Sustainability issues of U.S. swine production

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ABSTRACT: The incorporation of livestock into agricultural systems ensures a more sustainable agriculture. Sustainable swine production systems are defined as those that combine production and management techniques to enhance profit and improve the ecological and socioeconomic surroundings. Over the long term, the systems should maintain or enhance the environment and resource base, the quality of life for the producers and society as a whole, the profit level of producers, and the quality of pork produced. Swine production in the United States is rapidly changing to fewer and larger production units. At the interface of sustainable agriculture and swine production are several levels of issues. Four levels of issues are the farm, the rural community, the society or consuming public, and the ecosystem or environment. By examining each level, long-term sustainability issues for U.S. swine production emerge. Some of these issues include swine care and husbandry, producer health, management and production systems, access to markets, information, technology and genetics, producer entrance requirements, specialization, manure utilization, industry structure, pork quality and leanness, and the impact of modern intensive systems on the environment, farms, and rural communities. The challenge beyond identifying issues is to incorporate sustainable concepts into profitable, ecologically based swine production systems. Several major groups of issues are discussed, including swine industry structure change issues, access and entrance issues, manure, by-product and nuisance issues, and pork quality issues. Many of these issues can be addressed. The solutions often rely on increased education, management, or technology applications. These processes provide broad opportunities for animal scientists. Examples of current solutions are quality assurance programs, segregated age rearing techniques, educational and promotional commodity programs, manure management programs, phase feeding, diet manipulation to alter manure nutrient concentrations, young producer assistance programs, producer networking, and environmental awareness activities. There are many more opportunities for improving the sustainability of U.S. swine production, when a long-term, issue-oriented viewpoint is maintained.

Key Words: Swine, Sustainable Agriculture, Manure

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Introduction

Incorporating livestock into agriculture often improves the sustainability of the system from an environmental, economic, and social viewpoint. Livestock production counteracts two major environmental effects of agriculture: decreasing soil fertility and soil erosion (Baker et al., 1990). These advantages occur primarily through the application of animal manures to cropland and the subsequent nutrient cycling, increased organic matter, and maintenance of soil tilth. Livestock production often encourages a diversity of crops, which favors crop rotation. A stable agricultural ecosystem involves cycling carbon, nitrogen, and minerals via soil, plants, and animals.

Economically, livestock production is "the most important value-added industry in the U.S." (Parker, 1990). At the farm level, grain and forage are converted to high-value animal products. Baker et al. (1990) listed several other economically sustainable characteristics of livestock production, including livestock production cushions trade, market, and feed supply disruptions; livestock production diversifies farms, controls risk, and enhances farm economic viability; livestock production increases farm labor efficiency and more fully utilizes farm labor; and livestock production increases the economic activity of rural communities.

From a social viewpoint, livestock production often increases pride and satisfaction in farming. The

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relationship with animals is, for many people, enjoyable and brings them in closer touch with nature (Baker et al., 1990).

Sustainable Swine Production Defined

Sustainable swine production is a combination of production techniques that enhance profit and improve the area's environmental and socioeconomic conditions (Honeyman, 1991). To achieve this enhancement, swine production must be successfully integrated into the crop and human systems in a synergistic manner. Several opportunities have been outlined that may enhance sustainability, including 1) feeding with increased use of forages and by-products, 2) nutrient cycling through improved handling of manure, 3) low-capital, high-management housing systems that offer a better environment for the operator and reduced financial risk, 4) management systems suited to the pig's behavior, and 5) preventative approaches to swine health and a broader genetic base (Honeyman, 1991). Over the long term, a sustainable swine production system should maintain or enhance the following areas: the environment and the resource base (land, water, air, human); the quality of life for producers, pork consumers, and society as a whole; the profit level of producers; and the quality of pork produced (leanness, flavor, wholesomeness, marbling) (Honeyman, 1991).

The Changing Structure of U.S. Swine Production

Swine production in the United States has been historically organized on relatively small, diversified farms. These farms followed a traditional agricultural cycle (Figure 1) of growing and feeding feed grains and forages (Honeyman, 1991). Livestock manure was used as fertilizer. Diverse crop rotations were commonly followed. Family labor was active in all phases of livestock production, including feeding and care of animals, feed preparation, and frequently also slaughter, processing, and meat consumption.

Swine production today is rapidly changing. Many of the changes have an impact on sustainability. The number of U.S. swine farms continues to decline. In 1993 there were only 27% as many farms with hogs in the United States as there were in 1970 (Lawrence, 1994). In some states with rapidly increasing swine numbers (e.g., North Carolina), this trend is more accentuated. In 1993, North Carolina had about 13% of the number of hog farms it had in 1970. In contrast, in 1993 the midwestern states of Iowa, Minnesota, and Nebraska had about 37% of the number of hog farms they had in 1970. Overall, the number of hogs produced in the United States is about stable. Thus, the number of hogs per farm has doubled in the nation and in most midwestern states. However, North Carolina has experienced an eightfold increase in the average number of hogs per farm from 1970 to 1991 (Lawrence, 1992). Table 1 shows the hog marketings by size of farm from 1978 to 1987. The small farms (<1,000 head marketed annually) have rapidly decreased their share of hog marketings and in 1987 supplied 42.5% of the hogs but represented about 90% of the farms. All of the larger-sized farm categories (>1,000 head marketed annually) are increasing in number of farms. The 2,000 to 5,000 head and over 5,000 head categories are rapidly increasing their share of hog marketings (Lawrence, 1992). "If current trends continue, the 1992 Census of Agriculture will show continued growth from farms with over 5,000 head, a decline in the under 2,000 head farms, and stabilization in the 2,000 to 5,000 head category. The over 5,000 head category will likely account for 25% of all hogs marketed in the U.S." Lawrence (1992) predicts. The trend toward fewer and larger hog farms continues rapidly.

Swine production in the United States is very rapidly becoming more specialized, concentrated, and industrialized. Hamilton (1994) defines industrialized agriculture as the "movement of food processors and input suppliers into food production," often using contracts. A recent University of Missouri survey (Rhodes and Grimes, 1994) of 57 U.S. hog producers that market more than 50,000 hogs annually found that this group marketed 13% of all U.S. hogs in 1993. The group included seven "mega" hog producers that marketed 500,000 hogs or more per year and 50 producers that produced between 50,000 and 500,000 hogs per year. During 1993, these large hog producers

Table 1. U.S. hog marketings by volume class, Census of Agriculture, 1978, 1982, and 1987[a]

Annual marketings	Percentage of total farms	Percentage of total marketings
Less than 1,000 head		
1978	96.8	66.4
1982	93.1	51.9
1987	89.9	42.5
1,000 to 1,999 head		
1978	2.4	16.3
1982	4.8	21.1
1987	6.7	21.9
2,000 to 4,000 head		
1978	.7	10.3
1982	1.7	15.2
1987	2.7	18.5
5,000 head and more		
1978	.1	7.0
1982	.4	11.8
1987	.7	17.1

[a]From Lawrence, 1992. Note: 1992 Census of Agriculture detailed breakdown data was not available at time of article preparation.

increased hog marketing about 25%, or 2.5 million more hogs. Most of the 57 large producers raised a majority of their hogs under contract. The authors of the survey stated that the large hog producers will presumably continue expansion, regardless of hog market prices or feed grain prices. This is in contrast to traditional hog farmers who expand or reduce production in response to market signals.

Lawrence (1992) predicted increased specialization in the U.S. swine industry and structural change in the industry occurring at an increasing rate. Hayenga (1994) stated that large "integrated hog production and packing operations by Seaboard Corporation, Smithfield, and Premium Standard Farms may be the tip of the iceberg of emerging structural change in the pork slaughter industry." In Iowa, controversy regarding large hog production units has been widespread (Des Moines Register, 1994).

These changes are indicative of a changing pork market channel structure in which the linkages between the entities are more efficient and more communicative, rather than the loose market signals of the past. The new market channel structure will come about via vertical integration or contracts, which ensure communication and coordination (Lawrence, 1992). Agriculture, including the swine sector, is becoming industrialized into a system of food manufacturing according to Thomas Urban, president and chief executive officer of Pioneer Seeds, Des Moines, IA. This food industrial system cannot rely on a "cottage industry" structure of individual, traditional farms, Urban stated. Capital and technology favor an industrialized agriculture. Individual farmers cannot readily adopt new technologies or attract adequate capital for the industrial agriculture of the future according to Urban (Schied, 1994).

Sustainability Issues

Because of the rapid changes in swine production and the increasing emphasis on the long-term sustainability of agriculture, numerous issues emerge. Four levels of these issues are the swine farms, the rural community, society or consumers of pork, and the environment (Figure 2). Several major groups of issues include swine industry structure change issues; access and entrance issues; manure, by-product, and nuisance issues; and issues related to pork quality. The following discussion of each of these four groups of issues is not all-inclusive, but examines the issues relative to sustainability and the definition of sustainable swine production. The relevance of the issues to farm, community, consumer, and environment levels is also discussed.

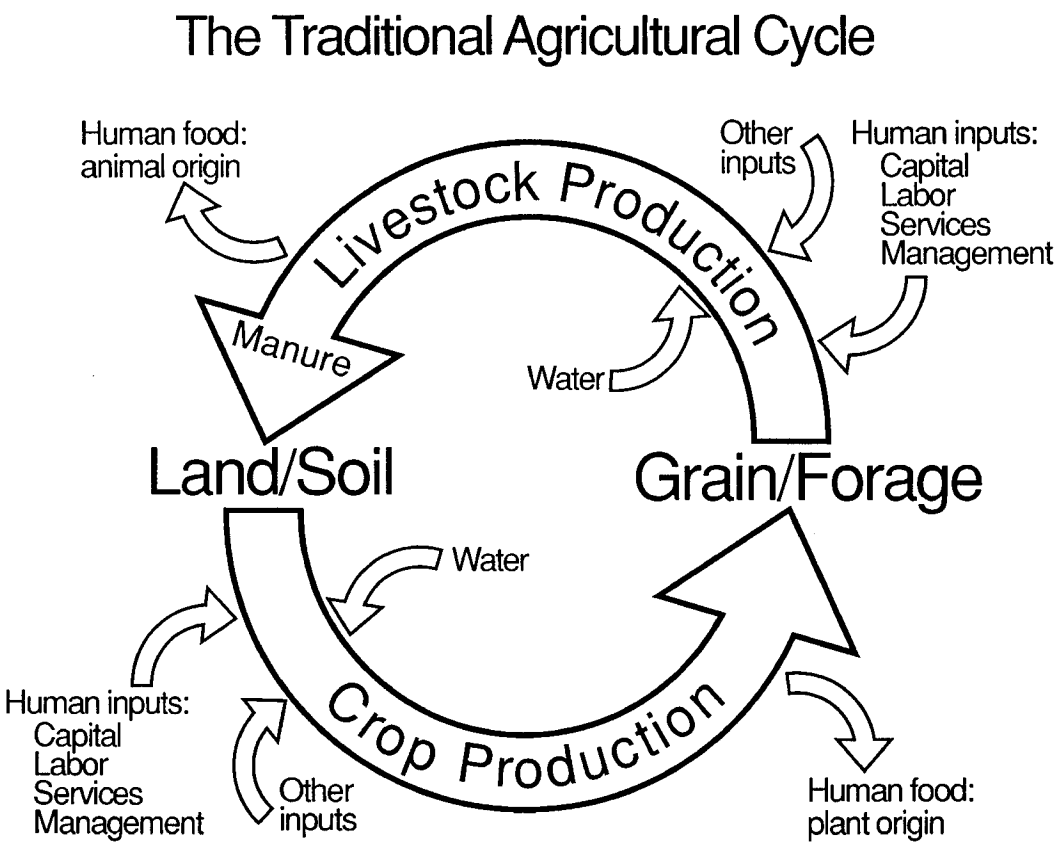

Figure 1. The traditional agricultural cycle (Honeyman, 1991).

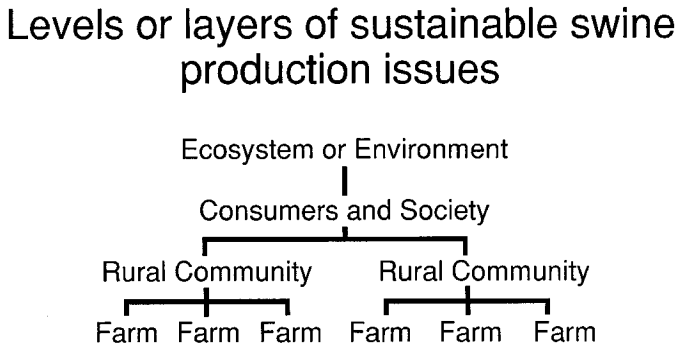

Figure 2. Levels or layers of sustainable swine production issues.

Swine Industry Structure Change Issues

Many socioeconomic issues are related to a swine industry that is rapidly changing with fewer and larger swine farms and is becoming vertically integrated and industrialized. A common form of vertical integration is contract feeding. Usually in contract swine production, the farmer/feeder provides the buildings, labor, and manure disposal, and the owner provides the pigs, feed, and management. Swine production that is contracted as opposed to individually owned production units has a markedly different effect on the farmer as well as on the local rural community. According to Ikerd (1994), the management and labor requirements for large-scale contract farrow-to-finish production are 4.25 people to generate $1.3 million in hog sales. Independently operated hog farms, however, employ 12.6 people to produce a similar amount of hog sales. Large-scale, specialized swine production units produce more hogs per person employed. When off-farm multipliers and indirect effects in retail and service sectors are considered, a shift from family-based independent pork production to large-scale, specialized units would displace about 13.5 jobs per $1 million of hog sales (Ikerd, 1994). One million dollars of hog sales is about 9,000 head of market hogs valued at $110 per head, or the number of hogs produced from about 600 sows during a year. The large-scale swine production units not only employ fewer individuals but usually spend less money for inputs in the local community. Smaller swine producers purchase a greater proportion, about 1.7 times as much as large units, of their inputs locally, i.e., within 20 miles (Chism, 1993). Therefore, the larger swine units support fewer nonfarm jobs, particularly in the local rural community.

In large-scale contract swine production, the returns to management often accrue to individuals not directly involved in the ownership or management of the hogs or the surrounding land. These returns to management, or profit, often exit the farm and the local community. Hogs have long been known as the farmer's "mortgage-lifter." In each of the last 10 yr, the average net profit of all producers on the Iowa Swine Enterprise Records Program has been positive (Stevermer, 1994). These were generally modest-sized producers with an average sow herd size of 100 head. A key to sustainability in agriculture is profit. It seems that large-scale specialized swine production could remove some of the hog raising profits from rural communities and greatly diminish its importance as a profit generator for many farmers.

Admittedly, contracts can be a very useful business arrangement in pig production. Farmers with limited capital or with an interest in limiting risk can produce pigs under a contractual agreement. For example, contracts can be particularly useful for beginning farmers. As long as both parties (company/contractor and farmer/feeder) can negotiate the contract under a balance of power, contracts offer advantages to both entities. The key is whether the contracts are sustainable over the long term. Problems arise when the balance of power shifts in favor of the company, the negotiating position of the farmer diminishes, and the farmer's profit level deteriorates.

A major problem in many rural communities is the decreasing availability of quality employment. From 1986 to 1993, North Carolina, where large-scale contract hog production is widespread, more than doubled its hog production, but during the same period the number of North Carolina hog producers declined by about one-half (Center for Rural Affairs, 1994). According to Ikerd (1994) "the substitution of capital and mass-production technologies for labor and management is the primary advantage that large, specialized hog production units have over smaller, diversified operations."

More than 20 yr of studies have consistently shown the negative influence of large-scale specialized farming on rural communities (Allen, 1993). Lobao (1990) found that "an agricultural structure that was increasingly corporate and non-family owned tended to lead to population decline, lower incomes, fewer community services, less participation in democratic processes, less retail trade, environmental pollution, more unemployment, and an emerging rigid class structure." Ikerd (1994) states that "an increase in large-scale contract hog production can only be expected to accelerate the past trends toward declining rural communities." Iowa State University rural sociologists summarized data from 12 studies covering the United States over 40 yr and concluded that "a change towards corporate agriculture produces social consequences that reduce the quality of life for rural communities" (Lasley et al., 1993).

Ikerd (1994) states that "there is clear evidence that independently owned, modest-sized family-operated farms can be commercially competitive with current contract production units," and that "successful modest-sized, family-operated hog farms contribute more to the economic and social well-being of rural

communities than do their corporate counterparts." He recommends "improving management capabilities of independent hog farmers as a high priority rural economic strategy." "Greater reliance on intensive management creates more quality employment opportunities in rural areas by enhancing the productivity of people rather than replacing people with capital intensiveness and large-scale, mass-production technologies," Ikerd concludes (1994). For example, a sustainable, management-intensive swine production system has been developed in Sweden (Algers, 1991; Algers et al., 1991).

From a sustainable agriculture viewpoint, the trend in the swine industry in the United States toward large-scale contract corporate swine production is a potentially negative trend because it seems to displace farmers and farm families, remove the profit of swine raising from rural areas, change the role of the swine producers from entrepreneur and manager to employee, concentrate pigs, and damage rural communities. These effects may not be apparent in areas where the swine industry is rapidly expanding, but over the long term and in aggregate there seems considerable evidence to support this analysis. What are the long-term impacts of this trend from a social, economic, and environmental view point? The trend toward large-scale pork production in the United States is strong and rapid, but it is not inevitable or entirely positive, as many of its advocates claim.

Issues of Access and Entrance in U.S. Swine Production

As U.S. swine production rapidly moves toward large-scale, specialized hog production units, issues of access begin to emerge. In the past, genetics, breeding stock, markets, information, and technology related to swine production were largely public domain and accessible to virtually any individual. Swine breeding stock produced by many seed stock producers was available to whoever purchased it. The hog market was the result of many small producers selling pigs on a given day. Information and technology was developed by researchers at land-grant universities and disseminated to farmers via extension staff, the public media, and input suppliers.

This scenario is beginning to change. Swine genetics and breeding companies are arranging exclusive contracts for breeding stock with large-scale hog producers. Pork processing companies and large producers are developing marketing agreements. In some areas, the same company produces pigs and owns the processing facility. Some large swine companies retain their own research staff or contract for research exclusively controlled by the company and used within the companies' production system rather than marketed to the industry. These developments run contrary to the concept of sustainable swine production and could block equal access. On the other hand, government and university swine-related research and outreach programs in the United States and in other countries are continuing to be very active.

Another issue is the aging of many producers and the lack of young producers entering swine production. Data from the U.S. Census of Agriculture (1992) show only about 2% of Iowa farmers with hog sales of greater than $50,000 annually who were under the age of 25 and an additional 19% who were below the age of 35. About 28% of Iowa producers in that category were over 55 yr old.

The reasons for the shortage of young swine producers is unclear. Perhaps it is related to the increasing capital requirements of modern swine production, or it could be related to concerns about air quality in swine confinement building. The combination of hazardous gases—ammonia, hydrogen sulfide, carbon monoxide, and carbon dioxide—and airborne dust coupled with extended exposure may pose a significant health hazard to swine production workers (Donham and Popendorf, 1985).

Manure, By-Product, and Nuisance Issues

Manure is the primary by-product of swine production. The other principal "by-product" of swine production is the pigs that die on-farm before slaughter. Pig death losses from birth to weaning are typically 15% and from weaning to market are an additional 5% (Stevermer, 1994). Odor, noise, dust, flies, and rodents also often occur in conjunction with swine production and can be public nuisances.

Swine manure is nutrient-rich but variable in nutrient and dry matter content. Average swine manure nutrient values are shown in Table 2 (Killorn and Brenneman, 1993). Because of the variability in nutrient content in manure, chemical analysis is the

Table 2. Estimated average N, P_2O_5, and K_2O content of various types of manure[a]

Type of manure	Total N	Total P_2O_5	Total K_2O
	lb/1,000 gallons		
Liquid-Pit[b]			
Finisher/grower	49	35	25
Nursery	37	28	22
Farrowing	13	10	8
Mixed	29	19	15
Liquid-lagoon[c]	4	2	4
	lb/ton		
Solid[d]			
Scrape and haul			
Summer	33	34	15
Winter	21	17	9

[a]From Killorn and Brenneman, 1993.
[b]Values determined from chemical analyses of samples from Iowa.
[c]From Midwest Plan Service, 1985.
[d]A. M. Rieck. 1992. M.S. thesis. Dept. of Agron., Iowa State Univ., Ames.

best method to determine nutrient content. A good system is in place to supply nutrients to pigs as feed, but a similar system to disperse excreted nutrients is not in place. The variability of nutrient content, the location of manure relative to cropland, and the calibration and timing of application are common problems in using manure as a crop fertilizer (Honeyman, 1991).

As a fertilizer, swine manure not only adds the key plant nutrients of nitrogen, phosphorus, and potassium, but also returns valuable organic matter to the soil, which builds soil structure and improves soil tilth. Swine manure can also be used as a feedstuff for ruminants or as a biomass in methane production. Interestingly, swine manure has a seven-times-higher dollar value as feed than as fertilizer or as methane (Fontenot, 1991). However, swine manure feeding is not widely practiced.

Many swine producers are unaware of potential environmental problems of swine manure. A survey of Kansas pork producers found that less than half of the producers were concerned about nitrates in swine manure as a potential environmental hazard and only 27% showed a concern about the phosphorus content of swine manure. About three-fourths of the producers were uncertain about the quantity of waste generated in raising a pig to market (Richert et al., 1994). Thus, awareness and education in this area are a major challenge.

When hogs are raised on a diversified grain-livestock farm, an economic and environmental synergism is possible. Duffy (1993) demonstrated that profit when Iowa farms combined swine production (1,750 head marketed annually, 120 sow farrow-to-finish) and a corn-soybean rotation increased when compared with grain farms alone, regardless of soil quality. The hog-crop combination provided year-round employment, diversification, reduced risk, and improved efficiency. The farms produced corn at a 15 to 20¢ per bushel lower cost. When fed to hogs, the lower-priced corn reduced the break-even price for the hogs by about $2.50 per head. Both corn and soybean crop costs were lower because of reduced fertilizer inputs as a result of hog manure application to cropland. “Proper utilization of animal manure as a fertilizer source will help alleviate many energy and environmental problems,” Duffy (1993) concluded.

The nutrient content of swine excreta can be altered by manipulating the composition of the diet. Nitrogen and phosphorus excretion levels can be decreased by phase feeding, feed formulation based on amino acid digestibility and available phosphorus, use of crystalline amino acids, and addition of phytase enzymes (Honeyman, 1993). In swine-dense regions with inadequate arable land to recycle nutrients, this approach would result in an environmental benefit. However, despite the advantage of improved feed utilization and reduced nutrient excretion, the traditional advantages of linking crop and livestock production would be reduced. As with many new technologies, the apparent advantages are only a portion of the long-term consequences (Honeyman, 1993).

The relationship of swine population to arable land is important. Large swine production units built on small acreages or not part of farms that also produce feed grains can have manure utilization problems. Therefore, often there is too little land to adequately recycle swine manure nutrients on cropland. Swine production in the United States seems to be increasing in regions of low population density (e.g., the High Plains and the mountainous West). Some of these regions may not have adequate arable land to utilize swine manure nutrients as crop fertilizer. In the long term, nutrients will build up in the soils in these situations (Melvin and Zhang, 1993). “If crop production and animal (swine) production systems are separated, (or mismatched) both systems will suffer in the long run,” concluded Melvin and Zhang (1993).

Rendering is a viable process to recycle dead swine nutrients into feed (Kelly, 1992). Although rendering is becoming less available in some regions, a vigorous rendering industry is important to sustainable swine production.

Swine odor has been identified as the 1993 top priority research topic by the National Pork Producers. Odors from manure are a public nuisance. As swine production has become more concentrated, odors from individual units have intensified. About 95% of complaints concerning livestock production involve odor (S. Melvin, personal communication). Odor control methods include covering manure with water, frequent cleaning, covering manure storage facilities, proper citing, distancing manure storage from neighbors, adequate storage capacity, and incorporating manure into the soil (Melvin and Zhang, 1993).

Nutrient management is key to successful sustainable swine production. The size of swine operations may be limited based on nutrient management. More research is needed on manure as the link between swine and crops, the environmental effects of swine manure spreading, and integration of manure application into soil management plans (Hatfield, 1993). Nuisances, particularly odor, associated with swine production must be controlled to minimize negative public perceptions, because of the dramatic increase in the number of people living in rural areas who do not farm or raise livestock commercially.

Pork Quality Issues

Pork quality is a serious problem for the U.S. swine industry. The U.S. pork supply has about 16% pale, soft, and exudative (PSE) pork and 10% dark, firm, and dry (DFD) pork (Kauffman et al., 1992). Increasingly, hogs are being purchased on a carcass merit basis (Kauffman and Russell, 1993). Therefore,

leanness and muscling are becoming more important to producers. The porcine stress syndrome (**PSS**) gene is related to both leanness and PSE/DFD pork. Work by Goodwin and Christian (1994) on the frequency of the PSS gene in U.S. swine suggests that about half of PSE/DFD pork is attributable to swine carrying the PSS gene. The remaining PSE/DFD pork is the result of a variety of unspecified factors.

Another pork quality problem is that selection of pigs for fast deposition of lean may lead to lower levels of intramuscular fat or marbling (Barton-Gade, 1990). This may produce drier or less tasteful pork. This problem has been documented in Denmark and may occur in the United States as selection for lean intensifies.

Consumers are concerned about the use of antibiotics in swine production and the potential for violative levels of drug residues in pork. About three-fourths of U.S. swine receive antibiotics at some time in their lives (Hays et al., 1986). A pork quality assurance program and producer education activities have been successful in reducing drug residues. New age-segregated-rearing techniques help minimize chronic swine health problems. The chronic health problems generally result in decreased growth and performance. Frequently antibiotics have been used to control many of these chronic health problems.

The resolution of these pork quality concerns and others is critical to long-term, strong consumer pork demand and sustainable pork production.

A Sustainable Swine Production Model

Based on the issues discussed, a possible model of sustainable swine production system for the United States can be described. It would include several characteristics. An ideal or model system is perhaps unattainable but is valuable in outlining desired outcomes and structure. Many of the details of the model would depend on social, economic, and environmental situations. Several elements of the system are not original and some are currently in process. The uniqueness is the overall sustainability goal of the model.

Structure. A sustainable swine production system in the United States would have a major component of the hogs produced by many, modest-sized, independent, diversified family farms. The farms would be large enough to allow at least one of the farmers or producers to specialize in modern swine production. The farms would be managed by owner-operators or long-term tenants who are good stewards of land, air, water, soil, pigs, family, and community. The farms would be linked by networks or alliances to facilitate swine production, coordination, technology transfer and adoption, and system communication. Some networks are already being formed by independent swine producers.

Swine production would be management-intensive and fully integrated into the crop, human, and other animal systems on the farms. The natural environment or ecosystem of soil, water, air, topography, and native plant and animal life would be carefully considered in designing, siting, and sizing the farm's swine production.

Access and Entrance. Swine information, technology, markets, and genetics would be accessible to all producers. The concept of a "level playing field" would allow all swine producers to compete based on their inherent abilities in swine production. Young and beginning producers would be viewed as a critical resource, necessary to sustain the system. Special development programs would provide educational, experiential, environmental, management, and leadership training for beginning young producers. Social and recreational activities would be a part of the programming, also.

Diversity. Innovative alternative forms of swine production that emphasize sustainable concepts would be encouraged and communicated throughout the networks. Research and demonstration priorities would be developed with producer input and sustainable objectives.

Manure and Dead Pigs. Swine manure would be handled as an important nutrient resource and be used for fertilizer, ruminant feed, or methane generation, depending on individual farm plans and needs. Also, dead pigs would be handled as a nutrient resource. Prompt rendering services would be utilized or some other efficient form of recycling (e.g., burial or composting).

Pork Quality. Lean, quality pork would be a key outcome of the system. Pork could be traced to individual producers to assist in quality control. Quality assurance programs would be widespread and expanded. Animal care, feeding, handling, and breeding would be designed to optimize pork quality and leanness. Communication and coordination from consumer to producer would be a clear interchange. Lean, quality pork would be the standard, and deficiencies would be penalized.

Implications

For long-term success, the social, economic and environmental dimensions of U.S. swine production need to be carefully considered at the farm, rural community, consumer, and ecosystem levels. Rapid changes in the U.S. swine industry structure have an impact on all levels in fundamental ways. Young beginning producers are vital to the future of swine production and must have access to technology, genetics, markets, and information. Manure nutrient management is the key linkage between swine and crop production. Quality pork to meet the consumer's

demands will help ensure a vibrant industry. New sustainable alternatives are needed that select the appropriate technologies and combine them into management-intensive systems coupled with crop production. Virtually every issue involving sustainable swine production provides opportunities for research, education, dialogue, and change. The implications of sustainable swine production are a wholesome balanced environment, healthy rural families and communities, many profitable, modest-sized family-based swine/crop farms, and quality pork.

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