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THE SHAPE OF THE SWINE PRODUCTION INDUSTRY TODAY AND TOMORROW

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I. INTRODUCTION

Agriculture in general and the swine industry in particular continue to evolve and change. One of the few things that we know with certainty is that tomorrow's food and fiber industry will not be the same as todays. Change is inevitable. For those of us involved in the swine industry -- be that as producers, processors, marketers, consumers and even as academics -- we need to be concerned about tomorrow's changes. We need to think about the future in order to position ourselves to anticipate, direct, and benefit from these changes in the world around us. A problem situation that is anticipated is one that is partially solved.

The purpose of this paper is to look at the structure of the hog production industry from both historical and futuristic perspectives. Focus will be on changes at the farm production level including number and size of farms, new production technology, and management control as influenced by on-farm and off-farm institutional and technological changes. The bottom-line question to the producer is "Am I competitive today? Can I be competitive tomorrow?"

II. SIZE and NUMBER of FARMS

A. A Historical Perspective

Total farm numbers in the United States have declined over one percent (1%) per year during the last decade. As presented in Table 1, the change has accelerated in more recent years. The loss of over 60,000 farm units in 1985, a 2.7% annual decline, was the largest absolute annual drop during the last decade. Such a demographic change reflects the adverse economic situation being experienced by many of agriculture's commodities.

Swine producers are no exception to this reduction in farm operations. In fact the numbers presented in Table 1 describing changes for all of agriculture probably understate the case for commercial agriculture in general but certainly understate the reduction of swine producing farms. Changes during the 1980's in the population of hogs and hog farms in the U. S. as presented in Table 2 indicate some dramatic changes. The reduction in number of hog farms averages an annual decline of eight percent (8%). This recent rate of decline is more rapid than was our experience during the previous generation. Going back to the year 1950 when the peak of more than 2 million hog producers was reached in the U.S. and calculating to 1980, an average annual rate of decline of about 2.2% would result. The gist is that the rate of change in declining hog operations has accelerated in more recent years. However, these gross descriptions of changes in the hog farm demographics mask the changes occurring within the hog production industry with regard to distribution of farm size.

Within the hog production industry, the distributional shifts in size of hog farms has been dramatic. The numbers in Table 2 suggest that the average size of hog farm has been steadily increasing but the rapid shift to larger farm units and their increasing dominance in the commercial swine production industry deserves some emphasis. Data presented in Table 3 suggests that the hog farm size with more than 500 head in inventory and probably selling in the neighborhood of 1000 head or more per year are becoming dominant. Since 1980 their share of hogs in inventory and presumably their production share has increased from 42.0% in 1980 to 56.4% in 1986. Combining the two largest categories in Table 3, it is seen that over 90% of the hogs are on about 27% of the hog farms.

Swine producing farms with over 500 head in inventory have in the 1980's increased in individual farm size. Data in Table 4 indicates that the varied number of these hog farms is consistent with the hog cycle but that the long-term trend is for these larger farms to increase in individual farm size if not in absolute total number of farms. It appears certain that the relative importance of these larger farms in the total hog production industry will increase.

B. Reasons for Change

Why has the structure of the hog production industry changed? Will this direction of change continue in the future? Answers to these type of questions can help us anticipate the number and organizational format of the hog farms in the 21st century?

1. Macro or Big Picture Considerations

a. Production

The deterioration of the economic position of agriculture producers in general is evidenced by the continuous decline in aggregate U.S. farm equity since 1980. Although aggregate debt levels have declined since 1982, equity value has been lost because of the even faster rate of decline in farm real estate values. The decline in land prices can be partially explained by increasing global capacity to produce grain crops and subsequent reduction in exports. This loss in export demand results in lower grain prices which translates to negative profits in crop production and subsequent reduction in land values. The impact upon the hog sector, in the short run, is cheaper feed prices. These type of scenarios in the past have played into something called the hog cycle; i.e. cheap feed encourages an increase in hog production in an attempt to add value to the corn that is produced by the farmer-feeder and eventually results in depressed hog prices. Will history repeat or will the structure of the swine industry change?

b. Consumption

Consumption of pork in the U.S. on a per capita basis has declined from a peak of 78.7 pounds in 1971 to an estimated 58.4 pounds per capita in 1987. If a different year is selected to initiate the consumption comparison, the situation may not appear quite so alarming. Table 5 contains annual U.S. consumption per capita data for pork, poultry, and fish from 1975 to 1985. As demand for pork has softened, a concomitant increase in both poultry and fish has taken place.

Price analysis of the pork sector by M. Ingco suggests that demand has shifted negatively since the late 1970's. That is, the inflation-adjusted price for any given amount of pork consumed today is less than it was in the late 1970's. To be emphasized is that consumption is not equivalent to demand. It is assumed that all pork available will be consumed. The question is "what price will clear the market?" As seen in Table 5, per capita pork availability in 1983, 1984, and 1985 varied only slightly. Yet in inflation-adjusted dollars, the price fell in both 1984 and 1985. The concern is whether this apparent decline in pork demand can be slowed down or even reversed.

The factors that influence demand include income, population, prices of substitute and complementary products, and changes in tastes and preferences. We can hypothesize that pork demand is influenced by concerns and perceptions about nutrition and health, food safety, availability of pork products with built-in consumer services tailored for dual-earner households including the yuppie couples, and retail portions of size targeted for the single parents and singles. The fresh meat market shares for consumer segments are compared in Table 6 for the years 1983 and 1985. It is evident that the consumer segments labeled as active and health conscious are becoming increasingly important to the demand for meat and to eventual welfare of the pork producer. Will these trends continue? Can the demand for pork be enhanced such that pork can hold its own or even increase its share of the consumer's food expenditure?

c. Marketing Structure

How hogs are marketed can influence the ideal size of hog operation and the type of hog produced. Market weight hogs in Canada are sold on the basis of carcass weight and backfat thickness. Ontario hog producers sell through a centralized marketing agency. In the U.S., the number and percentage of hogs sold on some type of grade and yield basis has been increasing over time but as of 1985 was still only 16.2% of the market weight hogs sold. Direct purchases of hogs to include buying at country buying stations has increased to 84.2% of all market weight hogs sold in 1985. The compensating loss has been in the number of hogs sold through terminal markets and auction sales. As the marketing system changes, the price discovery techniques used by all participants in the hog marketing chain changes. How must hog producers tailor their own operation to discover the prices for various types of hogs and how will they change their live product to optimize their returns from this market?

d. Policy

Legislation and resulting policies at the national, state or provincial, and local level can have determinant impacts upon the organization/operation of individual swine farms and upon the structure of the overall swine production industry.

Illustrative examples might include: 1. environmental protection policies that closely monitor air and ground water quality; 2. animal welfare policies that limit animal population density and living conditions; 3. tax legislation which changes the profitability of capital-intensive e.g. confinement housing, relative to less capital intensive facilities or vice versa. As our respective developed nations become even more developed and less rural, who among us expects to have less legislation that impacts upon animal production practices?

2. Micro or Farm Level Considerations

The demographic data indicate the decline in number of hog producing operations and increased size of those remaining. An explanation of these changes usually revolves around the concept of economies of size.

The theory of economies of size maintains that total cost per unit of production declines as a result of increasing the amount of production. This reduction in cost in the short run is from fuller utilization of a given-sized farm; e.g. farrowing house, nursery, grower-finisher of a given size. Over a longer period of time where size of facilities can vary, economies of size occur because the lowest cost plant or building capacity has been identified and reached. As conceptually illustrated in Figure 1, the short-run average cost curves (SAC) could represent the current swine operation whereby costs decline if the current facilities are fully utilized. But as expansion occurs via more intensive use of facilities, there comes a point where additional building capacity is needed and constructed. Conceptually, the farm shifts to another SAC that enables more production, and ideally lower cost as the farm expands. The concern from a practical view is at what size of farm might costs actually increase rather than decrease because expansion has resulted in a size of business that exhausts current managerial ability and/or goals.

Further explanation of economies of size should include the idea of technical and of pecuniary advantages. The economies of size due to technical advantages are where the fixed costs associated with ownership of durable assets; e.g. swine facilities and equipment, are spread over a larger amount of production. The issue here is how intensively are the building facilities, equipment and breeding stock being used. Generally speaking, the higher the amount of hog production from a given sized facility, ceteris paribus, the lower will be the fixed cost of ownership associated with the durable assets per unit of production.

The pecuniary economies of size relate to the marketing program for both the inputs purchased and the hog output sold. Most typically, the price discounts associated with bulk volume purchases of feedstuffs, medicinial supplies etc. are where the price advantages are gained on the input side. Regarding the price advantages gained per unit of hog sales, the question is whether and how much price advantage can be gained by large hog operators. Utilization of techniques such as direct sales same-day kill and pricing agreements with slaughter firms, utilization of forward pricing tools that require a defined minimum size, and communications technology relaying instantaneous price data are possible tactics that could be employed to give a price advantage.

Evidence of economies of size existing in the real world of hog entrepreneurs can be presented via cost of production data. Farm record data from Michigan farrow-to-finish producers enrolled on the TELFARM financial record-keeping system provides support for the notion that large producers have lower feed cost, lower non-feed variable costs, and lower fixed expenses per unit of production. (See Tables 7,8 and 9) Analysis by Van Arsdall of Illinois data for years 1980-83 indicates a feed cost advantage of $0.44 per 1000 cwt produced in favor of larger producers. This cost would be influenced by both physical production efficiencies and by prices paid for feed. Cost of production data compiled by USDA and presented in Table 10 indicates cost economies for feed, non-feed variable, and fixed expenses per cwt of production up to 10000 head produced annually on a farrow-to-finish operation. Of concern in anticipating and planning optimal farm size is whether and when the long-run average cost curve turns up. That is, do diseconomies of size eventually occur that limit farm size. A study by Crall, et. al. in 1975 developed long-run average cost curves for three systems of farrow-to-finish swine production. As presented in Figure 2, the pasture system had cost economies up to 3500 head per year. The open front system has declining costs up to an annual production of 9000 head per year. The environmentally controlled system also had cost economies until approximately 9000 market hogs were produced annually. All cost curves appeared rather flat, or constant cost, over quite a range of production. Each individual farm can have a different optimal size based on managerial ability to control resources but we are concerned with the collection of swine producing farms in total. That is, what will this industry look like going into the 21st century?

A warning or caveat is appropriate regarding interpretation of this type of cost-of-production data. Large size alone is not a guarantee of success. There is an immense degree of variability of performance within any size category. Many smaller producers do indeed have costs that are as low or lower than larger producers. Also survey data and actual farm record data are subject to the impact of survivors. Those who are today's large producers have obviously survived and grown. Those who have grown are hypothesized to have been the more financially successful. This selection process based on financial ability would obviously result in data indicating that larger producers have lower costs than small producers. The bottom line rule-of-thumb is to get better before getting bigger.

Data presented in Table 11 indicate some technical efficiency differences that would result in economies of size. Evident in this data is that as size of the hog operation increased, there was improved efficiency with respect to use of feed, labor, breeding stock, and capital resources.

Our observations on the characteristics associated with the large swine producers that result in economies of size include use of specialized confinement swine housing, scheduled use of farrowing facilities by grouping sows, early weaning permitted by hot nurseries, rebreeding of sows on first heat period, terminal cross-breeding program for growthier pigs, breeding stock generated from separate herd or purchased from supplier with production records, rations balanced to nutrient requirements for at least five different phases of production, a health program that focuses on the breeding herd, and a healthy environment in which the pigs can thrive. In addition to these production practices are the managerial attention to details that includes an excellent financial and production record-keeping system, recognition of debt-servicing ability, and production details as sanitation and feeder adjustments, etc.

Given these general observations on what producers have done to be competitive in the past and present, what about the future? We expect changes to continue as rapidly as has been the case in the recent past. We turn now to some of these on-going and expected changes for the future.

III. FUTURE CHANGES

In the future, swine producers will be competing in an industry with variable and probably tighter profit margins. Swine entrepreneurs will need to continually improve their efficiency of production. Technological and other changes to improve efficiency and requiring benefit/cost evaluation before adaption will now be discussed.

A. Use of Antibiotics

The question of whether or not the low-level use of antibiotics in animal feeds is a human health hazard is one of the most fully studied scientific subjects in recent years. Hundreds of research reports are available and numerous symposia have been held. However, this issue continues to be one of the most controversial of all facing swine producers in the future. It is estimated that this practice provides a cost savings of about $100 million a year in feed and other costs for livestock producers, and $3.5 billion a year for consumers (Hays et al. 1981). Justification for use of antibiotics in livestock feeds is predominately related to animal health: increases in animal weight, increases in efficiency of feed utilization, increases in reproduction efficiency and decreases in morbidity and mortality (Hays et al., 1981). Penicillin and tetracyclines are among the most effective and least expensive of the antibiotics used in animal feeds. Table 12 shows the type of improvement expected in performance of young pigs when antibiotics are included in the diet (Hays and Black, 1985).

Pressure has been mounting by consumer groups, the Food and Drug Administration (FDA) and others on the theoretical grounds that subtherapeutic use of antibiotics may result in antibiotic-resistant bacteria in animals that could be transmitted to humans. The potential result would be that the effectiveness of certain human antibiotics used in treating diseases would be compromised. Recently, the Center for Disease Control and the Los Angeles County Department of Health reported that they had tracked antibiotic-resistant salmonella in 45 victims of a California outbreak to undercooked meat, which was then tracked to the slaughter houses and from there to the dairy farms where the cattle were routinely treated with small doses of antibiotics (Spika et al., 1987). Because of this continued pressure and heightened awareness from health officials and the American public, use of penicillin and the tetracyclines will be restricted and possibly even banned for use in swine and other livestock production in the next 5 to 10 years.

Sulfa residues in pork continue to plague the swine industry although the violative rate has been reduced to below six percent (Table 13). Concern is for the small percentage of the human population that is hypersensitive to sulfa and may develop allergic reactions after consuming low levels of sulfa that may be present in meat. Increased efforts on the part of the USDA Food Safety Inspection Service will intensify the monitoring program for residues in meat with urine being collected from pigs at slaughter for sulfa screening. Presuming that hog identification systems are in place, farms found to be marketing pigs with sulfa residues will bear the cost of having a marketing embargo placed on the farm and having the pork carcasses condemned at the packing plant for containing residues.

B. Biotechnology

According to (FDA) study on veterinary biotechnology, at least 92 U.S. firms are engaged in biotechnology research. About two-thirds of these companies are less than

10 years old and were created expressively for biotechnology research and development. FDA predicts more than 200 veterinary products and processes made possible through biotechnology could emerge from these projects, with two-thirds of these available for use in two to five years. Most of the products fall within four major areas:

- disease diagnosis, prevention and treatment;
- nutrition, growth and reproduction;
- large scale production of genetically engineered products; and
- genetic improvement of animal breeds.

Consumer and industry trends are directed toward meat products with a lower fat content. Major changes have occurred in the manner in which pork products are being marketed to "active" and nutrition conscious consumers. Consumers demanding low sodium, low fat products have resulted in increased shelf space in the local grocery store for these types of products. It is only logical that research effort, be exacerbated to develop new compounds and products to reduce the fat content and increase the lean portion of pigs fed during the growing and finishing stages. Survival in the swine industry may well depend on efforts to develop new technology to improve both the leaness of pork products and lower the cost of production. Somatotropin and beta agonist are two compounds that have been evaluated in recent years to improve both performance and carcass quality.

1. Somatotropin (Growth Hormone)

Somatotropin is a small protein that is produced by the anterior pituitary, broken down in the small intestine, and acts on the liver to release somatomedin-C which causes an increase in cell division. It stimulates protein synthesis and growth in most tissues of the body, while also decreasing fat storage. It has been clear for several years that providing extra somatotropin to a pig caused it to grow more rapidly and be leaner. However, the only way to get porcine somatotropin was to isolate it from the pituitary glands of slaughtered pigs, which proved to be extremely expensive and difficult to obtain large quantities. In recent years, advances in recombinant DNA technologies have resulted in economically feasible production of large quantities of this hormone.

Remarkable effects on growth and carcass composition have been shown when pigs were injected with somatotropin. Boyd (1987) reported up to 19% improvement in gain and nearly a 30% improvement in feed efficiency when pigs received somatotropin injections (Table 14). Boyd (1987) also reported that both loin eye area and individual muscle weights could be dramatically increased with somatotropin while back fat thickness was substantially decreased in a dose-dependent manner (Table 15) In addition, total carcass lipid was reduced and total carcass protein was increased. Similar effects of somatotropin on improvement in growth performance and carcass quality in swine have been shown by Etherton et al. (1987). Their results also showed a decrease in backfat with a concurrent increase in muscle mass (Table 16).

Somatotropin is a protein that is broken down by normal enzymatic hydrolysis in the small intestine. Therefore, humans consuming pork containing somatotropin residue should not be able to absorb this compound in an active form. By the same token, pigs consuming this protein will not be affected as well. The research cited involved the use of daily injections which would not be practical for producer utilization of this product. Therefore, the current problem facing researchers is the development of an appropriate delivery system. It is anticipated that a delivery system will soon be developed and the result will be potential availability and use of somatotropin by hog producers to improve pig performance and carcass merit.

2. Beta Agonist

In recent years a series of beta-adrenergic agonists such as clembuterol and its analogue cimaterol have been demonstrated to effectively alter the manner which dietary energy intake is partitioned, shifting the nutrient partitioning to favor lean tissue growth at the expense of fat growth. Ricks et al. (1984) reported that when finishing pigs were fed clembuterol there was a 13% reduction in carcass fat and a 10% increase in carcass muscle as compared to pigs fed the control diet. However, there were no differences between pigs fed control diets and those consuming clembuterol for growth performance and feed efficiency.

In similar studies with cimaterol, Jones et al. (1985) fed various levels to finishing pigs and reported dramatically increased loin eye areas and decreased backfat in treated pigs (Table 17). While cimaterol fed to pigs resulted in a small improvement in feed efficiency, feed intake tended to be reduced and rate of gain was not affected (Table 18). However, when pigs were withdrawn from the drug seven days prior to slaughter, feed efficiency was poorer, probably as a result of compensatory deposition of fat.

Another promising compound appears to be ractopamine. Recent studies have shown an average of 8% increase in average daily gain and 9% improvement in feed efficiency when pigs were fed diets containing 20 ppm ractopamine. In addition, percent carcass fat was reduced by an average of 11% with a concomitant increase in loin eye area by an average of 12%. These products could result in a significant economic impact on the swine industry. It is also quite possible that instead of a seven day withdrawal period for residue clearance, the withdrawal period is more likely to be little more than 24 hours which will be of less concern since most pigs are off feed for this amount of time prior to slaughter.

Somatotropin and beta agonists may indeed revolutionize the swine industry. The first obstacle will be to prove to FDA that these products are not only effective but also not a threat to food safety. This task has already been initiated and is well on the way to being achieved. The economical impact of these products on the industry are difficult to determine. For producers to be rewarded for using these products, the marketing system will need to provide a price structure which will offset the cost of using such products. Today it is estimated that less than 20% of all U.S. hogs sold are marketed on some type of grade and yield system. The vast majority of hogs are purchased on a volume basis with little emphasis placed on quality when demand is high. With the trend toward increased consumer demand for meat products with a lower fat content, the price structure for leaner hogs will have to change to reward producers for their efforts and expense to produce this type of pork product.

Use of these products would result in faster and more efficient growth of pigs and have the added benefit of more volume of saleable meat from each carcass. The improvement in gain and efficiency of only about 10% for both types of products could improve feed efficiency in the grower-finisher phase from current levels of 3.25 pounds of feed to produce a pound of pork to about 2.5 pounds of feed. This improvement in feed efficiency would certainly change the amount of corn needed by the swine industry. If a conservative estimate was used, suggesting five to ten percent less corn needed on a whole herd basis, the implication for corn prices could be significant. This reduction in corn needed would be partially offset by the concomitant increase in the need for soybean meal because of the resulting increased need for amino acids to support the improved lean tissue development.

3. Elisa Tests

Diagnostic technology has been developing for years at an accelerating pace and biotechnology has shortened the continuous search for new and simple ways to detect substances in food, feed, water and tissue. Today, enzyme linked immunoassays (ELISA) have filled the requirement for rapid screening tests. They are simple enough to be performed by producers and feed manufacturers, but do not require expensive equipment, and are considerably less expensive than conventional methods.

Today, ELISA test kits are commercially available to producers to evaluate grains and mixed feed for mycotoxin contamination from feed trucks and bins. Tests are available for aflotoxins, deoxynivalenol and zearalenone. Zearalenone annually causes millions of dollars of losses to producers in the U.S. and Canada by causing delayed breeding, poor conception and farrowing rates and small, weak pigs at farrowing, when fed to gilts and sows. Deoxynivalenol reduces feed intake and subsequently reduces performance. Producers using these kits will be able to more conveniently and closely monitor the contamination of feedstuffs. This will allow prevention of considerable losses in production because of possible zearalenone and vomitoxin contamination of feedstuffs.

The USDA Food Safety Inspection Service (FSIS) is currently evaluating ELISA tests to detect sulfa residues and trichina in carcasses at slaughter. Sulfa tests can be utilized by producers on the farm to detect potential residue in the urine of pigs ready for marketing. If FSIS detects residue in the carcasses, the carcasses are tanked and a marketing embargo is placed on the contaminated source herd resulting in the producer losing valuable time and money in marketing subsequent hogs. In addition, testing for trichina to identify this parasite in carcasses will allow packers to label pork as "trichina free" which may result in increased consumer acceptance and use.

4. Allyl Trenbolone

Synchronizing estrus in gilts allows for natural mating or artificial insemination (AI) of groups of synchronized gilts at one time without relying on close daily estrus detection. A major problem facing most large commercial operations is the difficulty of getting gilts bred during a short period of time to fill all farrowing crates for a particular group in an all-in-all out system of management. Studies have shown good synchronization of estrus by feeding the progesterone derivative allyl trenbolone to gilts. Estrus can be blocked regardless of the stage of the estrous cycle at which the hormone feeding is started. Allyl trenbolone is usually fed for 14 to 18 days at 15 mg/gilt with gilts typically returning to estrus 4 to 7 days after withdrawal of this product from the feed. The resulting increases in reproductive efficiency from feeding ally trenbolone are presented in (Table 19).

The relatively high cost per insemination, if only a few animals per day are inseminated, and the difficulty in accurately detecting estrus, discourage the widespread use of AI in most large herds. The use of allyl trenbolone will potentiate utilization of AI since in natural service, a mature sire can be expected to mate with no more than 250 to 300 sows/year, whereas with AI the number can be increased to 2500 or more services. In addition, fewer gilts will be needed in the gilt pool to ensure adequate numbers bred in a short breeding period. Allyl trenbolone has been thoroughly tested in the U.S. and is currently legalized for use in France. Within three years it is likely this product will be available for use in the U.S.

C. Building Systems and Environmental Issues

With the continued push for increased efficiency measured by lower costs of production, most commercial swine operations have almost totally adopted some form of confinement housing. This capital for labor substitution that results in increased labor efficiency was necessitated by the perception of insufficient quantity and quality of hired labor. Data on swine facilities used in finishing hogs is presented in Table 20.

Adoption and utilization of confinement facilities creates potential problems associated with large concentrations of animals. Of concern to our own natural resource stewardship and to our increasingly litigious society are environmental issues including pollution in the form of odor, surface and ground water contamination from waste products, primarily manure. Swine operations have the potential of creating dust, noise, and smell levels that are unacceptable to the human population.

If environmental concerns continue to escalate, the likelihood increases for new legislation to limit the size of swine production units according to minimum land space requirements for disposal of manure. Also likely in more densely populated areas are restrictions on distance or proximity between swine operations and the neighbor's house. Producers intending to expand or build new facilities need to be sensitive to the values of others and keenly aware of legal constraints and regulations governing the size of the unit and disposal of waste products.

D. Business Organizational Changes

1. Contract Feeding

Many industry analysts suggest that contract feeding will be a factor in the evolution of the swine industry. This happened to the broiler and turkey industries years ago. Reduced profit taking and the need and desire to produce high quality products and command adequate premiums in the market place led these two commodities to see the process through to the end--from egg to final product purchased by the consumer.

Contract feeding hogs has been done for years in North Carolina, Pennsylvania and Arkansas and today has expanded throughout the midwest. Industry participants suggest as many as 10% of the hogs marketed in the U.S. today are raised on a contract basis. A recent survey (Rhodes, 1987) showed that mid-to large-sized farm contractors (with 1,000 to 100,000 annual production) controlled 6.3 percent of the nation's market hogs in 1986. Of the operations that started production from 1983 to 1986, 17 percent were farmer contractor or contractee concerns. A reason often emphasized for contracting includes more homogenity of product. Contractors have more control over the genetics of their hogs which results in better and more consistent quality of feeder pigs to be raised on contract. There is not the need to re-invent the wheel as many smaller independent producers often end up doing. The large size of contracting companies lend themselves to "cook book" systems. Facilities are large and all similar in building style and type. Management is more specialized and similar for these similar facilities. These "cook book" systems provide for quicker education of new labor supply and potentially allow laborers from one part of the facility to move to another phase of production with less loss of labor and management efficiency. The size of these units (e.g. 500 to 1000 sows each) increases the opportunity for labor specialization. For example, compare two people managing a 200 sow farrow-to-finish operation to four or five people managing a 600 sow farrow-to-finish enterprise. One person may be in charge of the farrowing rooms, while another is in charge of the nurseries, etc. On the other hand, the managers at the 200 sow unit must be more generalized to manage more phases of the operation which may result in less efficiency.

The use of contracting also offers opportunity for those contracting to raise pigs. Much of the risk of financial loss has been shifted to the swine owner or contractor. The operator gets paid a fee for use of facilities and provision of labor. Often these are producers who have had at one time difficulty in maintaining adequate cashflow or young producers who wanted into the business but could not afford the initial investment for buildings, the hogs and operating capital. A recent survey (Rhodes, 1987) cites financial difficulties as the reason why 73 percent of the farmers who were once independent became contractees. Another 19 percent were lured by the guaranteed income and lower risk that comes with contracting. Contract production of hogs enables these producers to share the risk with the contractor who provides the feeder pigs and feed which are the largest costs to the producer. In addition, banks tend to be more willing to lend capital for buildings if there is some long term contract commitment in which the risks are shared.

Not all contractors operating today will be in business in the near future. Contractors can be divided into basically two types. There are the long-term contractors who share the risks in a contract agreement for 5 to 10 years and who provide the technical input as to the type of buildings, management and production levels required by producers if they commit to contract growing hogs. On the other hand, there are short-term contractors who have no long-term commitment to hog production but rather, enter into the business during profitable periods or who maintain a feed manufacturing facility and seek to maintain consistent volume of feed sales. Contracting allows this type of contractor to maintain consistent tonnage merchandised in addition to sharing profits during profit taking periods. This type of contractor has no long-term commitment to improving animal performance and efficiency. Because of the diverse nature of the hog production process, the movement towards contracting and/or vertical integration is not expected to be of the magnitude experienced in the poultry industry. As illustrated in Table 21, some forms of vertical integration have been tried in the past and apparently failed.

We expect to see an increase in the volume of hogs produced under some type of risk-sharing agreement. The need for increased quality and uniformity of the live hog and eventual pork product to satisfy consumer demands will encourage this movement. A recent announcement that Smithfield Packing and Carrol Foods have entered a vertical integration agreement for production from 20,000 sows only lends additional momentum to this prediction. This movement towards control of the pork product from conception to consumption by a lesser number of entrepreneurs is expected to result in increased efficiency in the pork production system. As producers do indeed compete with one another in a cost sense, it will be necessary for the sole proprietor to also become increasingly efficient.

2. Structural Changes in Feed Manufacturing

The number of feed manufacturing firms has been on the decline over the past twenty years. According to USDA Economic Research Service surveys, 7,919 feed manufacturing plants were in existence, in 1969 but that number had declined in a 1984 volunteer survey to about 6,600 plants (Dr. Bill Lin, 1987, preliminary data). this represents a decline of nearly 17% during this time period.

There has also been a trend toward more on-farm feed manufacturing. A dramatic decline in the number of swine farms purchasing complete mixes from local feed manufacturers has occurred with a concomitant increase in the number of farms using base mixes or vitamin-trace mineral premixes. Those farms who have purchased supplements or concentrates in the past and who are increasing in size of production will undoubtedly go more to purchasing premixes or base mixes and purchase corn and soybean meal independently to reduce costs. Table 22 shows the greatest number of farms on the Iowa Swine Enterprise Record System in 1985, purchased a premix and mixed it on the farm with corn and soybean meal. Price of feed was also considerably reduced as producers purchased more individual ingredients and manufactured their own diets. Also of interest in this survey was the fact that herd feed efficiency tended to improve as producers did more of their own feed manufacturing.

With the domestic feed manufacturing industry being a mature industry, there will be increased competition for market share from swine producers. But as number of swine operations decline and those remaining viable becoming larger, there will be reduced need for purchasing complete feeds and supplements. There may be strength in regional firms who are very service oriented in addition to offering high quality feed products since these plants may be able to aptly service large swine operations within a 25 to 50 mile radius of the plant.

3. Genetic Composition and Source of Seedstock

Efforts to increase the number of pigs produced per sow per year has resulted in increased use of some combination of Yorkshire and/or Landrace in the sow herd for increased productivity and milking ability (Table 23). In the future, an increase in the use of "white line" females (some combination of Yorkshire, Landrace, Large White or Chester White) will occur because of pressure to maximize sow productivity. Where producers cannot effectively raise their own replacement gilts to maintain productivity, they will be forced to purchase highly selected females and boars from purebred producers or breeding companies.

The sources for seedstock will change in the future with fewer purebred producers remaining in the business and increased market share going to large commercial breeding companies. Because of the decline in purebred herds, some breed associations have already pooled resources and are operating together. More of this consolidation is expected in the future. The majority of replacements purchased today are from purebred breeders (Table 24). However, as commercial farms become fewer and larger, numbers of replacement boars and gilts needed will increase and volume, as well as genetic progress and health, will be major factors as to where replacements are purchased. Commercial operations will undoubtedly purchase purebred stock not from one purebred operation but rather from a "company" comprised of several purebred producers with similar genetics and health programs or from a commercial company specializing in selling replacement stock. To remain viable, producers must put greater emphasis on selection pressure as the need to get more production out of each sow will be paramount. For purebred producers to remain viable, seedstock will have to be sold on the basis of deliverable specifications. Included will likely be specifications on size of loin eye area, amount of backfat, structural correctness and conformation in addition to volume of stock delivered at a certain preconceived time. Perhaps most paramount in these deliverable specifications will be slaughter health information on pigs from the contemporary group.

E. Management Information Systems

A management information system (MIS) refers to the means of supplying data to the manager for purposes of making a decision. This system will become computer-based and link together on-farm and off-farm data. The MIS system will be integrated to include physical data on swine performance, marketing data, and financial data. This data base will then be used in conjunction with computer software in a decision-support system context to assist the manager in solving problems and rendering correct decisions consistent with the defined goals of management.

The futurist Naisbitt contends that we are shifting from an industrial society to an information society. New developments in computer and communications technology will accelerate the pace of change by collapsing the information float. That is, there will be a shorter time lag from the time a new development occurs, to awareness of the change, and then adoption of or managerial adaptations to take advantage of the change.

F. Labor

With the trend toward increased size of individual swine operations, the need for high quality labor will be increasingly recognized as a critical input to the success of most swine ventures. Swine entrepreneurs will become more reliant upon hired nonfamily labor. The owners will need to recognize that those hired for operational management must have the capacity and opportunity to develop themselves beyond jobs requiring manual dexterity. Cheap labor is not necessarily inexpensive and conversely, higher cost labor need not be expensive. Labor productivity will be an important issue.

A limited hierarchy of operational management and labor will need to be established. Labor will become increasingly specialized and needs to be capable of problem-solving within this specialized area. Interpersonal skills will become increasingly important for both the owner and operational manager. Some of the more critical decisions influencing success will be personnel management in identifying and hiring the right person for the right job.

IV. FUTURE TRENDS IN THE SWINE PRODUCTION INDUSTRY

Projections about the swine production industry are closely linked to predictions regarding demand for the pork product. Many of these predictions have been alluded to earlier in the paper. This section will be used to present a summary listing of our predictions as we see them at this point in time.

A. Long-term Demand for Pork

Our long-run outlook for U.S. pork production, hog prices, and per capita supply of meats is summarized in Figures 3, 4, and 5 respectively. We have painted two alternative scenarios to bound the range of possible outcomes.

Scenario I assumes that demand continues its negative shift at the same rate in the next 10 years as has occurred in the past 10 years. Scenario II assumes that the negative shifts in demand for pork will stop in 1990. Most likely the actual demand scenario will fall between the two bounds. Figure 5 projections on per capita consumption are for Scenario I only. Scenario II would show somewhat higher per capita consumption over the latter part of the forecast period.

The increase in pork production from the current time period until 1989 is driven by the abundant supply of feed grains and associated cheap feedstuffs. These forecasted corn and soymeal prices used in the model, although rising from current levels, remain very low compared to history over the entire forecast period.

The long-run projections can be summarized as an increase in swine production until 1989 and associated decline over time in hog prices from current levels until 1990. Even though a specific price is predicted for each year, we are more comfortable with predicting the general direction or trend rather than a specific point price estimate. The bounds on the trend production suggest a U.S. hog production industry that will be producing 15 to 16 billion pounds of carcass weight per year. The predicted prices associated with this level of production will average in the $37/cwt neighborhood with the negatively shifting demand painted in Scenario I and will average in the $41.50/cwt neighborhood if the negative shift in pork demand is curtailed as presented in Scenario II.

B. Trends

1. Swine production industry will be increasingly demand-driven, not supply driven. That is, entrepreneurs will be increasingly cognizant of the price required to earn a profit. If the price is not available and/or sufficient value can not be added to earn a profit, firms will exit the industry.

2. Increased size of individual units. The 500-sow unit will be increasingly common. Using this as a base to estimate number of commercial units in the future given our projected demand, the number of commercial farrow-to-finish units could conceivably be 10,000 to 12,000 depending on the estimate of reproductive efficiency.

3. These units can be farm family owned and organized. However, because of the capitalization and managerial expertise required, only the top 10 to 20% of the current operations will prosper going into the 21st century.

4. Contractors will increase their share of the swine industry. Those contractors who are successful will share risks and have long-term commitments to the industry. Those not having the goal of long-term commitment to the swine industry will exit as profit margins narrow.

5. Vertical integration will increase in the swine industry but not with the rapidity or extent of the broiler and turkey industry due to the productive complexities of this specie.

6. Involvement of the feed industry in owning swine operations and breeding stock will increase as the need to maintain feed volume, control risks, and earn profits rises.

7. There will be fewer feed manufacturing firms with increased purchasing of only premixes by the larger swine operations. The larger more efficient swine production operations will purchase more individual ingredients on a bulk basis and manufacture diets on the farm.

8. Swine Production profit margins are expected to shrink necessitating increased efficiency for production, marketing, and financial management activities. As farms become larger, these management activities will be specialized among individual owners or more likely paid consultants.

9. New production technology employed will include use of somatotropin and beta-agonists pending their legal approval in an attempt to increase carcass leaness and growth performance. Allyl trenbolone will become legalized for use in estrus synchronization.

10. Marketing technology employed will include techniques to manage risk of adverse price movements. These techniques might employ increased use of currently available forward pricing techniques as options, futures markets, or direct shipment and price contracting with the packer. Development of new pork contract markets with packers is a possibility.

11. Financial management technology employed will include techniques to manage risk of adverse interest rate movements. These techniques might employ increased use of the options, futures market, or direct contracting with outside traditional agriculture capital sources.

12. Computer technology will be increasingly used. Examples of use could range from the early warning monitoring systems employed in livestock housing to decision support systems that include models to assist in determining strategy and tactics with regard to production, financial, and marketing decisions.

13. Greater emphasis will be placed on increasing sow productivity. There will be fewer purebred producers and a concomitant increase in the market share for replacement stock supplied by commercial seedstock companies. This seedstock will have to be merchandised on the basis of deliverable specifications.

14. Less emphasis and activity placed on production of own feedstuffs. The land base will be more concerned with adequate space for manure disposal.

15. Vigorous competition in the food marketplace will require increasing response to changing consumer demands. Hogs must become more uniform to meet the tighter specifications of the packing, retailing, and foodservice industries.

16. Consumers will be increasingly active in expressing their desires for a healthy, nutritious, tasty, and safe pork product that satisfies their many lifestyle desires.

17. Legal restrictions on swine production activities will increase. Pork producer organizations will need to become increasing active in representing interests that are good for the pork industry as a whole. It is likely that permits to produce may be required in the more densely populated areas as environmental concerns escalate.

18. The animal rights groups will become increasingly sophisticated and active. Animal welfare problems and the application of possible legal provisions to animal husbandry will remain an area of dispute for many years as the problems involved intensify. Legal restrictions and requirements will likely be imposed on some facility designs and management practices.

In summary, change is inevitable and the rapidity of change appears to be increasing. Agriculture in general and swine producers in particular are no longer isolated. We operate in a global economy composed of ever more expressive consumers. New technology in production, marketing, and finance will continue to be developed. Computerized information systems in all these areas will be available to assist in decision-making. Only those who can anticipate change and adapt to the ever-changing environment will grow and prosper.

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TABLE 1. FARM NUMBERS IN THE UNITED STATES[1]

Year	Number of Farms[2]	Annual Change %
1986[3]	2,214,420	-2.7
1985	2,274,730	-2.3
1984	2,328,400	-1.8
1983	2,370,200	-1.3
1982	2,400,550	-1.4
1981	2,433,920	+0.1
1980	2,432,510	+0.01
1979	2,432,300	-0.2
1978	2,436,250	-0.8
1977	2,455,830	-1.7
1976	2,497,270	-1.0

1/ Source: National Agricultural Statistics Service

2/ Farm is defined as a place that sells or could sell $1000 or more of agricultural products per year.

3/ Estimate

TABLE 2. NUMBER OF U.S. HOGS AND HOG FARMS

Some Change, 1980-86 [1/]

	Total U.S. Hogs & Pigs December (1,000 Head)	Total U.S. Farm Operations With Hogs	Average Number Hogs Per Farm
1986	50,960	346,890	147
1985	52,312	391,000	134
1984	54,073	429,580	126
1983	56,694	462,110	123
1982	53,933	482,190	112
1981	58,688	580,060	101
1980	64,512	670,350	96

1/ Source: "Hogs and Pigs," Statistical Reporting Service, USDA, Washington, D.C., December issue, 1981-1986.

TABLE 3. DISTRIBUTION OF U.S. SWINE FARMS CLASSIFIED BY SIZE[1]

	Size of Operation (Number of Hogs & Pigs on Inventory)			
YEAR	1-99	100-499	500+	TOTAL
1986:				
Percentage of U.S. Operations	72.6 %	20.3 %	7.1 %	100 %
Percentage of Hogs & Pigs	9.5	34.1	56.4	100 %
1985:				
Percentage of U.S. Operations	73.5	19.6	6.9	100 %
Percentage of Hogs & Pigs	10.3	34.0	55.7	100 %
1984:				
Percentage of U.S. Operations	74.5	19.5	6.0	100 %
Percentage of Hogs & Pigs	11.3	36.8	51.9	100 %
1983:				
Percentage of U.S. Operations	73.4	20.4	6.2	100 %
Percentage of Hogs & Pigs	11.3	37.6	51.1	100 %
1982:				
Percentage of U.S. Operations	76.1	18.8	5.1	100 %
Percentage of Hogs & Pigs	12.6	38.9	48.5	100 %
1981:				
Percentage of U.S. Operations	76.8	18.5	4.7	100 %
Percentage of Hogs & Pigs	14.4	39.9	45.7	100 %
1980:				
Percentage of U.S. Operations	77.3	18.5	4.2	100 %
Percentage of Hogs & Pigs	15.8	42.2	42.0	100%

1/ Source: "Hogs and Pigs," Statistical Reporting Service, USDA Washington, D.C. December issue, 1981-1986.

TABLE 4. NUMBER OF U.S. HOGS AND HOG FARMS
With More than 500 Head
Some Changes 1980-1986 [1/]

	Number Hogs & Pigs on Farms With 500+ Head in December (1,000 Head)	Number Farms With 500+ Head Hogs	Average Number Hogs Per Farm
1986	28,741	24,629	1,167
1985	29,741	26,979	1,000
1984	28,064	25,775	1,089
1983	28,971	28,651	1,011
1982	26,158	24,592	1,064
1981	26,820	27,263	984
1980	27,095	28,155	962

[1/] Source: "Hogs and Pigs," Statistical Reporting Service, USDA, Washington, D.C., December issue, 1981-1986.

TABLE 5. PER CAPITA DISAPPEARANCE OF PORK AND POULTRY AND FISH RETAIL WEIGHT BASIS, 1975 - 1985.[a]

Year	Pork	Poultry	Fish
1985	62.0	70.1	14.5
1984	61.7	67.1	13.7
1983	62.2	65.1	13.1
1982	59.0	63.9	12.3
1981	65.0	62.4	12.9
1980	68.3	60.6	12.8
1979	63.8	60.5	13.0
1978	55.9	55.9	13.4
1977	55.8	53.2	12.7
1976	53.7	51.8	12.9
1975	50.7	48.6	12.2

a/ U.S. Department of Agriculture; American Meat Institute Meatfacts, 1986.

TABLE 6. VOLUMETRICS OF FRESH MEAT.

CONSUMER SEGMENTS:

1983 vs 1985.

Consumer Segment	Market Share For Total Fresh Meat %		Ratio to Market Share to Segment Size No.	
	1983	1985	1983	1985
Meat Lovers	25	11	114	110
Creative Cooks	22	20	110	118
Price Driven	27	26	108	113
Active Lifestyle	12	21	75	81
Health Oriented	14	22	82	92

Source: The Consumer Climate for Red Meat. Yankelovich, Skelly and White, 1985.

TABLE 7. SWINE COST OF PRODUCTION
MICHIGAN TELFARM DATA
FARROW-TO-FINISH

	Less than 200 Litters			More than 200 Litters		
	Feed Cost	Non-Feed Cost	Total Cost	Feed Cost	Non-Feed Cost	Total Cost
	(\$/cwt Produced)			\$/cwt Produced)		
1985	\$26.94	\$18.48	\$45.42	\$25.61	\$16.34	\$41.95
1984	31.79	16.41	48.20	29.17	14.93	44.10
1983	25.00	17.42	42.42	27.79	12.36	40.15
1982	28.41	16.14	44.55	27.69	16.40	44.09

TABLE 8. FARROW-TO-FINISH COST OF PRODUCTION MICHIGAN TELFARM DATA

LESS THAN 200 LITTERS PER YEAR

(cwt. Produced)	1985 (1745)	1984 (2579)	1983 (2791)	1982 (2536)
		($/cwt Produced)		
FEED COST:				
Concentrate	$14.86	$16.86	$11.62	$17.57
Supplement	12.08	14.93	13.38	10.84
	$26.94	$31.79	$25.00	$28.41
Non-Feed Variable Cost				
Repair	1.30	1.42	1.46	1.24
Energy-Utilities & Fuel	1.64	1.61	1.57	1.53
Veterinary Service and Medicine	1.12	1.03	.89	1.40
Supplies & Misc.	.60	.63	.59	.61
Marketing & Trucking	.19	.26	.24	.17
Interest on Operating	1.72	1.46	1.60	1.75
Labor	5.71	3.85	5.30	4.35
	$12.28	$10.26	$11.65	$11.05
Non-Feed fixed Expenses				
Insurance	.27	.21	.19	.18
Depreciation	3.84	3.65	3.42	2.89
Interest on Improvement & Equipment	1.73	1.85	1.69	1.64
Land Charge	.36	.44	.47	.38
	$ 6.20	$ 6.15	$ 5.77	$ 5.09
Total Cost	$45.42	$48.20	$42.42	$44.55

1/ Source: Schwab, Gerald D. "Business Analysis Summary for Swine Farms" Michigan State University, , Various Agricultural Economics report for years 1982, 1983, 1984, 1985.

TABLE 9. FARROW-TO-FINISH COST OF PRODUCTION
MICHIGAN TELFARM DATA

MORE THAN 200 LITTERS PER YEAR

(cwt. Produced)	1985 (6,944)	1984 (9,164)	1983 (8,792)	1982 (7,638)
		($/cwt Produced)		
Feed Cost:				
Concentrate	$14.23	$16.72	$15.20	$15.27
Supplement	11.38	12.45	12.59	12.42
	$25.61	$29.17	$27.79	$27.69
Non-Feed Variable Cost:				
Repairs	$ 1.06	$ 1.07	$ .97	$ 1.17
Energy-Utilities & Fuel	1.55	1.33	1.21	1.62
Veterinary Services & Medicine	1.27	1.09	.81	.94
Supplies & Misc.	.60	.42	.36	.56
Marketing & Trucking	.23	.20	.14	.19
Interest on Operating	1.91	1.93	1.85	2.01
Labor	4.13	3.43	2.05	3.34
	$10.75	$9.47	$7.39	$ 9.83
Non-Feed Fixed Expenses				
Insurance	.20	.23	.21	.26
Depreciation	3.62	3.51	3.02	3.77
Interest on Improvement & Equipment	1.41	1.37	1.38	2.03
Land Charge	.36	.35	.36	.51
	$5.59	$5.46	$4.97	$6.57
Total Cost	$41.95	$44.10	$40.15	$44.09

1/ Source: Schwab, Gerald D. "Business Analysis Summary for Swine Farms" Michigan State University, Various Agricultural Economics reports for years 1982, 1983, 1984, 1985.

TABLE 10.

FARROW-TO-FINISH COST OF PRODUCTION - 1985 FOR U.S. NORTH CENTRAL REGION[1]

	Annual Number Sold					
	140	300	650	1600	3000	10000
	($/Cwt)					
Feed	$26.07	$25.70	$25.52	$25.52	$23.78	$22.83
Other Variable	6.67	5.97	6.21	6.17	6.31	8.19
Total Variable	$32.74	31.67	31.73	31.32	30.09	31.02
Fixed Overhead	6.94	3.56	3.17	1.99	1.71	1.65
Interest	13.96	6.08	8.37	4.43	4.11	2.03
Unpaid Labor	9.55	6.69	4.28	4.22	3.44	1.04
Total	$63.19	$48.00	$47.55	$41.96	$39.35	$35.74

Source: "Economic Indicator of the Farm Sector, Costs of Production, 1985." USDA, ERS, ECIFS S-1. August, 1986.

TABLE 11. ECONOMIES OF SIZE

SOME EXPLANATIONS FOR FARROW-TO-FINISH OPERATIONS in North Central States [1]

Number Sold Per Year	Better Feed Efficiency: Pounds Feed Per Pound Produced	Labor Efficiency: Hours Per Litter	Reproductive Efficiency: Pigs Weaned Per Litter	Capital Efficiency: Number Litters Per Farrowing Crate Space	Capital Efficiency: Hogs Produced Per Grower-Finisher
100-199	4.54	33.4	6.6	2.0	1.4
200-499	4.18	26.0	7.3	2.8	1.3
500-999	4.51	17.0	7.4	4.0	1.7
1,000-1,999	4.23	15.0	7.5	4.3	2.0
2,000-4,999	4.49	10.0	6.7	7.2	2.3
5,000+	4.13	9.0	7.8	8.4	2.3

[1] Source: Van Arsdall, R.N. and K.G. Nelson, "U.S. Hog Industry," USDA, ERS, Agricultural Economics Report 511, June 1984.

TABLE 12. IMPROVEMENTS IN PERFORMANCE OF YOUNG PIGS (STARTER STAGE) FROM INCLUDING ANTIBIOTICS IN THE DIET[a]

Antibiotic	No. of Experiments	Improvement Due to Feeding Antibiotic	
		Gain %	Feed/Gain %
Tylosin and tylosin plus sulfamethazine	29	14.7	6.2
Penicillin and penicillin plus streptomycin	47	14.0	7.6
Bacitracin	11	9.7	3.3
Virginiamycin	23	11.0	5.0
Tetracycline and tetracycline plus penicillin plus sulfamethazine	146	17.7	7.6

[a] Hays and Black, 1985.

TABLE 13. INCIDENCE OF SULFA RESIDUES IN PORK LIVER[a]

Year	Violations, %
1985	5.4
1984	5.9
1983	8.0
1982	4.3
1981	6.0
1980	4.5
1979	6.3
1978	9.7
1977	13.2

a/ Cromwell, 1986

TABLE 14. EFFECTS OF PORCINE SOMATOTROPIN ON SWINE GROWTH PERFORMANCE[ab]

Criterion	0	Somatotropin dose, u/kg body wt.			
		30	60	120	200
Avg. Daily gain, kg/d	0.95	0.97	1.13	1.10	1.05
Feed intake, kg/d	2.87	2.72	2.77	2.39	2.24
Feed/gain ratio	3.02	2.82	2.49	2.18	2.14

a/ Boyd, 1987.

b/ Forty crossbred pigs, 45 to 100 kg.

TABLE 15. EFFECT OF PORCINE SOMATOTROPIN ON CARCASS CHARACTERISTICS[a]

Criterion	Somatotropin dose, u/kg body wt.				
	0	30	60	120	200
No. pigs	8	8	8	8	8
Avg. backfat, cm	2.74	2.51	2.39	2.13	1.83
Loin eye area, cm^2	33.7	34.6	35.3	37.0	37.8
Semimembranosus, g	889	877	949	1011	1013
Carcass lipid, kg	22.4	20.3	17.8	12.5	10.2
Carcass protein, kg	35.3	36.9	39.3	41.2	43.6

a/ Boyd, 1987.

TABLE 16. EFFECT OF PORCINE SOMATOTROPIN ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS[a]

Criterion	Somatotropin dose, ug/kg body wt.			
	0	10	30	70
Avg. daily gain, kg/d	.90	.98	.95	1.03
Feed/gain ratio	2.9	2.7	2.6	2.4
Avg. Backfat, cm	2.4	2.4	2.2	2.1
Loin eye area, cm^2	22	23	25	27

[a]/ Etherton et al, 1987

TABLE 17. EFFECT OF BETA AGONIST ON CARCASS CHARACTERISTICS[a]

	Cimaterol level, ppm					
Criterion	0.0	0.25	0.50	0.5 + w[b]	1.0	1.0 + w[b]
Loin eye area, cm^2	29.85	31.96	33.96	32.09	33.42	32.97
Biceps femoris, kg	1.34	1.44	1.47	1.41	1.49	1.42
Tenth rib fat, cm	2.58	2.31	2.27	2.46	2.13	2.39
Leaf fat wt, kg	1.28	1.17	1.14	1.30	1.10	1.20

a/ Jones et al., 1985.

b/ W indicates withdrawal of drug for 7days prior to slaughter.

TABLE 18. EFFECT OF BETA AGONIST ON GROWTH PERFORMANCE[a]

	Cimaterol level, ppm					
Criterion	0.0	0.25	0.50	0.5 + w[b]	1.0	1.0 + w[b]
Avg. daily gain, kg	.76	.80	.77	.76	.79	.79
Avg. daily feed, kg	2.99	2.84	2.77	2.83	2.73	2.88
Feed: gain ratio	3.93	3.55	3.60	3.72	3.46	3.65

a/ Jones et al., 1985.

b/ w indicates withdrawal of drug for 7 days prior to slaughter.

TABLE 19. REPRODUCTIVE PERFORMANCE OF GILTS FED ALLYL TRENBOLONE[a]

Criterion	Treatment	
	Control	Synchronized[b]
No gilts bred	38	29
No. gilts farrowed	33	27
Farrowing rate, %	86.8	93.1
Total pigs/litter	10.3	11.0
Live pigs/litter	10.1	10.3

a/ Pursel et al., 1981.

b/ Fed 15 mg/gilt for 18 days. Gilts returned to estrus 4-7d after withdrawal of allyl trenbolone.

TABLE 20. FACILITIES PRINCIPALLY USED IN FINISHING HOGS[a]

Facility Type	% of reporting units by size of unit			
	U.S.	5000-6999	7000-14999	15,000+
Total confinement, environmentally controlled	35.6	30.9	38.7	37.8
Total confinement, natural ventilation	23.0	25.4	20.9	24.4
Total confinement, environmentally control in winter, natural in summer	13.5	15.9	10.4	17.8
Open front, concrete floors	20.1	18.3	22.7	15.6
Dirt lot, some shelter	5.7	7.1	5.5	2.2
Other	2.1	2.4	1.8	2.2
Total	100.0	100.0	100.0	100.0

a/ Rhodes et al., 1981

TABLE 21. NUMBER OF SLAUGHTER PACKERS FEEDING HOGS[1]

	Number Packer Firms	Number Hogs Per Year (1000 head)
1985	4	24
1984	4	25
1983	6	68
1982	8	42
1981	9	105
1980	7	58
1979	12	88
1978	11	90
1977	9	109
1976	13	166
1975	11	82
1974	14	93
1973	12	107

1/ Source: "Packers and Stockyard's Statistical Report, 1985 Reporting Years," P & SA Statistical Report 86-2, Table 13, December 1986.

TABLE 22. METHODS USED TO BUILD SWINE RATIONS[a]

Item	Grain and Supplement	Grain, soybean meal and premix	Delivered as complete feed
Producers, %	38	56	6
Herd feed efficiency	396	394	431
Price of feed, $/cwt	6.62	6.47	7.98

[a] Iowa Swine Enterprise Record Survey, 1985.

TABLE 23. GENETIC COMPOSITION OF SOW HERDS IN IOWA [a]

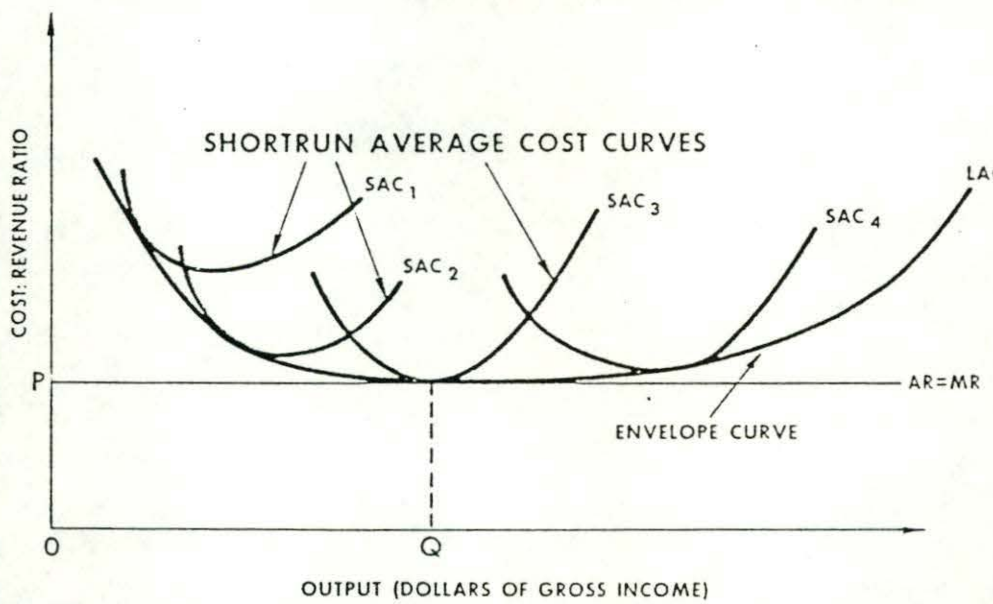
Breed Combinations	% of Producers	Pigs/Litter	Lit/Sow/Yr	Pigs/Sow/Yr
York X Landrace	17.2	8.35	1.88	15.72
York X Hamp	14.6	8.19	1.75	14.31
York X Duroc	18.4	8.15	1.79	14.65
Hamp X Duroc	3.8	7.76	1.62	12.50
PIC	5.4	8.63	1.99	17.22
Boar Power	14.9	8.24	1.86	15.31
DeKalb	3.5	8.11	1.86	15.17
Kleen Lean	3.4	8.30	1.85	15.34
Other	18.8	8.03	1.87	15.12

[a] Iowa Swine Enterprise Record System, 1985.

TABLE 24. SOURCES OF U.S. SEEDSTOCK

Source of Seedstock	% of Seedstock Sold
Purebred Breeder	68.9
Seedstock Company	19.9
Commercial Producer	11.2
* National Pork Producers Council survey, August, 1985	
Several Breeders or Producers	53.0
Single Breeder or Producer	29.0
Seedstock Company	18.0
* Pork '85 Subscriber Survey, October, 1984.	

Figure 1. THEORETICAL ILLUSTRATION OF SHORTRUN AVERAGE COST CURVES AND ENVELOPE CURVE



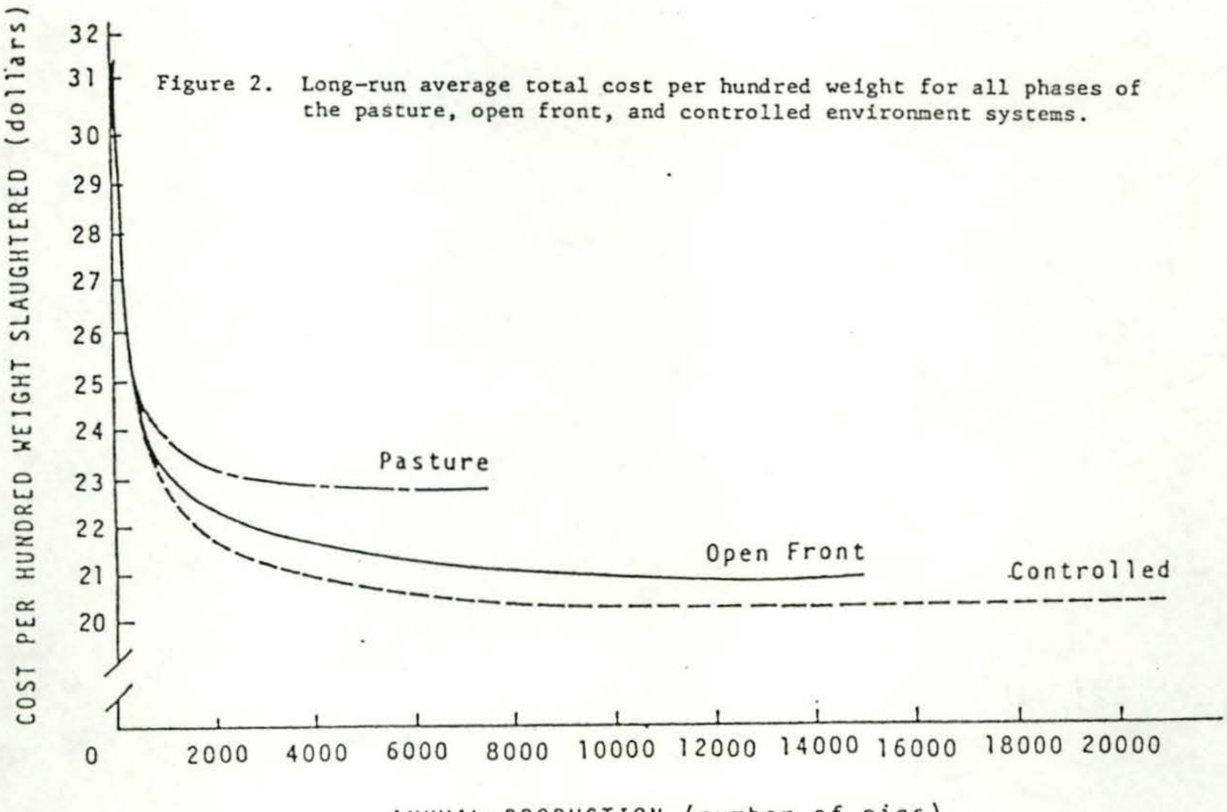


Figure 2. Long-run average total cost per hundred weight for all phases of the pasture, open front, and controlled environment systems.

Figure 3

U.S. PORK PRODUCTION, CARCASS WEIGHT, 1965-1997

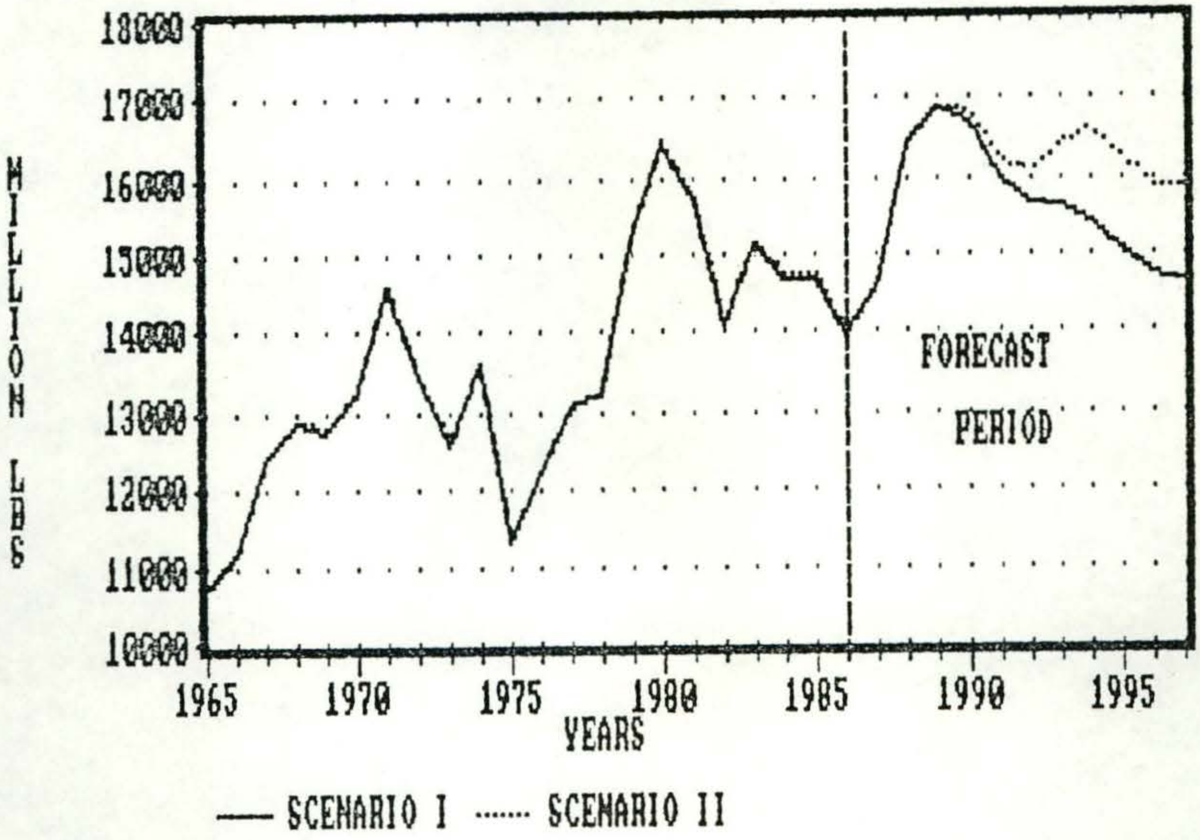
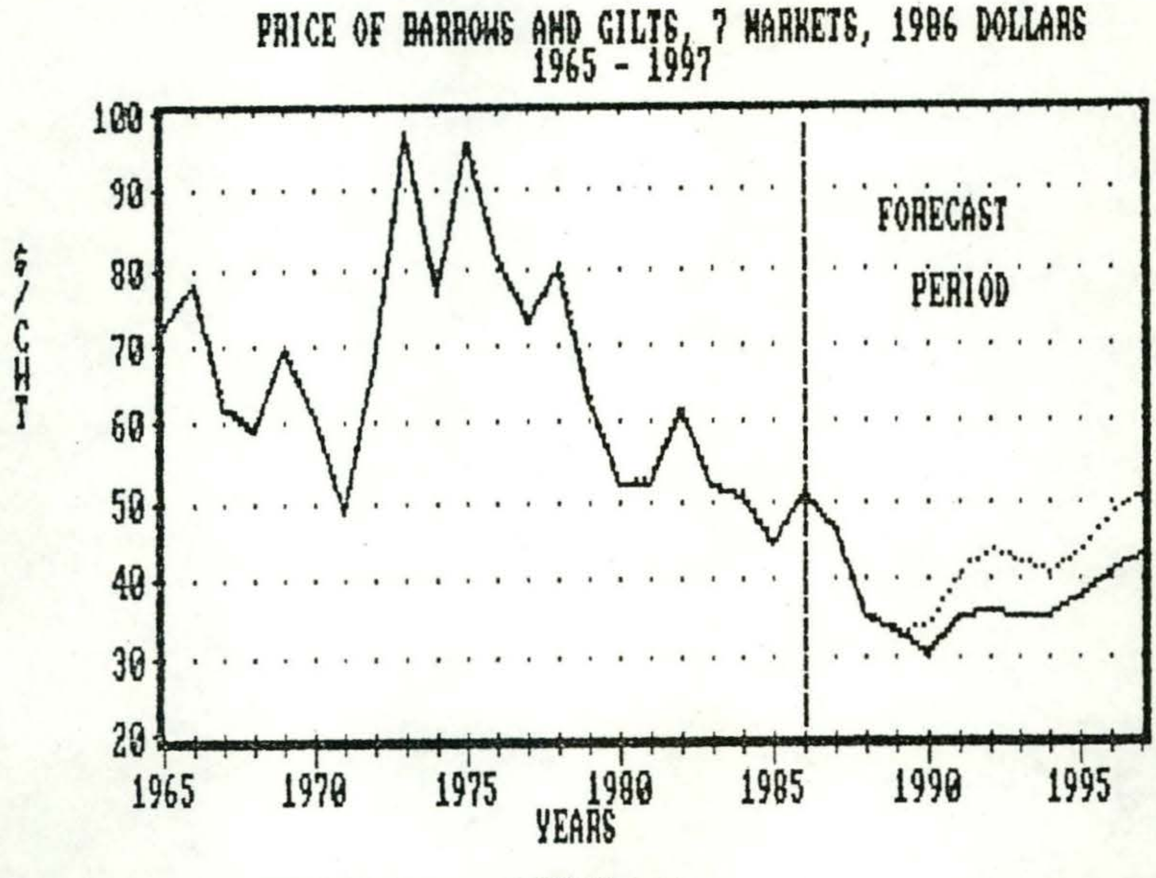
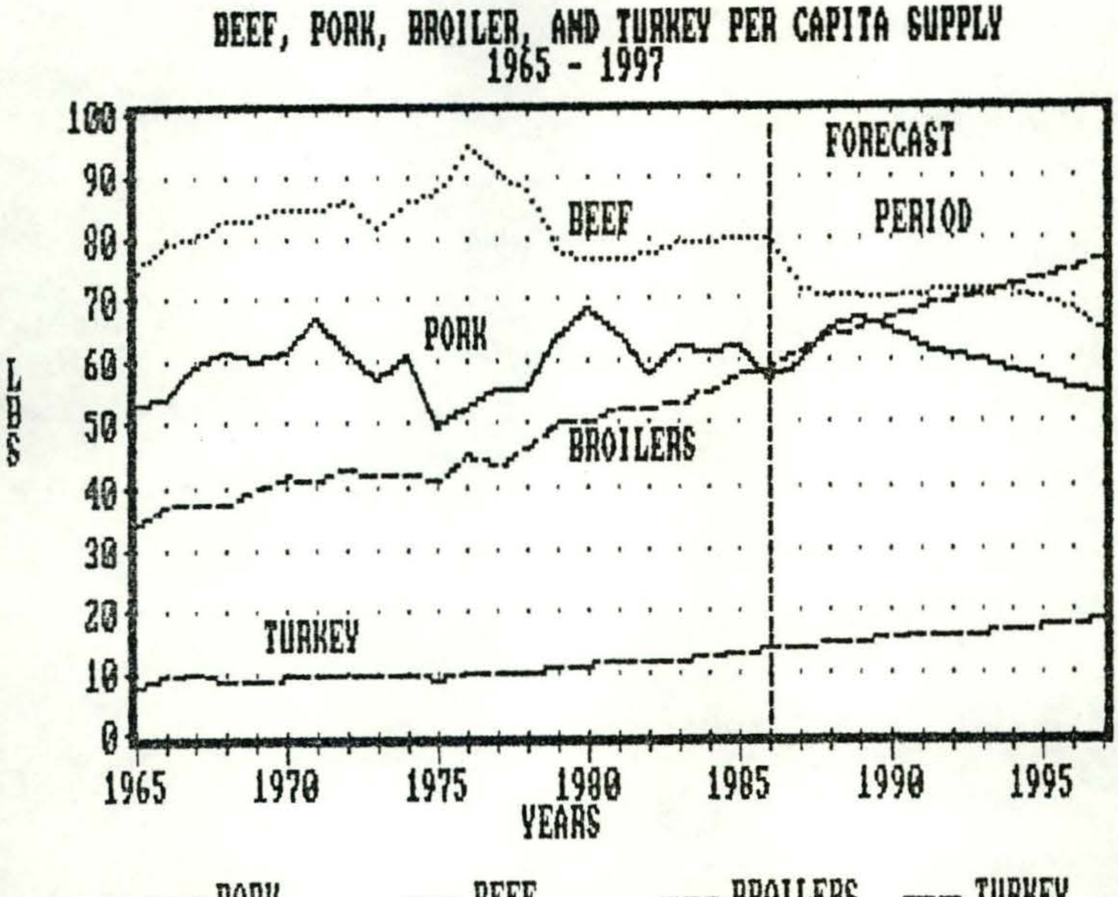


Figure 4



PRICE OF BARROWS AND GILTS, 7 MARKETS, 1986 DOLLARS
1965 - 1997
100
90
80
70
60
50
40
30
20
$/CWT
FORECAST
PERIOD
1965
1970
1975
1980
1985
1990
1995
YEARS
SCENARIO I
SCENARIO II

Figure 5


BEEF, PORK, BROILER, AND TURKEY PER CAPITA SUPPLY
1965 - 1997
100
90
80
70
60
50
40
30
20
10
0
LBS
FORECAST
PERIOD
BEEF
PORK
BROILERS
TURKEY
1965
1970
1975
1980
1985
1990
1995
YEARS
PORK
BEEF
BROILERS
TURKEY