative to many jobs in rural Colorado. The table shows that wages in the Western United States tend to be higher than the national average. Table 3 indicates that many swine industry jobs provide benefits, a feature often absent in among independent producers. Table 3 also shows that larger operations tend to provide better benefits than smaller ones. This can be inferred by the difference between the percent of producers and the percent of employees reporting different sorts of benefits. Where there is a large difference (e.g. life insurance) larger operations tend to provide the benefit more often than smaller operations. Health benefits are important since as many as 30% of workers in confinement swine operations suffer from upper respiratory distress compared to about 20% across the agricultural sector (Thu & Durrenberger, 1998). Table 4 shows the relative wage rates of jobs across the agricultural sector. It is important to remember, at least in the swine industry and at least at the beginning, managers are recruited from of

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Table 2: Mean salaries in the hog industry (1995) (US$)

Nationwide	24,721
Western United States	26,932
Manager	27,729
Assistant Manager	21,298
Farrowing Manager	20,884
Herdsman	18,862

Source: Hurley et al., 1996.

Table 3: Percent of swine industry employees receiving benefits (1995) (US$)

Benefit	Reported by Producer	Reported by Employee
Paid vacation	62	79
Paid holiday	44	63
Paid sick leave	30	52
Major medical	45	80
Disability	15	55
Life insurance	16	66
Pension/retirement	11	36

Source: Hurley et al., 1996.

Table 4: Mean salaries in agriculture(1998) (US$)

Job	Swine	Dairy	Beef	Crop
Manager	33,022	32,500	26,833	30,750
Assistant Manager	26,067		21,700	
Herdsman	22,463	23,673		
Milking Couple		29,833		
Crop Assistant				23,467

Source: Wobbekind, 1998.

outside the community. However, most other jobs are likely to be filled with local people if adequate supply of sufficient quality is found.

Slaughter plant wages are now about $6-10 per hr depending upon how finely the plant cuts and packages products. The greater the value-added, the finer the cuts, the higher the skill required, the higher the wages, generally speaking. The turn-over rate is as high as 70% per yr., and the accident risk is higher than in other parts of the industry. Historically, packing plant jobs were unionized and, therefore, paid better and had better benefits. Currently, packing plant jobs are commonly filled by young people and immigrants (Duncan et al., 1997).

Q: Do AFOs generate other income or employment benefits to the community?

A: All businesses have direct, indirect, and induced impacts on the number of jobs and amount of income in a community. The business directly employs people. In addition, the business may locally purchase goods and services to run the business. These are indirect effects. The employees of the business and of the local enterprises with which it does business spend money in the grocery store, buy houses and send children to local schools. These are induced effects of the business. Some types of businesses have larger impacts than others. New businesses in direct competition with existing businesses in a community may result in a net loss of jobs and income in a community. Indirect and induced effects of businesses are calculated using estimates called "multipliers."

Swine industry indirect income and employment multipliers reported by university researchers range from 1.26 to 2.22. Industry sources and consultants generally report larger multipliers. A Virginia study found increases of 14-16 total jobs per 1,000 sows (Thornsbury et al., 1997). Cattle feedlot multipliers are thought to be similar. For the poultry industry, one million dollars of poultry sales generates 8.66 indirect jobs (2.05 multiplier), about $750,000 in indirect sales, and $280,000 in indirect personal income. Induced poultry multipliers are 12.48 employees for each million dollars of processed broiler sales (Musser & Mallinson, 1996). The true multipliers depend upon the goods and services available in the community, the spending patterns of the new business, the quantity and quality of available labor, housing, schools, etc. Table 5 shows the number of jobs generated directly and indirectly by a farrow-to-finish operation. Note that less labor per sow is required as the size of the operation increases.

Similar to the swine industry, substantial economies of scale in labor and capital exist in cattle feeding. While feed costs do not significantly change, capital costs range from $468 per head for the projected 1,000-head feedlot to $243 for the 20,000-head feedlot. Labor costs range from $52 per head for the 1,000 head feedlot to $23 per head for the 20,000 head feedlot (Duncan et al., 1997)

Q: *What about short term construction jobs?*

A: Estimates of short term construction sector employment generated by new livestock operations vary substantially in the literature. Many estimates depend upon qualified local labor availability and whether the incoming operation chooses to bring their own construction crews (Thu & Durrenberger, 1998). Estimates range from 7 to 25 $14,000/yr jobs per 1,000 sows entering, and construction times are estimated between one and two years (Seidl & Grannis, 1998). For cattle feed lots about 82% of the total construction cost are expected to be spent locally. Using a multiplier of three, the benefits for the community of the feedlot construction for a 20,000 head operation are $11.37 million, and the annual ongoing economic benefits for the community are $11.82 million (Duncan et al., 1997).

III. Infrastructure and public finance

Q: *Do livestock operations increase the budget demands for infrastructure (roads, hospitals, schools, police)?*

A: The local government receives revenue from the livestock operation directly from personal income and property taxes and indirectly from state and federal taxes. The introduction of livestock operations increases the local budgetary demands on roads, schools, police, and fire protection services (Thornsbury et al., 1997). Whether the increased revenues outweigh the increased budgetary demands depend upon the existing community infrastructure, the value of the operation, tax rates and any concessions a community might make to encourage new industries. A Virginia study found that the community tax burden decreased between $15,700 and $17,000 with a new 1,000 sow facility. An Iowa study found a tax burden decrease of $8,800 and an assessed property tax increase of $2,580 to $2,860 per 1,000 sows (Thornsbury et al., 1997). Published information in this area is scarce, but anecdotal evidence generally indicates that counties that have not provided concessions have seen increases in their tax revenues.

Research indicates that there is one student enrolled in local schools for every two jobs created and that $2,000 in revenues to schools per job is generated. Whether this is a net benefit or cost to the community depends upon the current situation in the schools and whether the new students have special needs, including English as a second language. Many communities in Colorado's Eastern Plains are aging and, thus, have excess capacity in the schools. Some school districts are facing consolidation. In this case, additional students in the public schools are likely to be viewed positively. Except in the packing industry, most research indicates that these students do not tend to be "special needs" students.

Additional issues to consider include increased health care demands (discussed above), dust, traffic, accidents and repairs. For example, one Iowa community estimates that its gravel costs increased by about 40% (about $20,000) per year due to truck traffic to operations totaling 45,000 finishing hogs in the immediate area. Annual estimated costs of a 20,000 head feedlot on local roadways were $6,447 per mile due to additional truck traffic (Duncan et al., 1997). Colorado counties that have experienced recent increases in livestock operations report increases in the costs of roads, but specific dollar values are not available at this time.

IV. Real Estate Impacts

Q: *How do livestock operations influence real estate prices?*

A: The introduction of a livestock operation to a community is likely to have two impacts on the local real estate market: a positive price impact through an increased demand for housing and a negative price impact due to the odor generated by the operation. However, cattle feedlot operators often provide housing or mobile home hookups for employees and therefore

Table 5: Employment and Income from Farrow-to-Finish Swine Operations, by size (Iowa)

Sows	300	1,200	3,400
Direct jobs	3	10	21
Salary/job ($)	29,033	29,469	33,767
Indirect jobs	2.7	9	19
Salary/job ($)	17,097	17,354	19,780

Source: Otto et al., 1998.

have little development impact on the housing market. Although information on how CAFOs in Colorado affect real estate prices has not been systematically compiled, studies have been prepared for North Carolina, Iowa and Minnesota. Although these states differ from Colorado in many respects, they have also experienced concentration in the pork industry, and their examples may provide insight into what could happen in Colorado. Definitive evidence of lower assessed value or depressed sale prices due to livestock operations is not readily available for Colorado. However, some Coloradoans have expressed concern that they will not be able to sell their land for what they feel it is worth due to the presence of hog operations.

In North Carolina results indicated that home values decreased $0.43 for every additional hog in a five mile radius of the house. The study found a decrease of 4.75% (about $3,000) in the value of residential property within 0.5 miles of a 2,400 head finishing operation where the mean home price was $60,816. As homes were located farther from an operation, the decrease in total home value decreased to less than $100 at 2 miles away (Palmquist et al., 1997).

However, in Minnesota a similar conclusion was not possible. Homes closer to confined livestock operations sold (mean = $26,500) for more than expected based on the characteristics of the house. Though this was not the expected result, the author considered the possibility that, due to limited available housing, the demand by hog farms for worker housing increased the value of the houses. In addition, a casino had recently moved in to the area, confounding the actual hog farm effect. Another possibility that is the CAFO owners bought the homes to reduce the number of neighbors living nearby and in a position to complain about the odor (Taff et al., 1996). Finally, odor can be mitigated by a number of factors which have not been considered in existing research.

An Iowa study found that agricultural land values increased due to an increased demand for "spreadable acreage." However, total assessed value, including residential, decreased in proximity to a hog operation. In Illinois and Iowa county assessors have, somewhat arbitrarily, discounted the assessed value of homes within a certain range of a hog operation. For example, one county in Iowa has decreased the assessed value of homes within 0.5 miles of a hog operation by 40%, within 1 mile by 30%, 1.5 miles by 20% and 2 miles by 10%, much greater discounting than the N.C. study would warrant (Padgitt & Johnson, 1998).

IV. Social impacts

Q: Who invests in new livestock operations?

A: New livestock operations tend to be large and technologically advanced requiring substantial capital investment. Generally speaking, the principal investors in new livestock operations are large diversified corporations with interests in other aspects of animal agriculture (e.g., other species, packing, or feed). Local people tend to be involved as employees or as contractors to larger vertically integrated operations (Thu & Durrenberger, 1998). Benefits and losses of investment tend to accrue proportionally to the amount of financial involvement and power of the investor.

Q: Does industrial agriculture have different health effects than traditional agriculture?

A: It is argued that jobs in single output industrial agriculture require fewer types of activities than a traditional diversified farm. Highly repetitive tasks have been shown to cause a number of physical and mental maladies in factory workers. In addition, industrial agriculture workers may have greater exposure to dust, noise, odor and toxic gases if their limited activities require them to stay in an exposed environment for longer periods of time (Thu & Durrenberger, 1998).

Q: What societal mental health impacts might be expected from odor?

A: Broad conclusions about the impacts of odor are difficult to draw. This is in part due to the individual nature of people's reactions to different smells and, in part, due to the measurement difficulties in research.

However, it has been found that smells can alter moods of people, and have a significant negative impact on the mood of nearby residents. Environmental odors can affect a population's physiological and psychological well-being. People can experience annoyance and depression, along with nausea, vomiting, headache, shallow breathing, coughing, sleep disturbance, and loss of appetite in response to unpleasant odors. People living near swine operations and who smelled odors from them were found to be significantly more angry, depressed, tense, fatigued, confused, and less vigorous than control participants not living near swine operations (Shiffman et al., 1998).

V. Industry economic issues related to communities

Q: Will livestock industry stay in my community?

A: While the future cannot be predicted with any precision on a case by case basis, there are a number of indicators that might act to influence the likelihood of a hog operation closing. Changes in the industry have come with far greater financial investment in buildings and machinery. Lagoons are constructed to last from 10-25 years. High fixed investment costs, greater size, integration and specialization of operations increase the likelihood that an operation will remain in place.

Current estimates indicate that the market for U.S. hog exports should increase by 20-50% over the next decade in part because the U.S. produces market hogs for the least cost on a worldwide basis. Mexico is expected to continue to be a growing market for US pork, and the sales to Asian markets are expected to increase, despite the financial crisis, as more countries enter a free-trade marketplace. While domestic estimates are not optimistic, overall market improvements should increase permanence. Transportation prices continue to decrease, encouraging specialization of the industry and farrowing operations in Colorado. Increased environmental regulations, if passed and enforced, in Colorado and the United States, increase the costs of production and tend to decrease the incentives for industry permanence in Colorado and the US. Whether the industry chooses to move depends upon other advantages of Colorado and the US and changes in environmental standards in other parts of the world. Many US hog operations trace their roots to (currently more highly regulated) Northern Europe, for example.

Q: What if they close down?

A: The closing of a business makes the multipliers work in reverse. Like a personal financial portfolio, when a community is highly dependent upon one industry, a closure can be devastating. Examples of mining communities in Colorado provide an illustration. In the short term, when a livestock operation goes out of business, hired labor stops spending money at stores, feed crop acreage declines, fertilizer companies' sales may decrease, local feed grain companies do less business, etc. However, in the longer term, substitute economic activity occurs: other livestock operations increase the herd size, new operations enter the industry, hay acreage converts to other crops or to housing, hired labor find new employment, etc. The extent to which this substitution occurs and over what time period depends on many local economic factors (e.g., size, depth, diversity, entrepreneurship) (Hemmer, 1998).

Q: Do regulatory changes affect the livestock industry?

A: While strongly enforced regulations undeniably steer the industry, Mo and Abdalla (1997) conclude there was no support for the hypothesis that the stringency of state environmental regulations impacted hog inventory growth over the 1988-1995 period for 13 hog-producing states. Martin and Norris (1998) conclude that it is an oversimplification to state that environmental regulations have significantly affected the structure of animal agriculture. They state that changes in farm size, vertical coordination and location of animal agriculture are driving changes in agriculture and in environmental regulations (Martin and Norris, 1998).

Q: Do "corporate" operations create greater environmental and socio-economic risks to a community than "family" operations?

A: For a community, the only important difference between legal designation as a public corporation and a family business is that the corporation is responsible to its stockholders. These stockholders do not typically live in the community where the livestock operation is located and are not necessarily concerned about community welfare. However, the same criticism can be leveled against large, diversified, integrated family operations. Although livestock policy increasingly discriminates against corporate operations, in our opinion, the better question is whether large operations and small operations have differential impacts on communities.

Q: Do large operations create greater environmental and socio-economic risks to a *community than an equivalent number of smaller operations?*

A: Although livestock policy commonly discriminates against larger operations, it is not clear that there is greater environmental risk from one 10,000 head operation than from ten 1,000 head operations. Confined animals create a greater potential for soil water pollution than unconfined animals due to the greater concentration of their wastes. Large operations argue that economies of scale in producing management plans, construction, and monitoring, allow them to hire better expert assistance and decrease the level of environmental risk more than smaller operations can. However, small operations may be more efficient in manure utilization costs. Smaller operations (<$400,000 sales) tend to purchase more of their inputs locally than larger operations (80% versus about 50%). Smaller operations tend to use more labor per head than larger operations (Table 5). Diversified operations (large or small) are less likely to go out of business than single output operations. Contracted or vertically integrated operations are less likely to go out of business than independent operations. Due to packer demands for uniformity, contracted operations tend to be larger rather than smaller.

IV. Natural resource management issues

Q: Is animal manure a waste product or a resource?

A: Properly applied, manure can be a valuable fertilizer and soil amendment by increasing soil organic matter, improve soil tilth, water holding capacity etc. Depending upon the species of livestock, manure provides nitrogen, phosphorous and potassium amendments to the soil. For example, each cow produces about $75 in manure fertilizer each year. The fertilizer replacement value of hog manure is about $3 per hog. Phosphate and potash values reach as much as $2.22 per hog or about $5,500 per 1,000 head finishing house (Table 6). The gross nutrient value of swine effluent ranges from about $11 to $70 per 1,000 gallons (mean $32.40) from concrete pits and from about $5 to $59 (mean $17) from earthen lagoons. The cost of handling effluent is about $10 per 1,000 gallons or $0.01 per gallon. However, over-application of manure can result in soil, surface and ground water pollution, harming crop quality and yield, and creating a health hazard to humans and other animal species. The use of manure as a fertilizer is constrained by the costs of nutrient content analysis and transport due to its bulk, weight and nonuniformity (Van Horn et al., 1998; Hilborn & Brown., 1996).

Q: What does it cost to use manure as a resource and reduce odors at the same time?

A: Two of the most common techniques for mitigating the odor emanating from swine operations are covering the lagoon or pit and incorporating the effluent into the soil rather than spraying it in application. Odor from effluent application can be reduced 50 to 80% by avoiding volatilization through soil incorporation (Davis et al., 1997). Soil incorporation/injection costs about $1.39 per year-sow from a lagoon and $0.49 from a bin or pit. Incorporation costs about $0.13 per gallon more than broadcasting from a lagoon and $0.09 per gallon more from a bin. Table 6 reviews the costs of covering storage facilities for farrowing operations (Table 7). Odor can be decreased as much as 80% by covering the storage facility. Here, the costs of covering a lined lagoon, the first stage of a two stage lined lagoon system, and an above ground bin are explored. The cost of plastic covering is assumed $2.50 per ft^2. Straw should not be used in lagoon systems. Other odor mitigation techniques available include aeration ($1.00 per finished hog) and experimental chemicals and feeds ($0.30 to $5.00 per finished hog) (Babcock et al., 1997).

Q: Are livestock operators concerned about natural resource management issues?

A: Responses to a survey of North Carolina livestock and poultry producers indicated that more than half (55%) of the 410 swine producers responding stated that the potential for reducing odor was a "very important" influence on their waste-management decisions. Only the potential to control water pollution was cited as "very important" by more swine producers (73%). Most swine producers responding also felt that "public concern over animal waste is really more about odor than about water quality." A majority of swine producers (78%) disagreed with the statement that "producers should have the right to manage their waste in any way they choose." However, of the swine producers who apply their wastes to land (63%), only 49% had calibrated their equipment in the past five years and 40% had tested the wastes for nutrients in the last five years (See, 1995).

Q: Do large operators have different attitudes than smaller operators about natural resource management issues?

A: Among the significant findings of the North Carolina study above is the contrast between the responses of small and large-scale producers. About 75% of those swine producers having more than 1,000

Table 6: Nutrient Value of Different Types of Manure

Manure	Nitrogen	Phosphate	Potash	Total Value
Dairy Liquid	14 lb/1,000 gal	7 lb/1,000 gal	30 lb/1,000 gal	$12/1,000 gal
Swine Liquid	24 lb/1,000 gal	11 lb/1,000 gal	20 lb/1,000 gal	$15/1,000 gal
Poultry Solid	51 lb/1,000 gal	25 lb/1,000 gal	34 lb/1,000 gal	$31/1,000 gal
Dairy Solid	3 lb/ton	3 lb/ton	11 lb/ton	$3.50/ton
Poultry Liquid	18 lb/ton	18 lb/ton	25 lb/ton	$15,50/ton

Assumptions: Incorporations in 24 hours, spring application.
All nutrients are required by this year's or subsequent crops.
Nitrogen = $0.32/lb; Phosphate = $0.33/lb; Potash = $0.16/lb

Sources: Van Horn et al.,1998 and Hilborn & Brown, 1996.

Table 7: Per sow costs of covering effluent storage facilities (farrowing)

Category	Total Cost	Annual Cost
Lagoon w/plastic	74.25	11.07
Stage I Lagoon w/plastic	46.75	6.97
Bin or pit w/plastic	20.08	2.99
Bin or pit w/straw	2.19	2.19

Assumes: 8% interest rate, 10 yr. plastic life, 1 yr. straw life

Source: Babcock et al., 1997.

animals had tested their swine wastes for nutrients, only 18% of those with fewer than 250 animals had done so. In addition, only 9% of large-scale producers agreed that "growers should have the right to manage waste in any way they choose" compared to 36% of small-scale producers (See, 1995).

Part III: Innovations in Odor Management Technology

By Kirk Iversen and Jessica Davis[5]

I. Introduction

Odors are an inevitable part of livestock production systems. They come from a variety of sources within the system, but the predominant contributor is the manure from the animals. While the odors cannot be completely eliminated, they can be controlled so that they are not a problem to the animals, operators, or neighbors. The following information is a beginning point for choosing appropriate methods for individual operations.

II. Sources of odors

Most odors from manure in a livestock system come from three sources: 1) livestock and their facilities; 2) manure storage and treatment; 3) land application of manure. These sources each have components that contribute to the overall odor production. Each can be targeted to reduce the odor released to the environment.

IIA. Components of odor

The odors from manure come from more than 100 substances, mostly volatile fatty acids, nitrogen derivatives, and reduced sulfur compounds. Dust may be the most detrimental component of air quality because it absorbs odors and can transport them long distances, depositing them on surfaces where they become a problem.

Odor is a function of animal diet, animal metabolism, and environmental conditions during the decomposition of the manure. Most of the unpleasant odors from manure develop during anaerobic decomposition (where oxygen is lacking). Temperature, pH, and moisture affect anaerobic decomposition.

IIB. Principles of odor control

For an odor to be a problem downwind it must be: 1) formed; 2) released to the atmosphere; 3) transported to where it is a problem. If any of these can be inhibited, odors will be reduced. Inhibiting the microbial

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activity that decomposes the manure can minimize odor formation. Reducing moisture, chlorinating, adjusting pH, and lowering temperatures are examples of methods to reduce the formation of odor-causing compounds.

Reducing the release of odors to the atmosphere can be accomplished by controlling ventilation from livestock buildings, covering manure storage structures, and changing the biology and chemistry of the manure environment.

Scrubbing dust particles from the air and using methods that direct air upward to mix fresh air with the dust and gases can reduce transport of odors. Siting the facilities where wind patterns do not carry odors to sensitive places is also a solution.

III. Site Selection

IIIA. Site Location

Description

Problems with neighbors can be avoided if livestock operations are located far away or in places where the odors will not be carried to locations where they are objectionable. This can be accomplished by considering factors that affect the transportation of odors.

Avoid siting near residential, commercial, or recreational areas. For operations of less than 1,000 animal units (AU), a quarter-mile is usually adequate separation distance. Larger operations require a half-mile, in many cases. Where a growing community is nearby a distance of 2-3 miles is probably a good idea.

Wind can carry odors one mile or more, depending on circumstances. Try to locate the facilities downwind of any sensitive areas. In many places the wind moves in several directions during the year, so "downwind" may be difficult to define. Choose a direction that minimizes the frequency of wind blowing towards developments. Manure odors tend to be at a maximum during spring and summer, so the wind direction during those times is most important.

Odors will often move downhill, especially in the evening when the air is cooling. Hilltops are good choices when there are no sensitive areas below. Avoid hilltops where developments are downhill. If this is unavoidable, increase the distance between the facilities and sensitive areas. Relatively flat landscapes are best, where air movement will dilute and disperse odors.

Effectiveness

Locating facilities far away from problem areas and avoiding transportation of odors towards them can be 100% effective in reducing potential complaints. While these methods do not reduce the production of odors, if no one smells them there will be no complaints.

Cost

Costs of these methods can be negligible as long as they do not require moving existing facilities. Land prices usually decrease with distance from sensitive areas. Potential costs could come from increased distances from utilities.

IIIB. Landscaping

Description

People "smell" with their eyes. If they cannot see the facilities they will not notice odors as easily. Well-maintained buildings and manicured lawns give the appearance of a well-managed operation, while an unkempt picture invites complaints. Fences, trees, or other barriers that hide facilities from public roads can reduce complaints.

A shelterbelt of trees can affect airflow and the transport of odors. Trees that are upwind of the facility will deflect wind that would capture and transport odors to sensitive areas. Trees downwind of the facility will trap some of the dust particles and odors and will direct the airflow upwards, where it will mix with fresh air and be dispersed.

Select a mixture of fast-growing trees and slower, longer-lasting ones. Fences and soil berms can also be used to keep the view cleaner and move air upward. Shrubs and grass will not hide much nor trap many odors but the facility will "look" cleaner and draw less negative attention.

Effectiveness

Shelterbelts or barriers can significantly reduce odors downwind. They do not completely remove them but tests have shown that odors are less intense when they are used.

Cost

Costs of tree-planting, fence-building, and grounds maintenance have been estimated at $0.10 to $0.20 per animal unit. These are at least partly compensated by the difficult-to-quantify improvement in aesthetics.

IV. Production

IVA. Feeding and Feed Additives

Description

Manipulation of animal diets can affect both the amounts and characteristics of the manure produced in a livestock operation.

Increasing the efficiency of feed utilization can reduce the amount of manure produced. If the animal can utilize more of the food, less will be excreted. Feed digestibility can be improved by processing; grinding and/or pelleting can improve N digestibility. Better balancing of nutrients in the feeds can reduce the volumes required.

Higher nitrogen content in manure causes greater odor (N is a key part of ammonia). Animals excrete more nitrogen when the N in the diet is excessive or when amino acids are not in balance. Correcting these will not only reduce odors but will also lower feed costs.

Modifying feeds can alter manure characteristics. Reducing crude protein content and substituting synthetic amino acids can make feeds less wasteful and result in less nitrogen in the manure. Some dietary supplements (calcium bentonite, zeolite, sagebrush, charcoal, etc.) can absorb odors; unfortunately, they can also negatively affect feed efficiency and animal growth.

Some additives seem more successful, controlling both odor and improving feed performance. Sarsponin, an extract from yucca plants, reduces ammonia and promotes beneficial microbes in manure pits and lagoons; it passes through the animal's digestive tract unabsorbed.

Adding fiber to the diet, reducing the amount of sulfur-containing amino acids and sulfates, increasing the water content of swine feeds have all been reported to reduce odors. Adding oils or fats to feed can reduce dust emissions.

Effectiveness

Some studies have found that some feed additives cut concentrations of odor-causing compounds by over 70%. Results of some other studies:

- Grinding and/or pelleting can improve N digestibility by 5-12%;
- Wet-feeding hogs (3:1 water : feed) reduced odors by 23-31%;
- Adding fiber (soybean hulls, etc.) to hog feed reduced odors by up to 68%;
- Reducing sulfur-containing amino acids and mineral sulfates cut odorous sulfur compounds by 49 to 63%;

A number of products on the market have shown no effect on manure odor in studies. It is not advisable to use any that are not research-proven. Ask for documentation or check with your county extension office.

Cost

Some small-scale studies have found useful additives cost about $0.75 per hog produced.

IVB. Facility Management

Description

Cleanliness in animal facilities will minimize odors. The main goals are to minimize manure-to-air contact and to keep manure relatively dry, minimizing anaerobic decomposition which is a major cause of unpleasant odors.

Keeping animals, floors, pens, walls, and other building surfaces free of manure will reduce the amount of manure exposed to air. Frequent scraping of floors and flushing of gutters removes manure exposed to air. Misting the building air with water or vegetable oils settles dust that carries odors.

Keeping manure at less than 40% water content will minimize anaerobic degradation and the resulting odors. Slatted floors, which allow manure and urine to fall below the floor into pits or conveyor belts, prevent the accumulation of liquids on the floor. Bedding absorbs moisture and allows manure to be handled as a solid.

Where slatted floors are used and manure is stored under the floor, under-floor ventilation can promote drying and remove dust and odors. Shallow pits, covered with two to three inches of water, reduce ammonia emissions. When cleaned every 2-3 weeks, anaerobic degradation is avoided.

To inhibit bacterial action that produces odors, keep buildings cool. Using zone radiant heaters where needed allows the overall building temperature to be lowered.

Effectiveness
Reducing manure contact with air and keeping the moisture levels low can result in significant reductions in odor.

Spraying canola oil and other vegetable oils on surfaces to reduce dust has cut odors by 30 to 50%. In one study concentration of dust particles was reduced by 81%, with a 50% reduction in odor intensity. Cooling the top surface of manure slurry pits to 59 degrees F reduced odors by 75%.

Cost
Spraying vegetable oils on building surfaces cost $1.14 per pig. 70% of that cost was the manual labor; costs would be lower if the spraying was automated.

IVC. Biofilters

Description
Biofilters can dramatically reduce the amount of dust and odor leaving ventilated livestock buildings. The biofilter is composed of moist organic materials such as compost, peat moss, chopped corn stalks, and chipped brush, and a community of microorganisms. As air passes through the biofilter, dust particles and odors are adsorbed to the material and broken down by the microbes.

When air is vented from the building it is directed to a biofilter, often de-dusted first. Pipes take the air into the filter, and the air moves through the organic material before getting to the outside air. Once the bacterial population has matured, odors are converted to benign substances.

Filters need to be kept moist by water additions or humidification of the vented air. Inoculation of the material speeds its maturation. Maintenance includes loosening the filters every few months to reduce air resistance.

Effectiveness
Studies have found average odor reductions of about 50%, improving to 80 to 95% when kept at optimum moisture.

Cost
One gestation/farrowing swine project found the cost of biofilters was about $0.22 per pig over a three-year period. Another study of a farrowing system (700 sows) found a cost of about $0.30 per piglet produced.

IVD. Windbreak Walls

Description
Ventilated animal buildings can blow large amounts of odorous dust and gases into the air outside the building. Windbreak walls, placed in front of these exit points, create a settling area in front of the wall where some of the dust settles out. The air is redirected upward, over the wall, where it mixes with fresh air and is diluted.

Walls can be made of any materials, including concrete, plywood, plastic sheeting, and hay bales. One large wall works for buildings in which most of the air is vented from one end. In buildings where fans blow out of various locations along the walls, several smaller walls are needed.

Shelter belts of shrubs and trees can also remove dust and direct air upwards.

Effectiveness
Demonstrations have shown that walls remove a portion of dust from exhaust air. Significant reductions in odor concentrations have been measured.

Cost
Windbreak walls are very inexpensive to construct.

IVE. Solid Separation

Description
Removing solids from the manure stream reduces the amount of liquids that must be stored and treated. When solids are dried to 40% moisture or less, odor-producing anaerobic decomposition is reduced. Solids can be composted or applied directly to cropland. The smaller volumes of liquid manure have less surface area in contact with air, so they produce less odor.

Solids can be separated mechanically or by gravity. Mechanical methods include straining, filtering conveyors or net systems, decanting centrifuges, and inclined floors, where liquids flow down to pits while solids accumulate on the floor and are scraped off.

Gravity removal includes settling tanks and filtration, where solids settle on filters while liquids pass through.

Dairy cattle manure is more suitable for mechanical separation. Swine manure, with smaller particles, is more suitable for gravity separation.

When bedding is used in animal housing, odors are reduced and increased amounts of manure can be handled as solids.

Effectiveness
In the Netherlands, separating urine from manure reduced ammonia odors by 60%. (Manure volume was also reduced, reducing handling costs.) Separation requires equipment for handling both solid and liquid materials.

Cost
Expenses include the cost of equipment and additional energy for pumping in mechanical systems. Fixed costs for dairy mechanical systems are about $135 per dairy cow; settling tank costs in swine systems are about $25/sow or $7 to $10 per finishing pig space.

V. Manure Storage and Treatment

VA. Pit / Lagoon Additives

Description
Pit additives are a common technology for odor control. When used in buildings they can reduce ammonia concentrations in the building, improving animal health and worker safety. They also decrease amounts of volatile fatty acids and hydrogen sulfide. In outdoor lagoons, algae products can aerate the surface of the lagoon, reducing odors from anaerobic decomposition.

Additives can be grouped into several categories:

- Masking agents are mixtures of aromatic oils to cover bad odors with less offensive ones.
- Counteractants are aromatic oils with smells that cancel or neutralize odors to reduce their intensity.
- Deodorants are strong oxidizing agents or germicides; the first type oxidizes odor-causing compounds, and the second type eliminates bacterial activities that produce odors.
- Enzymes alter biological pathways in the decomposition process.
- Adsorbents are products with large surface areas that adsorb odors.
- pH adjusters affect the volatility of compounds. Lime reduces hydrogen sulfide concentration while increasing ammonia levels, and acids reduce ammonia loss and preserve nitrogen in the liquid for crop use.

Organic compounds break down with time while bacteria and algae may die off; frequent re-applications may be necessary. Some products attack specific compounds, and do not affect other odor-producing materials.

Effectiveness
Some products work very well, reducing odors as much as 90%. Other products do not work at all. Before buying any check with your county extension office.

Cost
In swine systems costs have varied from $0.10 to $1.50 per pig produced; $0.60 to more than $3.00 per pig capacity.

VB. Manure Drying

Description
Odors from manure come primarily from anaerobic decomposition, which occurs when the material is so wet that oxygen is limiting. Under wet conditions, aerobic decomposition is minimized, and anaerobic reactions predominate. Removing most of the water in manure will reduce the odors that accompany anaerobic processes. In outdoor feedlots scraping manure regularly from pens and piling into stockpiles can encourage drying. The pens will have less manure exposed to urine and rainfall, stockpiling encourages drainage of excess water and presents less surface area to direct contact with rainfall.

In animal housing buildings, manure can be dried with ventilation. With underfloor pits, air can be directed below the floors to dry the material and remove harmful gases. If the air is vented out of the building through scrubbers or biofilters, the odors will be treated before release to the atmosphere.

Manure slurries can be dried outdoors in concrete beds. Filled to a depth of eight inches the slurry will dry in a few weeks.

Effectiveness
Dry manure attracts fewer flies and other pests, has fewer odors, is cheaper to transport, and can be easier to apply and incorporate.

Moving manure from pens to stockpiles or from holding tanks to drying beds will expose odors for several hours, until aerobic degradation begins. Other odor-control methods can minimize these odors.

Cost

No data are available. The major costs would be for energy used moving the materials or running ventilation fans.

VC. Optimizing Anaerobic Lagoons

Description

Anaerobic lagoons are a common method of treating and storing liquid manures. Oxygen levels are low in most lagoons, so anaerobic reactions predominate. The products formed during decomposition include methane, carbon dioxide, ammonia, hydrogen sulfide, and other materials, many of which are odorous.

Odors can be especially strong in the spring and early summer. If the slurry temperature falls below 40 degrees F during the winter, decomposition ceases. In the spring and early summer there can be a bloom of bacteria and odors as the accumulated materials are broken down. Additions of antibiotics or germicides can kill off bacteria, which will reduce both the odor and the treatment effectiveness of the lagoon.

Anaerobic systems work better if solids are removed before reaching the lagoon. Diluting with water (6 to 10 times water to manure) is recommended. Slurry should be added continuously (at least weekly) rather than in surges. For optimum manure treatment, a lagoon should never be completely drained. The treatment volume must be maintained in order to support the bacterial population. The pH should be between 6 and 8, and the electrical conductivity should be less than 4 mmhos/cm.

Effectiveness

The anaerobic process produces unpleasant odors, but good management can reduce them somewhat. Some success has been found by oxygenating the surface layer or by cooling the liquid to slow decomposition. Scum layers will cover the surface and reduce odors. If swine manure is not forming a layer of scum, increasing fiber in the diet may help. Covering the lagoon will effectively control the odors.

Cost

Anaerobic lagoons are not extremely expensive if filled by gravity. Simple systems cost about $21 per sow. Some of the control methods to keep odors minimized can be very costly.

VD. Aerobic Digestion

Description

Aeration of liquid wastes reduces odors. Major products of aerobic degradation are carbon dioxide, water, and sulfates, none of which are odorous. Nitrogen-containing materials are converted to nitrate, rather than ammonia.

Air is forced into the waste lagoons or tanks with floating aerators or fixed pipes. Microbes in the liquid are provided oxygen to perform the aerobic reactions.

Some systems combine both anaerobic and aerobic treatment. The upper portion of a tank is aerated while the bottom remains anaerobic.

Effectiveness

Studies have found that aerobic digestion results in reductions of 99% of ammonia-N, 75 to 93% of total-N, 90% of biological oxygen demand, 50 to 97% of chemical oxygen demand, and 97% of suspended solids.

In aerobic systems nitrogen is not usually lost to the atmosphere but is conserved as nitrate. Treated water can be used as fertilizer through irrigation systems. If the reactions slow down because of extreme cold some nitrate may be lost as odorless gases (N_2 and N_20).

Cost

Aerobic treatment is expensive because of energy requirements. Energy costs in swine systems have been estimated at $3 to $5 per pig space. Floating aerators cost around $3,000 to $6,000. Complete systems for large operations may cost $4 to $6 per sow.

Energy costs could be reduced with the use of wind power at many locations.

VE. Anaerobic Digestion and Biogas

Description

Anaerobic digestion of liquid manure results in a very low-cost supply of methane, which can be used as a propane replacement on the farm. Although anaerobic processes produce a lot of odor, a closed digestion system prevents the odors from escaping and results in a low-odor method of manure treatment. The solids and liquids remaining after digestion are low in odor and high in nutrients for plant use.

Digester sizes are based on the amount of solids produced and the required retention time. Some new designs separate solids from the liquid, allowing liquids to be passed out more quickly, reducing size requirements.

Effectiveness
Well-maintained systems can reduce odors almost completely. Treated materials should have little odor. Digesters have had uneven performance in the past, but newer designs are more reliable. Post-treatment solids and liquids contain plant nutrients that can be used as fertilizer.

Cost
Digesters can repay much of the cost of construction over time. One 800-sow operation (farrow to finish) cost $325,000 and produces up to $100,000 of usable energy per year. Another, 1500 sows, farrow to finish, cost $250,000 and produces about $65,000 in energy per year. A third operation of 1700 sows, farrow to finish, cost $180,000 and produces about $50,000 of energy per year. The fertilizer value of the remaining solids and liquids was not determined.

VF. Synthetic Covers
Description
Covers over manure lagoons and pits form a barrier between liquid manure and the air, preventing odorous gases from escaping. Synthetic covers can be made of concrete, plastic, wood, or other materials. The most popular covers are floating plastic sheets or pellets.

Covers must be designed to withstand wind and must cover all or most of the liquid. They are especially attractive in swine systems. Unlike cattle waste, swine liquids do not usually form a natural crust.

Effectiveness
Covers can be an effective method of odor control. Fixed covers have reduced odors by 80 to 90%; floating pellets by about 55%.

Cost
Costs for materials and installation are in the neighborhood of $1.00 per square foot. For a 10 to 12 foot deep pit for finishing hogs the cost was about $4.00 per head capacity.

VG. Biocovers
Description
Covers over manure lagoons and pits form a barrier between liquid manure and the air, preventing odorous gases from escaping. Biocovers are made of straw, chopped cornstalks, rice or soybean hulls, peat moss, vegetable oils, or other organic materials that can float and form a barrier.

Because the materials are porous the layer must be at least eight inches deep. It must cover most or all of the surface area of the liquid.

Effectiveness
Biocovers reduce odor significantly, about 50% in one study. Straw, especially barley straw, is often preferred because the waxy coating keeps it floating longer than other materials such as cornstalks. Spraying oil on the straw may increase the effective life. Biocovers must be replaced every year, the most important times being spring and summer when odors are at their maximum.

Cost
Costs have been estimated at about $0.10 per square foot per year, about $0.50 to $0.80 per head capacity, about $0.25 to $0.40 per head marketed per year.

VH. Constructed Wetlands
Description
Constructed wetlands are used to treat wastewater after solids have been separated. Microbes break down and transform suspended particles and chemicals; the plant matter filters and precipitates suspended matter. The filtration continues in the sediment and soil.

In a typical system, solids are separated, and the water is held in a holding tank or lagoon until it moves by gravity into the wetland. After moving through the wetland, it ends up in another holding pond or is released through grass strips for absorption.

Effectiveness
Wetlands are a viable alternative to larger wastewater treatment systems. They provide a high level of treatment with very efficient removal of nutrients and solids. Significant reductions have been shown for phosphorus, nitrate, ammonia, biological oxygen demand, and suspended solids. Once constructed they are inexpensive to operate with little equipment used. Odor is reduced significantly, and land requirements for application are reduced.

Wetlands require a constant supply of water and can be affected by seasonal weather changes. In cold weather wetlands require deeper water levels (to avoid freezing) and longer treatment time.

Cost
No data were available.

VI. Composting

Description
Composting is an aerobic process that degrades manure materials into stable, odorless materials. Mechanical devices are usually used to mix and oxygenate the materials. Static composting pumps air into the bottom of piles instead of turning them.

Besides odor-free treatment, composting reduces the volume of material, thus reducing transportation costs. Nitrogen is lost during the process.

Effectiveness
Well-managed composting is essentially odor-free. If the material is too wet or not mixed well odors can be produced. Although nitrogen content is reduced compost is considered a high-quality soil amendment.

Cost
Composting equipment is expensive. Material is normally turned with front-end loaders, tractors pulling mixers, or self-propelled turners. Active static composting does not use as much equipment but does require air pumps and energy to run them. Passive static composting dies not require pumps, but is less effective. Concrete pads are often used; composting is sometimes done under roofs or inside buildings.

Costs for a swine operation using tractors and loaders were $0.20 to $0.40 per marketed head. Compost can be marketed to recover production costs. Prices vary from $10 to $20 per cubic yard. Bagged compost brings higher prices at retail outlets.

VII. Manure Application

VIIA. Optimizing Broadcast Applications

Description
Applying manure by broadcasting has a great potential for odor release. There are some practices that will minimize problems.

- Use materials that are less odorous. Solids should be dried as much as possible; liquids should come from secondary tanks or lagoons where odors have already been reduced;
- Use low trajectories, reducing exposure of the material to air;
- Apply in the early morning to early afternoon so that warming air carries odors upward and mixes and dilutes the odors;
- Avoid spreading just before weekends or holidays, when neighbors will be most affected;
- Avoid spreading when the wind is blowing towards sensitive areas;
- Cool days with low humidity and strong winds will have less smell and will dry faster;
- Incorporate the material immediately.

Effectiveness
Odors will be minimized if the materials do not smell too badly and are incorporated immediately. Immediate incorporation will preserve more nitrogen for crop use.

Cost
No data were available. Broadcasting and incorporating can be the least expensive method if performed properly.

VIIB. Injection

Description
Injection of waste materials inserts the material into the soil and covers it up immediately, resulting in significant odor reduction. It is a popular method for application of liquid wastes. Injection systems include narrow tines, sweeps, disc covers, and conventional chisel plows.

Effectiveness
Injection covers materials more completely than broadcasting followed by tillage, so odor reduction will be greater. Odor reductions of 50 to 85% have been described. Sweeps require more horsepower but allow shallower application. Disc covers require the least energy.

Cost
Compared to broadcasting, injection is more expensive, about 0.3 cents per gallon of liquid manure. The additional nitrogen available for crop production can offset that.

Part IV: Community or County Level Animal Feeding Operation Policies: Common Components and Considerations

By Michael Patton and Andrew Seidl[6,7]

The objective of Part IV is to provide counties and rural communities an improved understanding of the types of policies commonly used by communities to guide the livestock industry, the issues that should be considered in choosing to implement such policies, and an idea of the legal language commonly used in framing them. This information found in this document should help communities to "rough-out" the local livestock policy environment in order to further refine their efforts under the guidance of an agricultural counsel.

Animal Feeding Operations provide both economic development opportunities and challenges to rural communities. A variety of policy alternatives and tools are available to communities in guiding these industries toward community objectives. Communities must evaluate their assets, concerns, goals and objectives in crafting the policy environment appropriate to them. Here, broad categories of community concern are described. Next, the common AFO policy alternatives available to communities to address their concerns are described. These policy components are discussed in view their common provisions and considerations. Figure 1 illustrates the process a community should follow in creating an appropriate policy environment for guiding new or existing livestock operations. The discussion in this report parallels this illustrative model.

I. Community objectives and concerns

Prior to creating the ideal and unique policy environment, communities must determine their economic growth and development objectives and their environmental and their public health and safety priorities, conditions, and concerns. Communities should have engaged in dialogue to arrive at answers for a variety of questions regarding their development prior to entering into the policy-making process including:

Economic Growth Issues:

- Do we want economic growth and development?
- How much growth of what kind do we want?
  …more jobs or better paying jobs?
  …improve general welfare or specific portions of the community?
  …the highest average or least variable community welfare or income?
- What features of our community can help us to reach our development objectives?
  …what are our skills and abilities?
  …what is our infrastructural base?
- How will our economic growth alternatives impact…
  - ◊ local population demographics?
  - ◊ local government?
  - ◊ local business?
  - ◊ local culture?
- Given above, do we want growth through AFOs?
- If yes, what affects the growth of AFOs?
- Do we have/want to provide the conditions for the growth of AFOs in our community?

Environmental Issues:

- What is our natural resource base?
  …what are our local water quality and quantity supplies and demands?
  …what is our local climate?
  …what are our local land use alternatives (e.g., agricultural, residential, recreational, wildlife habitat)?
  …what aspects of our local climate need special consideration (e.g., extremes of temperature, precipitation, wind)?
- How does the proposed livestock operation impact our natural resource base?
  …how does the livestock operation affect our land use alternatives?
  …what demands does the livestock operation put on the natural resource base?
  …what natural resources does the livestock operation create?
  …what measures are available to maximize the positive economic contribution of the proposed development while minimizing the negative economic impact of current and future alternative uses of our natural resource base?
- How does our natural resource base impact the proposed development?
  …what specific measures are available to maximize the positive economic contribution of the proposed development while minimizing the negative environmental impacts or risks?

Health and Safety Issues:

- Do AFO employment opportunities include health risks?
  …are these risks known by those who might be employed by the AFO?

1) Determine Community Assets, Objectives & Concerns

Human Economy
(Local people, Infrastructure, Culture, Business)

Natural Environment
(Land uses, Water, Climate, Wildlife)

Health & Safety
(Employee health, Community health,Environmental health)

2) Assess Current Situation & Plan for the Future

Planning Tools
(Land use planning, Strategic planning)

Community Development Tools
(Holistic Management, Business Retention & Expansion, Community Asset Mapping)

Assessment Tools
(Economic Impact Analysis, Environmental I.A., Cost-Benefit, Community I.A.)

3) Design & Implement Policy Alternatives & Tools to Meet Community Objectives & Concerns

Incentives
(Grants, subsidies)

Incentives or Disincentives
(Zoning, Taxation, Quotas, Permits, Technical Assistance)

Disincentives
(Regulations, Stan--dards, Moratoria)

4) Common Components of AFO Policies

Siting & Construction Standards
(Setbacks, Seepage Rates, Liners, Capacity, Odor)

Plans, Permits, & Practices
(Permits, Land Application, Air, Water, Wetlands, Management Plans, Animals)

Monitoring & Enforcement
(Education/Training, Records, Incentives, Reporting, Local Control, Financial Assurance)

…are these risks acceptable to the community?
…is the proposed operation's approach to addressing these health risks adequate?

- Do AFOs create health risks to the community at large (e.g., water supply, odor, crime, traffic, dust)?
  …are these risks acceptable to the community?
  …is the proposed operation's approach to addressing these health risks adequate?
- Do AFOs create risks to the natural environment (e.g., wildlife habitat, soil, water, air)?
  …are these risks acceptable to the community?
  …is the proposed operation's approach to addressing these risks adequate?

II. Policies to Address Community Concerns and Objectives

Role and Scale of Public Policy:
Public policy initiatives, or government intervention, are normally said to be justified

public costs from private action or when the public benefits from a proposed action would exceed the private costs, public intervention is commonly seen as appropriate.

Public policy interventions can occur at any level in the government chain. There is a tradeoff between flexibility and continuity as one moves up and down the levels of government. Interventions at higher levels of government afford greater consistency. Interventions at lower levels of government allow greater adjustment to peculiarities of the area and to "micro-manage" an issue. In addition, higher level governmental entities naturally have greater financial wherewithal to implement policy, while local governments may have greater detailed knowledge of the issue and greater ability to enforce the policy. In practice, public policy is integrated through several governmental levels to take advantage of the benefits of each.

Tools of Public Policy:

In the implementation of a desired policy, there are two general approaches. There are incentives and disincentives; the carrot and the stick. Grants and subsidies fall under the first category, while regulations, standards, and moratoria fall under the latter. There are also policy tools that can be either incentives or disincentives. Tools that are in this category include zoning, taxation, quotas, and permits.

When there is a minimum acceptable level of a criterion, regulations, standards, and permits are the most appropriate choices. Health and safety issues and some environmental issues are examples. Incentives are best to motivate behavior above the minimum standard or when flexibility or innovation is a policy objective.

Synthesizing Government Roles and Scale with the Tools:

For a policy to be efficient and effective, certain features should be evident. Both sides of the issue must feel that the policy (also the process) is fair and unbiased. Involving affected individuals in the process and relying on best available science are both ways of enhancing this "fair" view. An effective and efficient policy must be clear to understand, and the features must be necessary and able to do what it is supposed to do. External effects (intended and unintended) should be minimized. Policies must be enforceable and there should be a graduated system of penalties for violating the policy provisions. There must be a regulator who has both the will and the power to enforce the policy. Typically, the regulator must have at least equal power to those regulated.

III. Review of Existing Regulations

To assist in deliberating about policy, a review of the current legislation in 33 states is provided. The information was gleaned from three different studies and so the information availability is not consistent across states. Since the last information in the studies was from 1997, there may be some changes from that which is listed. Indeed, in our own state, the legislation was just changed with the approval of Amendment 14. Similar situations may exist elsewhere. The information is reported in three subsections: Plans, Permits and Practices; Siting and Construction Standards; and Monitoring and Enforcement.

IIIA. Plans, Permits and Practices

Permits:

Twenty-six of the thirty-two responding states have permitting requirements related to AFOs. Almost all permitting is done at the state level, but permits related to NPDES are reported by a few states. One state (California) reported county permitting.

Permit features include: facility construction, storage pond structures, waste systems and discharge, feedlots, and soil erosion. Most frequently, permits seem to be used for construction and/or operation of facilities and waste systems and discharge of waste. Permits are also frequently associated with scale of operation, either by number of animals or water use per day. Commonly, a threshold of 1000 AU is used.

Monitored and enforced permitting can help maintain minimum water quality standards for health and environmental purposes. Variation can occur within the permitting system due to variation in nutrients and contaminants in the waste of the operations. To date, that variation does not seem to be of significant concern to governing bodies.

Design and Waste Management Plans:

Nine of thirteen states require waste management plans. The required plans vary significantly across respondents. Plans are required for lagoons, livestock facilities, and waste storage depending on the purpose of the plan.

Land Application Limits:

Waste is often managed by applying it to crop fields as a substitute for commercial fertilizers. Waste

Air Quality:
Air Quality regulations related to AFOs were reported for only 11 of 25 responding states. Of those 11, at least 2 were local regulations. Responses reflected that air quality in rural areas is not normally a concern, except for airborne particulates and odor. Dust control and odor are the two concerns specifically listed.

Dust control might be addressed through incentives that motivate an operation to find solutions to the problem on its own. Still, there would have to be a standard to which the firm must comply. Measurement that is site-specific is a challenge, so monitoring compliance may be difficult. Since air quality is a health issue, other, more direct tools, such as Best Management Practices (BMP) or setbacks, may be appropriate.

Groundwater Related Requirements:
Twenty of 25 states provided information about groundwater requirements. Most states reported requirements that either deal with ground or surface water use or quality. The National Pollution Discharge Elimination System (NPDES) is a series of recommendations related to the Clean Water Act which applies to all states.

Ground and surface water use and quality are regulated by a web of laws and regulations at different levels. Quality standards are normally instituted at the federal and state levels, while states have laws governing use in the form of water rights. States often regulate ground water use differently than surface water. Local governments may add layers of legislation/regulation to address specific local issues.

To increase performance above minimum standards, incentives could be implemented. Water markets, including leasing, subsidies, or tax credits or deductions, can be used to motivate user to invest in equipment that is more efficient and implement more efficient practices. Water markets and tax incentives are both difficult to implement at the local level since legislation introducing these tools is commonly at the state level. Localized markets do exist, however. Northeast Colorado has one of the most active water markets in the U.S. Due to the rural location of livestock operations, tax incentives would probably be limited to a property tax offset. For capital investment purposes, grants or subsidies would be more straightforward in administration.

In order to address particular contamination problems, additional standards could be instituted. A common practice is to establish setback requirements for waste handling from wells and the water table. Soil types (sandy versus clay soils, e.g.), climate, water table level, likelihood of water contamination, and well proximity all influence setback standards. In addition, land waste application is often restricted to agronomic uptake rates appropriate to the crops grown, based on nitrogen and/or phosphorus.

If still stronger measures are required, moratoria on certain offending practices could be declared. Temporary moratoria are commonly used to allow a community time to put appropriate guidelines in place. This is a more drastic step and, because of the political implications, may be a less desirable option.

Water Use Restrictions:
Restrictions were reported by 18 of the 26 responding states. The more restrictive laws tend to be in the western states. Eastern states more frequently require diversion notifications or permits for large withdrawal rates. Permits and state water law are most frequently cited. Colorado did not report restrictions, but Colorado's water use is based on a prioritized system of rights for beneficial use.

As with groundwater, local restrictions of water use could be implemented in situations where more strained resources exist. There must be a method of monitoring and enforcement for violations. Incentives for technology and practice improvements would be appropriate policy tools to increase the efficiency of water use beyond that required by the permit system. Incentives could be in the form of grants and/or subsidies. If water use is governed by rights or permits requiring beneficial use or "use it or lose it" philosophy, incentives are much less likely to work as desired. The overriding interest in this case would be to keep the right to the water rather than use the water efficiently. For incentives to work well, a water market of some form should be designed and implemented.

Wetland Regulation:
Fifteen of 26 responding states have some applicable state and/or federal wetlands regulations. The lower percentage of these regulations, compared to some other types of regulation, is probably due to the less frequent occurrence and/or conflict over wetlands in many states.

application can have advantages over commercial fertilizer because it has nutrients beyond just nitrogen and phosphorus. Yet waste application has variable levels of these nutrients and over-application can contribute to water resource contamination just as commercial fertilizers can. In addition, unwanted biological matter are present which may compromise drinking water supplies.

To address this method of waste management, twenty-six of twenty-nine respondents listed application limits. Almost universally, the approach to prevent over application of waste has been to limit application to agronomic rates for the crops grown. Nebraska bases application on hydrological in addition to agronomic considerations. The agronomic standard varies according to local growing conditions, including time of year due to food safety considerations and the risk of run-off from frozen soils.

These limits are based on Best Management Practices. Such standards do not account for economic considerations of efficiency, but it can be presumed that a farmer would not apply an economically harmful level of waste just to reach the agronomic limit. Thus, the real concern is about applying over the rate at which the crop can uptake the nutrients. This is ultimately a health concern, so such limitation is an appropriate policy response for this issue.

Wetland protection regulations are oriented toward water quality and, as such, are covered by NPDES standards. Eight states report having additional regulation beyond the federal guidelines. Monitoring and enforcing wetland regulations are subject to the same difficulties as most agricultural pollution issues. Non-point pollution cannot be adequately traced to specific sources. As a result, enforcement of a system of sanctions is prevented. Only in cases where direct discharge would be engaged, could there be specific oversight. Some wetland regulations aim to prevent such discharge.

Because of the non-point nature of the potential contamination, management tools appropriate to the concern include regulations, standards, and moratoria. Direct discharge into wetland waters can be prohibited or restricted. Storage and seepage requirements are often used for both wetlands and groundwater protection. Some localities and/or states require monitoring and/or soil samples on a regular basis. Land waste application is, as with groundwater protection, restricted in some form.

Incentives to assist in investing in technology to better store, distribute, and apply waste could be used to raise efficiency beyond the minimum standard. Best Management Practices could be supported to enhance the likelihood of a uniform use of scientific knowledge in waste management practices.

Dead Animal Requirements:
Twenty-two of twenty-four states reported policies regarding dead animal disposal. State health boards and counties were the government entities responsible for these requirements. Methods permitted include burial, incineration, composting, and rendering. Two states reported burial depths of 3 and 6 feet. Since the overriding issue here is one of health, regulation of procedure, rather than incentive approaches, is the easiest to implement and monitor, as well as update with changes in knowledge or disease vector requirements. Regulation would also likely be the least costly method.

IIIC. Siting and Construction Standards

Allowed Lagoon Seepage:
Twenty-six of 31 responding states have seepage limitation requirements. Most states list specific rates of seepage, but a few cite technical guides or state/federal guidelines. Seepage rates are listed primarily in distance units but two use volume rates instead. Distance seepage rates range from 1/32 in./day to 1/4 in./day (or the metric equivalent). Seepage rate determinations must consider similar issues as setbacks. Soil type, water table, likelihood of pollution, proximity of public water resource, scale of operation, and climate are all features to address.

Limiting seepage rates is a simple and straightforward way of limiting water contamination. The main difficulty is monitoring. Soil borings, soil samples, water balance calculations, and monitoring wells are approaches commonly used. To make such a monitoring system work, adequate trained personnel must be available to make on-site inspections. Interestingly, the survey indicates that such inspections are not particularly common – probably because of the required cost of supporting the personnel needed. Initial inspections to verify proper construction is done, and occasional records inspections are substituted for more regular on-site inspections. There was neither an indication of whether compliance is a problem nor of sanctions in the event of violations.

In addition, seepage could be affected by waste handling practices. The seepage rate applies to lagoons, but if waste lies on the ground or if there were frequent spills, seepage volume would increase, making the problem worse than rate compliance would indicate. Incentives to support innovation in waste management could be considered which would support efficiency and performance beyond minimum allowable standards.

Liner Material Used:
Twenty-six of twenty-eight states listed liner material requirements. Liner material requirements vary according to the soil type, capacity, and seepage rate allowed. Most states follow NRCS standards or specifically require clay/clay composite or synthetic liners. A few states allow any material that meets seepage rates (e.g., Colorado).

The two approaches to liner material (specific material requirement or any material meeting seepage rate) reveal different philosophies. The strict requirement, or regulation is more of the "stick" approach, while allowing any material meeting the seepage limit is more of a carrot approach. The second allows for more innovation and efficiency, but also possibly has a higher risk of non-compliance. The first approach is more certain to maintain compliance, but may be more expensive as new technologies are developed. Strict regulation also must be changed to allow for improvements in seepage prevention technology.

Storage Structure Capacity/Freeboard:
Twenty-five of twenty-eight states report waste storage capacity standards. As with seepage and liner material, most list specific standards, while some cite references, or allow for "sufficient capacity." The key consideration is the probability of spill due to weather. Some states follow the NPDES recommendation of capacity sufficient to hold volume from a 24-hr./25 year storm event. Statistically speaking, the standard allows for about 4 waste spills per century on average. However, four may occur in one year. Governing bodies must determine whether that standard is sufficient for their particular human and natural environments.

Alternatives to NPDES standards are common. For example, freeboard requirements range from 1 to 3 feet. The reported holding capacities range from 120 days to 365 days. Still other capacities are determined on a site-specific basis. Part of the consideration of capacity should involve the risk of damage given a spill occurrence. Proximity and sensitivity of water resources and ecosystem assets, as well as human health and property threats, are all factors of importance.

Odor Control:
Odor is a significant issue surrounding all CAFOs, no matter the species. Concern over odor is a source of strong CAFO opposition and nuisance lawsuits. As such, it is an issue that receives much attention by policy makers. At the same time, odor control is very problematic, so evidently few states have attempted specific odor control regulation. Out of 16 states, only 3 have odor control laws and even in those, enforcement is considered of low priority or difficult to enforce.

Rather than specific odor control regulations, more indirect methods are used. Setbacks, landscaping, and waste storage covers are alternatives that some states currently employ. None seem to provide incentives for odor control. Innovation would be an important tool with this issue and grants, subsidies, or variances in zoning or setbacks may help motivate a firm to explore alternative practices and technologies to reduce odor. In addition, avoidance of nuisance lawsuits should provide impetus.

Setback Requirements:
The majority of states reported the use of setbacks in four categories. Twenty states have setbacks from dwellings, 18 have setbacks from property lines, 25 from water wells, and 21 from the waste storage structure bottom to the water table. There are federal guidelines in this area, but no requirements. Most setbacks are locally governed.

Setbacks from dwellings range from 300 feet to one mile (3 miles from city limits). Most setbacks are about a quarter mile from dwellings and a half mile from population centers. Property line setbacks range from 100 feet to 1.4 miles for CAFOs over 1000 AU. Water well setbacks range from 50 feet for pesticide applications to 2000 feet from public wells. Private well setbacks are typically in the 100 to 300 ft. range. Waste structure bottom setbacks range from 0 to 20 feet, depending on the structure and liner material. Typically, the setbacks are 2 to 4 feet.

Setbacks are low cost methods of protecting water resources from waste contamination. Since conditions vary greatly from location to location, local governments are the likely entity to establish and administer setbacks. State governments sometimes establish broader standards. Soil type, water contamination potential, waste storage type, liner, odor, climate, air quality, and scale of operation are all considerations when setting setbacks.

IIID. Monitoring and Enforcement

Local Government Involvement:
This information was provided through a smaller survey than most of the other information. Of twelve states responding, 7 have local zoning authority with regard to AFOs, and 4 have public health authority involvement. If those percentages are fairly consistent throughout the nation, there is a great deal of local involvement in the oversight of AFOs. Local government involvement, as discussed in the section about policy considerations, offers more flexibility and "hands on" management than state or federal supervision. Personal relationships and knowledge of local characteristics enhance the possibilities of finding optimum answers to AFO issues. However, discrepancies in economic and political power among stakeholders may diminish the effectiveness of local solutions.

Education & Technical Assistance:
Educational and technical assistance programs are thought to enhance the rate of compliance with regulations. Training/technical assistance is provided to the AFO operator by such entities as Cooperative Extension, soil and water conservation districts, and the Natural Resource Conservation Service. Twenty of 23 states reported some kind of training or technical assistance. Since the assistance providers are often national agencies, it is likely that technical assistance is available in all states. Some states also have their own programs.

Management Incentives:
Eighteen states reported incentive programs. State and/or federal cost sharing and the Environmental Quality Incentives Program (EQIP), a federal initiative, account for most of the incentives reported. No local incentive programs were reported. Incentive programs tend to be targeted toward innovation and capital investment. The nature of an incentive is to guide profit-seeking operations toward the objectives of the community. Firms will tend to find the most profitable (least cost) way to achieve the desired performance to make the most of the incentive. Incentives too directly tied to specific solutions can introduce unintended inefficiencies and/or distortions.

Identification of Violations:
Twenty-eight states reported methods of identification of violations. In all twenty-eight states, identification was complaint driven or had occasional inspections to monitor compliance. Only 11 states have routine on-site inspections. No system of sanctions was identified in these surveys. Given the simplicity of a complaint driven system, it would be reasonable to believe that all states have at least that form of violation identification.

Recordkeeping:
Responses from only 14 states were available for this category. Nine states require on-site record keeping and 6 require record submissions to authorities. This is a monitoring function and to be reliable, the record keeping systems must be consistent and accurate.

Soil Borings:
Six of thirteen states require soil borings. The range of depth reported was 2 to 10 feet below the bottom of waste storage facilities. Climate, soil type, and water table factor into depth decisions.

Provisions for Clean Up if Operation Closes:
There was very limited information available on this subject for this report. Of the 7 states reporting, only 3 had provisions for site clean-up in the event that a CAFO closes. Those three states all reported that the existing provisions were at the county level. Financial assurance for site remediation is commonly addressed in one of two ways: bonding or an indemnity fund. Bonds are administered through private insurance companies. Indemnity funds tend to be administered at the level of the state government. Issues arise over the appropriate size of the bond or fund to assure remediation. Lack of information regarding the risk and impact of accidents and the costs of remediation make this determination difficult.

Part V: Conclusions

This report represents a collaborative effort among Colorado State University (CSU), Cooperative Extension (CE), and Colorado Counties Incorporated (CCI). Our objective was to summarize current knowledge on the role of the livestock industry in rural communities in order to facilitate community decision-making. The report was divided into four distinct parts representative of the broad areas of concern to rural Colorado communities. First, Ruth Kedzior (CU-Denver and CCI) discussed national trends in animal feeding operation policy. Secondly, Park, Lee and Seidl (CSU and CE) attempted to pose and answer the essential frequently asked questions surrounding rural communities and animal feeding operations. Thirdly, Iversen and Davis (CSU and CE) provided information on recent innovations in odor management technology including their effectiveness and costs. Finally, Patton and Seidl (CSU and CE) discussed the role of the state and communities in guiding the livestock industry through a discussion of current and potential livestock policy tools and a community development perspective.

The livestock industry, like any other industry, left to itself will not necessarily act in the best interests of the community at large. By the same token, a community without a healthy local economy ceases to exist as a community. Rural community leaders are challenged to evaluate the extent to which both traditional and new animal agricultural enterprises continue to contribute to the well-being of the people they represent. Rural and agriculturally dependent communities must forge strong and innovative partnerships among agribusinesses, retailers, local government and other aspects of rural society to guide the agricultural economy and the broader rural community toward their collective vision of the future. The authors hope that this report will provide the basic information and a jumping off point for community specific efforts to fairly, effectively and efficiently guide the livestock industry toward community goals.

Part VI: For More Information

National Policy Trends

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Endnotes

1 The Comprehensive Environmental Framework for Pork Production Operations was endorsed on December 12, 1997 by the Dialogue participants. This Framework's guidelines are offered to provide a known set of reasonable, more uniform environmental standards for pork producers to follow. The Summary for the Framework can be found at http://www.nppc.org/EnvDialogue/summary.

2 This paragraph came from the introduction of the Draft Unified National Strategy for Animal Feeding Operations, September 11, 1998. The complete draft can be found at: http://www.nhq.nrcs.usda.gov/cleanwater/afo/index/html

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