# SOME ECONOMIC FACTORS TO BE CONSIDERED IN SWINE PRODUCTION

THESIS FOR THE DEGREE OF M. S.
MICHIGAN STATE COLLEGE

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1955

This is to certify that the

thesis entitled

"Some Economic Factors to be Considered in Swine Production"

presented by

Charles Louis Beer

has been accepted towards fulfillment of the requirements for

M. S. degree in Agricultural Economics

Glenn Johnson
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Date March 8, 1955

O-169

# SOME ECONOMIC FACTORS TO BE CONSIDERED IN SWINE PRODUCTION

By

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A THESIS

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1955

## ABSTRACT

An examination was made of the economic and technical factors to be considered in pork production decisions. Input-output relationships were examined and approximate scale-line combinations of resources were determined for normal price relationships.

Ordinarily, greater profit can be realized if hogs and feed are combined in optimum proportions in the production process than can be achieved by assuming either hogs or feed fixed, and varying the other factor to a maximum profit position.

Under normal price relationships, probable least cost combination of factors in the production of 100 pounds of pork are:

| | |
|---|---|
| Labor . . . . . . . | 2 hours |
| Feed . . . . . . . . | 350 pounds |
| Protein . . . . . . | This is included in the feed according to price relationship between the grain and protein supplement. |
| Forage . . . . . . | 40 pounds dry weight (or up to 10 percent of the ration for growing pigs) |
| Land . . . . . . . . | 0.037 acre |
| Buildings . . . . . | 8 square feet (or 60 square feet per sow farrowed if farrowed indoors) |

These figures are requirements for production of 100 pounds of pork when hogs are carried from birth to a market weight of 225 pounds.

Labor requirements should be minimized because labor is becoming increasingly expensive in relation to the other factors. Feed also falls into this category. That is, an attempt should be made to minimize the amount of feed needed relative to other inputs, to bring hogs to a given market weight. The most profitable market

weight, however, depends upon the relationship between live-hog and feed prices, as it is profitable to feed hogs to heavier weights as long as the MR from this added weight is greater than the MC of adding this weight. The total feed consumption, therefore, depends upon the price relationship which exists between feed and live hogs. Forage is usually much less expensive than protein supplements, and can probably be substituted for concentrates economically up to 10 percent of the ration.

Break-even points were discussed briefly both in terms of theoretical concepts and in actual practice. This discussion indicates that, as the market price of hogs gets higher, a producer can use more feed to raise hogs to heavier weights and still make money by doing so. Experimental work was cited which shows how the most profitable weight at which to sell hogs depends on the prices paid for live hogs and on the price of corn.

Technical advances have been rapid in the field of antibiotics, and a majority of producers are now using antibiotics in their feeding programs. A simple method for calculating the price which one can afford to pay for antibiotics was formulated. This shows that the present price of antibiotics is, in most cases, well below the productive value of antibiotics. An exception may exist where unusually good sanitation practices are followed, for the value of antibiotics appears to increase directly with poor sanitation.

Disease and parasite control have been made less costly and more efficient by the introduction of new techniques and lower-cost drugs. Recent discoveries in this area have helped reduce the risk involved in pork production.

Selection of animals toward the meat type preferred by the market is enabling some producers to obtain a better price for quality. The introduction of electric heat lamps has made earlier farrowing dates possible at a very nominal increase in costs. This has great significance to the northern hog producer, for he can farrow earlier and therefore take advantage of a higher price in the market by marketing at an earlier date. It may affect the entire industry by moving the high price peak to an earlier date.

The question of evaluating knowledge was considered briefly. Optimum combinations of knowledge with other productive resources exist for the pork enterprise. To establish this optimum, however, it is necessary to consider knowledge as consisting of many various types which can be combined in various manners in the production of income. However, like other factors, some combinations would produce a greater income with less cost than others.

Approved

______________________________

Major Professor

ACKNOWLEDGMENTS

The author wishes to express his gratitude and appreciation to all those who helped with the completion of this study and the preparation of the manuscript.

Special thanks are expressed by the author to his major professor, Dr. Glenn L. Johnson, for providing much of the incentive and inspiration necessary in completing the study, and for the constant supervision and interest which he has given to this study.

The author also wishes to thank Sumner Griffin, of the Animal Husbrandry Department, Michigan State College, for his help and advice on this study.

Thanks are expressed to all the staff members of the Department of Agrícultural Economics, who have freely given of their time and advice when these were needed by the author.

Financial assistance provided through the department by Dr. T. K. Cowden and Dr. L. L. Boger, successive heads of the Agricultural Economics Department, made it possible for the author to continue his studies.

Mrs. Fay Tengelsen, Mrs. Carol Izzo, and Mrs. Margaret Fuller, of the secretarial staff, assisted with the typing of the original manuscript.

The author is also grateful to the other graduate students in the department for their contributions and assistance with some of the problems involved in this study. Responsibility for any errors which may be present in the completed work belongs to the author.

Charles Beer

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# CHAPTER I

## EARLY HISTORY OF SWINE PRODUCTION

In a book published in 1886, James Long[1] referred to the pork industry of the United States as follows:

> America has long been known as a swine producing country of surpassing prolificness and its people claim to produce as well as to consume more pork than any other nation; indeed, pork forms a large portion of the flesh food of the great majority of the American people.
>
> In the year 1881 the exports of pork in one form or another from the vast country amounted in value to 105,750,000 dollars . . . while the average annual value for six years was 84,500,000 dollars.

He continues and says that at that time pork exports exceeded exports of all products except wheat and cotton.

> The history of the pig has never been written and perhaps never will be. This really is a practical age and those who are interested in the animal desire to know rather how to improve and produce it with profit than to trace its connection with the wild boar, or to learn how the gaunt, grizzly long eared, long snouted beast, so long the object of sport in these islands [United Kingdom], and still hunted in many forests of Europe was transformed into the fleshy, fine boned, symmetrical and delicate animal of today. . . .

This points out that even in its early history the pig was considered an important aspect of the farm operation because it could be produced for profit. Very little information is available on just how swine were "combined" with other livestock on a given farm to

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[1] James Long, The Book of The Pig, L. Upcott Gill, 170, Strand, W. C. 1886.

yield maximum profit in early times or just how the swine industry fitted into the over-all picture. Some information along this line can be drawn from the following quotation. Zimmerman,[2] writing about livestock production as affected by World War II, observed:

> Evidently, the hog population seems to suffer more from war than the cattle population does. . . . One reason that hogs are written off in war time, especially in Europe, is the fact that they compete with human beings for edible crops, all through the north European plains the potato is the most important feed for swine. . . .
>
> Hog products differ materially according to breeding and feeding. Hogs are fed waste in China; potatoes supplemented with root crops and barley or other grains in northern Europe; forest products such as beechnuts, acorns, and other nuts fallen from forest trees in Yugoslavia, sections of the U.S.S.R., and the southern United States; corn (maise) in the United States, Canada, Argentina, and Brazil, etc. Hogs are the chief finished product of our corn crop, close to half the crop being devoted to this purpose.

## Swine Production in the United States and Michigan

The production of pork is a large operation in the United States today, yielding a gross product worth 3,649 million dollars. The major portion of these hogs are raised in the corn-belt states of Iowa, Illinois, Indiana, and Ohio.

Michigan ranks seventeenth in the United States in the production of hogs and pigs.

Michigan is not a major swine-producing state, largely because it is not a major corn-producing state. Hog numbers in the

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[2] Erich W. Zimmerman, World Resources and Industries, Harper Brothers, New York, 1951, p. 298.

state have followed the general hog cycle as is evident from Figure I-1. Hog numbers on farms January 1 each year reached a high of 1,400,000 head in 1944 and a low of 510,000 in 1935.

Swine tend to be a supplementary enterprise rather than a major one on most Michigan farms. However, the present trend is toward fewer farms raising hogs, but for those farms to raise more of them. Hill[3] states:

> Following the year 1920, the number of farms with sows decreased about one-half and have held fairly constant since 1930 but with about twice as many sows per farm.

The greatest concentration of swine in Michigan has been consistently found in those sections of the state producing the most corn. This corresponds with the southern one-third of the state, which includes crop-reporting districts 7, 8, and 9. These three districts accounted for 75 percent of the sows farrowed in 1953, 73 percent in 1952, and 75 percent in 1951.[4]

In spite of this concentration of pork production in the southern portion of the state, the sale of pork products accounted for 8 percent of the Michigan farm income for 1954. This amounts to 58 million dollars and can be compared with the 1943-52 average of about 57 million dollars. Even though it is not one of the major hog-producing states, the size of the hog industry in Michigan justifies considerable attention to the problem of producing better-quality pork at lower costs.

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[3] E. B. Hill and R. G. Mawby, Types of Farming in Michigan, Special Bulletin 206, Agricultural Experiment Station, Michigan State College, East Lansing, Michigan, 1954, p. 63.

[4] Information from Michigan Department of Agriculture, Bureau of Animal Industry.

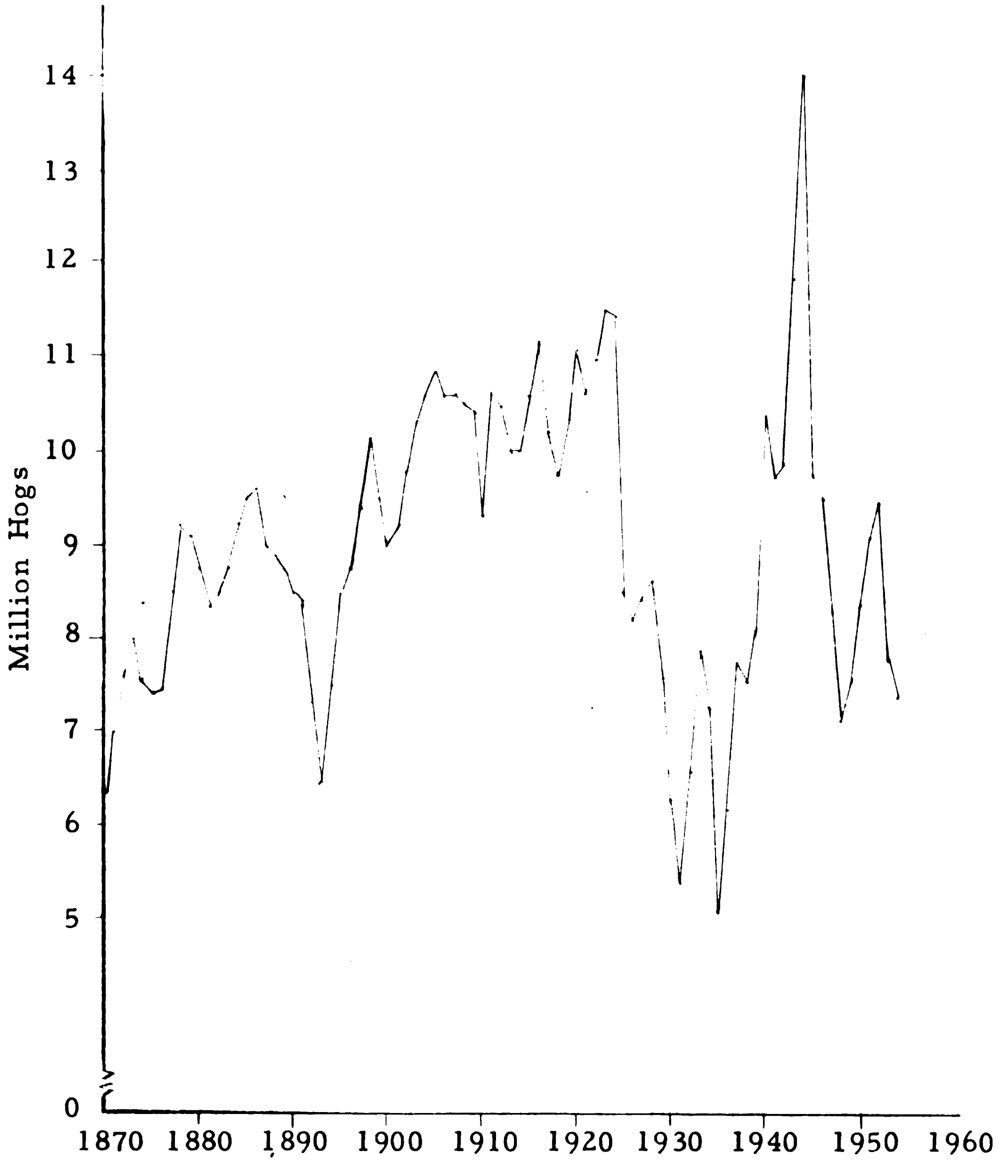


**Figure I-1**
Estimated Number of Hogs on Farms in Michigan
January 1, 1870 to 1954

Based on Michigan Crop Reporting Service figure.

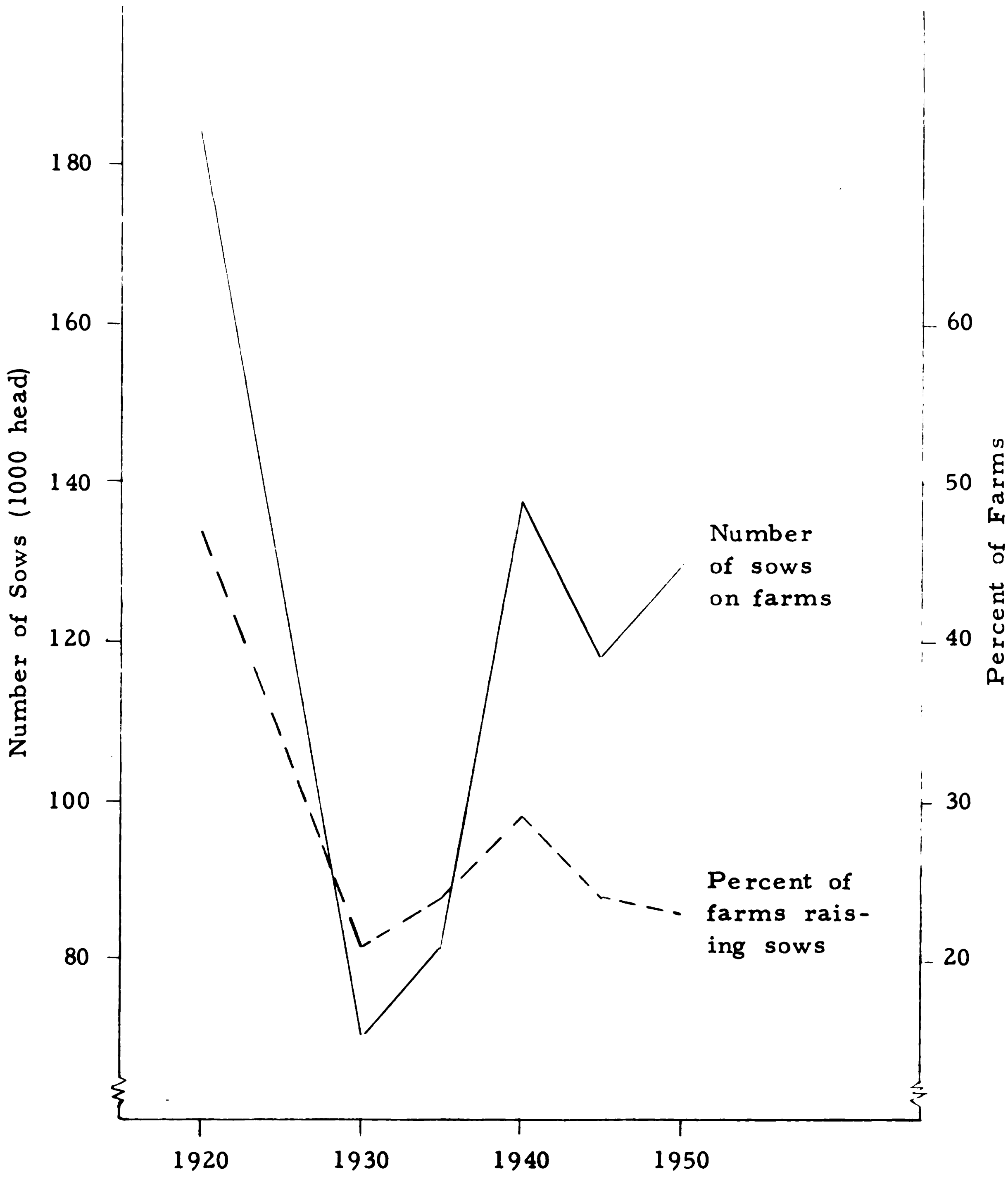


Figure I-2
Number of Sows on Farms and Percentage of Farms Keeping Sows, Michigan, 1920 to 1950[1]

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[1] E. B. Hill and R. G. Mawby, Types of Farming in Michigan, Special Bulletin 206, Mich. State College, E. Lansing, Sept., 1954, p. 64.

## Procedure and Purpose

The purposes of this thesis are (1) to examine some of the important factors of pork production in the light of production techniques being used, new research, and technical developments in the industry, and (2) to make recommendations where possible, on the use of these new techniques by pork producers wishing to reduce costs to maximize income.

In reporting the study, the procedure used is to divide the work into six parts or chapters. The first, or introduction, reviews history of hog production in Michigan and shows the importance of swine in the agricultural income of the state.

Chapter II covers methods of production; that is, it reviews alternative methods of producing pork and points out technological developments. Certain economic advantages and disadvantages of each method are discussed. Sources of information drawn upon include experimental work, college recommendations, and the actual experience of producers.

Technical advances in pork production are discussed in Chapter III. Such advances as antibiotics and new disease and parasite prevention and control measures are discussed to show their effect on the over-all cost and quality picture.

Next, one specific aspect of pork production, input-output relationships, is reviewed. A summary is made of the work on (1) rates of substitution between corn and protein, between concentrates and roughage, and among labor, land, and equipment, and (2) the rates at which inputs such as corn and supplements can be transformed into pork. Some of the research in this area is detailed and complete, while the work in other parts is sketchy. Though all

input-output data in existence are not covered, the more important data and their economic implications are presented.

Chapter V continues the consideration of input-output data by considering break-even points in pork production, the problem of pricing quality, and the problem of getting quality produced and delivered at a cost which will yield the largest profit to the pork producer. An attempt is made to show how the material discussed in the previous chapters can be related, by each individual producer, to the conditions under which he is operating in order to maximize the profits from his resources.

This is followed by a brief summary and a comprehensive bibliography of research work in this area.

# CHAPTER II

# NATURE OF SWINE PRODUCTION

Swine production is a profitable operation when it is adapted to the conditions best fitted to it. Further, it is well fitted to a wide variety of conditions. The swine enterprise can provide a few hogs for family use on subsistence and part-time farms, an important secondary enterprise on farms producing a considerable amount of both roughages and concentrates, or it may be the main, and, in some cases, the only income enterprise on farms producing primarily large amounts of concentrate feeds.

This chapter treats swine production as an individual enterprise and includes a discussion of farrowing systems, sources of purchased feeders, and methods of feeding. Swine production as a joint or complementary enterprise is also discussed in this chapter. A brief treatment of the degree of risk involved concludes the chapter.

## Swine as an Individual Enterprise

A detailed examination of the swine enterprise is necessary if one is to understand optimum combinations of it with other farm enterprises. The details can easily be grasped if one first considers several methods of pork production, leaving for later consideration various enterprise combinations and the utilization of fixed assets. Thus, this section considers the various ways in which pork can be produced without considering whether it is a major or minor enterprise or if it is to be influenced by shortages or surpluses of some factors of production.

Swine production, by its very nature, does not require much time or money at the outset as compared with other livestock enterprises. Some reasons for this are the large number of pigs produced per litter, relatively short gestation period, capacity for rapid growth, the possibility of producing two litters per year, and the early age at which gilts can be bred. Labor costs are low when large-scale production is combined with good organization and adequate equipment.

Pigs are obtained by either farrowing or purchasing. One seldom finds both methods used extensively and continuously on one farm because of the disease control problem created by combining them. Thus, each of these methods is considered separately.

Farrowing systems. Farrowing systems usually fall into either the one-litter system or the two-litter system. Pigs are usually farrowed in the spring and fall of the year. Some attention has been given a system referred to as a three-litter system, which Carrol and Krider[1] describe as a three-crop plan; i.e.:

> One crop of pigs is farrowed in March, another in June and a third in September. Under this plan the herd can be most advantageously developed on June farrowed gilts, which produce their first litter in June when a year old. They are then rebred to farrow the following March and again in September. Thus, they have produced their third litter by the time they are 27 months old rather than at 30 months and will have saved 3 months in the maintenance of the breeding herd.

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[1] W. E. Carroll and J. L. Krider, Swine Production, McGraw-Hill Book Company, Inc., New York, 1950, p. 130.

This three-crop system and a system of year-around farrowing recently discussed in a popular farm magazine by Anderson[2] are not new systems, but just adaptations of the basic one- and two-litter systems. A real three-litter system was considered a possibility by some when the introduction of artificial sows' milk took place, but many technical difficulties are still present both in the use of artificial sows' milk and the genetic make-up of the sows.

The gestation and lactation periods are such that sows can produce two litters of pigs a year if desired. In the one-litter system, the pigs are usually born in the spring by gilts which are then fattened for market as soon as the pigs are weaned.

A recent study at Purdue,[3] designed to compare the one- and two-litter systems of raising hogs, describes the most common pattern of the one-litter system as follows:

> Gilts were bred in January and February to farrow in May or June. The pigs were weaned in July and August and the sows were sold in September and October. Shoats were fattened over a long period for sale in December, January and February. Gilts were saved out of the feed lot for the following years summer pig crop.

Both spring and fall pigs are raised under the two-litter system. Gilts are needed in the two-litter system only as replacements for the sows which are culled each season. Under the most common practices these gilts produce their first litter at one year of age and the second at two. They are then bred to farrow twice a year

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[2] Ray Anderson, "He Sells Hogs the Year Round," Farm Journal, July, 1954, p. 33.

[3] Lowell S. Hardin, R. N. Wiegle, and H. S. Wann, Hogs--One and Two-Litter Systems Compared, Purdue University Experiment Station Bulletin 565, November, 1951.

as long as they continue to be satisfactory producers. Some rigidity of the breeding system can be eliminated by maintaining two gilt-breeding herds. That is, one of spring gilts to produce spring pigs and a herd of fall gilts to produce fall pigs. Under this system, all gilts farrow when a year old, and are fattened for market after weaning their first litter. One advantage of this system is that farrowing dates, both spring and fall, can be chosen to meet the needs of the individual farm, since neither herd is dependent on the other as to time of breeding and farrowing. Another advantage is that the breeding herd is a growing (weight-producing) group of animals which can usually be marketed advantageously. In reality, it is a one-litter system designed to spread the labor, equipment cost, and risk more uniformly over the year than can be done by maintaining a large drove of hogs at one time during the year. This system has all the disadvantages of a gilt or one-litter system as far as the selection of breeding stock is concerned.

The proportion of hog farms throughout the country which raise only one litter of pigs a year is not known. Carroll and Krider[4] say on this subject, "It is thought to be of the order of at least one-third of all farms which raise hogs. Certainly it differs from region to region."

A review of the accounts of Michigan State College Farm Records Cooperators for 1950, 1951, and 1952 shows that 75 percent of the farmers who raised hogs raised two litters per year. This percentage was slightly higher in the southern part of the state. A number of county agents in Michigan led the author to believe that

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[4] Carroll, op. cit., p. 132.

the larger pork producers in the state are using the one-litter system along with crossbreeding and pastures. On the other hand, the higher fixed cost of their breeding herds and the need for better selection cause purebred producers to use the two-litter system.

Comparison of the two farrowing systems. The cost of producing 100 pounds of pork on the one-litter farms averaged only 3 percent under the average cost of producing 100 pounds of pork on the two-litter farms, according to a Purdue study.[5] The important cost items and the proportion of the total cost indicated by this study can be grouped as shown in Table II-1.

Careful management is probably more important than the farrowing system used in increasing income. Some of the advantages for each system, as given by Hardin *et al.*, are listed below.[6]

Advantages of the one-litter system:

1. Had 3 percent lower cost of production
2. Fewer management headaches--easier to keep on schedule
3. Less total capital tied up in hogs, buildings and equipment
4. Corn storage requirements are fewer
5. Weather usually more favorable at farrowing time
6. Less labor and hard work required
7. Bulk of corn fed in season of low corn price
8. Pigs big enough to hog down corn, glean corn fields and follow winter fed cattle

Advantages of the two-litter system:

1. Hogs sold 5 percent higher
2. Can produce more pork on given acreage, more intensive
3. Equipment and buildings used more fully
4. Equipment use cost may be less per 100 pounds of pork produced

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[5] Hardin *et al.*, *op. cit.*, p. 8.

[6] *Ibid.*, pp. 16-17.

Table II-1. Items of cost in swine production, percent of total cost, one- and two-litter systems, Indiana, 1947-48.

| Cost Item | Percent of Total Cost | |
|---|---|---|
| | One-Litter System | Two-Litter System |
| | percent | percent |
| Shelled corn or its equivalent . . . . . . | 59.0 | 59.8 |
| Protein supplement . . . . . . . . . . . . . . | 10.8 | 10.0 |
| Labor and power . . . . . . . . . . . . . . . | 7.9 | 9.3 |
| Buildings and equipment . . . . . . . . . . | 3.7 | 2.4 |
| Overhead . . . . . . . . . . . . . . . . . . . . . | 9.1 | 9.1 |
| Other costs . . . . . . . . . . . . . . . . . . . | 9.5 | 9.4 |
| Total costs . . . . . . . . . . . . . . . . . . . | 100.0 | 100.0 |

5. Conducive to better selection of breeding stock
6. Labor load more evenly distributed
7. Income and market risk spread over two major marketing seasons instead of one
8. Larger proportions of pork marketed as market hogs rather than sows (92 vs. 77%)

Increasing the size of business is one of the main problems on many farms. Nearly two times the amount of pork is produced per sow with two litters per year as with one litter (2,760 pounds versus 1,450 pounds in the Purdue study).[7] This fact makes it

[7] <u>Loc. cit.</u>

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[8] J. L. Lush

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[9] Based on

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possible for the two-litter system to produce greater net income than the one-litter system on smaller farms where the facilities are limited.

Where breeding-herd development is important, the two-litter system fits well. With the one-litter system, the sows have gone to market before pig performance is known, and registration is not very practical as the life of a gilt or sow in the herd is too short. Therefore, the one-litter system is mainly a market-hog system, and purebred raisers should stay with the two-litter system. Lush and Molln[8] concluded:

> Selections will gain materially if based on averages of all litters a sow has produced. For example, the same intensity of selection will make about 31 percent larger increase in productivity if based on two litters each than if based on only one. Selections based on three litters each would make 50 percent more progress per selection than if based on one litter only.

The ultimate advantage of one system over another is apparently not so much in the cost figures, but depends, rather, on the choices which it affords in adjusting the enterprise to the specific conditions of labor, capital, and management ability which exist on individual farms.

This section would not be complete without some mention of the labor distribution for each system. Figures II-1, II-2, and II-3 are presented to show the monthly labor distribution for producing hogs in Michigan.[9]

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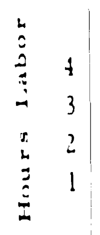
[8] J. L. Lush and A. E. Molln, Litter Size and Weight as Permanent Characteristics of Sows, Tech. Bul. 836, USDA, 1942.

[9] Based on unpublished data from the Department of Agricultural Economics, Michigan State College.

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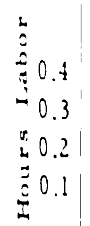


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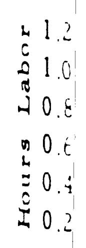


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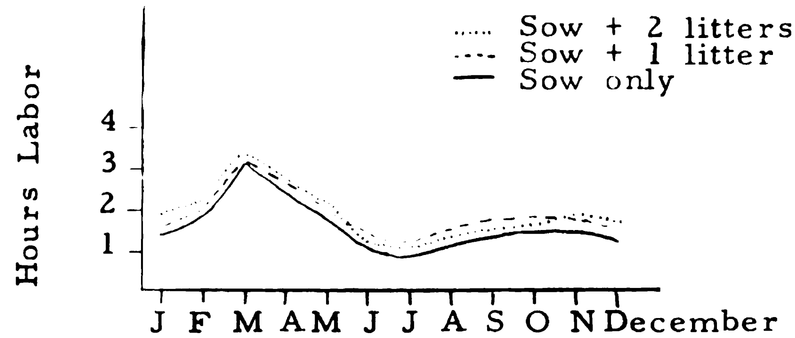


Figure II-1
Monthly Labor Distribution for Sow, Sow and One Litter, and Sow and Two Litters

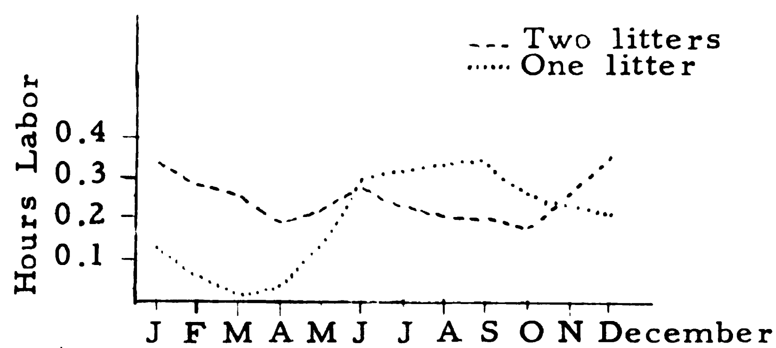


Figure II-2
Monthly Labor Distribution for One Litter Compared with Two Litters (does not include labor spent on sow)

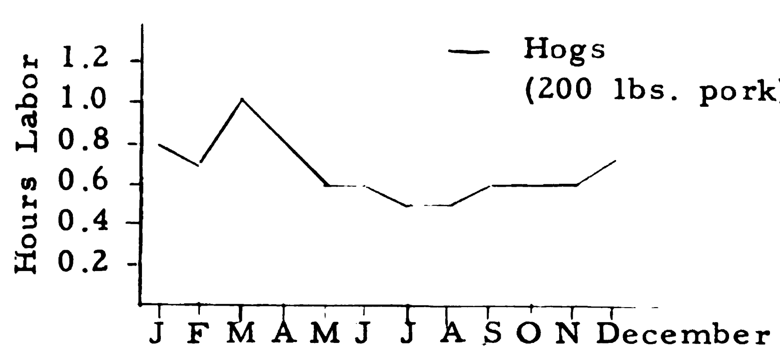


Figure II-3
Monthly Labor Distribution for Producing 200 Pounds of Pork (includes labor spent on sow herd)

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Sources of purchased feeders. Feeder pigs can be purchased and fed out successfully if they are from good breeding stock and in good healthy condition. A rule of thumb says that farmers raising from 75 to 100 pigs a year who cannot average 7 pigs per litter can do better buying feeder pigs. Cattle feeders without farrowing facilities can also benefit by purchase of feeder pigs. However, it is very likely that an average hog raiser will be able to raise his own pigs cheaper than he can buy them. Iowa State College figures a weanling pig from an average litter costs $10 to $12.[10]

Doane[11] indicates that feed charges against a pig at weaning vary according to size of litter as such charges cover the feed for sows during gestation and suckling time which vary only slightly with size of litter.

Additional costs such as vaccination and castration have to be calculated and added in figuring the cost of a weaned pig, as these services have been performed for most purchased pigs.[12] Once a decision is reached to purchase feeder pigs, possible sources of feeders must be considered. Feeders can be purchased either directly from the producer or they may be purchased from a local auction or market or through an intermediate or terminal market. The most important point in the selection of feeders is to obtain healthy, vigorous feeders, free from contagious diseases. Pigs which

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[10] Doane Agricultural Digest, Doane Agricultural Service Inc., St. Louis, Missouri, January, 1952, p. 223.

[11] Loc. cit.

[12] A more complete review of this type of information is given in Wm. W. Smith, Pork Production, The MacMillan Company, New York, 1937, pp. 434-45.

Table II-2. Cost per weaned pig as affected by size of litter.[1]

| Item | Number of Pigs per Litter | | | | |
|---|---|---|---|---|---|
| | 11 | 9 | 7 | 5 | 3 |
| | pounds | pounds | pounds | pounds | pounds |
| Feed charged against each pig: | | | | | |
| Corn . . . . . . . . | 101 | 125 | 160 | 224 | 373 |
| Oats . . . . . . . . | 36 | 44 | 57 | 65 | 100 |
| Supplement . . . . | 16 | 18 | 21 | 28 | 43 |
| Pig meal . . . . . | 40 | 40 | 40 | 40 | 40 |
| | dollars | dollars | dollars | dollars | dollars |
| Cost per pig for feed[2] . . . . . . . . . . | 6.16 | 7.08 | 8.45 | 10.61 | 16.00 |
| Cost per pig for feed and overhead[3] . . . . . . . . . | 7.70 | 8.85 | 10.56 | 13.26 | 20.00 |

[1] Figures based on Doane report.

[2] Prices used are: corn, 2.68¢/lb.; oats, 2.5¢/lb.; supplement, 3.5¢/lb.; pig meal, 5.00¢/lb.

[3] Feed cost figured as 80 percent of total cost.

are purchased from stock yards even when vaccinated against cholera are greater health risks than pigs which have never been shipped. A knowledge of the conditions of sanitation and feeding methods on the farm where the pigs were produced is necessary to enable a person to judge accurately their probable health and feeding qualities. It is also important when buying feeder pigs to look for pigs uniform in age, weight, condition, previous feeding, color, and type. Similarity of color and type usually means similar breeding and resulting uniformity in feed usage and maturity. To describe a good feeder pig one would say it is strong-backed, wide in its spring of rib, and has plenty of capacity of middle. A full heart girth and low flanks are an indication of gaining ability and should not be overlooked.

Exact information on the source and movement of feeder pigs in Michigan is very sketchy. Discussion with the members of the Department of Animal Husbandry at Michigan State College indicate that the majority of feeder pigs available in Michigan are produced by regular hog farmers who farrow more pigs than they can feed out and sell this surplus as feeders. Individual cases were cited where an operator farrows from 180 to 200 sows during a year and another who has 300 sows now and has plans for a thousand at some later date, but these are rare cases as yet. These pig hatcheries usually provide reliable feeder pigs. A few well-written magazine articles on the mass production methods of a pig hatchery have popularized this term. However, in most areas there are still many difficulties to overcome. No adequate information is available on the number or size of these operations in Michigan. It seems safe to assume that a few farmers in Michigan will be able to buy 8- to 10-week-old, 35- to 50-pound pigs from successfully operated hatcheries. Hatchery pigs are weaned, thrifty, and usually "deloused, dewormed, vaccinated, and castrated." As yet the hatchery operators prefer to sell to regular customers. Some will sell to customers 100 miles away, but prefer to limit sales to a shorter distance.

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A study conducted by Johnson[13] in 1942, with Michigan farmers, shows that "eighteen percent of all hogs and pigs reported sold from the sample farms were feeder hogs." He says that lack of available feed supplies and irregularity of feed production caused large percentages of the hogs marketed from farms in the northern area to be sold as feeder hogs. These data show the range to be from 16 percent for Area 1 (southern half of Lower Peninsula) to 37 percent for Area 3 (Upper Peninsula).[14] A more recent report from public auctions in the state shows twenty-three auctions reporting sales of feeder pigs.[15]

Parry found that 96 percent of the feeder pigs sold through auctions sampled came from farmers, and 4 percent came from dealers. He also found that 97 percent of the feeder pigs were purchased by farmers at these auctions.[16]

Methods of feeding. Methods of feeding can be treated in three general areas; i.e., (1) self-feeder with pasture or on dry lot, (2) hand feeding, and (3) hogging down of crops. The practice of limited feeding can be combined with either self-feeding or with

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[13] Glenn L. Johnson, "Relative Importance of Alternative Market Outlets Used by Michigan Farmers in Selling Livestock," unpublished M.A. thesis, Michigan State College, 1942, p. 55.

[14] Ibid., p. 56.

[15] Unpublished data, Department of Agricultural Economics, Michigan State College.

[16] Stanton P. Parry, "An Analysis of Michigan's Livestock Auction Industry," unpublished M.S. thesis, Michigan State College, 1953, p. 85.

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1. [illegible]

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hand feeding and will be discussed under a separate heading. Feed requirements and input-output relationships are discussed in Chapter IV.

1. Self-feeding: A good practice to follow prior to weaning, regardless of feeding methods thereafter, is to begin by creep-feeding pigs at two weeks of age and continue until weaning time.

In self-feeding swine, the feed is placed in a self-feeder and the pigs are allowed free access to the feed at all times. The grain supplement and mineral mixture can be offered free choice in separate compartments of the self-feeder unit or a complete mixed balanced ration may be self-fed. In the case of the complete mixed, balanced ration, the grain, protein supplement, minerals, and vitamins are mixed together. This provides for more complete control over protein consumed by pigs and is important when wide price differences exist between proteins and carbohydrates. Sometimes only the grain and protein are mixed together, and the salt and mineral are fed free-choice.

> In an experimental comparison, self-fed pigs gained 12 percent faster (0.17 pounds per head daily) than those that were full hand fed and required 11 pounds less feed per 100 pounds of gain.[17]

Self-feeding of growing pigs on pasture also is economical. Morrison[18] averaged nine trials in which pigs were self-fed corn and tankage free-choice on pasture, while others were hand fed these feeds. The self-fed pigs gained 1.32 pounds daily, compared with

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[17] Carroll and Krider, op. cit., p. 413.

[18] F. B. Morrison, Feeds and Feeding, 21st Edition, Morrison Publishing Company, Ithaca, New York, 1948, p. 973.

1.20 pounds for hand-fed pigs, and consumed 4 pounds more tankage and 1 pound less corn per 100 pounds of gain.

The main advantage of self-feeding is the saving in labor and the more rapid gains achieved. These advantages are secured at the cost of a small increase in the amount of feed. The saving in labor usually offsets this extra feed cost. (See Chapter IV, where this is treated in more detail.)

2. Hand feeding: Hand feeding of swine appears to be of little importance in commercial hog-raising operations of today. Hand feeding can be defined as the feeding of definite amounts of feed, either dry or in slop form, at one or several times during the day. The amount fed is usually the amount which the hogs will clean up at that time. As wage rates have increased, the use of hand feeding has nearly given way to the use of self-feeders and automatic waterers, since they require less labor and produce more-rapid gains. An exception exists where a slower rate of growth is desired.

A common practice, when hand feeding, was to feed grain mixtures in the form of a slop or swill. Experiments have shown that slop feeding is not generally superior to dry feeding.[19] If a finely ground mixture is fed outdoors in a windy location, it may be practical to use a slop feed, but then only to keep the feed from being blown away. The feeding of a warm slop in very cold weather may help the hogs consume a sufficient amount of water. Morrison[20] indicates that wheat and grain sorghums should be ground when hand

[19] Ibid., p. 974.

[20] Loc. cit.

fed but grinding of these gains is not practical when they are self-fed.

3. Hogging down crops: "Hogging down" is the practice of turning pigs into a crop field when the crop is mature and leaving them to harvest the crop. The practice of hogging down corn is not as general now as it was prior to the introduction of the mechanical corn picker. However, 6.3 percent of the 1951 Michigan corn crop was harvested in this manner. This compares with 6.4 percent of the total United States corn crop being harvested through this method.[21] Morrison[22] states:

> Numerous experiments have proved that this is an economical method of fattening pigs if one does not wish to market them early, before the price drops in the fall and thus before the new corn crop is ready. When corn is properly hogged down, pigs generally make fully as rapid gains as those fed corn and a good supplement in a dry lot. Also, they require no more feed per 100 pounds gain. In addition, hogging down corn saves labor, conserves fertility, and provides the pigs with a fresh field which is free from parasites.

It is advisable, experiments have shown, to grow some protein-rich supplemental crop with the corn to be "hogged down" or to provide the pigs with good pasture to help balance the ration. In addition, the pigs should be fed 0.2 to 0.3 pound per head daily of tankage or an equivalent amount of some other efficient protein supplement[23] (unless proteins are unusually high in price). If no supplemental crop is grown in the corn, slightly larger amounts of protein will

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[21] Crops and Markets, USDA, B.A.E., Washington, D. C., Vol. 30, 1953 Ed., p. 7.

[22] Morrison, op. cit., p. 482.

[23] Loc. cit.

be needed. Carroll and Krider[24] list four advantages of hogging down corn:

1. If corn is down or badly lodged, hogging-down has certain advantages over hand or machine methods of harvesting.
2. The labor needed in harvesting, cribbing and feeding saved per bushel of corn is equal to more than 1.5 pounds of live hogs.
3. In the field the pigs are on clean ground and sanitary conditions are superior to those in most dry lots.
4. The manure is left in the field where the crops that follow may derive full benefit from its fertility constituents. Much of the manure from many drylots never reaches the fields. Even though the hogs are kept under conditions in drylot so that all the manure can be saved, it must be hauled to the fields.

They also list the following disadvantages:[25]

1. The hogs will usually be ready for market at a time when prices are low.
2. It sometimes encourages feeding limited rations to pigs on pasture during the summer when pigs could have been more profitably fed to reach an earlier market.
3. Some corn is always lost by tramping it into the ground. The loss is particularly high in wet seasons.
4. Extra fencing of a temporary nature is usually required which represents some cash and labor outlay. Either temporary shelters or moveable houses in addition to watering facilities are needed in the corn fields.
5. During a wet season, the tramping of the hogs puddles the soil, especially heavy clay soil, and injures its tilth for subsequent crops.
6. Hogs damage the stover so it is of little or no value for other livestock.
7. In areas where wheat follows corn in the rotation, hogging-down corn interferes with plans for preparing the seedbed for the wheat.

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[24] Carroll and Krider, op. cit., p. 417.

[25] Loc. cit.

Hogging down of small grains is discussed in some detail by Smith.[26] Morrison says of this practice, "In humid districts, it is most economical to harvest the crop and feed the threshed grain."[27]

Where the fields are fenced for hogs one may profitably let them glean the field after harvest to pick up what grain is left. Carroll and Krider state, "So much grain is wasted in hogging-down ripe small grains that the procedure cannot be recommended."[28] They cite experiments at Iowa, Missouri, United States Department of Agriculture, and Purdue Experiment Stations to support this.

4. Limited feeding: The subject of limited feeding has been mentioned briefly in an earlier section. This practice has value when one wishes to put hogs on a later market, delay their growth until a new corn crop is ready (either for feed or for hogging down) or if one wishes to produce a carcass containing a larger proportion of lean than would be produced on full feed. The last reason will become more important as marketing by grade increases in popularity and use.

Limited feeding can easily be achieved by reducing the amount fed if hand feeding is being done. However, it is possible to use self-feeding economies and still limit feed intake by increasing the bulk in the ration being self-fed.

At times, limited feeding of late spring and summer farrowed pigs may be advisable. By limited feeding of such pigs, marketing can be delayed until sometime in January or February when prices

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[26] Smith, op. cit., p. 284.

[27] Morrison, op. cit., p. 428.

[28] Carroll and Krider, op. cit., p. 419.

have begun to rise after the usual November-December slump. High-priced feeds, unfavorable price relationships, a lack of capital for purchasing feed, and other items of this sort make limited feeding and thus delayed marketing more practical. Morrison[29] treats the subject of limited feeding versus full feeding hogs on pasture quite thoroughly, and concludes that full feeding is generally more profitable if pigs are farrowed early enough in the spring to be marketed before the usual fall price slump.

Table II-3 summarizes the results of twenty-eight experiments conducted to compare full feeding of pigs on good pasture throughout the season with feeding only a limited amount of grain during the pasture season and finishing them on full feed in the fall. Each experiment consisted of two lots of pigs averaging 56 pounds. One lot was full fed on pasture, the second was on limited feeding. The results are shown in Table II-3.[30]

The table shows that it took the pigs fed a limited ration at first 141 days to reach market weight, while only 110 days were needed for the pigs full fed from the start. In some experiments, pigs fed a limited ration on first-class pasture and then full fed have required considerably less concentrates per 100 pounds gain than those which were full fed continuously. However, in these many experiments there was, on the average, only an insignificant saving in the amount of concentrate required per 100 pounds gain, even though the limited-fed pigs undoubtedly ate considerably more pasture. He concludes that it will commonly be most profitable to

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[29] Morrison, op. cit., p. 968.

[30] Ibid., p. 969.

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Table II-3. Results of limiting concentrates during the summer for pigs on good pasture.

| Average Ration | Daily Gain | Time to Reach Market Weight | Concentrates for 100 Pounds Gain | |
|---|---|---|---|---|
| | | | Corn | Supple- ment |
| | pounds | days | pounds | pounds |
| Lot I, full fed entire time (4.9 lbs. corn, 0.43 lb. supplement) . . . | 1.44 | 110 | 339 | 30 |
| Lot II, limited ration in summer (3.0 lbs. corn, 0.33 lb. supplement) . . . | 1.12 | 141 | 338 | 27 |

full feed early spring pigs on pasture so that they can be sent to market before the price declines severely.

Morrison says:

> It is sometimes advocated that, to save grain, pigs in dry lot should be fed a decidedly limited ration until they reach a weight of 100 to 150 pounds and then be full fed until they are ready for market. However, in several experiments this method has been uneconomical, in comparison with continuous full feeding.[31]

He refers to Ohio and Nevada tests which indicate that plenty of well-cured legume hay should be supplied pigs fed a limited amount of grain in dry lot to allow them their fill of some feed. Self-feeding a mixture containing considerable proportions of ground

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[31] Ibid., p. 971.

alfalfa or other legume hay is another method of practicing limited feeding in dry lot. Carrol and Krider draw similar conclusions from a review of experimental work on limited feeding; i.e.:

> The results have shown that it is usually most profitable to full-feed the pigs and hurry them to market as rapidly as possible. The additional labor required to feed limited rations, the slower gains, and the increased overhead expenses will not offset the small savings of feed resulting from limiting the ration.[32]

If limited feeding is practiced, the ration should not be restricted more than about one-fourth for best results. At this level, limited-fed pigs have required less feed per 100 pounds of grain than full-fed pigs. Limiting to one-half or two-thirds of full feed causes slow and costly gains, as so much of the ration is required for body maintenance. The use of roughages in limited feeding is discussed in more detail in Chapter IV.

If limited feeding is to be used, the following points listed by Carroll and Krider are well to keep in mind:[33]

1. The pigs should weigh at least 60 pounds before limited feeding is begun, even on good pasture. Limiting the rations for small pigs results in runtier pigs, less uniformity and increased mortality.
2. Provide an abundance of good pasture. Limited-fed pigs will utilize from 50 to 100 percent more pasture than full fed pigs. This will vary according to the extent to which the grain is limited.
3. Feed enough grain to keep the pigs thrifty and to promote a gain of at least 1/2 pound per head daily. This will require from one-third to one-half of a full-feed of grain on the average.
4. Self-feed a simple mineral mixture free-choice at all times.

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[32] Carroll and Krider, *op. cit.*, p. 415.

[33] *Loc. cit.*

5. Scatter the grain so that every pig has an opportunity to get its share. If the pigs are hand-fed in troughs, provide enough space for all pigs to eat at the same time.
6. If the gains are limited considerably, it will not usually be profitable to feed a protein supplement to pigs on alfalfa or other legume pasture.

## Swine Production as a Joint or Complementary Enterprise

The farm is a multiproduct business unit as a rule. Exceptions to this generalization exist where conditions are such that a farmer may use all of his resources most profitably in the production of a single commodity. In these cases, the selection of the enterprise is more or less automatic and as long as there is no change in technology or in the availability of resources, no enterprise combination problems exist.

If conditions in a given area are such that only one enterprise can be carried on, the task becomes one of determining how much of the available resources should be used in this enterprise to yield the maximum profit. If adequate input-output information is available, it is relatively simple to determine how much to invest in the production of this commodity for maximum profit through the marginal approach.[34]

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[34] One would produce until the additional cost in producing one more unit of the commodity just equaled the additional return from this unit. See L. A. Bradford and G. L. Johnson, Farm Management Analysis, John Wiley and Sons, Inc., New York, 1953, pp. 130-32. Also, G. W. Forster, Farm Organization and Management, 3rd edition, Prentice-Hall, Inc., New York, 1953.

Farm operators find that because of new technologies, mechanization, and the availability of markets, there are now many more possible combinations of land-use systems, livestock enterprises, labor, machinery, equipment, and markets to choose from today than formerly existed. To illustrate this point, one need only recall the situation which existed in agriculture not so long ago. That is more farms were general farms of a subsistance nature. Because of transportation and other problems, it was not possible to specialize as much as can now be done. Now, however, with improved transportation, new technology and machinery, it is possible and often more profitable to specialize in the production of one or a few products.

Because of this, if more than one enterprise is to be carried on, the farmer faces the double task of first selecting enterprises and then of combining them into a profitable system of farming.

Forster says:[35]

> A farmer should have no uncertainty with respect to the following points if he is to obtain the most efficient use of resources.
>
> 1. Control of the factors of production. (This means that the farmer has complete control over all of the factors of production that he may need or that he can obtain at known prices.)
> 2. Prices that will be received for commodities produced.
> 3. Knowledge of production response when factors of production are substituted one for another.
> 4. Prevailing growing conditions.
>
> The conditions are highly unrealistic. They are postulated simply to show how allocation of the resources would be made if there were no uncertainty about any element in the problem.

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[35] G. W. Forster, Farm Organization and Management, 3rd edition, Prentice-Hall, Inc., New York, 1953, p. 62.

An enumeration of the causes for varying production patterns from farm to farm does not satisfactorily explain why farmers select and combine the particular enterprises which they do to form a system of farming. There appears to be no simple answer to how and in what way various causes converge to form a production pattern for an individual farm.

Each farmer, to the best of his knowledge and ability, will select and combine available enterprises in a way to maximize his returns. (It should be noted here also that the maximization of returns is not necessarily the maximization of monetary returns.) Most selections will be based on knowledge of the past performance and anticipation of the future which are based on past performance and reliable knowledge which he has obtained through the many sources available to him. The main problem, however, usually is not the amount of (money) resources to be used in each of the selected enterprises to obtain maximum return, but rather which enterprises and what combination of these enterprises will produce the greatest return from the limited resources a farmer can command.

In the production of swine, the question soon becomes one of producing only pork or pork with beef, milk, or any one of several other products which might work well with pork. Combinations need not be restricted to livestock enterprises, for it is technically possible to raise swine and purchase all of the feed used. Thus, a farmer might consider which cash or feed crop will work best with the swine enterprise. He must ask does any relationship exist between certain other enterprises and pork production which would make each more profitable if combined in one farm operation? Examples of this may be the collection and disposal of garbage and the feeding of hogs where the hogs produce a profit from garbage which would otherwise present an expensive disposal problem. Another example is the feeding of beef cattle followed by hogs in the feed lot. The cost of grinding grain can be eliminated and hogs make their gains on the grains which would be lost when beef are fed whole or coarsely ground corn. Carroll and Krider[36] comment:

> Hogs are considered essential to the success of a cattle-fattening enterprise especially when heavy corn feeding is practiced. Without hogs to salvage the waste corn, many cattle feeding operations would be unprofitable.

Dairy cattle and swine are also considered to work well together where butterfat is sold and skim milk remains on the farm. "In the production of 100 pound feeders, 10 head of 8,000 pound cows will provide skim milk for 13 sows and their litters."[37]

This is then a problem of the combination in which to produce two or more products with a given amount of money. If only two products are involved, the optimum combination can be shown graphically. This is done in the following section. Algebraically this condition exists when

$$\frac{P_{y_1} \cdot MPP_{(x_1 \ldots x_n)y_1}}{P_{(x_1 \ldots x_n)}} = \frac{P_{y_2} \cdot MPP_{(x_1 \ldots x_n)y_2}}{P_{(x_1 \ldots x_n)}}$$

In words, this equation states that the ratio between the value of the marginal physical product of the variable inputs devoted to the production of one product must bear the same relationship to the price of those inputs as exists for all other products which are produced with similar inputs. This will hold if the inputs are being

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36 Carroll and Krider, op. cit., p. 56.

37 Loc. cit.

used in optimum or scale-line combinations. For a more complete discussion of this subject, see Bradford and Johnson, "Farm Management Analysis."

The maximum profit, or the minimum loss, for any given amount of resources exists where the transformation curve is tangent to the iso-revenue curve. Therefore, the production of $y_1$ and $y_2$ should be combined in the quantities indicated by this point of tangency. The reason for this transformation curve being concave to the origin can be explained by the complementarity between the two enterprises.

The complementarity can be caused by any one of the following situations or by a combination of them. They are (1) the law of diminishing returns, (2) the need to employ fixed factors more fully, and (3) the production of by-products in one enterprise which can be best utilized in the other enterprise.

An example may help to explain more fully. For this example assume a group of factors of production, $x_a$ through $x_r$, which are available to a given operator. Assume also that these factors are divided into three groups, one group completely variable, one group fixed for the farm but not for the enterprise, and one group fixed for both the farm and the enterprise. Call them groups 1, 2, and 3, respectively.

Let group one include $x_a \ldots x_d$, group two include $x_e \ldots x_h$, and group three include $x_i \ldots x_n$ for enterprise A and $x_o \ldots x_r$ for enterprise B.

Then the factors in group one would be used in each enterprise to the point at which the marginal value product of the last factor just equaled the price of the factor. The factors in group two would be used in each enterprise to the point at which the

marginal value product of the last factor used was just equal to the price of that factor. However, in this case, since they are fixed for the farm but not for the enterprise, the price of the last factor used is determined by the alternative or on-farm-opportunity-costs in the other enterprise. Therefore, to determine the cost of these factors for one enterprise it is necessary to know the marginal value product of them in the other enterprise.

Since this is true, the optimum distribution of the group-two factors between enterprises on the farm exists when:

$$\frac{MPP_{x_e \ldots x_h (Y_1)} \cdot P_{y_1}}{MPP_{x_e \ldots x_h (y_2)} \cdot P_{y_2}} = \frac{MPP_{x_e \ldots x_h (y_2)} \cdot P_{y_2}}{MPP_{x_e \ldots x_h (y_1)} \cdot P_{y_1}} = 1$$

or

$$\frac{MVP_{x_e (y_1)}}{MVP_{x_e (y_2)}} = \frac{MVP_{x_f (y_1)}}{MVP_{x_f (y_2)}} = \frac{MVP_{x_g (y_1)}}{MVP_{x_g (y_2)}} = \frac{MVP_{x_h (y_1)}}{MVP_{x_h (y_2)}} = 1$$

The group-three factors, since they are fixed for both the farm and the enterprise, yield no return unless the enterprise for which they are fixed is carried out on the farm. Thus a combination of enterprises enables the farm operator to obtain a return from those factors which are not used if the enterprise for which they are specific is not combined to form the over-all farm operation.

In this group one would most likely find such items as buildings, and special equipment which have a salvage value of less than zero. Even in this case it is conceivable that if capital were so severely limited that the transformation curve were convex similar to that shown in Figure II-5 it would be more economical to leave them unemployed than to employ these factors and decrease total profit by doing so. Again the normal situation would more likely be such that the concave transformation curve will exist.

By-products could be the motivating force behind the combination of enterprises on some farms. This is the case when a greater return can be obtained from on-the-farm use of these by-products in another enterprise than can be received in any other manner. Examples mentioned earlier include feeder cattle and hogs where the hogs make use of the undigested corn in the cattle manure and also appear to gain some benefits from the manure. Another is the case of hogs and dairy enterprise when skim milk is a by-product.

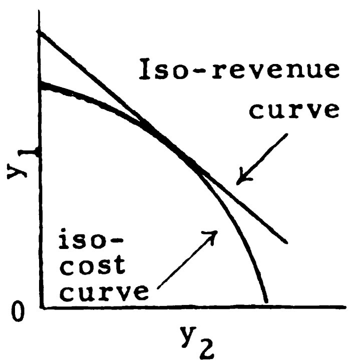
The optimum combination of enterprises cannot be shown graphically when three or more enterprises are being combined. However, the same reasoning follows for any two enterprises in the group. Therefore, it is obvious that optimum combination of enterprises exists when:

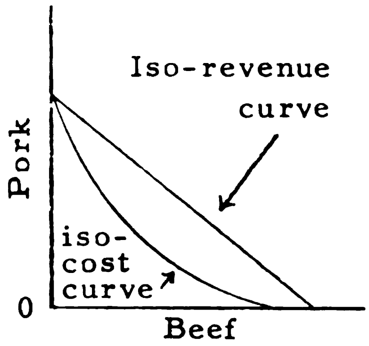
$$\frac{P_{y_1} \cdot MPP_{x_a \ldots x_n (y_1)}}{P_{x_a \ldots x_n}} = \frac{P_{y_2} \cdot MPP_{x_a \ldots x_n (y_2)}}{P_{x_a \ldots x_n}} = \ldots = \frac{P_{y_n} \cdot MPP_{x_a \ldots x_n (y_n)}}{P_{x_a \ldots x_n}}$$

The maximum profit is possible when this is set equal to 1.

The graphic analysis involved in the optimum combination of two products is shown at the top of the following page.

The diagram, Figure II-4, shows, by the iso-cost curve, various combinations of product $y_1$ and $y_2$ which can be produced from a given investment in resources. The iso-revenue curve shows the combinations of these two products which are necessary to yield a given revenue.



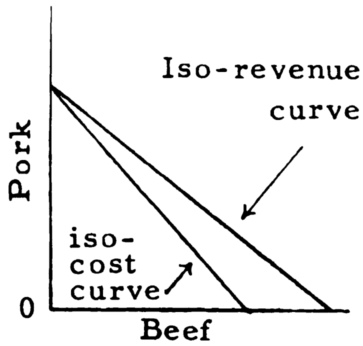




Figure II-4 Figure II-5 Figure II-6

Iso-Cost, Iso-Revenue Curve Relationships

If the iso-cost curve or transformation curve is a convex curve, a farmer can maximize profit by producing all of one product or the other, and therefore he will have no problem of enterprise combination. To illustrate, assume that Figure II-5 represents the transformation curve between pork and beef production with the available resources. Also, assume that the iso-revenue line shown represents the price relationship between pork and beef. It is then obvious that it would be more profitable to produce pork only, than to produce both pork and beef in any combination. This would also hold true if the transformation curve were a straight line, as shown in Figure II-6, with the exception of the special case where the transformation curve is parallel to the iso-revenue curve. In this case, a producer would theoretically be indifferent as to just what combination of pork and beef he produced because he would receive the same income from any combination of the two enterprises.

The normal situation, however, where more than one enterprise is carried out on any one farm, is to have sufficient capital so that the transformation curves or iso-cost curves are concave to the origin as shown in Figure II-4. When this is true some combination of products $y_1$ and $y_2$ will yield a greater profit than can be obtained when the same amount of resources are used in the production of either one alone.

Some other factors to consider. A degree of vertical integration appears to be very advantageous in the production of pork. Observation shows that pork production is usually concentrated in the areas where large quantities of feed grain are produced. This fact can be explained simply by the existence of transportation costs. That is, the cost of transporting feed grains is greater if they are transported as bulky grains than when transported in a concentrated form such as pork. This in turn gives the pork producer who produces his own feed an advantage pricewise over the pork producer who must purchase feed grains, for he does not have the transportation cost to pay.[38] He gains this advantage and whether he wishes to charge it as profit on the pork enterprise or on the crop enterprise is optional with the individual.

One other advantage exists in the ability to make efficient use of grains which are nonsalable because of moisture, et cetera. Some experimental work indicates that corn infected with Diplodia Zea is nearly as satisfactory for hog feeding as sound corn.

The conditions which exist or are expected to exist at some later date dictate the place of swine production on any given farm.

The place of hog production on any farm may depend on:

1. The physical character of the farm.
2. The grain and concentrates required to be bought or raised.
3. The advantage of combining hog production with other livestock.
4. Labor requirements throughout the year.

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[38] The pricing problem in this situation is discussed in more detail in Chapter V, on break-even points.

5. The size of enterprise.
6. The extent to which crops may be hogged off.
7. How the enterprise fits into the scheme of soil maintenance.
8. Time of year when hogs can be marketed.
9. Managers own ability to raise hogs.[39]

Hog production may be a means of adjusting scale of farm production to market conditions.

Degree of risk involved. Risk is defined by the dictionary as "the possibility of loss or injury." Though a thorough treatment of the risk problem is not possible at this time, it is of sufficient importance to be mentioned. The interaction which exists between the value which a person places on added knowledge and the value of possible losses because one lacks this additional knowledge is extremely important in any discussion of risk.[40] Johnson, in discussing problems of risk,[41] says:

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[39] Included here are such things as the value placed on additional knowledge, the ability to make full use of capital, both owned and borrowed, proper judgment of present conditions as they will affect future demands, willingness and ability to assume risk, and many intangible items which at present appear to be eluding any method of evaluation.

[40] For a more complete discussion of this subject, see L. A. Bradford and G. L. Johnson, Farm Management Analysis, John Wiley and Sons, Inc., New York, 1953, Chapter 23. Also, G. L. Johnson and C. B. Haver, Decision-Making Principles in Farm Management, Kentucky Ag. Expt. St. Bul. 593; and Frank H. Knight, Risk, Uncertainty and Profit, Houghton Mifflin Company, New York, 1921.

[41] G. L. Johnson, "Handling Problems of Risk and Uncertainty in Farm Management Analysis," Journal of Farm Economics, Vol. 34, No. 5, December, 1952, p. 813.

> The final formulation of dynamic theory will place heavy emphasis on psychological and sociological principles and data, particularly those dealing with increasing marginal utility of gains and increasing marginal disutility of losses which are so useful in understanding the insuring and risk taking activities of managers.

Generally speaking one can say that businessmen prefer ventures involving little risk to those involving great risk when income expectations are the same for each venture. Risk aversion, even where a higher return may be expected with a slight increase in risk, is especially prevalent among people who possess little capital, have a high ratio of liabilities to assets, have major family responsibilities, or have experienced important setbacks in the past.

It is obvious that most farmers are willing to bear a relatively large amount of risk and uncertainty or that they feel there is less risk for them in farming than in other occupations. If this were not true more of them would accept lower-paid jobs outside of agriculture where less risk and uncertainty regarding monetary income exist.

All livestock enterprises involve some technical and price uncertainty. Some, however, involve more than others. Therefore, livestock enterprises should be selected partly on the basis of their relative income expectations and variances. This method of handling variances appears to be one of the reasons why farmers do not specialize in production, especially if it means large investment in specific equipment and buildings not easily converted to other uses. Conversely stated, it is one of the reasons why farmers are interested in tools and equipment that may be used for a variety of purposes or those which do not demand a large investment.

Capital requirements. When funds are limited, farmers as a rule will favor annual crops over other crops which may be adapted to the regions but will require a larger investment. For the same reason hogs will be preferred to milk cows or beef. Hogs require about eighteen months before returns are realized; this may be compared with two to three years for cattle. In a study conducted in Iowa,[42] farmers were asked to rank dairying, beef cattle feeding, beef cattle raising, and hog production with respect to the degree of uncertainty which they attached to these enterprises.

> The hog enterprise was considered more uncertain than beef cattle [raising] or dairying. About two-thirds of the group thought hogs involved more uncertainty than beef cattle raising, and about 79 percent stated that hogs entailed more uncertainty than dairying.

Recent developments in the field of swine production have undoubtedly enabled the better swine producer to reduce his risk and uncertainty greatly by acquisition of new techniques and efficient management. So they believe the degree of risk involved in pork production for them is less than it would be with other livestock enterprises.

Nodlund and Pond show[43] that some farmers are much more efficient than others in hog production as indicated by wide differences in return over feed costs among farms in the same locality. In general, the difference which exists between farms in any one

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[42] Donald R. Kaldor and Earl O. Heady, An Explanatory Study of Expectations, Uncertainty and Farm Plans in Southern Iowa, Agri. Exp. Sta. Research Bul. 408, Ames, Iowa, April, 1954, p. 879.

[43] T. R. Nodlund and G. A. Pond, Managing Hogs for Greater Returns, Agricultural Experiment Station, Univ. of Minn., Bulletin 379, June, 1944.

year is greater than the difference which exists from year to year on the same farm.

## CHAPTER III

## TECHNOLOGICAL ADVANCES IN PORK PRODUCTION

Technological advance in pork production has been rapid and has accounted for much of the increased efficiency of the enterprise. The remaining portion is traceable to advances in other fields such as management practices, credit availability, and general knowledge. The main point of interest in this chapter is the effect which the adoption of new technologies has on the individual pork producer.

Convincing evidence is presented by many economists to show that the efficiencies of new technologies are passed on to the consumer in the long run. However, the effect which is exerted upon individual operator depends almost entirely upon the time at which he accepts this new technology and incorporates it into his production operation.[1]

To explain more fully, the operators who adopt these technologies early reduce cost per unit of production before a change is brought about in the selling price. This change brings about a shift of the supply curve to the right with larger quantities supplied at the same price or the same quantity supplied at a lower price. If one assumes that the demand remains constant, a lower price will be necessary to remove this additional supply from the market.

Once a sufficient number of producers adopt the new technologies, the remaining producers are forced to accept the new

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[1] Walter W. Wilcox and Willard W. Cochrane, Economics of American Agriculture, Prentice-Hall, Inc., New York, 1951, pp. 477-85.

technology or accept a smaller spread between cost of production and market price. If the cost-reducing effect of the new technology is great enough they are forced to accept the technological change or discontinue production of the commodity. Therefore, it is those farmers who adopt new techniques early who stand to gain the greatest financial return from them.

The purpose of this chapter is to examine briefly some of the technological changes which have been introduced in the swine industry and show some of the effects they have had on the economics of pork production. Some of the more important technological advances have been in feeding (antibiotics and more completely balanced rations); selection of animals toward desired market type (a change from lard to bacon type under present situation); the use of heat bulbs, farrowing crates, and other farrowing aids (this enables one to save a larger percentage of pigs born and reduce cost per pig produced); and improvements in disease and parasite control.[2]

An experiment at the Minnesota station[3] shows in part how technological advance in feeding methods has affected the rate of gain and the feed consumption of hogs over the past forty years. In this study hogs were fed on three different rations. These were typical rations for 1910, 1930, and 1953. Table III-1 shows the results obtained.

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[2] One should not overlook technological advances in the field of marketing, handling, and packaging; however, for the purpose of this study those factors are considered to be technological advances outside the field of pork production.

[3] Mimeo Report of Thirty-Second Annual Swine Feeders Day, University of Minnesota, Institute of Agriculture, St. Paul, Minnesota, 1954.

Table III-1. A comparison of pigs fed on 1910, 1930, and 1953 rations, as to daily gain and feed consumption, Minnesota Agricultural Experiment Station, 1953.

| Feeding Period | Ration Fed | Avg. Daily Gains | Feed per 100 Pounds Gain | | |
|---|---|---|---|---|---|
| | | | Corn | Tankage & Minerals | Supplement |
| | | lbs. | bu. | lbs. | lbs. |
| From weaning (51 lbs.) | 1910 | 0.64 | 9.1 | 16[a] | |
| to 125 lbs. average | 1930 | 0.96 | 5.7 | 44 | |
| weight | 1953 | 1.70 | 4.3 | | 59 |
| From 125 to 135 lbs. on | 1910 | 0.34 | 15.1 | 26[a] | |
| 1910 ration and to 200 | 1930 | 1.63 | 6.8 | 27 | |
| lbs. on 1930 and 1953 ration | 1953 | 1.92 | 6.1 | | 45 |
| From weaning (51 lbs.) | 1910 | 0.45[b] | 12.1[b] | 21[a] | |
| to 200 lbs. average | 1930 | 1.20 | 6.3 | 35 | |
| weight | 1953 | 1.81 | 5.2 | | 52 |

Record of Pigs Fed 1910 Ration Up to October 20, and Then Fed the 1953 Ration to 200 Pounds

| Item | 1910 Ration 9/19 - 10/20 | 1953 Ration 10/20 - 11/24 |
|---|---|---|
| | pounds | pounds |
| Average daily gain . . . . . . . . . | 0.34 | 1.96 |
| Average daily feed . . . . . . . . . | 3.00 | 6.60 |
| Feed per 100 pounds gain . . . . | 870.00 | 335.00 |

[a] Minerals only.

[b] Estimate based on record to October 21.

Some difference in results may have been obtained had 1910 pigs been fed on the 1910 ration, for one might assume they were better able to make gains on this ration; however, the converse may also be true (i.e., 1910 pigs might make less gain on the 1910 ration than the 1953 pigs). Much of the gain shown can undoubtedly be attributed to the use of better supplements and the antibiotics which have recently come into use.

## Antibiotics

Antibiotics are organic compounds which possess germ-killing properties, usually used in the field of medicine for combating disease. Antibiotics are not required and are not nutrients in the same sense as proteins, vitamins, et cetera, although experience seems to indicate that they have a special place in swine feeding. Workers discovered by accident that growth-promoting effects were achieved when these antibiotics were fed to livestock. Investigation showed gains above that which could be expected from the $B_{12}$ alone and that this growth stimulation was due to the antibiotics remaining in the residue. Specialists from the United States Department of Agriculture state:

> Although considerable information on which to base practical recommendations is available, research into the basic facts on the feeding of antibiotics to livestock and the manner in which they exert their effect has just begun. Every day new facts are being discovered which may modify our present knowledge and make present practices obsolete.[4]

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[4] Anon., Better Feeding of Livestock, U. S. Department of Agriculture, Farmers Bulletin No. 2052, Washington, D. C., August, 1952, p. 9.

The present cost and availability of antibiotics appears to be quite unstable; for example:

> In 1943, soon after it appeared commercially, penicillin was selling for $20.00 per dose of 100,000 units, wholesale. By 1951 a dose was selling for five cents and last year at one cent. . . . The break-even point for large manufacturers is about one cent.
>
> Penicillin-making capacity now stands at around 500 trillion units a year, compared with 300 trillion units in 1951 and only 100 trillion in 1948.[5]

This has been accomplished by improved techniques and competition within the industry. There appears to be no reason why similar progress should not follow for the other antibiotics. The competition in this field is strong and is in large part the reason for the rapidly decreasing prices illustrated above.

At present, growth of swine has been stimulated by penicillin, aureomycin, bacitracin, and streptomycin under certain test conditions. Some antibiotics are impractical for economic reasons because of the high level at which they must be fed to achieve optimum results. It seems important to note that the growth-stimulating effect is related to age. The greatest effect is shown in new-born animals. Effects are less pronounced with increases in age.

The great response of runts and unthrifty pigs to antibiotic feeding shows that the value of antibiotics may be influence by the amount of viral and bacterial infection present. Some work has shown that response from antibiotic feeding is very small where good sanitation practices are in use.[6]

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[5] Sydney B. Self, "Tetracycline Tussle," The Wall Street Journal, Vol. XXXV, No. 36, Chicago, Illinois, December 3, 1954.

[6] Unpublished material, Agric. Exp. Sta., University of Minnesota, St. Paul, Minn.

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Some of the early work in antibiotic feeding was done at Michigan State College under the direction of R. W. Lueck and F. Thorp.[7] Various trials used aureomycin, penicillin, neomycin, and terramycin. A 10- to 20-percent increase in growth rate and a 5- to 10-percent increase in feed efficiency resulted from the use of antibiotics.

Because of difficulty in mixing the proper amounts of antibiotics in a ration they are usually purchased by farmers in a commercially prepared supplement containing the desired amounts of antibiotics.

It is conceivable that if antibiotics could be purchased at a sufficiently low price hog producers may be able economically to feed out runt pigs. However, in the light of present knowledge it still appears that in the long run it would be cheaper to use sanitation measures to prevent runts.

Hoefer recognizes that the cost of antibiotics will affect the amount which can economically be used, for he writes:[8]

> Recommended antibiotic feeding levels will vary with existing conditions and of course will also be influenced by price particularly for heavier market hogs.

The problem of handling calculations which will give a producer information on how much he can afford to pay for antibiotics is an important one. It depends on detailed research to provide a basis for figuring the marginal physical product of added units of

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[7] Unpublished mimeo reports, Animal Husbandry Department, Michigan State College.

[8] J. A. Hoefer, Ration Suggestions from Weaning to Market Weight, mimeographed publication, Animal Husbandry Department, Michigan State College, East Lansing, Michigan

antibiotics when fed to pigs of various weights and under differing conditions of sanitation and disease control.

With the knowledge presently available one can set up the following equation to calculate the price which can be paid for antibiotics to be used in hog feed:

$$(X_1X_2)(X_3 + X_4X_5) + (X_6....X_n + S_a) = (X_1X_3) + (X_6....X_n)$$

where:

$X_1$ is the amount of feed without antibiotics required to produce 100 pounds of pork,

$X_2$ is one minus the percent improvement in efficient use of feed due to antibiotics,

$X_3$ is price per 100 pounds of feed without antibiotics,

$X_4$ is the quantity of antibiotics needed per 100 pounds of feed,

$X_5$ is the price per unit of antibiotics,

$X_6....X_n$ are costs other than feed costs (i.e., labor, buildings, gain or loss because of marketing time, interest on investment, risk, etc.) per 100 pounds of pork produced,

$S_a$ is change in $X_6....X_n$ due to use of antibiotics.

In words, the equation states: The new feed conversion rate is multiplied by the new feed price. The other costs which accompany the feeding of an antibiotic feed are added to this. The resulting figure is set equal to the alternative feed conversion rate multiplied by the price of feed without antibiotics after the other costs which exist when feeding a feed without antibiotics have been added to it. This indicates the maximum price which can be paid for antibiotics and still break even.

However, for practical use a producer may say that if the cost of feed with antibiotics plus the other costs associated with this feed is equal to or less than the cost of feed without antibiotics plus

the other costs associated with this feed, he can increase his profit by using antibiotics.

To illustrate the use of this equation, assume the following: a feed conversion ratio ($X_1$) of 350 per 100 pounds of pork; an improvement in feed efficiency due to antibiotics of 5 percent ($X_2$ = 1 - 0.05); the price of feed ($X_3$) at \$3.00 per 100 pounds; the quantity of antibiotics recommended ($X_4$) 1 gram per 100 pounds of feed; the price of antibiotics ($X_5$) unknown for this illustration; the other costs ($X_6 \ldots X_n$) \$2.65; and the change in costs due to the use of antibiotics ($S_a$) -\$0.50. Then:

$$(350)(1 - 0.05)(3.00 + 1X_5) + (265 - 50) = (350)(3.00) + 265$$

$$332.5X_5 = 1315 - 1212.5$$

$$X_5 = \$0.3082$$

Therefore, the top price which can be profitably paid for antibiotics is \$0.3082 per gram before a hog producer could not afford to use it in his feed (the present price is about \$0.10 per gram).

In other words, if a producer can purchase antibiotics for less than \$0.3082 per gram it will be profitable for him to do so under the assumptions used in this illustration which uses a 5 percent increase in efficiency of feed conversion.

Since the range of increased efficiency is reported to be from 5 to 10 percent, it may be useful to see what price one can pay for antibiotics in the case of a 10 percent increase in efficiency and still break even or make a profit. By the same process one gets a figure of \$0 .4920; therefore, one can pay up to \$0.4920 per gram for antibiotics and still increase profits by doing so in the case of 10 percent increase in feed efficiency and no change occurring in other costs.

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How much of a specific antibiotic can one afford to feed under a given price structure for antibiotics, feed, and pork produced? More is needed than the averages used up to this point. In order to answer the question of how much, information is needed on the marginal physical product of antibiotics as various ages and weights under different growing conditions. The average figures used thus far are not sufficient.

A near-ideal situation would exist if marginal product information were available for all of the components of "other costs" ($X_6 \ldots X_n$). Since they are not now available, one must attempt to measure them as accurately as possible or to obtain the best estimate possible. The information on conversion rates ($X_1$) seems to be the most complete. In applying these ideas, it is necessary to use the best research available including estimates or educated guesses in many instances. The producer must be aware of the factors affecting production costs and returns and be able to make his decisions on the basis of a reasonable analysis of available information.

In presenting this information to pork producers it may be advisable to prepare a chart showing comparative figures on how much they can afford to pay for prepared pig supplements containing antibioitics as compared with the price of the supplements without antibiotics. Few farmers have easy access to the unmixed antibiotics or would care to mix their own if they did have access to these antibiotics.

## Selection of Animals Toward Bacon Type

A few years ago hog breeders were selecting for a short, compact, thrifty lard-type hog which was in demand at that time. However, with the present demand for a carcass which contains a smaller percentage of fat or lard, the emphasis has switched toward the bacon-type animal. Prior to 1925, the principal United States hog breeds were classified as lard type or bacon type. The modern trend now refers to them as meat type and bacon type. The market trend is toward a hog with less lard. Ensminger comments on this:[9]

> In recognition of this change in consumer demand and in the consequent shift in type, most swine authorities now consider the term "meat type" as far more applicable than lard type. In holding to the meat type, the show ring has been stoutly augmented by swine type conferences.

Bacon-type hogs are more common where less fattening feeds are fed. Dairy by-products, peas, barley, wheat, oats, rye, and root crops are less fattening when compared to corn; and instead of fat being produced they build muscle in sufficient quantity for high-quality bacon. Ensminger states:

> It is not to be inferred that there is no hereditary difference . . . when bacon type hogs are taken into the Corn Belt and fed largely on corn, they never entirely lose their bacon qualities. Likewise, lard type hogs still retain their identity when taken into a bacon-producing area where they are fed dairy by-products and small grains.[10]

The breeders of meat-type hogs have emphasized the cut-out values of hogs and a minimum amount of lard. Therefore, the

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[9] M. E. Ensminger, Animal Science, The Interstate Printers and Publishers, Danville, Illinois, 1952, p. 754.

[10] Loc. cit.

difference between the more desirable meat types and the bacon types is quite small.

Some of the bacon types have become more popular through acceptance as a pure breed or through their use in crossbreeding. Ensminger comments further:

> Perhaps there is little difference in efficiency of production between the best specimens of the meat and the bacon type breeds. From a profit standpoint, therefore, any differences which may accrue are chiefly the result of price differentials that may exist on the market.

He also indicates little effort on the part of central livestock markets to pay a premium for bacon quality. A few of the small packers have adopted a practice of paying a premium for quality. However, as yet the effect has not been widespread either in Michigan or in the United States as a whole.

Research work has been done at several experiment stations on the marketing of slaughter hogs by carcass weight and grade,[11] and a person may reasonable assume that there is a trend in this direction. Several recent farm magazine articles[12] have strengthened

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[11] For more-detailed information on this, the reader is referred to: Gerald Engelman, Austin A. Dowell, E. F. Ferrin, and P. A. Anderson, Marketing Slaughter Hogs by Carcass Weight and Grade, University of Minnesota Agricultural Experiment Station, Technical Bulletin 187, April, 1950; and to North Central Regional Publication, Objective Carcass Grade Standards for Hogs, University of Minnesota, Bulletin 414, June, 1952.

[12] Among these are articles by John Strom and James Ball, including the following: "We Must Modernize Hog Marketing Now," Country Gentleman, May, 1953; "Meat Hogs in Every Breed," Country Gentleman, July, 1953; "Make More Money With Meat Type Hogs," Country Gentleman, September, 1953; and "Lean Hogs Fatten Their Pocketbooks," Country Gentleman, August, 1954. Another is F. J. Keilholz, "Meat-Type Hogs Save Time, Save Feed," Country Gentleman, August, 1953. These are just a few of the many articles which call farmers' attention to the importance of type in the hogs being produced for market.

this trend. The Hormel Packing Company, Austin, Minnesota, has for several years paid above-average prices for quality hogs. This company also offers farmers a chance to sell their hogs on a carcass grade and yield basis, within the six grades listed:[13]

| | |
|---|---|
| Premium. | High proportion of lean cuts, superior quality. |
| Standard. | Desirable type with cut-out of reasonably high proportion of lean cuts which grade number 1. Carcass not wasty. |
| Over-fat. | Lower than desirable ratio of lean-cuts to fat. Cuts will be number 1 grade only after trimmed of excess fat. |
| Very-fat. | Excessive lard, too little meat, too much interior fat. |
| Under-finished. | Cuts will not grade number 1. |
| Cull. | Just that, scalawags. |

As this practice becomes more general among the buyers and packers it will be reflected in a slight price premium for the better quality animals and a penalty for the lower quality at the market place. As a result, farmers will either adjust their production to the quality desired or feel that the cost of producing this quality exceeds the premium paid for it and continue to produce the lower quality animals. It is conceivable, because of the difference in subjective values placed on certain phases of the production process, that some producers will follow each course. The author expects, however, that a payment for quality will cause a majority of the producers to produce the desired quality if they can do so with little difference in "out-of-pocket" costs.

Another major effect of a purchasing program of this sort will be to increase producers' awareness of the factors which make

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[13] John Strom and James Ball, "We Must Modernize Hog Marketing Now," Country Gentleman, May, 1953.

good quality and make them strive for the most economical means of obtaining better quality.

## Heat Bulbs and Other Farrowing Aids

The introduction of heat bulbs and other farrowing aids has made earlier farrowing of sows possible with a lower building equipment and labor cost. Foster,[14] in an Indiana bulletin, shows that it is possible to get the same results, in terms of pigs saved, with less labor when heat lamps are used. The work at this station also shows that an average of 1.5 more pigs were saved per litter farrowed through the use of lamps.

The value of heat lamps is greater where a wide range in outdoor temperature exists. The work just cited also shows that the death losses in the houses without supplemental heat were progressively greater as the outdoor temperature at farrowing time decreased, and that outdoor temperatures had little if any effect on death losses when electric heat lamps were used.

A partial explanation of the effectiveness of heat lamps is contained in a study at Michigan State College on temperature adaptation in the baby pig. Among other things, the report states:

> The body temperature regulating mechanism in the new born pig is not fully developed. There was a body temperature drop of 3° to 13° F. in baby pigs during the first 30 minutes after birth, the amount of drop being related to the size of the pig and the environmental temperature. The initial drop was followed by a gradual return toward normal, which in environments

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[14] G. H. Foster and C. M. Vestal, The Use of Electric Heat in the Farrowing Pens of Young Pigs, Indiana Agr. Exp. Sta. Bulletin 494, March, 1944.

> environments of 60° - 75° F. was reached in about two days, and in environments approaching freezing temperatures was reached in about ten days.[15]

The resourceful operator will succeed in saving a large proportion of the pigs farrowed alive even if no artificial heat is available in cold farrowing quarters. However, the added labor and other expenses would be higher than the expense of electric heat bulbs normally are. For purpose of illustration one may assume the cost for the installation of heat lamps shown in Table III-2.

This assumes that the building has been wired or if it has to be done the cost should be charged as part of building costs and charged off in building depreciation at 5 or 10 percent per year.

Proper management of farrowing combined with a large enough herd to make use of them permits each unit to be used for about three litters per year at a cost of about 57.3 cents per litter.

If a producer is farrowing at an early date, this means he can save on the average of 1.5 more pigs per litter for a cost of 57.3 cents, while figures given in Chapter II, Table II-2, show a cost of $10.00 per pig weaned. However, the actual comparison should be made with the change in cost per pig weaned because of the increased number of pigs saved per litter. This saving would amount to $10.40 in a litter of eight pigs (about $1.30 per pig). This figure would be higher for smaller litters.

Another aspect of this development is that the hog producer living in a colder climate, who is now farrowing later, will be able

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[15] H. W. Newland, W. N. McMillen, and E. P. Reineke, with technical assistance by F. Thorp, Jr., and Sylva Laine, "Temperature Adaptation in Baby Pig," Journal of Animal Science, Vol. 11, No. 1, February, 1952, pp. 118-133.

Table III-2. Costs involved in installing heat lamps (estimated).

| Item | Initial Cost | Estimated Life | Cost per Hour | Cost per Litter[1] | Cost per Year[1] |
|---|---|---|---|---|---|
| | dollars | | dollars | dollars | dollars |
| Male plug . . . . . | 0.15 | 5 yr. | - | 0.010 | 0.03 |
| Wire . . . . . . . . . | 0.40 | 5 yr. | - | 0.026 | 0.08 |
| Bulb receptacle . | 0.25 | 5 yr. | - | 0.017 | 0.05 |
| Reflector . . . . . . | 0.60 | 5 yr. | - | 0.040 | 0.12 |
| Heat bulb (250 w) | 1.50 | 1,000 hr. | 0.0015 | 0.360(t) | 1.08 |
| Electricity (at 2¢/kw) . . . . . . . . | 0.00 | - | 0.005 | 0.120(t) | 0.36 |

[1] Assumes equipment can be used on three litters per year.

(t) Heat lamp to be used for ten days per litter, or 240 hours (may vary with outside temperature).

to move to an earlier farrowing date and, consequently, an earlier market to take advantage of the higher market prices. This entails very little increase in costs and in some cases even a decrease in costs by more efficient use of labor.

The long-range effect of this sort of a procedure is that the peak market prices will move to a somewhat earlier date. This movement is shown by the 1954 price peak which came well ahead of the average date for the last five years.

## Disease and Parasite Control

A major problem which is present in any pork production operation is the control of parasites and disease. The broad scope of this problem is indicated by the fact that 154 pages are devoted to diseases and parasites of swine in the 1942 Yearbook of Agriculture.[16] Thus, only a cursory treatment can be given in this thesis.

Improved disease and parasite control methods reduce the physical risk involved in the production of pork and, therefore, average costs. For example, the control of hog cholera by vaccination exchanges the risk of losing a large part of the herd from this disease for a relatively small cost of vaccination.

Much of the present application of disease and parasite control, where prevention and control measures are known, consists of relatively small expenditures in sanitation practices and in obtaining knowledge about diseases and disease control measures. In cases where the anticipated cost of these control measures and the cost of knowledge involved exceeds the anticipated value of the possible loss incurred by not using these control and sanitation practices, they will not be used. This situation will continue until there is a change in anticipated values on the part of the producer. This may come about by an actual loss which exceeds his anticipations, or he, in some manner, finds that control measures and knowledge costs are less than he anticipated them to be. The same sort of reaction can conceivably work in reverse. This is, a producer may be using certain practices which he believes yield him a greater return than

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[16] United States Department of Agriculture, Yearbook of Agriculture, Washington, D. C., 1942, pp. 673-827.

they cost. Yet, in reality the costs are in excess of the returns. He will continue to use them, however, until there is a change in his knowledge. The highly subjective nature of costs and returns, as used here, may partly explain why one producer uses all of the new methods to improve practices while another uses very few or none.

In some cases it may be more economical to hire the services of a veterinarian than to acquire the knowledge oneself. Such a case may be the invasion of a large herd by some disease unknown to the producer, in which case it would be more economical to hire veterinary services than to acquire the required additional knowledge and resources.

Large losses (this includes both losses and costs of research to find cause and cure) are incurred by producers from diseases with no known cure. One way to minimize such losses (or costs, if one prefers this term), is through use of the best-known sanitation practices which are justifiable under his production set-up to prevent them. If control measures are available and more economical than prevention it is logical that control measures will be used.

Twenty-three different swine diseases are reported by the Veterinary Reporting Service at Michigan State College. The diseases which infected one hundred or more herds are:[17] Erysipelas, 342 herds (1646 cases); Atrophic Rhinitis, 123 herds (743 cases); Influenza, 122 herds (1166 cases); and Hog Cholera, 106 herds (1314 cases). These figures are for an eleven-month period and include

[17] Reported between January 1, 1954, and December 1, 1954, by Veterinary Reporting Service, Michigan State College.

those cases reported through any one of the cooperating agencies.[18]

The losses from some of the more "minor" diseases and parasites such as a mange, lice, and the common round worm are not so noticeable because they seldom cause death. However, it is likely that these losses through runty unthrifty pigs and additional feed and labor required to get these pigs to market are far in excess of most estimates. It is nearly impossible to obtain comprehensive figures for this sort of information.

## Returns to Knowledge

The total return to a given amount of knowledge about a given production process becomes greater, over a wide range at least, as larger quantities of other inputs are used with it. Thus, from the standpoint of return to knowledge alone, one would expand production indefinitely on the base of the knowledge he possesses. However, the law of diminishing returns soon reduces marginal returns to the other factors to the point at which further expansion in their use is unprofitable. If one does not possess perfect knowledge, he can afford to acquire more of it if the cost of acquisition[19] is less than

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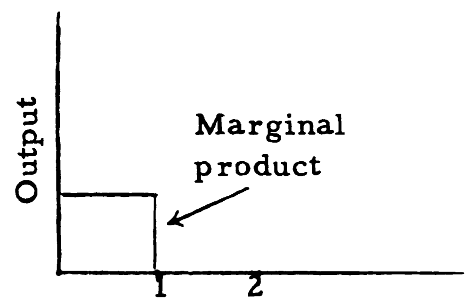
[18] Cooperating agencies are: Michigan Department of Agriculture, Bureau of Animal Industry; Michigan State Veterinary Medical Assn.; United States Public Health Service; Michigan Department of Health; M. S. C. School of Veterinary Medicine; Agricultural Research Service, USDA, local office.

[19] In this case, the cost of acquisition includes all costs--even alternative opportunity costs. See Glenn L. Johnson, Managerial Concepts for Agriculturists, Kentucky Agricultural Experiment Station

the return to the added knowledge in the size of enterprise being carried on.

Placing a value on knowledge involves the explanation of how knowledge is combined with other resources. The measurement of marginal returns to a given factor is accomplished by adding units of this factor to a fixed quantity of other factors, the resultant change in total output being called the marginal return due to the added unit of resource. When this is done for a given kind of knowledge, the result is similar to that shown in Figure III-1. This occurs because a second unit of the same information adds nothing to the total product. To illustrate, if a person knows some fact (call this a unit of $K_1$), a second knowledge of this same fact adds nothing to total product. However, when this unit of $K_1$ is held constant and $X_1$ varied, the marginal returns to $X_1$ will be as shown in Figure III-2.




$k_1 : x_1 = c | x_2 \ldots x_n$

Figure III-1
Marginal Product
of Knowledge

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Bulletin 619, University of Kentucky, Lexington, Kentucky, July, 1954, p. 11, in which will be found the following:

> If what can be learned has value, it may pay to arrange business affairs (even at a cost) so that they can be adjusted or readjusted to profit from what is learned. This characteristic of a business organization is referred to as flexibility. Whenever what can be learned may have value, flexibility has value. As flexibility is often costly in terms of delay and reduced productive efficiency, the value of flexibility must be matched against its cost in determining the optimum organization of a business. The value of flexibility, to an individual manager, depending as it obviously does on his ability to learn, is a personal, subjective, futuristic thing.

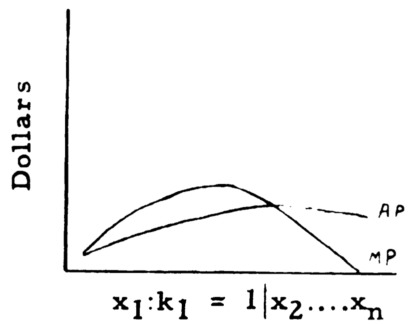


Figure III-2
Marginal Product
Curve for $x_1$, $k_1 = 1$,
$x_2....x_n$ fixed

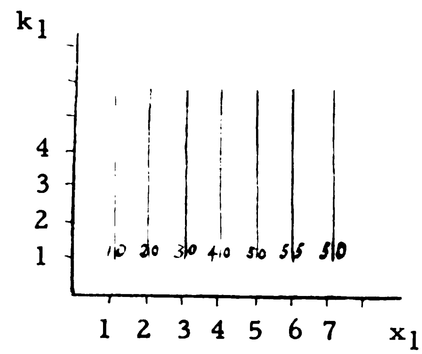


Figure III-3
Production Surface,
$k_1$ and $x_1$ Variable,
$x_2....x_n$ fixed

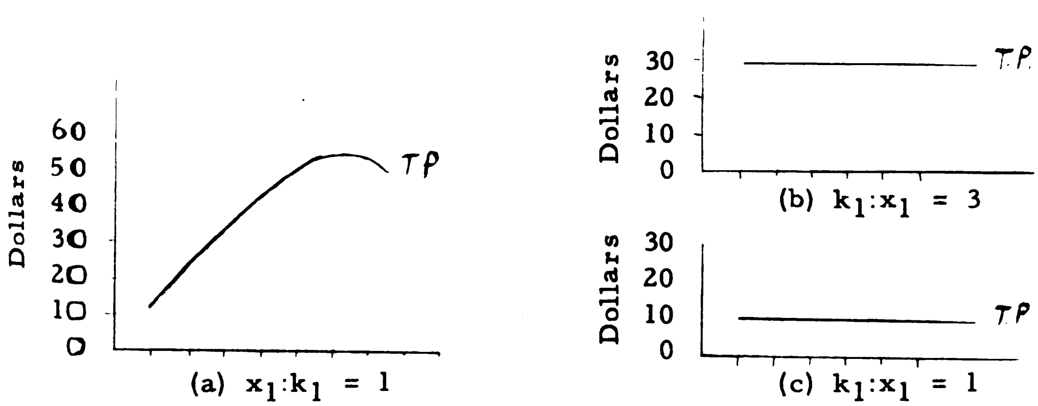


Figure III-4
Cross Sections of Production Surface Shown in Figure III-3

A three-dimensional function or production surface of this relationship is shown in Figure III-3. Cross sections where $K_1 = 1$ and where $X_1 = 1$ and 3 are shown in Figure III-4 (a, b, and c).

However, since knowledge is not commonly considered in identical units it is necessary to examine a situation in which various kinds of knowledge are combined. How should different kinds of knowledge be combined? One should know how one kind of knowledge can be substituted for another to produce income if different kinds of knowledge are to be combined in the optimum manner. Information is not available on rates of substitution of one type of knowledge for another. However, to illustrate the point, assume a rate of substitution similar to that shown by the iso-product curves in Figure III-5. $K_1$ and $K_2$ represent two types of knowledge which are substitutable over a given range to produce income when combined with other factors which are fixed. Some combination of these types of knowledge would constitute the optimum as indicated by the scale line.

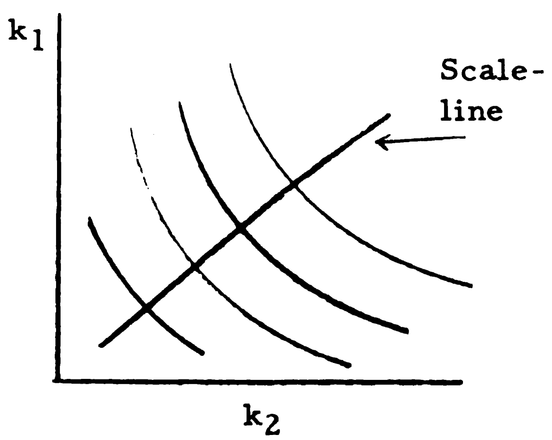


Figure III-5
Types of Knowledge
Combined

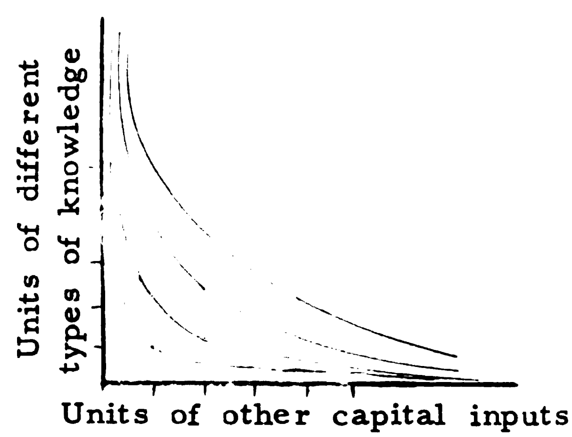


Figure III-6
Knowledge Combined
With Other Resources

On this basis, a person can assume that all knowledge can be combined in some optimum proportion.

Assuming such combinations, a production surface for knowledge and other inputs in a given production process can be developed in the manner shown in Figure III-6. The units of knowledge represented in the diagram consist of various types of knowledge combined in optimum proportions, as shown in Figure III-5. Other inputs are also combined in optimum proportions.

One can only envision the appearance of this production surface in theoretical terms. However, the previous development shows that the iso-product curves would never intersect the X or Y axis for knowledge has no value unless combined with some capital resource and likewise capital has no value unless it is combined with some knowledge.

Further developments along this line may aid greatly in management decisions, especially with regard to acquisition of knowledge and the type of knowledge to acquire.

CHAPTER IV

# INPUT-OUTPUT RELATIONSHIP OF THE SWINE ENTERPRISE AND THE COST OF PORK PRODUCTION IN THE FARM BUSINESS

An elusive yet important and intriguing aspect of pork production is the input-output relationships which exist within the enterprise. Some of these input-output relationships are discussed in this chapter. They include labor, roughage, grain and protein supplement, land, and building requirements. A summary of these requirements concludes the chapter.

## Labor Requirements

Labor is perhaps the most expensive single input in pork production. Therefore, the possibility of substituting capital investments for labor and the possibility of saving labor through good management practices are important in pork production.

The usual labor requirements are eight hours of labor for each 200 pounds of pork produced. This figure is an average labor requirement for pork production in Michigan.[1] The labor requirement reported by the United States Department of Agriculture in 1943 for Michigan was 3.5 to 4.9 man hours per 100 pounds of pork produced. This compares with 2.0 to 4.0, which is the average for

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[1] K. T. Wright, Man Labor Needed Monthly for Crops and Livestock in Michigan, F. M. 303, Mimeo sheet, Agr. Exp. Sta., Michigan State College, 1942.

the East North Central region and with 3.2 to 4.4 for the United States as a whole.[2]

It must be recognized, however, that these are average figures and that the amount of labor-saving equipment in use, the number of animals, the quantity of pork being produced, and the convenience and arrangement of the buildings and lots have an important bearing on the amount of labor needed on an individual farm.

The labor of feeding may be decreased one-half by the use of self-feeders, when compared with hand feeding.[3] One may expect even greater savings of labor today, since the work cited was done in 1924.

Small enterprises usually have higher labor costs than large ones. Table IV-1 shows the relationships between size of enterprise and cost of production.

The distribution of labor in the swine enterprise is fairly uniform from one month to the next. It usually reaches its peak in March when only one litter is raised. If two litters are produced, a second peak normally occurs in September.

Economy in the use of labor. Good management in the use of equipment and labor-saving arrangements on a farm can do much to

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[2] M. R. Cooper, W. C. Holley, H. W. Hawthorne, and R. S. Washburne, Labor Requirements for Crops and Livestock, F. M. 40, USDA, B.A.E., Washington, D. C., May, 1943.

[3] H. E. Dvorachek and H. A. Sandhouse, The Self Feeder as a Labor Saver, Arkansas Ag. Exp. Sta., Bul. 191, 1924.

Table IV-1. Size of enterprise and cost of production per 100 pounds of pork.[1]

| Avg. Pork Produced Annually | Farms | Records | Avg. Total Cost | Feed and Pasture | Man Labor | Horse Labor | Bldgs. and Equip. | Other Costs |
|---|---|---|---|---|---|---|---|---|
| pounds | no. | no. | $ | $ | $ | $ | $ | $ |
| 10,809 | 5 | 23 | 11.91 | 7.91 | 2.13 | 0.14 | 0.39 | 1.34 |
| 19,108 | 5 | 21 | 10.52 | 8.00 | 1.26 | 0.08 | 0.25 | 0.93 |
| 22,400 | 5 | 22 | 9.53 | 7.04 | 1.13 | 0.11 | 0.28 | 0.97 |
| 41,198 | 4 | 16 | 8.55 | 6.53 | 0.76 | 0.10 | 0.35 | 0.81 |

[1] Computed from Ohio Bul. 419, Ohio Agr. Exp. Sta., 1928.

reduce labor. In a Purdue University study,[4] work methods used by five different hog farmers in Indiana were studied for a year:

> The farmers produced 225 pound market hogs in an average of 1.7 hours of work per head, compared to the Indiana average of 5 to 7 hours. The farmers produced 100 market hogs (raising spring and fall litters) in a total of about 7 weeks (500 hours) less work than average.

To do this they worked out and used a definite system of hog management and housing. Cropping systems were arranged for adequate clean rotation pasture. Pigs, sows, and fattening hogs had a definite place each season of the year. Preparatory jobs--cleaning,

[4] J. W. Oberholtzer and L. S. Hardin, Simplifying the Work and Management of Hog Production, Agricultural Experiment Station Bulletin 506, Purdue University, Lafayette, Indiana, 1945, p. 8.

arranging houses, and storing feed--were completed at odd times before needed. An easy method of providing adequate water was worked out. Pressure water systems, field wells, or large-capacity water-hauling systems were used, depending upon the particular farm's arrangement and needs Feed was stored, prepared, and handled economically. Self-feeders, convenient field storage, self-feeding cribs, and feeding floors were used to minimize handling of grain. Adequate, economical equipment was provided. Plenty of farrowing houses, adequate fencing, supplemental farrowing heat (often home-made hovers), and a generous supply of small equipment aided in getting jobs done well with a minimum of time, cost, and hard work.

The labor requirement on these five farms averaged only 25 percent of the amount required under average conditions. The low farm used only 22 percent as much labor as the average requirement, while the high farm required 32 percent of average. A detailed breakdown of the labor required and the number of hogs raised is shown in Table IV-2.

Four additional tables from this study are included to illustrate how these savings were achieved. They show savings of time which were made in feeding sows, watering and inspecting hogs on pasture, and methods of feeding corn.[5]

If one assumes a walking speed of one mile per hour, the time consumed for walking alone varies by more than 17 minutes per day (5.69 to 22.74 minutes).

With today's higher labor costs the costs per 100 pounds of pork would vary even more than shown in Table IV-4 and Table IV-6.

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[5] Ibid., pp. 8, 12, 18, 19, 21.

Table IV-2. Labor required by the hog enterprise on five farms as compared with the average labor requirements for all Indiana farms.

| Farm No. | Average Number of | | | Hours Labor Actually Required | Hours Required Under Average Conditions[1] | Percent Actual is of Average |
|---|---|---|---|---|---|---|
| | Brood Sows | Boars | Market Hogs Raised | | | |
| 1 | 23 | 2 | 223 | 434 | 1635 | 26 |
| 2 | 15.5 | 1 | 212 | 346 | 1400 | 25 |
| 3 | 39 | 2 | 428 | 651 | 2980 | 22 |
| 4 | 37 | 2 | 500 | 803 | 3300 | 24 |
| 5 | 23 | 2 | 364 | 740 | 2340 | 32 |
| Total | 137.5 | 9 | 1727 | 2974 | 11655 | 25 |

[1] Hours which would have been required to produce the same number of market hogs in herds of average size under average conditions and efficiency. Based on Indiana Farm Management surveys over a period of years.

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Table IV-3. Labor required at each feeding to carry feed to thirty-eight sows in farrowing quarters 250 feet from permanent feed storage.

| Method | No. of Trips | Feet Walked | Max. Pounds Carried |
|---|---|---|---|
| Carry feed from barn in 100-pound bags . . . . . . . . . . . . . . . . . . . . . . . | 2 | 1000 | 100 |
| Carry feed from barn in two 30-pound buckets . . . . . . . . . . . . . . . . . . | 4 | 2000 | 60 |
| Haul feed from barn in hand cart[1] . . | 1 | 500 | 0 |
| Store feed in feed house in field . . . | 1 | 500 | 0 |

[1] Hand cart unsatisfactory in muddy weather.

Since no two farms are exactly alike, no master plan or schedule of work will fit every farm. Each farmer must work out for himself the easiest, least expensive way of getting his jobs done properly and on time. Studies such as those reported by work-simplification studies help, but are not an answer in themselves, for each individual farm must be judged separately on the fine points of this type of work.

Work-simplification studies have value and may with further development enable one to recommend more accurately the best combinations of enterprises for a given farm or for a given amount of labor. At present four approaches have been shown by experience

Table IV-4. Time and travel requirements and estimated costs of six methods of watering and inspecting one hundred hogs on summer pasture, 80 rods from the farmstead.

| Method of Watering[1] | Daily Requirements | | | Seasonal Requirements[2] | | | |
|---|---|---|---|---|---|---|---|
| | Man Min. | Miles Walk. | Miles Riding | Man Hrs. | Miles Walk. | Miles Riding | Labor and Equip. Cost |
| Permanent pipe lines .... | 6.0 | 0.30 | - | 14.0 | 40.3 | - | $32.40 |
| Field well, engine with automatic shut-off ...... | 6.5 | 0.30 | - | 15.1 | 40.3 | - | 22.53 |
| Field well, engine with no automatic shut-off ...... | 11.8 | 0.54 | - | 27.5 | 75.3 | - | 26.15 |
| Haul in tank wagon ....... | 15.6 | 0.02 | 0.31 | 36.3 | 2.6 | 42.9 | 45.37 |
| Haul in one 100-gallon fountain ...... | 40.5 | 0.06 | 1.6 | 94.4 | 8.0 | 225.8 | 89.96 |
| Haul in two 100-gallon fountains ..... | 28.0 | 0.06 | 0.82 | 65.3 | 8.0 | 115.1 | 68.59 |

[1] With the first four methods large field tanks equipped with float-type fountains or waterers are used. Tanks are set on wooden platforms. (Labor cost figured at 30¢ per hour.)

[2] 140 days.

Table IV-5. Time requirements for feeding ear corn using temporary field cribs and permanent cribs when summer pasture is 80 rods from permanent cribs.

| Method of Feeding Ear Corn | Times Corn is Lifted | Man Minutes per Ton of Corn | Man Hours per 100 Hogs per Season |
|---|---|---|---|
| Haul from permanent crib, hand shovel . . . . . . . . . . | 2 | 38.7 | 23.5 |
| Field crib, hand feed . . . . . . . . . . . | 1 | 20.0 | 12.1 |
| Field crib, self-feed . . . . . . . . . . . | 0 | 0.5 | 0.3 |

to be helpful in evaluating new work methods for farmers. These are:[6]

1. As a source of ideas on how to save time and energy doing the different kinds of farm work.
2. As a means of comparing alternative methods and deciding what method is best for their farm.
3. As standards for measuring the effectiveness of their own work methods.
4. As guides for instructing workers in how to do certain jobs by an improved and tested method.

In making use of work-simplification methods, one must remember:[7]

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[6] Lawrence M. Vaughan and Lowell S. Hardin, Farm Work Simplification, John Wiley and Sons, Inc., New York, 1949, p. 73.

[7] Overholtzer and Hardin, op. cit., p. 5.

Table IV-6.

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Table IV-6. Time requirements, labor, and equipment cost of different methods of preparing and feeding corn to fattening hogs for the summer feeding period.[1]

| Method of Feeding Corn[2] | Man Min. per Ton of Corn | Requirements per 100 Hogs: Man Hrs. of Labor | Requirements per 100 Hogs: Cost of Labor at 30¢ per Hour | Requirements per 100 Hogs: Total Labor Mach. Costs | Cost per 100 lbs. Pork Produced |
|---|---|---|---|---|---|
| Ear corn, self-fed from field crib ....... | 0.5 | 0.3 | $ 0.09 | $ 0.09 | $0.004 |
| Earn corn, hand fed from field crib ....... | 20.0 | 12.1 | 3.63 | 3.63 | 0.02 |
| Ear corn from permanent crib at barn ... | 38.7 | 23.5 | 7.05 | 11.05 | 0.05 |
| Shelled at farm, self-fed ............ | 71.5 | 43.4 | 13.02 | 32.29 | 0.15 |
| Shelled at elevator, self-fed ............ | 93.5 | 56.8 | 17.04 | 62.54 | 0.28 |
| Shelled and ground at farm, self-fed ....... | 97.5 | 59.2 | 17.76 | 45.23 | 0.20 |
| Shelled and ground at elevator, self-fed ..... | 101.5 | 61.6 | 18.48 | 136.78 | 0.61 |

[1] No allowance is made for possible differences in rates of gain or in quantities of feed which may be wasted.

[2] No charge for erection or use of cribs included.

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1. The . . . [rough[8]] test of efficiency is the pounds of hogs produced for each hour of labor and the value of hogs produced for each dollar of cost.
2. The cost of carrying a sow to farrowing time is the same whether a litter of 4 or 8 pigs is weaned. Four or five hours of labor is a small price to pay if it saves extra pigs at farrowing time.
3. Inefficient feeding or a poor sanitation program can be more costly than the most extravagant use of labor.
4. Thoughtful study can reveal easier ways to do any job correctly.

The author believes that more work along the lines of labor requirements, both minimum and maximum, would be of value in recommendations which are made to farm people by land-grant institutions. At present these recommendations are based on averages or upon more-complicated calculations which attempt to make more-specific recommendations possible, and as yet do not tell a farmer what is the optimum which can be expected under the present state of knowledge, but instead tell him how well someone else has done.

A problem exists in how to determine the value of additional knowledge. Many people say that ignorance on the part of the farmer is responsible for his apparent lack of interest in new and better methods.

The author believes it is possible that the farmer feels the cost of the additional knowledge necessary for use of new methods is more than the additional income he will receive from it. This may exist because the size of operation is too small to make adequate use of new methods. Or it may be due to any one of several other reasons which affect incentive. This is discussed further in Chapter V.

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[8] Inserted by author in place of the word "real."

## Land Requirements

Land requirements of the hog enterprise depend almost entirely upon the system of production followed. The minimum requirements for land exist where one raises hogs in dry lot or on concrete floors and purchases all the feed. At the other extreme is the case where one makes maximum use of pasture for forage and sanitation and raises all the feed used.

In this discussion, the land requirements for feed production, other than pasture, will not be considered. It is assumed that such land requirements are considered in studying the economics of the feed-producing enterprise. Land requirements for building space will be considered as building requirements and the land cost charged with building costs because of the inflexibility in use of such land.

The space requirements for hogs on pasture are about one-half acre for a sow and litter of eight pigs.[9] The Doane Agricultural Digest recommends two-fifths of an acre for a sow and six pigs. In each case the figures include carrying the sow till the pigs are weaned and then carrying the pigs to 225 pounds. On the average this is about fifteen pigs per acre of alfalfa. This may vary some according to the quality of pasture as shown in data from the Department of Agricultural Economics, Michigan State College, which appear in Table IV-7.

A relationship exists between land requirements and labor and capital somewhat as illustrated in Figure IV-1. There is a minimum amount of land which is required as space alone (point 1). This

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[9] W. N. McMillen and A. J. Paulus, Hog Profits for Farmers, Winsor Press, Chicago, 1952, p. 199.

Table IV-7. Acreage of hay and pasture required per sow and litter based on estimates of average yield per acre.

| Item | Average Yield per Acre (tons) | | | | | |
|---|---|---|---|---|---|---|
| | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| Acreage needed per sow and litter . . . . . . . . . . . | 0.79 | 0.59 | 0.47 | 0.39 | 0.34 | 0.30 |

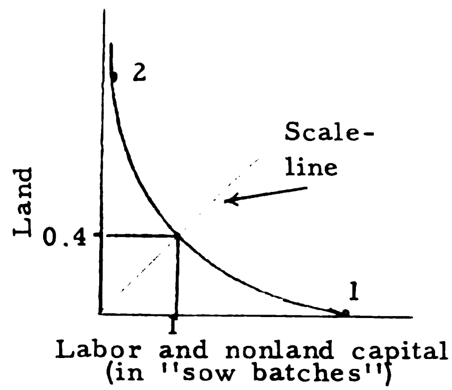


Figure IV-1
Land and Capital Combined

equals zero if space occupied by buildings is excluded. There is also a minimum amount of labor and capital (point 2) which will produce a given amount of pork. Though these minimums vary with the size of the hogs being fed, there is insufficient information available to predict what the contour line joining these points should look like. If this information were available in usable form, one could set up a production function and compute a scale line of optimum proportions at any specific price relationship. The experience of producers indicates that about 0.4 acre per sow batch of capital is an optimum combination.

## Building Requirements

Building requirements, like land requirements, vary with the type of hog enterprise. They also vary with climate. In Michigan, the house or shed must be tight enough to give some protection from winds, and in winter must provide a somewhat warmer temperature than the outside air. Floored pens that are wind-tight and not too large are necessary to assure adequate protection for pigs farrowed in February and early March, thus increasing the cost of early farrowed pigs in these areas. Some reduction in these costs, however, is made possible by the use of heat lamps.[10]

Changes in the management of swine under the introduction of the "McLean County System of Swine Sanitation" has caused a change in the housing requirements for producing hogs. The central farrowing house no longer holds the importance it did prior to this change. The central house, however, where they are already built have some distinct advantages over farrowing in movable houses. Suitable shelter can be provided in the form of movable houses at a much lower cost than is possible with permanent housing, especially if no permanent housing now exists. Even in some cases, where permenant buildings do exist, some alternative use may yield a higher return to these buildings. The problem of pricing is described in Chapter V for fixed assets. It is also discussed in the section on complementarity in Chapter II.

Movable houses have a special advantage for tenant farmers who may be renting a farm which has no permanent hog buildings. The lower cost is important; however, the fact that movable buildings can be taken to a new farm reduces or almost eliminates the risk of losing an investment in buildings.

The building space requirements for hogs recommended by Michigan State College[11] indicate that 15 to 20 square feet of floor

[10] See section on heat lamps in Chapter III of this thesis.

[11] Unpublished data, Ag. Econ. Dept., Michigan State College.

space is needed by sows not suckling pigs, and from 48 to 80 square feet of floor space is needed during and after farrowing. The minimum space needed for hogs (to 225 pounds) is 6 to 8 square feet of shed space and 8 to 10 square feet of paved feeding floor.

This compares with a more detailed breakdown presented by specialists from the United States Department of Agriculture, who have estimated the space needs for swine shown in Table IV-8. These space requirements, however, do not include space needed for self-feeders or for exercise.

In cases where pasture is used, a sun-shade should be provided in the pasture area. This usually is in the form of movable shades. Several types have been designed and are in use. Sun-shades expected to accommodate hogs of market weight should provide 10 to 15 square feet of space per head.

In figuring the cost per year of housing swine, one should figure on depreciation of 5 percent and repairs of 4 percent of the original cost for permanent structures and slightly higher on movable structures (10 percent depreciation and 5 percent repair costs). If buildings are fixed for the farm, the alternative opportunity cost method should be used to figure the charges for hog housing.

## Roughage Requirements

The relationships which exist between grain and roughage requirements in swine production have not yet received adequate attention. Swine are not roughage-consuming animals in the sense that ruminants are, yet the importance of good pastures has been shown in many experiments and in thousands of successful swine operations.

Table IV-8. Pen space requirements per hog.[1]

| Weight of Hogs | Space per Head in Cold Areas | Space per Head in Warm Areas | Weight of Hogs | Space per Head in Cold Areas | Space per Head in Warm Areas |
|---|---|---|---|---|---|
| lbs. | sq. ft. | sq. ft. | lbs. | sq. ft. | sq. ft. |
| 100 | 5-6 | 6-9 | 300 | 11-14 | 15-22 |
| 200 | 8-10 | 10-15 | 500 | 16-20 | 20-30 |

[1] From Circular 701, USDA, 1944.

The possibility of using forage crops other than pasture has received even less attention. A series of experiments over a six-year period at Beltsville attempted to find the most efficient levels at which sun-cured legume-hay meals could be fed to pigs from weaning to a market weight of 225 pounds. The hay meals were fed at 0-, 5-, 10-, 15-, and 20-percent levels. Somewhat more rapid gains were obtained on the 5- and 10-percent levels. Up to the 10 percent level, the ground hay affected an appreciable saving of concentrates. It was found that home-grown legume crops can be utilized in swine feeding at the 10 percent level with a saving in the purchase of protein feeds needed to help balance home-grown grains.

Other tests were conducted with spring- and fall-farrowed pigs at Beltsville to compare the value of dehydrated legume hay meals in the rations of feeder pigs from weights of approximately 62 to 125 pounds. Dehydrated alfalfa hay meals and sun-cured alfalfa hay meal were fed at 10 percent of the total ration; a check group received no hay meal. The pigs fed the dehydrated alfalfa hay meal made approximately 9 percent faster gains, with a saving of 10 percent of feed over those receiving the sun-cured hay.

The value of alfalfa hay in the ration of brood sows was demonstrated by investigators at the Wisconsin Agricultural Experiment Station. Sows that received only 5 percent of alfalfa hay in the ration during gestation raised only half as many pigs to weaning age as sows fed 15 percent. The pigs from sows receiving the lower level of alfalfa hay were much lighter in weight at weaning. Growing and fattening pigs made the cheapest gains from 53 to 200 pounds in weight when alfalfa made up 10 percent and 15 percent of the ration fed in dry lot. Feed costs at the 20 and 5 percent levels were more costly per 100 pounds of gain.

Young-grass silage preserved with concentrated whey can be used successfully as a supplement in the winter ration of growing and fattening pigs. Tests at Beltsville were conducted on this material, using four lots of ten pigs each. A standard ration plus supplements was fed from weights of approximately 65 to 225 pounds. One lot received ground alfalfa hay at a 5 percent level; the second lot, corn silage; the third, concentrated whey grass silage; and the fourth, concentrated whey grass silage and 2 pounds of concentrated whey per 100 pounds of live weight. The corn silage and the whey grass silage made up 13.6 percent of the ration. The pigs gained at the rate of 1.83, 1.48, 1.78, and 1.81 pounds each daily, and required 357, 422, 411, and 398 pounds of feed, respectively, on the rations in the order given.[12]

Experimental results at the Missouri Agricultural Experiment Station show that sows fed good rations in dry lot farrowed pigs that were not as healthy or thrifty as pigs farrowed by sows fed similar rations on good pasture. A noticeable improvement in health occurred when fresh growing forage was given the unthrifty pigs. These results also show that pasture is important for brood sows.

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[12] John H. Zeller, "The Use of Forage in Feeding Hogs," Yearbook of Agriculture, United States Department of Agriculture, Washington, D. C., 1948, p. 102.

John H. Zeller, from the Bureau of Animal Industry,[13] says:

> Young grass is nature's contribution to healthy livestock nutrition. Green forage crops provide succulent grazing for brood sows during the gestation and suckling periods, as well as for growing and fattening pigs.

Feeding sun-cured dehydrated hay is an excellent way to supply the nutrients found in pasturage. The dry legume forages are particularly valuable in speeding up gains in dry-lot feeding. They supply health-giving nutrients that might otherwise be lacking.

Alfalfa hay will show an appreciable saving of concentrates when fed up to the 10 percent level. When pigs over 65 pounds fed ground sun-cured hay meal and dehydrated alfalfa hay meals were compared, the pigs fed the dehydrated alfalfa hay meal made approximately 9 percent faster gains, with a saving of 10 percent of feed over those receiving the sun-cured hay. This and the Beltsville work would indicate that some substitution between grain and roughage is possible around the 10 percent level for feeder pigs.[14] It may be substituted up to about one-half or two-thirds of the ration where limited feeding is practiced. However, this will then mean much slower and somewhat more costly gains.[15] The results with sows shows that a ration containing 10 to 15 percent alfalfa hay produced larger and more-healthy litters of pigs than the sows receiving lower rates of alfalfa hay or none at all.

If the above results on the feeding of alfalfa meal to growing pigs on dry lot are reliable, and one assumes a cost of about $60.00 per ton for the ration being fed to the pigs, he can afford to add

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13 Ibid., p. 103.

14 Ibid., p. 101.

15 W. E. Carroll and J. L. Krider, Swine Production, McGraw-Hill Book Company, New York, 1950, p. 415.

dehydrated alfalfa meal up to the 10 percent level as long as it is available for less than $65.40 per ton ($60.00 x 0.09 = $5.40, the saving effected by the addition of the dehydrated alfalfa meal to the ration). On the other hand, ground sun-cured alfalfa meal should also be added to the ration up to the 10 percent level so long as the cost of the meal used is less than the cost of grain and protein which it replaces.

Recommendations indicate that swine should be supplied with good pasture during the growing season and with well-cured legume hay when pasture is not available. Few things are considered more important in reducing the cost of pork production and preventing nutritive deficiencies than good-quality legumes. These feeds aid greatly in meeting the protein requirements. This is because actively growing pasture crops and legume hay are fairly rich in proteins that help correct the deficiencies in the protein of the cereal grains. Legume hay and legume pasture crops are also very rich in calcium.

Work at the Pennsylvania station has made some progress in studies on the substitution of pasture roughage for grain.[16] Material presented in these studies would indicate a substitution of alfalfa pasture for from 2 to 4 percent of the protein in the ration. However, the consumption of pasture forage is not known, and unless one is willing to assume only a substitution of protein (i.e., replacement of the protein in the supplement and grain by that in the pasture forage) and not a possible interaction between various types of proteins which may provide for more-efficient use or less-efficient use

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[16] T. B. Keith, R. C. Miller, and M. A. McCarthy, Levels of Supplemental Protein for Pigs on Pasture, Agri. Exp. Sta. Bulletin 407, Pennsylvania State College, April, 1941.

of the protein or the entire ration, a person would not be able to determine marginal rates of substitution. If one is willing to make these assumptions, he can then calculate the protein replaced by pasture forage, determine the protein content of the forage, and from this figure out the amount of forage consumed and the rate of substitution.

Figures IV-2 and IV-3 compare total feed consumption of pigs on pasture shown by the Pennsylvania study and feed consumption of pigs in dry lot as reported by Atkinson and Klein in United States Department of Agriculture Bulletin 894.

They show that feed consumption per hundred pounds of gain varied slightly for the pigs on pasture as the percentage of protein in the ration was varied. The x's in the graph show the average feed consumption per 100 pounds of gain reported for the entire experiment. The four points used to draw the function were interpolated by the author from Pennsylvania Bulletin 407. The points on the curve showing dry lot feed requirements were taken from Table 12, page 25, of United States Department of Agriculture Technical Bulletin 894.[17] In analyzing the curves in Figure IV-2, one should keep in mind that the data came from experiments conducted at different times and that technological advances in composition of feed may cause the dry-lot feeding curve to shift to the left. Even considering this point, these curves show a considerable increment which can be credited to the alfalfa pasture. Figure IV-3 also bears out this fact. One should note also that a difference of 20 pounds

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[17] L. J. Atkinson and John W. Klein, Feed Consumption and the Market Weight of Hogs, USDA Tech. Bulletin 894, Washington, D. C., July, 1945.

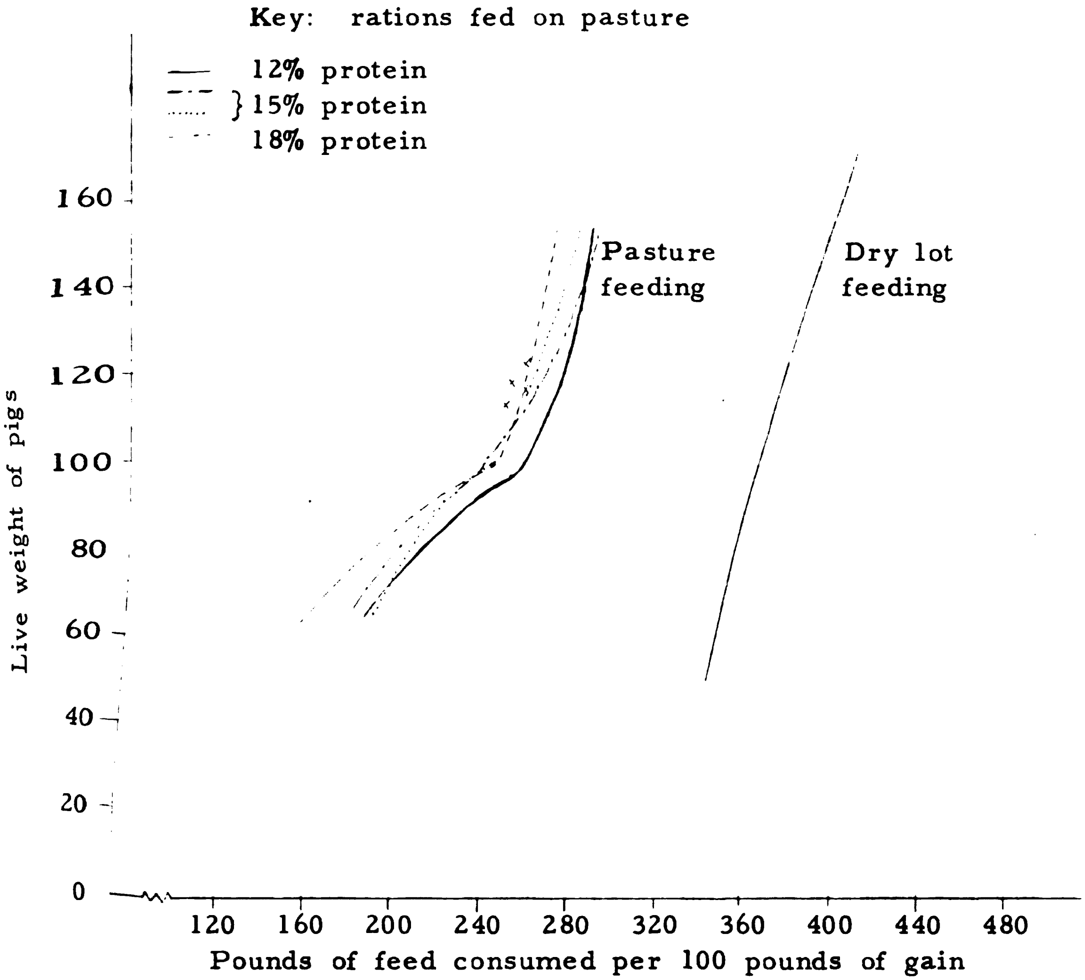
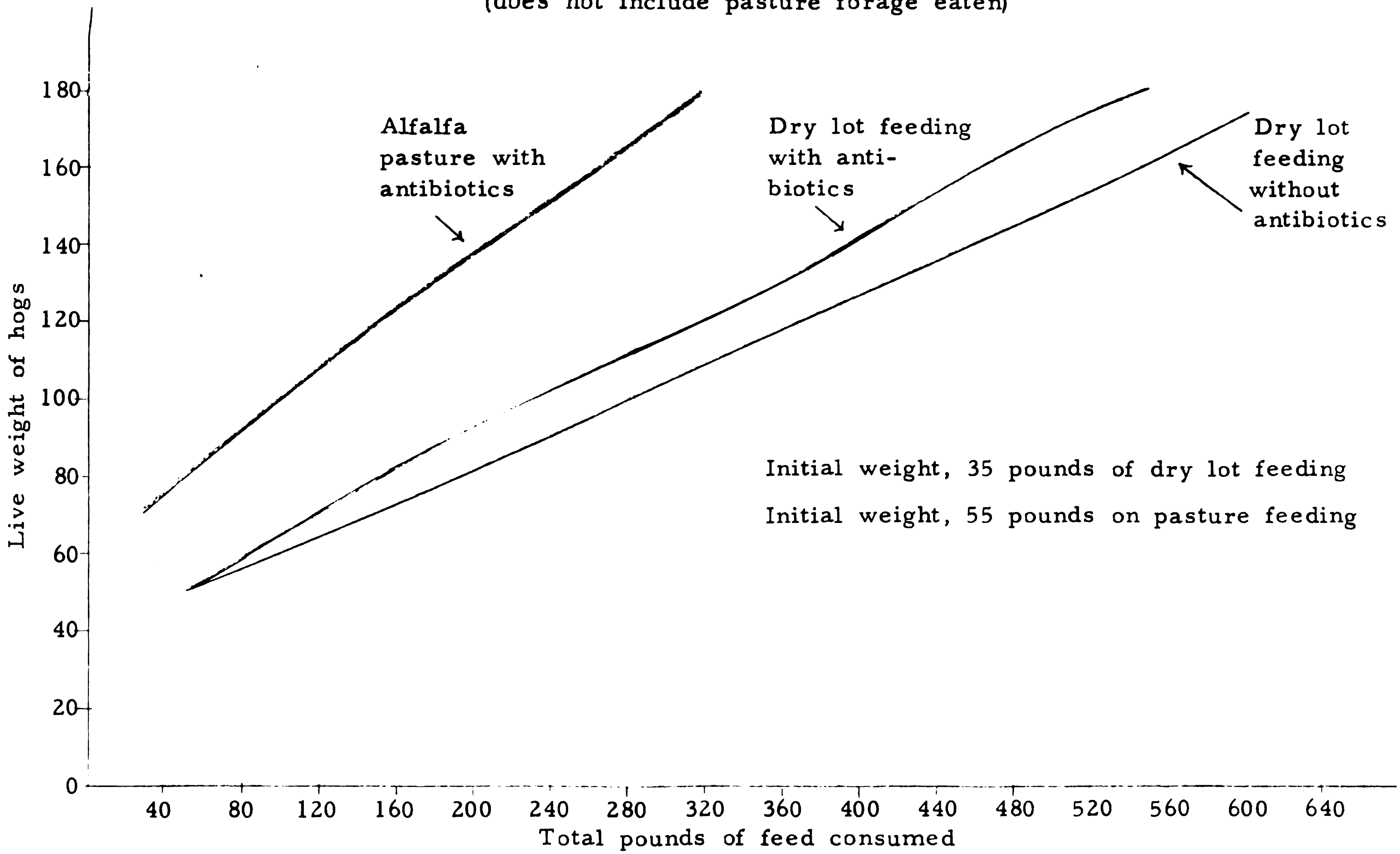



Figure IV-2
Feed Consumption per 100 Pounds of Gain at Various Live Weights, Dry Lot Compared with Alfalfa Pasture Feeding

Figure IV-3

Total Feed Consumed and Gain of Hogs After Weaning, Alfalfa Pasture and Dry Lot Feeding Compared, With and Without Antibiotics (does not include pasture forage eaten)



exists in the initial weight and proper allocation of the feed consumed to produce these 20 pounds would move the curves closer together. The third line on the graph represents the results of more-recent work at the Michigan station in which antibiotics were used, showing the feed consumption per 100 pounds of gain without the use of pasture.[18]

McMillen and Freeman,[19] at the Michigan station, indicate the value they place on alfalfa as a substitute for other feeds by stating:[20]

> By the use of succulent green pasture, pork can be produced with at least 15 percent less concentrates. . . . It has also been demonstrated many times that better hog pastures replace one-half of the protein supplement needed in dry-lot or where pigs are fed on concrete floor.

In reference to alfalfa in the ration of sows, Freeman[21] states:

> These results indicate that second cutting hay of good quality may be used successfully as the only supplement to corn or corn and oats for sows and gilts during the gestation period.

This information leads one to conclude that the substitution of roughage for concentrates can be shown diagramatically by Figure IV-4, which shows hogs cannot survive on roughage alone, and that a certain amount of grain is required regardless of how much roughage

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[18] Unpublished material, Dept. of Animal Husbandry, Michigan State College.

[19] W. N. McMillen and V. A. Freeman are members of the Dept. of Animal Husbandry, Michigan State College; work cited below.

[20] W. N. McMillen, "Swine Pastures Save Feed and Increase Profits," Michigan Quarterly Bulletin, Vol. 28, No. 4, May, 1946, pp. 333-337.

[21] V. A. Freeman, "Ground Alfalfa for Brood Sows," Michigan Quarterly Bulletin, Vol. 25, No. 2, August, 1942, p. 148.

is fed. In several experiments, feeding more forage merely increased the time required to finish a hog. The hog usually consumed as much grain and nearly as much protein as previously (i.e., when fed without the roughage in such quantities).

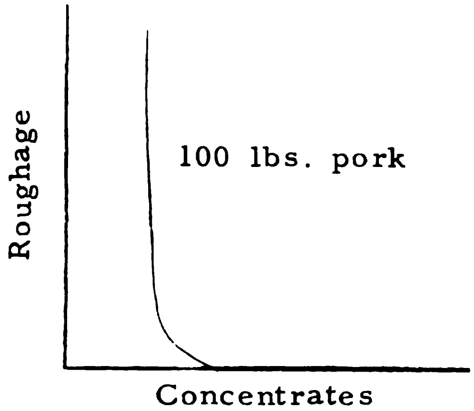


Figure IV-4
Relationship Between Concentrate and Roughage in Pork Production

However, there is a possibility that the timing of farrowing and finishing periods and the feed consumption may be changed to (a) produce a higher-value product or (b) utilize a cheaper feed. However, such changes also change other insputs such as labor, equipment, and capital.

It should be noted that roughage in the form of good-quality alfalfa meal can be used for 10 percent of the ration with beneficial effects; that is, more-economical gains. If the alfalfa meal exceeds 10 percent of the ration for growing pigs it is likely to have a limiting effect on the rate of gain and therefore cause an increase in costs. This was also discussed earlier in the section on limited feeding in Chapter II. The experimental data indicate that pasture roughage replaces some concentrates and protein. However, none of these experiments have measured the actual substitution rates.

It is also apparent that sows can consume roughage up to 20 percent of their ration without harmful effects.

## Protein Requirements

The marginal rate of substitution between grain and protein supplement is also important. The range of substitution is somewhat wider and according to studies by Catron et al., at Iowa State College, the substitution affects the rate of gain, the feed consumption per 100 pounds of gain, and the quality of carcass when the substitution is carried to extremes.

These studies show that, when soybean oil meal is used as a protein supplement to corn feeding 60-pound pigs, the marginal rate of substitution of protein for corn varies from 7.78:1 to 0.93:1 with a change in the percentage of protein in the ration from 9.38 percent to 20.02 percent.

The rate of substitution when feeding 175-pound pigs is not so wide (4.33:1 to 0.96:1) with a percentage protein change from 8.70 percent to 13.31 percent.

The actual rate at which corn and supplement should be fed to maximize profits depends upon the price ratio which exists between the two. In economic terms, one can say that[22]

$$\frac{\text{MVP som}}{\text{P som}} = \frac{\text{MVP corn}}{\text{P corn}}$$

defines the optimum combination to feed. This has been simplified greatly for use by farmers in an easily read computer called a "Pork Costulator." This was developed by three Iowa State College researchers.[23] All one needs to know is (1) the price of corn, (2)

[22] Where MVP = marginal value product, and P = price.

[23] Damon Catron, Gordon C. Ashton, and Earl O. Heady. Catron and Ashton are members of the Animal Husbandry Department; Heady is a member of the Economics Department.

price of supplement, (3) approximate weight of hogs, and (4) whether one wants the fastest or the cheapest gains. The "Pork Costulator" tells how many pounds of corn and supplement to mix for the gains desired.

One must remember that this information is very specific, yet indicative of substitutions which can be made, and that with sufficient interest similar information can be developed for all other pairs of inputs. The process of using information presented in this chapter to maximize returns (both monetary and nonmonetary as valued by the individual) is discussed in Chapter V.

## Summary

In summary, this chapter indicates near-optimum combinations of the factors of pork production for "normal" price relationships. These are expressed in terms of requirements per 100 pounds of pork produced. The requirements are given in a range within which they may vary without substantially affecting the amount of pork produced. Then, by assuming the long-run normal cost relationship which exists between prices of these factors of production, a combination of these factors is set up which probably approximates the least cost combinations.

The treatment of sanitation costs, veterinary costs, taxes, and interest are not included in this list because they are known to be dependent on the other factors. That is, the cost of sanitation measures varies inversely with the amount of land used and the rotation of pastures, and the interest cost depends upon the length of time between acquisition of the animals and marketing of them.

Table IV-9. Factor requirements per 100 pounds of pork produced.[1]

| Factor | Requirement per 100 Pounds of Pork |
|---|---|
| Labor . . . . . . . . . . . . . . . | 2 to 4 hours |
| Grain . . . . . . . . . . . . . . . | 300 to 400 pounds |
| Protein . . . . . . . . . . . . . . | 35 to 80 pounds |
| Forage (pigs) . . . . . . . . . . | 35 to 40 pounds (10% of total ration)[2] |
| (sows) . . . . . . . . . | 15 to 20 percent of ration |
| Land . . . . . . . . . . . . . . . . | 0 to 0.037 acre |
| Building . . . . . . . . . . . . . | 0 to 8 square feet of floor space[3] |

[1] Estimated from preceding material on the basis of 225-pound market pigs from birth to market.

[2] Alfalfa forage should be used to add protein to the diet up to this level since protein from this source is usually cheaper than protein supplement.

[3] Building space requirement will depend upon the time of farrowing and will usually be about 8 square feet.

The probable-least-cost combinations of factors needed per 100 pounds of pork produced under the stated assumptions are:

| | |
|---|---|
| Labor: | 2 hours |
| Feed: | 350 pounds |
| Protein: | This would be included in the feed according to price relationship between the grain and protein supplement.[24] |
| Forage: | 40 pounds dry weight |
| Land: | 0.037 acre |
| Buildings: | 8 square feet (or 60 square feet per sow farrowing if farrowed indoors) |

Labor requirement should be minimized because it is becoming increasingly expensive in relation to the other factors. Feed also falls into this category. Forage is much less expensive than the protein supplement for which it will substitute. The pricing of land and buildings varies from farm to farm because of the fixed nature of these factors.

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[24] For further details on this matter, see page 86.

## CHAPTER V

## DETERMINATION OF BREAK-EVEN POINTS IN PORK PRODUCTION

The break-even point can be technically defined as the intersection of the total-cost curve and the total-revenue curve of an enterprise. However, as the term is used in this chapter, the "break-even" point will mean that point at which a falling marginal value product curve intersects the marginal factor cost curve for feed. Viewed another way, it is the point at which the cost of an additional unit of output equals the additional income derived from producing that unit of output. Therefore, the break-even point as used here is the same as the maximum profit point for the enterprise.

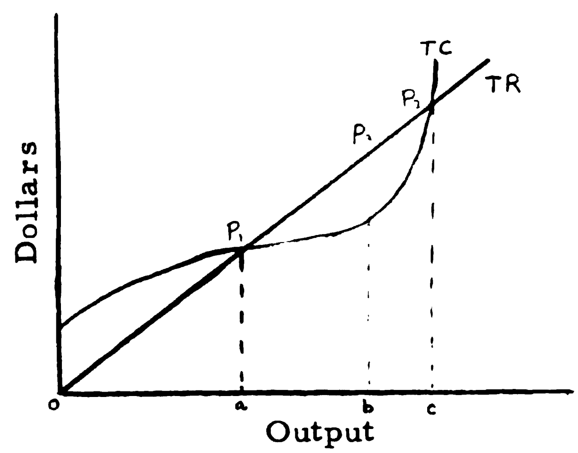


Figure V-1
Break-Even Points

A diagram will aid in showing the distinction between technical and marginal break-even points. In this diagram points $P_1$ and $P_2$ are technical break-even points. At either of these points one would cover costs but would not make any profit. At any output less than "Oa," or greater than "Oc," the output for the technical break-even points, a person would not cover total costs. At any output between "Oa" and "Oc" a person would be able to make a profit. Since profit is the motive for operating, one can assume that an enterprise would be carried on only when it could be operated between these two technical break-even points. An exception to this may exist in the short-run situation. This would be a case where the total revenue exceeded the total variable cost and the operator would lose less money by operating than he would lose by not operating.

It seems logical to assume that one would produce where the maximum profit can be obtained. The maximum profit point as shown in this diagram is at output "Ob." At this output, total returns exceed the total costs by the greatest amount. This is the point where the marginal cost is equal to the marginal revenue curve when the MC curve is rising. This is also the point at which MVP is equal to MFC. It is the marginal break-even point which determines the most profitable level of pork production.

## Dynamic Considerations in Use of Break-Even Points

The determination of break-even points in the production of pork is not a simple matter when actual production situations are being considered.

If one possessed perfect knowledge, determination of such points would simply be a matter of acting on the basis of the certainty which accompanies perfect knowledge to determine the break-even point. This would require the use of information on the price obtainable for the product sold and the quality of product desired by the market. Complete knowledge of production possibilities and, therefore, the least cost combinations of productive factors and highest profit levels of output would also be part of the information used. A person with perfect knowledge would know the optimum combinations of all the possible resources as well as the present and future price and market situations. He would overlook no factor which should be considered in making a decision and would never sustain a loss. A producer with perfect knowledge would make his production decisions on the basis of perfectly forecasted future events.

The imperfectly or incompletely informed producer, however, makes his decisions on the basis of imperfect knowledge of the present and on the basis of imperfect foresight of the future. The major problem is that expectations of the incompletely informed producer about future events differ (at times quite widely) from the actual future occurrence. How does this affect his actions? In the short run, say where only one variable is considered, he can act almost as though he possessed perfect knowledge for the span of decision-making is such that he can predict the possible outcome quite accurately. In longer spans, where two variables are considered, he can act with less certainty. As he enters still longer-run situations, the number of factors which are variable increases so that in the final analysis all factors of production are variable and he has no fixed factors to rely on. The variable factors far exceed the number which the human mind can handle. This increase in uncertainty which occurs along with an increase in the number of variable inputs has caused the best break-even or input-output data to be developed and used for the simpler cases.

Good information on break-even points exists for feed, one of the most important factors of pork production, and the weight of the animal. To be able to use this information an operator must predict future prices. How much will a given quality of pork bring on the market on any specified day? The answer to this question is extremely important in any attempt to determine break-even points in the production of pork. An answer can be secured by predicting or forecasting within a range of prices.[1] In commenting on the farmer's ability to forecast the price a hog may bring in two weeks after 25 pounds of gain have been added, Black et al.[2] indicate that this is somewhat complicated by the fact that both the market price of hogs and the value of 100 pounds of feed may change during a period of time. Some account should be taken of the fact that the ration of heavier hogs contains less protein and therefore is less expensive. Also, a change in pork quality occurs with the increase in weight. Usually the farmer knows the current feed prices but must estimate the future price of his animals.

The fact that producers do react with some uniformity to a given set of facts is borne out by Atkinson and Klein in the following statement:[3]

> Rather rapid shifts in hog production according to changes in the price situation have been so characteristic that ratios between the price of corn and hogs at breeding time have been regarded as crucial in regulating production. This is in spite of the uncertainty regarding changes in prices between breeding time and marketing time.

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[1] L. L. Boger, Seasonal Price Changes of Major Michigan Farm Products, Bulletin 355, M. S. C. Agricultural Experiment Station, East Lansing, 1949, p. 28.

[2] John D. Black, Marion Clawson, Charles Sayre, and Walter W. Wilcox, Farm Management, The Macmillan Company, New York, 1947, p. 271.

[3] L. J. Atkinson and John W. Klein, Feed Consumption and the Production of Pork and Lard, USDA Tech. Bulletin 917, Washington, D. C., June, 1946, p. 9.

Break-Even Points in Pork Production

The problem, then, is one of acquiring information on the production process, the prices of inputs, and the price of the product when it is ready for market.

Information of value in locating break-even points for feed in pork production is available in Michigan Extension Bulletin 321[4] entitled "What is the Most Profitable Weight to Market Your Hogs?" It provides a "break-even table" which tells an operator the price per hundredweight he should get for his hogs after putting on an additional 25 pounds if he is to cover the costs of putting on this added weight, or, in other words, break even on the marginal operation of adding another 25 pounds. This assumes that the operator knows, or has available, the current prices of corn and hogs, and that he is willing and able to estimate the price of live hogs of the quality he can market in two weeks with the added 25 pounds of weight. Anything he can get for them above the break-even price will be profit for him. He may even find it profitable to feed them for a longer period of time and to an even heavier weight and still increase his total profit. A United States Department of Agriculture publication entitled "How Heavy Should I Feed My Hogs" contains similar information.[5]

An example may serve to illustrate how "break-even" points are used in the selection of the most profitable weight at which to

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[4] Harold Riley, What is the Most Profitable Weight to Market Hogs? Extension Bulletin 321, Mich. State College, East Lansing, Michigan, August, 1953.

[5] United States Department of Agriculture, Bureau of Agricultural Economics, AIS No. 78, Washington, D. C., November, 1948.

market hogs. The "break-even" point as used in this bulletin[6] is the point where the cost of adding the extra 25 pounds of weight is equal to the additional income available because 25 pounds of weight has been added. If these are equal--that is to say, if the cost of adding 25 pounds is $4.00 and the additional income is $4.00--there is no change in total profit. If the cost of adding the 25 pounds is only $3.50 and the increase in total income is $4.00 the operator can increase his profit by $0.50. The object is to feed for this additional 25 pounds when a profit can be made by doing so or to just "break even" when a person wishes to "sell" more feed or labor at going rates.

This information can be used to increase profits if an operator considers feed variable and everything else fixed. Anyone using this information should note, however, that marginal costs are calculated on the basis of discontinuous units; i.e., the amount necessary to add 25 pounds of live weight.

The next few pages show that it is possible to increase total profit by varying more than one factor; also that total profit will be maximized when all factors of production are combined in proportions as near the optimum as possible.

## Break-Even Points for Other Inputs

Expansion of pork output in the vary short run can be achieved only by an increase in the amount of feed which is fed. In the somewhat longer run, both hog numbers and feed can be varied in the

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[6] Riley, op. cit.

process of increasing pork production. A different output will maximize profit when hog numbers as well as feed can be varied.

The diagrams on the following page show the relationship which may exist between pork output and cost structures. These diagrams illustrate how costs and optimum output can vary when first one and then two inputs are controlled by the producer.

Figure V-2 shows the iso-product curves or the rate at which feed and hogs will substitute for each other in producing a given amount of pork. A scale-line has been drawn in to show optimum proportions of combining feed and hogs under the assumed price relationship.

Figure V-3 shows the marginal and average total cost curves which exist when only one input is variable as well as the marginal and average cost curve which exists when both inputs are variable. An average revenue curve equal to the marginal revenue curve equal to the price of pork has been added to show where the optimum output, assuming maximum profit, would occur for each of the conditions shown in Figure V-2.

Now consider the case illustrated in Figure V-2 with hogs fixed at g, and feed variable. The maximum profit point in this case is at output C as shown in Figure V-3. However, Figure V-2 shows that output C can be achieved only by moving off the scale line. Since the scale-line shows the most economical method of combining feed and hogs in the production of a given output of pork the cost of producing output C could be decreased by producing this output from the combination of feed and hogs shown by the intersection of this output contour and the scale-line. This would indicate that the number of hogs should be increased and the amount of feed used should be decreased. This is a movement along the average

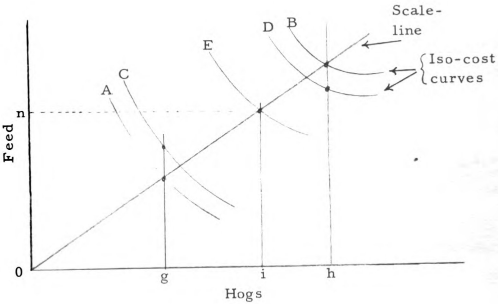


Figure V-2
Scale-Line and Production Surface
in Pork Production

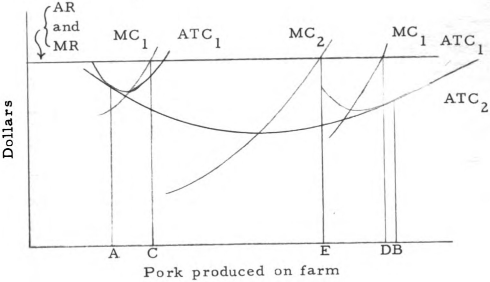


Figure V-3
Cost Curves for One and Two Variables

cost curve $ATC_2$ which exists when both inputs are allowed to vary. If the hog numbers are increased so that output C could be produced on the scale-line a new average cost and marginal cost curve for feed not plotted but similar to the one shown could be constructed. This marginal cost curve would show that the production for maximum profit on it would again be at a point off the scale-line. Since the minimum point on the average cost curve occurs to the right of the point of tangency of the last ATC curve considered to the average cost curve for two variables, a further increase in the total output is necessary to achieve the maximum profit.

Next, consider what the situation would be with hog numbers fixed at h in Figure V-2. Figure V-3 shows that the maximum profit point is at output D, which is again off the scale-line in Figure V-2. An examination of the average cost curve shows that the minimum point on this curve is left of the point at which it becomes tangent to the average cost curve for two variables. This means that the number of hogs fed could be decreased some amount and total profit increased. Therefore, it can be said that the number of hogs to feed for maximum profit is some number between g and h, in Figure V-2. An examination of Figure V-3 shows that the only point at which the minimum point on the average cost curve for one variable is tangent to the average cost curve for two variables is at the minimum point on the average cost curve for two variables. Further examination of Figure V-3 shows that the intersection of the marginal revenue curve and the marginal cost curve for two variables exists at output E. At this output the total profit is greater than at any other point shown when this cost structure is assumed to exist. Figure V-2 shows that output E would occur on the scale-line using i number of hogs and n amount of feed. This serves to illustrate that if hog numbers are fixed at any point except i the total profit can be increased, by varying both feed and hog numbers, over what it would be by varying only feed or hog numbers alone.

The work cited earlier on how heavy to feed hogs[7] considers only one variable, feed. Atkinson and Klein's work on feed consumption[8] considers both feed and hog numbers as variable; however, they do this under the assumption that only one is variable at any time. They list their assumptions as:[9]

> (1) The total number of hogs is assumed to be fixed. The feed consumption is then related to the output of live weight, dressed weight, and edible pork and lard resulting from hogs marketed at specified weights and resulting from specified changes in marketing weight. (2) The supply of feed is assumed to be fixed whereas the number of hogs varies. The feed consumption is related to the output of pork and lard at specified weights and to indicated changes in marketing weights.

They also consider the relationship between the output of pork and lard by holding one constant as the number of hogs is changed to study the effect upon the variable either pork or lard.

It appears that work showing the optimum combination of hogs and feed would be of value. Some work has been done on the optimum proportions of the components of feed to be used in producing

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[7] Riley, op. cit.

[8] L. J. Atkinson and John W. Klein, Feed Consumption and the Market Weight of Hogs, Technical Bulletin 894, USDA, Washington, D. C., July, 1945; and Atkinson and Klein, Feed Consumption and the Production of Pork and Lard, op. cit.

[9] Atkinson and Klein, Feed Consumption and the Production of Pork and Lard, op. cit., p. 1.

pork.[10] However, little work has been done on the optimum combination of the factors of pork production where factors other than feed are allowed to vary. The author is aware that this is not an easy task; however, he believes that the returns from this work would more than justify the cost.

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[10] Earl O. Heady, Roger Woodworth, Damon V. Catron, and Gordon C. Ashton, New Procedures in Estimating Feed Substitution Rates and in Determining Economic Efficiency in Pork Production, Research Bulletin 409, Iowa Agr. Exp. Sta., Ames, Iowa, May, 1954; and, by the same authors, "An Experiment to Derive Productivity and Substitution Coefficients in Pork Output," Journal of Farm Economics, Vol. XXXV, No. 3, August, 1953, pp. 341-54. Also, V. A. Freeman's work at Michigan State College on the use of forage in the ration of hogs as well as other work along this line can be cited.

CHAPTER VI

# SUMMARY

Close examination of the nature of the swine enterprise shows an almost limitless number of production methods which may be used to produce pork. The method which is the most practical and profitable depends upon price relationships, the physical arrangement of the farm and the ability of the farm operator.

Studies in Indiana show a 3 percent lower average cost per 100 pounds of pork produced by the one-litter system than when produced by the two-litter system. These studies also show that management is likely to be more important in cost determination than the farrowing system followed.

A brief review on sources of feeder pigs indicates that a farmer who can average seven or more pigs weaned per litter can generally raise feeder pigs cheaper than he can purchase them.

Feeding methods were examined in some detail. The great difference in labor cost for hand as contrasted to self-feeding shows that self-feeding is usually the most economical in spite of the fact that somewhat more feed is required per 100 pounds gain when self-feeding is used.

Limited feeding seldom proves economically sound unless a producer is short of feed and cash or credit, and wishes to carry a drove until a field of corn is ready to be harvested or hogged down. An exception to this rule may exist when pigs are farrowed in the summer and carried on limited feed for a period of time so that they can be marketed, between the fall and the spring rush of marketings, at a higher sale price. However, it is usually more economical to regulate time of farrowing and full feed them to market at the higher price peaks rather than farrow early and use a limited-feeding program. Late farrowing, to take advantage of lower costs, combined with limited feeding may be a possibility.

The practice of hogging down a corn crop has become less popular with the introduction of the corn picker. In 1951, 6.3 percent of the corn crop in Michigan was harvested in this manner. Comparative cost figures are not available on this practice.

The pork enterprise usually can be profitably combined with a beef operation. It can also be profitably combined with dairy farming where the butterfat is sold and the skim milk retained and used for hog feeding. The hog enterprise also works well with some types of grain farming, especially corn.

Risk is an important factor to be considered in hog production. Studies show that some farmers believe that the hog enterprises are more uncertain than other enterprises. However, their actions often indicate that this uncertainty can be reduced by knowledge or experience and efficient management of the hog enterprise.

Feed costs make up 80 to 85 percent of total costs in swine production; therefore, it is not surprising that the majority of the research work has been done along this line. The input-output relationships here are quite well defined. Experiments show that substantial savings can be made in feed by using the improved rations. The substitutability between feeds is receiving attention where economists and animal husbandry departments are cooperating on these experiments. This work shows that savings on a large herd would more than justify even minute modification of the corn-protein ratio in the ration according to the price relationship of the two.

Size of operation is usually the determining factor in whether to purchase commercial feed, make use of custom mixing services or own and operate mixing equipment as part of the enterprise. Where an excess of low-cost labor is available this may not hold true; however, labor can usually be employed more profitably than by hand mixing of feed. Determining if one should mix feeds at home or purchase this service is a simple matter of cost comparison which can be easily performed.

Labor, another important factor in pork production, is used inefficiently in many cases. Wide variation exists between the average labor requirement in Michigan to produce 100 pounds of pork and that which would be required under ideal conditions. Examination of studies in this area shows that labor savings up to 50 percent are possible. In many cases this means that twice as many pounds of pork could be produced with no increase in labor. Much of this saving can be made with farm work-simplification practices with no addition of other inputs. The addition of machinery or other equipment, however, makes further savings possible. The possible rate of substitution of capital for labor has not been studied adequately in this or in other available studies.

The requirement for land in the production of pork appears to be quite flexible. Its value depends upon its use for pasture and sanitation purposes. Only estimates are available for either one of these values.

The technological advances in recent years have been so great that a majority of producers are making use of the new antibiotics in their feeding programs. Optimum amounts to be used have not yet been determined, but the amounts now in use appear to be yielding returns well above cost. Selection of animals toward the meat type preferred by the market is enabling some producers to get a somewhat better price for quality. The value of this improvement in quality is being recognized by packers, and the breed associations appear to be adding emphasis to better-quality animals being produced and delivered to the market.

The introduction of electric heat bulbs has enabled earlier farrowing dates at a very small increase in costs and makes it possible for northern producers to sell on the earlier market's higher price.

Disease and parasite control have been made less costly and more efficient by the introduction of new techniques and lower-cost drugs. Recent discoveries in the field of disease control have helped reduce the risk involved in pork production.

The question of evaluating present and additional knowledge was considered briefly in an attempt to determine what value knowledge has to the pork producer with special emphasis on the influence of size of operation. It appears that some optimum combination of knowledge exists for any given enterprise.

Break-even points for single factors can be readily calculated when other factors are held constant, such as in a short-run situation; however, in the longer length of run the calculation of these break-even points depends upon an individual's ability to handle the number of variables involved. The factors of production are likely to vary in cost from farm to farm and to be a function of the alternative opportunities and the willingness and ability of the operator to accept risk or take a chance. The process of equating marginal value product and marginal factor cost can be used in the calculation of the break-even points in whatever length of run is being considered. For example, in the short run, when only feed is considered variable, an operator continues to feed a hog to a heavier weight until the MFC of putting on this addition weight is just equal to the MVP received because of the additional weight.[1]

Some information on the substitutability of feed and protein has already been established.[2] The factors of labor, equipment, and housing have received very little attention in regard to substitutability one for another. The author feels that this would be a productive area in which work remains to be done. Until more information is available, however, it appears that the probable-least-cost combination of factors per 100 pounds of pork produced is that listed below:

| | |
|---|---|
| Labor: | 2 hours |
| Feed: | 350 pounds |
| Protein: | This would be included in feed, according to the price relationship between the grain and protein supplement. |
| Forage: | 40 pounds dry weight (up to 10 percent of the ration for growing pigs) |
| Land: | 0.037 acre |
| Buildings: | 8 square feet (or 60 square feet per sow farrowing if farrowed indoors) |

These figures are based on the production of 100 pounds of pork by carrying hogs from birth to market weight.

Labor requirements should be minimized because it is becoming increasingly expensive in relation to the other factors. Feeds also fall into this category. Forage is much less expensive than protein supplements, for which it can be substituted.

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[1] Harold Riley, What is the Most Profitable Weight to Market Hogs? Extension Bulletin 321, Michigan State College, East Lansing, Michigan, 1953, p. 4.

[2] See input-output relationships discussed earlier in this paper.

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