October 1998

ARPR 98-05

Agricultural and Resource Policy Report

Colorado State University Extension

Department of Agricultural and Resource Economics, Fort Collins, CO 80523-1172
http://dare.colostate.edu/pubs

THE SWINE INDUSTRY AND COMMUNITY ECONOMIC DEVELOPMENT: A REPORT TO THE BACA COUNTY COMMISSION

Jennifer Grannis and Andrew Seidl [1]

"Predicting is tough…especially when you are talking about the future." Yogi Berra

Executive Summary

Colorado has seen large swine operations recently move onto the Eastern Plains. Changes in technology, and marketing frameworks have made this nontraditional swine producing state a growing national competitor. Rapid changes in Eastern Colorado communities have generated a number of controversial issues. Concerns over corporate versus family farms, the human condition, rural communities and the natural environment have been raised in Colorado and across rural America.

The citizens of Baca County, Colorado are struggling with many of the same economic development issues facing much of rural America. The opportunities and challenges potentially provided by the swine industry to Baca County have been raised in North Carolina, Illinois, Iowa, Kansas and Oklahoma as well as in other Colorado counties. This paper seeks to provide unbiased information to the citizens of Baca County about swine production practices, industry structure, environmental and economic indicators on rural communities as applied to Baca County wherever possible. Since specific information is not always available for either Baca County or Colorado, this analysis often depends upon experiences collected from other states.

The report is divided into three principal sections sandwiched between the introduction and conclusions. The introduction is followed by a look at the basics of the development of the swine industry, including the reasons for the changes we are seeing from small diversified family farming to concentrated and specialized corporate farming. Especially important are the issues of vertical integration and contracting covered in section II.A., and followed by a description of the changes in production costs that have revolutionized the industry.

Community and natural resource economic issues follow, with special emphasis on employment, infrastructure and real estate. Natural resource management is also discussed, and where possible information has been collected from Extension publications, especially concerning natural resource management. As concentrated hog farming becomes more prevalent in Colorado, more written Colorado specific information will become available. Until then, Colorado Cooperative Extension is attempting to provide information and technical information based upon the experiences of other states.

[1] Graduate Research Assistant and Assistant Professor and Extension Economist--Public Policy, Department of Agricultural and Resource Economics, Colorado State University, Ft. Collins, CO, 80523-1172. Phone: 970-491-7071. Fax: 970-491-2067. E-mail: aseidl@ceres.agsci.colostate.edu.

The third section of this report deals with some of the more common components of swine legislation across the country. Though similar in many respects, individual states have legislation that is most suited to the specific needs of their citizens. In Colorado, the 1992 Clean Water Quality act carries provisions to regulate some aspects of animal feeding operations and a number of counties have developed their own regulatory environment. Alternatives are proposed by state amendments #13 and #14 and several nationwide initiatives are currently being explored. Following the concluding remarks the report closes with a section listing where additional resources and information can be found. Complete references and annotations are included as well as a glossary of terms to help with some of the more swine specific definitions.

Traditionally, Colorado has not been a major hog producing state. However, over the past decade, Colorado has seen the number of hogs more than double and the state is becoming an important center of hog production in the United States. These hogs have been concentrated in the Eastern Plains surrounding Baca County. The opportunities and challenges facing rural communities regarding the potential introduction of swine operations are common across communities and states. However, the answers to the questions posed are specific to individual communities and their citizens. As a result, we anticipate research will be undertaken to understand the interaction of this industry with the communities of Colorado. We contribute this report to the citizens of Baca County and their representatives to facilitate their ability to reach the future that they collectively envisage.

I. Introduction

The introduction of new businesses has social, cultural, economic and natural resource impacts on communities. The issues are consistent across communities, but the answers are specific to a particular locale. The citizens of Baca County are faced with understanding their present opportunities and challenges and guiding the future of their community. Swine operations are among the choices facing the citizens of Baca County. This report has been prepared in order to facilitate decisionmaking about swine operations in Baca County. The report is divided into five parts following this introduction: Industry Profile; Community and Natural Resource Economic Issues; Common Components of Swine Policy; Concluding Remarks; and Where You Can Go (for more information).

II. Industry Profile: Past, Present and Future

Until two decades ago, the hog industry was highly concentrated in the upper-Midwest. In the 1980s the industry began to change, and nontraditional hog states became important producers of pigs.[2] Most notably, North Carolina went from the bottom of the list of hog producers to second behind Iowa. Because it was cheaper to feed a pig closer to the feed center, places like North Carolina had not been able to compete with Corn Belt states. However, changes in technology, disease management, concentration on genetics, and improved control of feed rations contributed to the ability of nontraditional hog states to be competitive.

A change in consumer demand is partially responsible for the change in the hog industry. Starting in the late 1970s, consumers became increasingly concerned with the amount of fat they were consuming. Pork and beef lost market share to chicken. Changed preferences pressured producers to produce a leaner hog. Producers could grow a hog predisposed to be leaner, and feed them a ration that allowed the market hog to develop less fat. Feeding a specialized ration is more expensive than traditional feed practices, but a farmer feeding a large number of hogs could reduce costs by taking advantage of volume discounts. Feeding genetically similar hogs also assured the farmer that weight gains would be the same across the entire group of animals. Less variation in market hogs meant lower costs for the packer, and thus the lean, mass produced hog received premiums at the packing plant.

Today, 55% of all hogs produced in the U.S. are produced on farms with more than 2,000 animals and 35% of all hogs are on farms with 5,000 or more hogs. Colorado's pig production increased 24% from 1996 to 1997 to about 700,000 hogs, but the number of farms producing pigs has decreased. Colorado mirrors the national trend of moving from a state where pigs are produced part-time on many small farms to where the hog farming industry is concentrated.

Currently the broiler industry is the most concentrated agricultural industry. At one time, growing broilers was not unlike the pork industry. Small, part time chicken farmers produced birds for home consumption and then sold the remainder in a relatively open market. Today, all aspects of production from the breeding inventory to the packing and distribution of a product are controlled by a single firm in a vertically integrated industry. The broiler industry is controlled from top to bottom by a small number of processors.

[2] A glossary of terms is appended to this document.

As fewer farms produce hogs, and those in business maintain ownership of pigs throughout their growth stages through the use of contracting, the likelihood of market structure evolution in the pork industry analagous to the poultry industry increases. Table 1 contrasts the characteristics of localities more likely to attract confined animal feeding operations (CAFO) with the current situation in Colorado.

II.A. Market Structure: Specialization, Vertical Integration and Contracts

Traditionally, all phases of hog production were located within the same operation. Changes in production and managerial technology and decreases in transportation costs have facilitated the specialization of the hog industry into three phases: farrow, nursery and grow/finish. Specialization has aided a transition from an open market dominated industry to one where contracts are used. Contracts are important across all components of the hog operation. It is most common for the breeding stock to be wholly owned by the breeding or farrowing unit, and to contract with nurseries and growers or finishers to feed the hogs to market weight (250 lbs.). The contracted farms are paid a fee and premium that usually depends on weight gain. Selling market hogs and the prices received are determined in advance by a contract between the hog's owner and the packer. This increases industry efficiency by guaranteeing deliverable product on time and stability by linking production units while spreading risk across many links in the production chain.

However, contracting can reduce open market activities. If hogs are produced and prepared to the specifications of a processor and sold, not by the grower but by the contract owner, then there is little opportunity for the small producer to enter the market independently and be competitive (Table 2).

Table 1: Characteristics of locales attracting CAFOs

Attractive characteristics	Current Situation in Colorado
Drier climate	Eastern Plains are dry (rainfalls less than 20 inches)
Existing larger swine facilities	National Hog Farms, 17,000 sows; Seaboard Corp., D&D Farms, Alliance Farms, and Midwest Farms, 20,000 sows each; Bell Farms, 40,000 sows, all in Eastern Plains.
Larger populations of rural people	No metropolitan centers in the eastern counties
Local governments have less authority to regulate animal facilities	Many local governments had no zoning or planning prior to concentration
Lenient to environmental law violators	Current law is water quality & complaint-based.
Exempt agriculture from local zoning ordinances	Few local zoning ordinances developed before the migration.

Source: Yin Mo, and Charles, Abdalla. "Analysis of Swine Industry Expansion in the US: The Effect of Environmental Regulation." Staff Paper 316. Agricultural Economics and Rural Sociology, The Pennsylvania State University, March, 1998.

Table 2: Issues in vertical integration and production contracts

Potential benefits of contracting	Potential costs of contracting
Guaranteed uniform input supply	Poor performance reduces premium received
Products of specific quality	Non-renewal or termination of contracts
Introduction of new production technology	Liability of processors to producers to purchase contracted hogs even if they aren't high quality
Reduction of overall farm risks	Farmer's loss of independence
Production cost control	Loss of control of farming enterprise
Gains in market share	Monopoly power gained by processors

Source: Erkan Rehber. *Vertical Intergation in Agriculture and Contract Farming*. Working Paper #46. NE-165 Private Strategies, Public Policies and Food System Performance. University of Connecticut: Food Marketing Policy Center, 1998.

Contracting is popular in many places in the country, but differences in state regulations and local attitudes cause variations across the country. The larger an operation is, the more profitable it is to concentrate on one phase of production and have other farmers complete the raising of the pig. Most contracts are owned by the concentrated sow operation that has arranged to have its pigs fed to market weight by other farmers. However, networks where ownership is partial or changes as the animal changes hands also occur. Another group using contracts are feed producers who own pigs and contract with farmers to raise them guaranteeing them a market for their feed.

II.B. Production Costs

Because of recent low prices for hogs, a national average of approximately $30.00 to $35.00/cwt and an estimated production cost of about $40.00/cwt, some producers may go out of business.[3] Some small, higher cost farmers have benefited from the establishment of new hog farms. Large farrowing operations (>1,200 sows) have contracted with neighbors to provide nursery services (weaning to 50 lbs.) and growing and finishing services. Anecdotal evidence in Minnesota showed some farmers, who otherwise would have given up farming, were able to switch from their labor intensive farrowing operations to relatively less time consuming contracted finishing operations.[4] Feed constitutes about 2/3 of the total cost of producing a hog for market. About 10% of farrowing and nursery pig production costs are feed, while about 80% of a finishing operation's costs are feed. Concerns have been voiced that the contracted hog feeder does not own the hogs they are raising, and thus does not have as large an income or as meaningful a job. However, they also are not bearing the majority of the risk any longer. Kansas State University has estimated the returns to non-contracted farmers producing feeder pigs will lose $33.56 per hog. They also estimate that only finishing a hog under contract will return $3.47 per hog, and they conclude that there is an opportunity for contracted finishers to make profits at the finishing stage.[5]

Since corn is the most common ingredient in swine feed, the more expensive corn is the more costly it is to feed a pig. The lower the corn prices, the less expensive it is to feed a pig and the more incentive a farmer has to put pigs on feed. Since feeding a pig is a value-added way to increase profits for the farmer, they are motivated to increase or decrease swine production based on the prices of corn. To explain this relationship, and to aid in the projection of possible changes in the market in the future, the hog:corn price ratio was developed (Table 3). The ratio uses the price of corn and the market price of swine per hundredweight in the expression. The price of swine per hundredweight divided by the price of corn per bushel gives a unitless indicator of the overall strength of the hog market. A high hog:corn price ratio indicates that the price of corn is low relative to the price of market hogs.

A lag of one year is expected before more hogs reach market as farmers increase breeding stock, breeding, and the number of swine that they are raising for market. As the number of hogs reaching the market increases, a reduction in the hog:corn price ratio occurs. More pigs at market means the prices are reduced for hogs. As the top of the ratio goes down and the price of corn remains the same or rises, the overall ratio will be reduced. A low ratio signals that prices for hogs are low compared to the price of corn and fewer hogs will be placed on feed, reducing the number of market hogs.

Table 3: Annual hog:corn price ratios

Year	Ratio	Year	Ratio
1990	23.6	1994	16.4
1991	20.7	1995	16.4
1992	20.3	1996	14.4
1993	20.5	1997	15.5

Source: National Pork Producers Council. "Facts." Fact Book on the Swine Industry, 1998.
Note: The ratio is the swine price per hundred pounds divided by the corn price per bushel.

[3] "AgLetter." *Chicago Fed Letter* 1896 (January 1998).

[4] Bob Koehler, Bill Lazarus, and Brian Buhr. "Swine Production Networks in Minnesota: Resources for Decision Making." Staff Paper P96-6. University of Minnesota, Department of Applied Economics, April, 1996.

[5] Michael Langemeier. "Contract Hog Production: An Economic Evaluation." MF-1070. Cooperative Extension Service, Department of Agricultural Economics, Kansas State University, Manhattan, July, 1993.

The hog corn price ratio is a simplified expression of the hog cycle. The hog cycle is an economic tool to explain activity in the hog market. As prices rise, more animals are prepared for market, and increases in quantity reduces the price when the hogs all reach the market at the same time. The low prices signal farmers to reduce breeding stock and produce fewer hogs, which will raise the price again as fewer animals reach market.

III. Community and Natural Resource Economic Issues and the Swine Industry

Rural communities need to determine the employment, services, and life style objectives of their communities in view of their opportunities for economic development and the resources at their disposal. Based upon objectives, opportunities and resources, communities can guide their evolving business, cultural, social, economic and natural environment using a creative mix of policy tools. Currently, a number of rural Colorado communities are deciding whether and how to manage the opportunity for swine operations to locate in or near them. Common questions surrounding the potential of swine operations as engines of economic development include employment and income, infrastructure and public finance, real estate, and natural resource management.

III.A. Employment and Income

III.A.1. General Features

Communities that have decided that job and income growth are among their objectives and are entertaining the possibility of having a swine operation enter their region may ask: how many jobs, of what sort, and how much income in the short and long term will be directly or indirectly created by the introduction of the new enterprise. The answers to these questions depend on the size and type of enterprise under consideration, the available human and natural resources, and the existing infrastructure, policy environment and agribusiness community.

Table 4 provides an overview of the wage rates found in the swine industry. In addition, a National Pork Producers Council publication finds that larger firms pay relatively higher wages due to greater skill required by newer technologies.

Table 5 provides illustrates employee benefits as an indication of job quality. From Table 5 it is possible to infer how job benefits are distributed across the size of swine industry operations. For example, it appears that 16% of producers are providing 66% of employees' life insurance; larger producers more commonly provide life insurance benefits than smaller producers.

Table 4: Mean salaries in the U.S. hog industry (1995)

All positions in the United States	$24,721
All positions in the Western United States	$26,932
Manager	$27,729
Assistant Manager	$21,298
Farrowing Manager	$20,884
Herdsman	$18,862

Source: Terrance Hurley, James Kliebenstein, and Peter Orazem. "Structure of Wages and Benefits in the U.S. Pork Industry, December." Staff Paper 283. Department of Economics, Iowa State University, December, 1996.

Table 5: Percent of swine industry employees receiving benefits (1995)

	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: Terrance Hurley, James Kliebenstein, and Peter Orazem. "Structure of Wages and Benefits in the U.S. Pork Industry, December." Staff Paper 283. Department of Economics, Iowa State University, December, 1996.

Paid vacations, holidays and medical insurance appear to be more commonly provided across operation sizes.

Another indicator of job quality is health impact. Reports indicate that employees in the hog industry are more likely to complain about work related health problems. In particular, about 30% of hog industry employees complain of upper respiratory distress compared to about 20% across the agriculture sector.

III.A.2. Short and Long Term Employment Prospects

Short-term job creation tends to be in the construction sector. Estimates in the literature vary substantially and may depend upon qualified local labor availability. Estimates range from 7 to 25 jobs per 1,000 sows entering the community at about $14,000/yr-job.[6] Longer term jobs can be in traditional farrow-to-finish operations, or specialized farrowing/breeding, nursery, and finishing/growing operations in addition to packing plant job opportunities. Table 6 reviews the available job and income information for farrow-to-finish operations illustrating both economies of scale in labor and higher wages with size increases. In line with the Iowa results, a Virginia study found increases of 14-16 total jobs per 1,000 sows in the community.[7]

Indirect job and income effects are due to multipliers". An employee at the hog operation may spend part of his salary on housing, food, services, and entertainment in the local community. The hog operation may purchase milling services and feed, trucking, and/or veterinary services and supplies locally. These expenditures create jobs and income in the community or multiply the effects of the original action. Actual local multipliers certainly depend upon the current stock and quality of labor, housing, retail and service sector and may depend upon the size and management structure of the CAFO. Multipliers will be higher for counties with corn surpluses and unemployed labor. Though it is common for large operations to import feed from a consistent and often distant source, there are indications that producers prefer to work with local suppliers if consistent quantity and quality can be achieved. Reported multipliers commonly result from the assumptions of the computer program used for estimations. Reported hog industry employment multipliers range from 1.28 to 2.22 and income multipliers range from 1.26 to 2.22[8,9] An employment multiplier of 2 means that for each job created in the hog industry another job is created in the community. An income multiplier of 2 means that for every $17,000 job created in the hog industry an addition $17,000 in income is generated in the community.

Farrowing operations are the most common new swine operation in Colorado. Farrowing operations generate about 3-4 jobs per 1,000 sows at about $14-$18,000 starting annual salary. Mean reported salaries in farrowing operations are about $20-$22,000 per year. Managers earn around $45,000 per year and tend to be recruited from outside of the community, at least

Table 6: 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: Daniel Otto, Peter Orazem, and Wallace Huffman. "Community and Economic Impacts of the Iowa Hog Industry." *Iowa's Pork Industry - Dollars and Scents*. Iowa State University, 1998.

[6] "Estimated Economic Impacts from the Annual Operations of a Proposed Farrowing Facility." Department of Agricultural Economics, University of Wyoming, August, 1997.

[7] Suzanne Thornsubry, S. Murthy, Kambhampaty, and David Kenyon. *The Economic Impact of Increased Swine Production in a Rural Virginia County*. Virginia's Rural Economic Analysis Program. Department of Agricultural Economics, Virginia Tech: Virginia Cooperative Extension, 1995.

[8] Suzanne Thornsubry, S. Murthy, Kambhampaty. *The Economic Impact of Increased Swine Production in a Rural Virginia County*. Virginia's Rural Economic Analysis Program. Department of Agricultural Economics, Virginia Tech: Virginia Cooperative Extension, 1995.

[9] Daniel Otto, Peter Orazem, and Wallace Huffman. "Community and Economic Impacts of the Iowa Hog Industry." *Iowa's Pork Industry - Dollars and Scents*. Iowa State University, 1998.

initially. Another indicator of job quality, annual turnover, reportedly ranges from about 17-30% in farrowing operations.

Reported wages in the packing industry range from about $6-$10.00 per hour largely depending upon how finely the plant cuts and packages pork products. Approximately, 10 jobs are created per 1,000 head per day packing operation. Higher end salaries are reserved for more specialized cuts. This part of the industry experiences greater turn-over rates (about 70%) and has a greater on the job accident risk. Due to the turn-over rate, the higher accident rate, and the common 6 month window on health insurance coverage, this portion of the industry may present pressure on indigent health care in rural communities. Reportedly, packing plant employees tend to be more culturally diverse relative to host communities than other sectors of the industry and tend to be recruited from outside of communities.

The 1990 census of Baca County estimated there was an unemployment rate of 2.5%, and a population of 4,556 persons, or about 113 people unemployed in the county over the age of sixteen. It appears that most of the farms moving into Colorado are sow units. If 25 short term jobs are created per 1,000 sows in the building phase (one to two years), a 5,000 sow unit will exhaust the available employable people in the county only considering the direct jobs created. A multiplier of two would mean that for every job created on the farm site, an additional job would be created in the community. People who are not currently working, but who were not listed as unemployed, may enter the workforce because of the employment opportunities. Additionally, seasonally underemployed farmers may have an opportunity to work on these farms and supplement their income. However, it does not appear possible to build these facilities without employing workers from outside the current county population. Neighboring counties will most likely provide the workers since evidence has not shown that sow units are likely to recruit labor from distant sources. Another possibility is that former residents of Baca County, who left because of lack of jobs, may return to work on the farms. Management positions tend be hired from outside of the region, though evidence does not indicate this is always the case. Opportunities may exist for experienced local residents to enter management positions commensurate with their experience.

III.A.3. Industry Permanence

Communities may not only be concerned with the impact of the introduction of a new industry to the community, but also the likelihood and impact of a potential pull-out. 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 and "rust belt" cities of the Northeast provide an illustration.

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 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.

III.B. Infrastructure and Public Finance

Among the issues of concern with any proposed private economic development is whether it will pay for itself in terms of increased demands on community resources and services. Increases in county tax base and decreases in tax burden should result from appropriate economic development initiatives. Impacts

depend upon the local tax rate, the existing infrastructure, any concessions made to encourage the industry, and the type and size of the operation.

A community's tax burden decreases with increases in the assessed value of properties. The tax burden increases with increases in demands on infrastructure (e.g., roads, sewer) and services (e.g., utilities, hospitals, and schools). 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.[10] Similar studies have not yet been undertaken on a per sow basis, but anecdotal evidence from other states indicates that counties that have not provided concessions, have seen increases in their tax assessments.

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 the 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.

Evidence in Baca County seems to suggest that, at least initially, there will be no problem absorbing the students of workers who move to the county. Low enrollment is an indicator of the aging of the community as well as evidence of population drain. New workers who enter the community, and stay past the initial building stage of the operation, will pay taxes just as current residents do, and enroll their children in school. Low turnover on CAFOs indicates that the school system can expect a long term increase in students as well as the revenues to pay for their enrollment.

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. Though finishing hogs have not been moving into Colorado in any large numbers, all counties that have had swine development have had an increase in costs of roads, but specific dollar values are not available at this time.

III.C. Real Estate Impacts

The introduction of a hog 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. Although information on how CAFOs in Colorado affect real estate prices does not exist, studies have been prepared for North Carolina and Minnesota. Though these two states are different from Colorado in many respects, they have both experienced concentration in the pork industry, and their examples may provide insight into what could happen in Colorado.

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) of 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.[11]

However, in Minnesota a similar conclusion was not possible, as houses closer to feedlots 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 is the CAFO owners bought the homes to reduce

[10] Suzanne Thornsubry, S. Murthy, Kambhampaty, and David Kenyon. *The Economic Impact of Increased Swine Production in a Rural Virginia County*. Virginia's Rural Economic Analysis Program. Department of Agricultural Economics, Virginia Tech: Virginia Cooperative Extension, 1995.

[11] Raymond Palmquist, Fritz Roka, and Tomislav Vukina. "Hog Operations, Environmental Effects, and Residential Property Values." *Land Economics* 73(1) 1997: 114-124.

the number of neighbors living nearby and in a position to complain about the odor.[12] Finally, odor can be mitigated by a number of factors which have not been considered 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.[13]

III.D. Natural Resource Management

The introduction of any new business or industry to a community will increase the demands on the local natural resource base. Communities have broader constituencies and longer planning horizons than businesses and should, therefore, consider broad watershed impacts, alternative uses of water, the precautionary principle and safe minimum standards in their determinations. Communities must decide whether these demands are acceptable and what steps they should take to guide industries to minimize their impact on the local natural resource base. Agriculture poses particular demands on land and water supplies and quality. With the hog industry concerns surround the management of effluent to mitigate the risk and amount of air (odor and gasses) and water pollution (surface and ground).

The best solution for effluent management would be an odor free application to a crop that could utilize all of the nitrogen, phosphorous, and potassium in the effluent. This is not possible yet, but research and experiments are showing that effluent can be a cost-effective replacement for commercial fertilizer. The fertilizer replacement value of hog manure is about $3 per hog. There is evidence that the amount of nitrogen in hog effluent is substantial enough to replace all commercial fertilizer purchases in a given year, especially in Colorado where center pivot irrigation is used. 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, the inconsistent nature of manure as a fertilizer means that the most important step in using hog effluent may be the accurate testing of the contents. This is costly, and techniques vary across storage systems. Different types of application processes also call for more or less testing, agitation of the effluent, different loading rates and favorable weather conditions. Thus, farmers using effluent as fertilizer are not always using best management practices (BMPs) in applying effluent.

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.[14] Soil incorporation/injection costs about $1.39 per year-sow from a lagoon and $0.49 from a bin. Incorporation costs about $0.13 per gallon more than broadcasting from a lagoon and $0.09 per gallon more from a bin. Table 7 reviews the costs of covering storage facilities for farrowing operations. Odor can be decreased as much as 80% by covering the storage facility. Here,

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 w/plastic	20.08	2.99
Bin w/straw	2.19	2.19
Assumes: 8% interest rate, 10 yr. plastic life, 1 yr. straw life		

[12] Steven Taff, Douglas Tiffany, and Sanford Weisberg. "Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature." Staff Paper P96-12. Department of Applied Economics, University of Minnesota, July, 1996.

[13] Steve Padgitt and Jim Johnson. "Livestock Issues: Q & A." Pm-1741d. University Extension, Iowa State University, March, 1998.

[14] Jessica Davis, J. Andrews, and Mahdi Al-Kaisi. *Liquid Manure Management*. 1.221 Managment. Livestock. Colorado State University: University Cooperative Extension, 1997.

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).[15]

IV. Common Components of Swine Policies

As Colorado considers new legislation for the Confined Animal Feeding Operations (CAFO), particularly swine, voters must consider the necessity, sufficiency and efficacy of the current and proposed policy environment to determine the appropriate course of action. Coloradoans are not alone in making this determination. Due to recent changes and challenges in the swine industry, a number of states have adopted new legislation to guide the industry. In addition, the federal Environmental Protection Agency (EPA) is working in conjunction with the United States Department of Agriculture (USDA) to craft a new policy framework for confined animal feeding operations based on the provisions of the 1972 Clean Water Act. State level swine policies commonly include provisions for siting and construction standards, set-back requirements, effluent management plans, financial assurance, size and management structure requirements, training or educational requirements, the assignment of ownership or liability, and "nuisance" civil suit protection. These typical features of swine policies will be discussed here.

IV.A. Size and Management Structure

Livestock policies commonly specify a minimum size requirement below which the policy does not apply unless specific problematic operations are identified. The justification for size discrimination stems from the perception that larger operations create a greater environmental risk due to the volume and concentration of their waste. It is also commonly argued that smaller operations cannot afford current effluent management technologies. Current research does not provide evidence in support of or in refutation of these positions.

An animal feeding operation (AFO), as defined by the Colorado Water Quality Control Commission, feeds livestock at one place for 45 days or longer in any 12 month period, and forage growth is not maintained in the confinement area. A CAFO is an AFO with 1,000 or more animal units (AU) confined in that area. An AU equates different types of livestock into the same units so that regulations can be developed for many types of animals at once. In Colorado, 5 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 (50 lbs. and greater) whereas 2,500 is the federal standard. Table 8 lists equivalent units for livestock confinement units.

Table 8: Colorado Animal Unit Equivalency Factors

Animal Species	Colorado Equivalency Factor	Federal Equivalency Factor
Slaughter and feed cattle	1.0	1.0
Mature dairy cattle	1.4	1.4
Swine, butcher and breeding (over 55lbs)	0.2	0.4
Sheep or lambs	0.2	0.1
Horses	0.5	2.0
Turkeys	0.02	0.02
Chickens, broiler or layer	0.01	0.01/0.03

Source: *Confined Animal Feeding Operations Control Regulation*. 5 CCR 10002-19. Colorado, 1992.

Note: Federal Standards are 0.01 for a facility using continuous overflow watering, and 0.03 for a liquid manure system.

[15] Bruce Babock, Ronald Fleming, and Dwaine Bundy. *Resource or Waste? The Economics of Swine Manure Storage and Management.* 97-BP 17. The Cost of Regulating Hog Manure Storage Facilities and Land Application Techniques. Iowa State University: Center for Agricultural and Rural Development, 1997.

Several states have adopted legislation regarding the acceptable management structure of a CAFO. In some locations, corporate ownership is outlawed in favor of individual family businesses, family corporations, and/or cooperative structures. In some locations, packing houses cannot own CAFOs ("captive supply" provisions) and in some cases contracting arrangements are legally limited.

The justifications for management structure discrimination stem from the contention that corporations are less accountable to rural communities and that they tend to purchase fewer inputs locally, diminishing the positive "multiplier effects" on the community. Vertical integration regulations are justified according to free access to markets and price discovery criteria. Anecdotal evidence does appear to point to challenges facing smaller producers regarding price discovery and free access to markets. However, it is their size and not their structure that appears to create the barriers to market access and information. Small farms tend to purchase a greater proportion of their inputs locally (about 80% within 20 miles of the operation) than larger operations (about 50%). Current research does not support or refute the contention that management structure rather than either sheer size or type of operation differentially influences community economic impacts of CAFOs.

IV.B. Siting and Construction Standards

Standards for siting CAFOs commonly address odor and water quality concerns. Some of these concerns are dealt with via set-back requirements which are covered in the next section. In addition, the location of a CAFO should consider the type of soil on which the operation is being built and the rights to water available to the operation for effluent management. Because only a few states are attempting to require that a farm producing hogs must own or lease land on which to apply the effluent as fertilizer, the preferred storage method is to build a storage facility that can last 10, 20 or 25 years. The likelihood of a leak causing serious damage to the local water quality is reduced when the soil a CAFO is built on will filter and slow the effluent from reaching groundwater sources. This suggests that effective regulation will account for soil type in addition to water quality, quantity and odor. General provisions of Colorado's construction standards are found in Table 9.

In Baca County there are seven soil types identified by the Natural Resource Conservation Service (NRCS). Some soil types in the county are considered to be at severe risk of seepage, but individual site inspections by experts are the only way to assure that a CAFO is located on an appropriate soil type. Table 10 provides basic information about soils in the county. Most of the sites that would be considered for CAFOs are at some risk for seepage. The key is that a low water table, little slope and clay soils are the best situation for building a lagoon system, but on site evaluations by an expert cannot be replaced by any generalizations.

IV.C. Set-back Requirements

Set-backs are distances established to protect vulnerable water supplies from nutrient contamination and/or neighbors of CAFOs from the odors produced by the facility. Odors from CAFOs have been reported as far as 15 miles from a facility, but in other cases may not be detectable as close as a few yards away. No federal set-back standards exist. State and local set-back distances vary from about 200 ft to about 2 miles depending upon the operation size, but not generally according to production practices. Ballot Amendment 14 carries a 1 mile set-back provision. Due to the difficulty in determining the amount, type, frequency and impact of swine odors considered a nuisance or health hazard to a sufficient number of people, odor oriented set back distances are commonly subjectively determined or couched in terms of water quality protection standards.

Set-backs to protect water supplies generally specify the minimum distance that a CAFO can be located and/or spread effluent from a surface water source, well head, or flood plain. Set back distances can also be based upon the amount of land needed to agronomically spread the effluent generated by the operation. Under these provisions, the CAFO must own or lease adequate lands or must arrange to obtain the rights to spread its effluent on neighboring land. Kentucky currently mandates that the land surrounding the CAFO to which effluent is applied must be owned by the CAFO. The amount of land needed depends upon the soil and crop type, available water and the size of the operation. Clearly, such provisions confound the distinction between an adequate effluent management plan and set-back distances.

Set-backs to mitigate the effect of odor can specify the minimum distance from a road, neighbor, or public building (e.g., school or church). Distances can be measured from and/or to the property line or from and/or to buildings. Homes of neighboring agriculturists may be exempted. Commonly, exemptions can also

Table 9: Current & Proposed Colorado CAFO Legislation

Topic	Confined Animal Feeding Operations Control Regulation 5 CCR 1002-19	Proposed Amendment 1997 – 98 #14
CAFO Size	1,000 AU	800,000 pounds of swine
Seepage	Not to exceed 1/32 inches per day	Seepage must be minimized
Lagoon Liner	Natural or Plastic	See seepage requirements
Capacity	If 50% of runoff storage is exceeded then dewatering to full runoff storage capacity required within 15 days	Permit must be received from the Colorado Department of Health. Must minimize runoff.
Rainfall Capacity	Lagoon must withstand 24 hr period of maximum recorded rainfall over past 25 yr.	Water Quality Control Commission must adopt rules regarding construction, operation and management of effluent.
Earthen Liner	Minimum of 12 inches in thickness	Not specified, but would fall under permitting.
Grandfathering	Lagoons completed August 30, 1992 exempt from 1992 CWA regulations	Must get permit if currently "commercial", under construction or expanding.
Effluent Application	Not to exceed agronomic rates.	Not to exceed nutritional requirements of the plants on the land. Must not degrade public or state trust lands.
Monitoring	Not required, unless by the request of the Water Quality Control Commission	Land applied wastes monitored by farms and reported to the state health department
Reporting	No self reporting required	Immediate reporting to state and county health departments of spills
Costs of Monitoring	Complaint driven. Normal Dept. of Health budget covers	Assessment of permit fees from owners and operators up to $0.20/AU
Setbacks	Not Required	Must be established between new land waste application sites and occupied dwellings, schools and municipal boundaries
Bonding	Not Required	Financial assurance required to return site to state before development of the facility
Covered Waste Storage Sites	Not Required	Required
Odor Management	Suggests that management practices promote odor control	Odorous gases must be managed by covered lagoons. Minimize odor emissions from operation.
County Government	Not precluded from passing more stringent regulations	Not precluded from passing more stringent regulations

Note: In addition, Amendment 1997-98 #13 is a proposed constitutional amendment mandating that all livestock species fall under the same regulations on an AU basis. This amendment is targeted to CAFOs over 1,000 AUs.

Table 10: Baca County soil associations: risks and descriptions

Soil association	Description	Risk for sewage lagoons
Richfield-Ulysses-Norka	Deep, nearly level to gently undulating silt loams on loess uplands	Moderate: Seepage and slope
Baca-Wiley	Deep, nearly level to sloping clay loams on loess uplands	Moderate: Seepage and slope Areas w/ more slope have a severe risk
Vona-Manter-Dalhart	Deep, nearly level to gently undulating sandy loams and loamy sands on uplands	Severe: Seepage
Travessilla-Kim	Shallow, strongly sloping stony sandy loams on sandstone breaks and bluffs and deep, dominantly gently sloping loams on bordering foot slopes	Moderate: Seepage and slope Severe: Depth to rock and some areas due to slope
Minnequa-Manvel-Penrose	Deep to shallow, nearly level to sloping loams on limestone and marl uplands	Moderate: Slope Severe: Depth to rock
Otero-Potter	Deep and shallow, undulating and rolling loams and gravely loams on uplands	Moderate: Seepage and slope Severe: Cemented pan and slope in some areas.

be obtained by the written permission of affected individuals.

Unfortunately, most set-back provisions do not encourage technological or managerial innovation to mitigate odors. Odor can be controlled to some extent by having clean barns, altering the feed ration, and building covered lagoons. Further, once the manure is applied to the soil as a fertilizer, incorporating it into the soil quickly reduces the amount of odor it produces. Covering lagoons and effluent incorporation can reduce odors by as much as 50 to 80%. Landscaping and creative siting can also reduce off-site odors or reduce nuisance complaints.

IV.D. Effluent Management Plans

Traditionally, effluent management plan requirements addressed the risk of ground and surface water pollution resulting from system failures/flaws or inappropriate effluent application. Effluent management plans recognize that effluent is a valuable fertilizer if used at agronomic rates of application and an environmental hazard otherwise. Effluent management plans increasingly consider odor in recommending or mandating management technologies or best management practices (BMPs). These standards are dependent upon the sort of soil (to determine seepage rates and nutrient content), crop (to determine nutrient uptake rates and application timing), effluent (to estimate nutrient content), land (gradient and ownership), weather (spreading on frozen soil is often prohibited), and available technology (e.g. broadcasting versus incorporation, lagoons versus pits). Currently, Colorado statutes do not demand a nutrient management plan (Amendment 14 does). Other states mandate manure management plans and administration varies across states, and many concentrated farms already provide a plant and readily absorb the costs of this preventative action. The general rules for an effluent storage system in Colorado are summarized in Table 9.

Indoor concentrated swine operations usually collect wastes, including manure and urine, and store it in liquid form. Barns are built with slatted floor and the wastes are flushed from below into either a waste treatment lagoon or a waste storage pond. There are other options for waste collection, including a pit system below the floor of the barn that is periodically flushed of wastes. Scrapers, to remove the wastes are also used. Dairies may also use liquid management techniques. Wastes from feeding and housing areas are collected in solid form, but the wastes from the milking parlor are flushed and stored in liquid form.[16]

[16] Jessica Davis, J. Andrews, and Mahdi Al-Kaisi. *Liquid Manure Management*. 1.221 Managment. Livestock. Colorado State University: University Cooperative Extension, 1997.

Once the waste is flushed from the barn or parlor it is collected in either a waste storage pond or a waste treatment lagoon. These two practices are the most common in Colorado, though the use of above ground storage tanks is also seen. Wastes are stored in the pond for utilization later as fertilizer. The waste storage ponds are designed to be emptied once a year, and must maintain enough space for the a 24 hour, 25 year rain event, and store all of the effluent collected during that time. Once full, the pond is emptied and the manure is spread on surrounding land that can utilize the nutrients (nitrogen, phosphorus, and potassium) available from the effluent. The wastes are removed using a pumping system, and agitating the pond stirs up the nutrients, making the testing of the effluent essential before application so that best management practices can be used.

A waste treatment lagoon is also designed to store wastes, but at the same time it is intended to decompose the nutrients present in the effluent. Lagoon treated effluent can still be applied as fertilizer, but as the object is to reduce the amount of nutrients available, the economic value of this effluent as fertilizer is reduced. A waste treatment lagoon must still be able to accommodate the rainfall from a significant weather event, but the amount of liquid maintained in the lagoon will depend on the specific type of waste treatment system the pond uses. For instance, an anaerobic lagoon works because there is no oxygen present in the active layers. An anaerobic lagoon may produce more odor than an aerobic lagoon, but an aerobic lagoon, which utilizes oxygen to reduce waste volume, can be more expensive. An aerobic lagoon either needs a larger surface area so that more effluent can interact with the oxygen from the air, or a pump in the lagoon to aerate the effluent. Specific storage treatment decisions have previously been the provenance of producers, but regulations are now being introduced that specify how manure by-products should be managed for whole states.

How effluent is defined will determine how it is valued and how efficient our management of it will be. Is there a correct solution to how effluent should be handled? Not yet, and probably not ever, but there are basic tenets of waste management that can benefit everyone. Wastes should not be land applied when the chances of runoff are high, on sloping ground, or even when the odor they produce will inconvenience neighbors. Waste treatment or storage facilities should not be built in flood plains, and should be built to the best specifications of environmental suggestions and evidence available. Barns and facilities should be kept clean, with dead livestock disposed of promptly and in a way that does not encourage disease. All of these practices are outlined in literature from other states, as well as in publications by the NPPC.

IV.E. Financial Assurance

A number of states have required that swine operations provide proof of financial assurance sufficient to clean up spills and to return the site of an operation to its state previous to the introduction of a swine operation should that enterprise close. Financial assurance of this kind is required of industries posing substantial risk of environmental damage requiring clean-up or remediation (e.g., mining operations). Operations can be self insured or can be insured through an insurance or bonding company. The bond amount is determined by the estimated cost of returning a site to its previous state plus the estimated risk and impact of a potential spill. Bond amounts vary based upon operation size, perceived risk and impact of spills, and site remediation costs and are determined by the regulating authority. The bonding company guarantees payment to the regulating authority and receives an annual payment of 1 to 3% of the bond amount from the insured operation. Payment rates depend upon the financial status of the operator and its historical performance. One example from Iowa set bonding rates of $2.00/lb of swine for operations using lagoons, $0.50/lb for pits, and $0.25/lb for above ground storage containers to insure spill clean-up and about $20,000 per 2,000 hog finishing building for remediation. However, the Iowa State Supreme Court struck down these requirements.

IV.F. Training or Educational Requirements

Several states require manure management training for managers of operations greater than a specified size. Size considerations also guide whether managers need to attend training or pass a test. In some cases, managers can "test-out" of the training requirement. Several states are using the National Pork Producers Council's Environmental Assurance Program to guide their educational efforts.

IV.G. Ownership and Liability

Ownership and liability for any damages caused by a swine operation vary across states because of contracting arrangements. In some cases, animal ownership and liability for all damages caused by a swine operation is the responsibility of one individual. In some cases where integration through contracts is in

evidence, the owner of the pigs and the individual responsible for manure management are different people. In some cases, the owner of the pigs is still liable for manure management and in other cases, the contracted individual is liable. The argument in favor of animal owner liability stems from the perception that manure management technology is costly and the animal owner is the individual with the most power and financial wherewithal in the contracting relationship. On the other hand, some argue that the contracted manager is in the best position to monitor compliance with on-site regulations and should, therefore, be held responsible.

IV.H. Civil Suit Protection

All 50 states have "Right to Farm" legislation. This legislation prevents "nuisance" civil suits of agricultural operations under certain conditions. In most cases the burden of proof is on the individual or community bringing the suit. In some cases, existing agricultural operations are protected, but new or expanding operations are not protected from civil suits from existing residents. It is sometimes argued that lifting protections from nuisance suits may impact smaller producers with fewer resources available for legal costs more than larger operations with greater financial abilities to defend themselves. In Colorado, the "Right to Farm" statute has not been tested with regard to swine CAFOs to our knowledge.

V. Concluding Remarks

Whenever a new business enters a community economic, social, cultural, and natural resource impacts result. Communities must determine whether and under what conditions they are interested in inviting these impacts. These decisions are complex and specific to each community's situation. Here, we have reviewed many of the common questions regarding the community and natural resource economic issues surrounding the swine industry. Our knowledge is improving, but also shows many informational needs. For example, very little of our information was found in Colorado. Good information for Colorado communities will derive from a combination of strong local knowledge, good science, and the identified objectives of those communities.

Baca County has and will be faced with many decisions regarding this potential change to the community. Everyone concerned with the future of the county can benefit from the resources to be found here. Successful community evolution is dependent upon the inclusion of all potential gainers or losers in community decision-making. Whether the investment is money, time, or emotions, addressing these concerns is essential. Various state government offices are available for consultation and information. The growing debate over the swine industry in the press, dependent upon the outcomes of the upcoming vote on the proposed amendments, will be an important consideration in making appropriate policy decisions for Baca County. The information provided here is designed to be an outline of the issues that citizens can be expected to raise, as well as a resource of readily available factual information. Deciding on the appropriateness of the influx of swine operations into Baca County is in the end a decision, albeit difficult, that must be made by the citizens of Baca County. The examples provided from other states, as well as the information collected for Colorado and Baca County are exactly those, examples. The reality of the decision for Baca County will be evaluated in the future on whether this course of action met the goals of the county and it citizens.

VIII. Where You Can Go

VI.A. Swine Industry Trends

1. Confined Animal Feeding Operations Control Regulation, (5 CCR 10002-19). The 1992 amended Colorado Water Quality Act that specifically discusses the topic of CAFOs. This regulation will be subject to change depending on the outcome of the Proposed Amendments 13 and 14.

2. Proposed Amendments 13 and 14. Possible changes that may be voted for by the constituents of the state. Summaries of the proposed amendments have been included in this paper in comparison to the current Colorado regulations.

3. National Pork Producers Council publication on the Pork Industry. Various fact sheets that are available on the worldwide web. Provides an industry viewpoint of the basics of the pork market. Statistics used here are summarized from National Agricultural Statistics Service (NASS) and the USDA.

4. "Industrialization of Agriculture: What Are the Consequences?" By Michael Boehlje from the Purdue University Department of Agricultural Economics. Dr. Boehlje's paper explains the changes in agriculture in a business format. As agriculture

industrializes lessons from other industries are applied to help understand the changes.

5. "Pork Industry Price Discovery: A Look Ahead." By David Kenyon at the Virginia Tech Department of Agricultural Economics. Though technical in some places, this book chapter explains some of the major changes in the hog industry, including the change from Live Weight futures contracts to a carcass weight contract. Dr. Kenyon discusses the difficulties of non-contracted farmers in receiving or determining fair market prices with the reduction in the number of open markets.

6. "Investment under Uncertainty and Dynamic Adjustment in the Finnish Pork Industry." By Kyosti Pietola and Rober Myers. Though very technical, the paper does make the conclusion that the Finnish hog industry, a strong European competitor to the continental leader in pork production, Denmark, are expanding their operations through contracting and increased concentration to the boundaries set by environmental law.

7. "Swine Production Networks in Minnesota: Resources for Decision Making." By Bob Koehler, Bill Lazarus and Brian Buhr at the University of Minnesota. Provides a sketch of opportunities of small farmers to benefit from some of the large scale improvements in production usually thought only accessible to CAFOs.

8. "Contract Hog Production: An Economic Evaluation." By Michael Langemeier at Cooperative Extension Service Kansas State University. Information about costs, returns and appropriate returns to contracting across various stages of pork production.

VI.B. Community and Environmental Economic Issues

9. "Options for Managing Odor: a Report from the North Carolina Swine Odor Task Force." A recommendation paper based on extensive research by NC experts on the best ways to deal with the issues of odor in NC. The broad based conclusions made can be applied to other states and their specific situations providing a basis of information for Colorado residents.

10. "Importance of Being a Good Neighbor." By Paul Lasley of Iowa State. Simple, and sensible solutions that can be applied in conjunction with regulation to make a CAFO a valued member of the community, rather than an intrusive force.

11. “Hog Operations, Environmental Effects, and Residential Property Values.” By Raymond Palmquist, Fritz Roka and Tomislav Vukina in the Journal of Land Economics. Though the estimation procedure used in this article is very difficult to understand, the first page of the article summarizes the results of the research. Also of interest is Table Four that outlines the expected price declines according to proximity to a swine CAFO.

12. “Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature.” By Steven Taff, Douglas Tiffany and Sanford Weisberg. This paper uses a different method of estimation than the NC paper, and thus the results are not comparable. However, these authors did find that prices increased the closer a home was located to a CAFO.

13. “Structure of Wages and Benefits in the U.S. Pork Industry.” By Terrance Hurley, James Kliebenstein and Peter Orazem. As detailed above this study explores national wages for workers in this industry, as well as touches on the issue of air quality for workers.

14. “Managing Swine Effluent Applications Under Irrigated Conditions in Northeast Colorado.” By Mahdi Al-Kaisi and Regan Waskom of CSU. A description of effluent management through a center pivot irrigation system in Yuma County. Describes the potential for replacing all commercial fertilizer use with swine effluent.

15. “Most Commonly Asked Questions About Pork Production and the Environment.” NPPC publication on topics that have been addressed in the popular press and by pending legislation. Pro Pork production.

VI.C. Common Components of Swine Policy

16. "Animal Waste Control Programs of Iowa and Eight Other States." By Ubbo Agena the Iowa Department of Natural Resources. Though published in 1994 this paper provides a snapshot of regulations in place in IA, IL, KS, MN, MO, NB,

NC, SD, and WI. A chart that summarizes survey responses is included and gives basic information about these states' regulations.

17. "CAFO Standards for Pork Production: A Survey of the Major Pork Producing States." By the ASIWPCA and published in February of 1998. This article summarizes results in chart form another survey that covers USEPA/NPDE, VA, MI, KS, IA, KY, MO, NB, UT, IL, OK and EPA Region VI.

18. "Odor and Odor Policy Criteria." By David Schmidt and Larry Jacobson of the Missouri Extension Service. Provides a more detailed explanation for the problems of the problems in measuring odor.

IX. Acknowledgements

In no particular order, the authors would like to acknowledge the time, technical advice and support of the following individuals and organizations: Jessica Davis, Steve Koontz, Dana Hoag, Reagan Waskom, David Cockrell, Lloyd Walker, Mahdi Al-Kaisi, and Jeff Tranel, CSU-CE; Rich Bell, Bell Farms; Jeff Deveres, Environmental Health Southeast; Diane Colby-Ricken, Prowers County Economic Development Commission; The Plum Bear Ranch, Springfield, CO; Colorado State Forest Service; Verlin Hopkins, Natural Resource Conservation Service, Springfield, CO. Errors remain our responsibility.

Appendix 1: Glossary of Terms

Barrow	A neutered male pig. Barrows eat more feed and gain weight faster than gilts, making split-sexed feeding appropriate
Boar	An adult male hog. Boars have greater weight gain and less back-fat than gilts and barrows.
Farrowing	A swine operation dedicated to producing piglets.
Feeder Hog	A pig greater than fifty pounds of weight that has not yet reached market weight.
Feed Ration	What a pig is fed. Ration includes all protein, energy and supplements rolled into one.
Finishing	A stage in the pigs life where they are fed to market weight (240-260 lbs.). However, due to the introduction of phase feeding and split-sex feeding the distinction between feeder and finishing animals has been blurred. Today the phrases are almost interchangeable.
Hog	A big pig. There is no true distinction between a pig and a hog, except that hog usually refers to swine weighing more than fifty pounds.
Gilt	A female hog that has not been bred. She is a gilt until after her first litter is delivered. Gilts have different weight gain patterns than barrows or boars, and split sexed feeding capitalizes on their leanness, higher weight gain and better feed conversion.
Litter	A group of pigs born from the same sow. Current national averages for the number of pigs per litter per sow weaned is 8.6. Concentrated operations can have numbers over ten for their sows.
Market Hog	A hog that has reached a market weight of 240-260 pounds. These weights tend to vary over time according to retail demand. Currently a 250 lb. market hog will yield a 184 pound carcass of which 76% of that is a retail cut.
Pig	See "hog."
Nursery Pig	A weaned pig weighing less than fifty pounds.
Sow	A female pig that has produced at least one litter of pigs. Sows are fed different feed rations depending on whether they are gestating (pregnant), lactating (nursing young) or being prepared for breeding. Sows eat more than other swine and, as the production unit of the industry, are very valuable.
Segregated Early Weaning	A process by which pigs are weaned at a very young age. Some experiments and operations can wean pigs and feed them successfully to market weight when weaned at 5 days.