Niche Pork Production

Peter J. Lammers, David R. Stender,

and Mark S. Honeyman

Iowa State University

2007

With support from the National Research Initiative of the USDA Cooperative State Research, Education and Extension Service (grant number 2005-55618-15791), the Value Chain Partnerships for a Sustainable Agriculture Project, the Pork Niche Market Working Group, the Iowa State University Department of Animal Science, the Iowa Pork Industry Center, the Graduate Program in Sustainable Agriculture, the Hatch Act, and State of Iowa funds.

Acknowledgements

Niche pork production is a new development in agriculture and the information shared in this handbook is the product of many individuals' work and experiences. The farmers who shared their hard-won understanding of pig production for niche markets were indispensable to this project and are warmly thanked. The authors also wish to recognize members of the Pork Niche Market Working Group, Iowa State University Hoop Group and Midwest Plan Service for their contributions to this publication. A special thank you is given to the individuals involved in reviewing this handbook for their critiques and insight.

Dwight Ault, Austin, MN

Jude Becker, Dyersville, IA

Tom Frantzen, New Hampton, IA

Jay Harmon, Professor, Iowa State University Department of Agricultural and Biosystems Engineering

Palmer Holden, Emeritus Professor, Iowa State University Department of Animal Science

Sherilyn Hoyer, Communication Specialist, Iowa Pork Industry Center and Department of Animal Science, Iowa State University

Jim Kliebenstein, Professor, Iowa State University Department of Economics

Martin Kramer, Algona, IA

Steven Lonergan, Associate Professor, Iowa State University Department of Animal Science

Larry McMullen, Extension Swine Field Specialist, Iowa State University

Daryl and Rae Ann Peterson, Blooming Prairie, MN

Lyle Rossiter, Superintendent, Iowa State University Allee Demonstration Farm, Newell, IA

David Serfling, Preston, MN

Dan and Colin Wilson, Paullina, IA

Foreword

The Midwest has been the center of United States pig production for more than a century. Pig production infrastructure is well established and has been supported through the work of land grant institutions such as Iowa State University. Historically, a mixed agricultural system dominated the landscape, characterized by many family-based farms producing surpluses of corn and other grains that were fed to livestock, particularly pigs, to increase its value.

In the 1980's and 1990's consolidation and industrialization of pig production happened quickly in the Midwest. The number of pig farms in the region fell while the number of pigs per farm rose. In response to this trend, some producers sought alternative pig production systems such as pasture farrowing or deep-bedded hoop barns to reduce fixed costs and remain financially viable. In 1998 and 1999, U.S. market pig prices fell to historic lows, encouraging many producers using alternative systems to consider niche marketing approaches.

While producers were seeking markets that better compensated them for their efforts, U.S. consumers were becoming responsive as well. Concerns for environmental stewardship, livestock care, community impacts, and human dietary issues were resulting in some consumers being willing to pay a premium for pork raised by producers who effectively addressed those issues. Consumers also wanted more assurances that antibiotics were not fed to pigs. Much of the pork that meets this description is labeled "natural." Also, as commodity pork became more lean, poor quality pork occurred more often, leading some consumers to demand better tasting pork.

Niche pork markets grew rapidly in the late 1990's and have continued to expand. There currently are at least 35 pork niche markets active in Iowa. These range from direct sales to consumers by individual farmers to organized marketing groups. Marketers consistently report more demand for pork than the existing supply of pigs raised to meet the niche market criteria can provide. They also consistently report a shortage of producers and the expectation that the niche markets will continue to grow.

The lifestyle and financial opportunities that niche market pork offers are attractive to many individuals. These individuals may have little or no experience with raising pigs. Much of the existing pig production resources are not appropriate for this audience. This handbook was written to serve as an introduction to pig production with a focus on the practical issues niche market pig producers face. While perhaps of most value to the novice, the information in this handbook also is useful to the more experienced pig producer considering niche pork production as well as the seasoned niche pork producer.

September 2007

Conclusion

Niche pork production is growing rapidly in the United States. In some markets, demand for pork exceeds supply. Opportunities for producers who are willing to raise pigs according to the specifications of a niche market exist. Meeting these guidelines can be challenging, but a growing number of producers are demonstrating the viability of this type of pig production.

Pig production is constantly changing, and niche pork is no exception. Success depends on the producers' ability to innovate and learn from their peers and neighbors. Individuals should seek opportunities to network with other producers and service suppliers such as veterinarians and nutritionists, and to interact with extension and university staff.

Niche pork production offers lifestyle and financial opportunities that are attractive to many individuals. The low capital nature of most operations makes it a good complement to other farming activities or as partial employment for someone who wants to remain connected to livestock production. Niche pork production rewards pig husbandry, attention to detail, and innovation. It is hoped that this handbook will provide useful insights to stimulate thinking by niche pork producers as well as technical information. This handbook is only a start. There is an abundance of other good information sources, some of which are listed on the following pages.

Table of Contents

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Record Keeping

IPIC NPP110 2007

Records are crucial for success. How can you evaluate the purchases of tools or find your optimal levels of labor, scale, and efficiency without records? Records are absolutely necessary to help you make more informed decisions that will directly impact your competitive position and profitability.

Not only will some basic records help you make more informed decisions, but a group benchmark will help confirm certain things are important while other things are not. Young people will not enter niche pork production unless they know that making a fair profit is possible. Also, a list of critical management areas to master is needed in order to be successful. You can only effectively manage what you are able to measure.

Important questions that records can help you analyze:

- Which tools are valuable?
- Will additional inputs increase your profit? Which inputs?
- What herd size is optimal?
- Is the way you raise pigs the most cost effective method?
- Are there small changes you could make to improve your return?
- Are you spending too much time on things that do not change your financial position and too little time on things that will?
- Is the operation financially sustainable?

Keeping records just for the sake of keeping them is only useful for taxes, but taking your tax records and relating them back to your performance is useful in making more informed decisions.

In a small lower overhead operation, whole herd cost records related to gain are needed for benchmarking certain areas critical to financial sustainability. This type of record keeping links cost to performance and requires only a minimum amount of data that is easily obtained by most operations.

First, the number of pounds pork produced by the operation is essential. Pounds produced for the operation can be calculated by the following formula:

Pounds Produced =
(Ending Inventory Wt + Sale Wt)
– (Opening Inventory Wt + Purchase Wt)

Once the number of pounds produced is calculated, cost then can be related to performance (pounds produced).

For example, if your operation had the same opening and closing weight, did not purchase any animals, and sold 10,000 pounds of market hogs, your operation would have produced 10,000 pounds. If you spent $2500 on feed, the feed cost of gain would be $0.25/pound or $25/cwt.

The important discussion begins when you find out that another operation spent only $1800 on feed to produce 10,000 pounds. You wonder if the $700 you spent on additives to enhance growth rate had a good payback. Records can help producers make more informed decisions.

Basic records can help you decide what is best for your operation. The same type of benchmarking analysis can be made for all the cost items in the operation. You just need to track the costs of things like utilities, fuel, repairs, bedding, etc. After these cost items have been recorded, then cost of gain can be easily calculated and analyzed. Some basic records can help you decide what is best for the operation.

Successful operations that have kept records over the years have found that purchasing inputs, facilities, and equipment to fix a problem will not always help. Producers who use records successfully are able to search for an alternative management solution. This may be an approach someone else keeping records used to solve the root problem instead of simply purchasing a Band-Aid type “tool.” For example, if your operation has a herd health issue, a feed product that treats the symptom is not a solution. Rather, the use of performance records to identify and connect the stress factors that triggered the health problem is the first step in correcting the situation.

Many record systems are commercially available to help track information. Iowa State University has a business record system that can help summarize and process information from your record system. Check with your local Iowa State University Extension swine field specialist to find out more about the Swine Business Record (SBR) analysis. The SBR is flexible. You can use it to help analyze the records you already have or use the input forms to record your cost. ISU Extension swine field specialists are available to help answer your questions, to help analyze the information gathered, and to help set goals and direction for the operation. Check the map on the following web site listed below to find the swine field specialist who serves your operation.
http://www.extension.iastate.edu/ag/fsswine/fsswine.html

Additional Resources

Iowa Pork Industry Center.
109 Kildee Hall. Iowa State University, Ames, IA, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

Iowa State University Extension. 2007. Ag Decision Maker. Iowa State University. Ames.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Example Production Budgets

NPP 120–2007

Production budgets can be effective planning tools. A budget is as useful as the accuracy of the information used. Three example budgets are presented. The budgets are based on a number of assumptions shown. These examples are intended as models of a production budget. Predicted costs of production and return are only estimates. Producers should generate budgets and cost projections for their own operation for business planning purposes.

Finishing Pigs in Hoop Barns

Some niche pork producers purchase feeder pigs and feed them to market weight. Hoop barns are structures commonly used for finishing pigs. The following budget projects cost of production for finishing pigs in hoop barns. The following are assumed:

Assumptions for Finishing Pigs in Hoop Barns

Feeder pig price	$55.00/hd	Batches per hoop barn	2.5/yr
Pig start weight	40 lb	Bedding use	200 lb/pig
Pig end weight	270 lb	Price of cornstalk bedding	$30.00/ton
Overall feed:gain ratio	3.5:1	Dressing percentage	74%
Price of corn	$3.65/bu	Operating interest	8%
Price of soybean meal	$250.00/ton	Depreciation and repairs	9%
Price of base mix	$0.40/lb	Fixed interest	5%
Death loss	4%	Taxes and insurance	1%

Operating cost calculations

Feed

$$Corn:\ 634\ lb \times \frac{1\ bu}{56\ lb} \times \$3.65/bu = \$41.32$$

$$SBM:\ 154\ lb \times \frac{1\ ton}{2000\ lb} \times \$250/ton = \$19.25$$

$$Base\ mix:\ 18\ lb \times \$0.40/lb = \$7.20$$

$$Feed\ Costs = \$41.32 + \$19.25 + \$7.20 = \$67.77$$

Bedding $$200\ lb\ cornstalks \times \frac{1\ ton}{2000\ lb} \times \$30.00/ton = \$3.00$$

Operating interest

$$Operating\ Interest =$$

$$Operating\ costs\ excluding\ labor \times Annual\ interest\ rate \times Length\ of\ production$$

$$\$130.37 \times 8\%/yr \times \frac{1\ yr}{2.5\ turns} = \$4.17$$

Labor $0.25\ hr/pig \times \$15.00/hr\ =\ \$3.75$

Operating costs after death loss $\$138.29 \div 0.96 = \$144.05$

<u>Fixed costs calculations</u>

Facility and equipment investment

Hoop barn	$80.00 per pig space
Feed and manure equipment	$20.00 per pig space

$$\$100/pig\ space \times \frac{1\ pig\ space}{2.5\ turn/yr} = \$40/turn$$

Fixed Cost

$$Facility\ and\ equipment\ investment \times (Depreciation\ \&\ repairs + Fixed\ interest + Taxes\ \&\ insurance)$$

$$\$40.00 \times 15\% = \$6.00$$

Fixed Cost after death loss $\$6.00 \div 0.96 = \$6.25$

<u>Breakeven price calculation</u>

$$\frac{Cost}{270\ lb} \times \frac{100\ lb}{1\ cwt} = Breakeven/cwt\ live\ weight$$

$$Breakeven/cwt\ live\ weight \div 74\% = Breakeven/cwt\ carcass\ weight$$

Example Budget for Wean–Finish Pigs in Hoop Barns

Operating Costs		
Feeder pig	$55.00	
Feed	$67.77	
Bedding	$3.00	
Fuel, repairs, and utilities	$1.05	
Veterinary and medical	$1.55	
Marketing	$2.00	
Operating interest	$4.17	
Labor	$3.75	
Total	$138.29	
Total operating costs after death loss		$144.05
Fixed Costs	$6.00	
Fixed costs after death loss		$6.25

Total costs per pig sold $150.30

Breakeven price	Live Weight	Carcass Weight
Operating costs after death loss	$53.35/cwt	$72.09/cwt
Total production costs	$55.67/cwt	$75.23/cwt

Table 1. Effect of feed:gain ratio on total production costs and break even price.

	Feed:gain ratio					
Item	3.25	3.50	3.75	4.00	4.50	5.00
Feed, $/pig	$62.92	$67.77	$72.60	$77.44	$87.12	$96.80
Operating costs after death loss, $/pig	$138.84	$144.05	$149.25	$154.45	$164.86	$175.26
Fixed costs after death losses, $/pig	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25
Total costs, $/pig sold	$145.09	$150.30	$155.50	$160.70	$171.11	$181.51
Break even price						
Live, $/cwt	$53.74	$55.67	$57.59	$59.52	$63.37	$67.23
Carcass, $/cwt	$72.62	$75.23	$77.83	$80.43	$85.64	$90.85

As table 1 illustrates, feed conversion can significantly affect the cost of production and the corresponding break even price.

Producing Feeder Pigs for Niche Markets

Some producers focus on their sow herd and sell feeder pigs to others for finishing. Hoop barns with individual feeding stalls are well suited for gestating sows. An insulated, warm building is needed for farrowing pigs year-round in Iowa. The following budget projects cost of production for producing feeder pigs using a hoop barn for gestation and a well insulated building for farrowing. The following are assumed:

Assumptions for Producing Niche Market Feeder Pigs

Gestating sow feed	5 lb/d	Market value of a replacement gilt	$200/hd
Lactating sow feed	16 lb/d	Price of corn	$3.65/bu
Sow weight change	0 lb	Price of soybean meal	$250.00/ton
Litters per year	2 / sow	Price of base mix	$0.40/lb
Weaned pigs	7/ litter	Bedding use, cornstalks	1500 lb/yr
Lactation length	42 d	Bedding use, oat straw	500 lb/yr
Weaning weight	40 lb/pig	Price of cornstalks	$30.00/ton
Annual sow replacement rate	10%	Price of oat straw	$50.00/to

Operating cost calculations

Feed

$$Corn:\ 2136\ lb \times \frac{1\ bu}{56\ bu} \times \$3.65/bu\ =\ \$139.22$$

$$SBM:\ 517\ lb \times \frac{1\ ton}{2000\ lb} \times \$250.00/ton\ =\ \$64.63$$

$$Base\ mix:\ 96\ lb \times \$0.40/lb\ =\ \$38.40$$

$$Feed\ Costs\ =\ \$139.22 +\ \$64.63 +\ \$38.40\ =\ \$242.25$$

Bedding

$$Cornstalks:\ 1500\ lb \times \frac{1\ ton}{2000\ lb} \times \$30.00/ton\ =\ \$22.50$$

$$Oat\ straw:\ 500\ lb \times \frac{1\ ton}{2000\ lb} \times \$50.00/ton\ =\ \$12.50$$

$$Bedding\ Costs\ =\ \$22.50 +\ \$12.50\ =\ \$35.00$$

Replacement gilts

$$50\ sows\ in\ herd \times 10\%\ replacement\ rate\ =\ 5\ gilts\ annually$$

$$5\ gilts \times \$200.00/gilt\ =\ \$1000.00\ replacement\ \cos ts$$

$$\$1000.00 \div 50\ sows\ =\ \$20.00\ annual\ replacement\ \cos ts\ per\ sow$$

Operating interest

$$Operating\ Interest\ =$$

$$Operating\ costs\ excluding\ labor\ \times Annual\ interest\ rate\ \times Length\ of\ production$$

$$\$341.45 \times 8\%/yr \times 1\ yr\ =\ \$27.32$$

Labor $7.0\ hr/sow \times \$15.00/hr\ =\ \$105.00$

Fixed costs calculations

Facility and equipment investment

Gestation hoop barn and farrowing facility

(New gestation hoop & equipment and farrowing facility / expected useful lifespan) / number of litters per sow space

$850 / 15 years = $56.67 per sow space / 2 litters per space annually = $28.33 per litter

Example Budget for Producing Niche Market Feeder Pigs

Annual Operating Costs	per sow	per litter	per pig weaned
Feed	$242.25	$121.13	$17.30
Bedding	$35.00	$17.50	$2.50
Replacement gilts	$20.00	$10.00	$1.42
Fuel, repairs, utilities	$14.40	$7.20	$1.03
Veterinary and medical	$19.80	$9.90	$1.41
Insemination supplies	$10.00	$5.00	$0.71
Operating interest	$27.32	$13.66	$1.95
Labor	$105.00	$52.50	$7.50
	$473.77	$236.89	$33.84
Fixed Costs	$56.67	$28.33	$4.05
Total	$530.44	$265.22	$37.89

Table 2. Cost per pig by number of pigs weaned per litter.

		Cost per Pig					
	1 Litter	5 pigs	6 pigs	7 pigs	8 pigs	9 pigs	10 pigs
Operating	$236.89	$47.38	$39.48	$33.84	$29.61	$26.32	$23.69
Fixed	$ 28.33	$5.67	$4.72	$4.05	$3.54	$3.15	$2.83
Total	$265.22	$53.05	$44.20	$37.89	$33.15	$29.47	$26.52

Table 2 demonstrates the impact of weaning more pigs per litter. As number of pigs weaned increases, the cost per pig drops dramatically. If feeder pig market price is $55.00 per head, the producer weaning 10 pigs per litter will receive five times the return on investment as the producer weaning 5 pigs per litter.

Farrow-to-Finish Pig Production for Niche Markets

Most niche pork producers raise pigs farrow-to-finish. The following budget shows cost of production for 1 pig using the information from the previous scenarios. The following are assumed:

Assumptions for Farrow-to-Finish Pig Production for Niche Markets

Gestating sow feed	5 lb/d	Growing pig feed:gain	3.5:1
Lactating sow feed	16 lb/d	Bedding use, cornstalks	1500 lb/sow
Sow body weight change	0	Bedding use, oat straw	500 lb/sow
Litters per year	2 /sow	Bedding use, cornstalks	200 lb/pig
Annual sow replacement rate	10%	Price of cornstalk bedding	$30.00/ton
Market value of replacement gilt	$200	Price of oat straw bedding	$50.00/ton
Pigs weaned	7/litter	Weaning weight	40 lb/pig
Lactation length	42 d	Market weight	270 lb/pig
Price of corn	3.65/bu	Post-weaning death loss	4%
Price of soybean meal	$250.00/ton	Batches per hoop barn	2.5/yr
Price of base mix	$0.40/lb	Dressing percentage	74%

Example Budget for Farrow-to-Finish Pig Production for Niche Markets

Operating Costs			
Sow feed	$17.30		
Pig feed	$67.77		
Bedding	$5.50		
Replacement gilts	$1.42		
Insemination supplies	$0.71		
Fuel, repairs, utilities	$2.08		
Veterinary and medical	$2.96		
Marketing	$2.00		
Operating interest	$6.12		
Labor	$11.25		
	$117.11		
Post-weaning death loss	$5.76		
Fixed Costs	$10.05		
Post-weaning death loss	$0.25		
Costs per pig sold			
Operating costs after post-weaning death loss		$122.87	
Fixed costs after post-weaning death loss		$10.30	
Total		$133.17	
Breakeven price		Live Weight	Carcass Weight
Operating costs after post-weaning death loss		$45.51	$61.50
Total production costs		$49.32	$66.65

Additional Resources

Iowa Pork Industry Center.
109 Kildee Hall. Iowa State University,
Ames Iowa, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

Iowa State University Extension. 2007.
Ag Decision Maker. Iowa State
University. Ames, Iowa.

Purdue University Extension, 2007.
The New Pork Industry Handbook.
Purdue University. West Lafayette,
Indiana.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Feed Budgets

IPIC NPP130 2007

Tracking feed usage is an important part of record keeping. Feed costs typically are 2/3 or more of the total cost of producing pigs, so even a small change in feed costs can affect profitability. Without accurate feed records, it is impossible to evaluate diet changes that result in a lower cost diet but may affect pig growth. Section 300 of this handbook discusses pig nutrition in detail and leaflet number 370 provides example pig diets. For the following examples, diets will be summarized and feeding phases will be simplified (Table 1).

Table 1. Reference diets for pigs[1].

	Growing pig body weights			Sow diets	
	30-80	80-160	>160	Gestation	Lactation
% Corn	65	77	85	86	69
% Soybean meal	32	21	13	10	28
% Base mix	3	2	2	4	3
Phase Name	**1**	**2**	**3**	**G**	**L**

[1] Adapted from Life Cycle Swine Nutrition, 1996.

Production assumptions

Litters farrowed	2/sow/yr	Lactating sow feed	16 lb/d
Lactation length	42 d	Sow weight change	0
Weaned pigs per sow	18/yr	Feed:Gain, phase 1	2:1
Weaning weight	40 lb/pig	Feed:Gain, phase 2	2.5:1
Market weight	270 lb/pig	Feed:Gain, phase 3	3.5:1
Gestating sow feed	5 lb/d		

Feed Budget to Produce 18 weaned pigs

Gestation Feed

$$365\ days/yr - (2\ lactations \times 42\ days/lactation) = 281\ days$$

$$281\ days \times 5\ lb/day = \textbf{1405 lb gestation diet}$$

$$1405\ lb\ gestation\ diet \times 86\%\ corn = 1208\ lb\ corn$$

$$1405\ lb\ gestation\ diet \times 10\%\ SBM = 141\ lb\ SBM$$

$$1405\ lb\ gestation\ diet \times 4\%\ base\ mix = 56\ lb\ base\ mix$$

Lactation Feed

$2\ \ lactations/yr \times 42\ \ days/lactation\ = \ 84\ \ days$

$84\ \ days \times 16\ \ lb/day\ =$ **1344 lb lactation diet**

$1344\ \ lb\ \ lactation\ \ diet \times 69\%\ \ corn\ = \ 928\ \ lb\ \ corn$

$1344\ \ lb\ \ lactation\ \ diet \times 28\%\ \ SBM\ = \ 376\ \ lb\ \ SBM$

$1344\ \ lb\ \ lactation\ \ diet \times 3\%\ \ base\ \ mix = \ 40\ \ lb\ \ base\ \ mix$

Table 2. Feed to produce 18 weaned pigs.

	Gestation	Lactation	Total	Per Pig
Corn, lb	1208	928	2136	119
Soybean meal, lb	141	376	517	29
Base mix, lb	56	40	96	5
Total, lb	1405	1344	2749	153

Each pig weighs 40 pounds, thus the whole herd feed conversion for producing weaned pigs in this example is:

$153\ \ lb\ \ feed \div 40\ \ lb\ \ gain\ = \ 3.85$

Feed budget to raise 1 pig from 40 lb to 270 lb

Phase 1

$80\ \ lb\ \ end\ \ wt - 40\ \ lb\ \ start\ \ wt\ = \ 40\ \ lb\ \ gain$

$40\ \ lb\ \ gain \times \frac{2\ \ lb\ \ feed}{1\ \ lb\ \ gain}\ =$ **80 lb Phase 1 feed**

$80\ \ lb\ \ Phase\ 1\ \ feed \times 65\%\ \ corn\ = \ 52\ \ lb\ \ corn$

$80\ \ lb\ \ Phase\ 1\ \ feed \times 32\%\ \ SBM\ = \ 26\ \ lb\ \ SBM$

$80\ \ lb\ \ Phase\ 1\ \ feed \times 3\%\ \ base\ \ mix = \ 2\ \ lb\ \ base\ \ mix$

Phase 2

$160\ \ lb\ \ end\ \ wt - 80\ \ lb\ \ start\ \ wt\ = \ 80\ \ lb\ \ gain$

$80\ \ lb\ \ gain \times \frac{2.5\ \ lb\ \ feed}{1\ \ lb\ \ gain}\ =$ **200 lb Phase 2 feed**

$200\ \ lb\ \ Phase\ 2\ \ feed \times 77\%\ \ corn\ = \ 154\ \ lb\ \ corn$

$200\ \ lb\ \ Phase\ 2\ \ feed \times 21\%\ \ SBM\ = \ 42\ \ lb\ \ SBM$

$200\ \ lb\ \ Phase\ 2\ \ feed \times 2\%\ \ base\ \ mix = \ 4\ \ lb\ \ base\ \ mix$

Phase 3

$$270\ lb\ end\ wt - 160\ lb\ start\ wt = 110\ lb\ gain$$

$$110\ lb\ gain \times \frac{3.5\ lb\ feed}{1\ lb\ gain} = \textbf{385 lb Phase 3 feed}$$

$$385\ lb\ Phase\ 3\ feed \times 85\%\ corn = 327\ lb\ corn$$

$$385\ lb\ Phase\ 3\ feed \times 13\%\ SBM = 50\ lb\ SBM$$

$$385\ lb\ Phase\ 3\ feed \times 2\%\ base\ mix = 8\ lb\ base\ mix$$

Table 3. Feed to feed 1 pig from 40 lbs to 270 lbs.

	P1	P2	P3	Total
Corn, lb	52	154	327	533
Soybean meal, lb	26	42	50	118
Base mix, lb	2	4	8	14
Total, lb	80	200	385	665

Thus the feed conversion ratio for 230 lb of gain in this example is:

$$665\ lb\ of\ feed \div 230\ lb\ gain = 2.89$$

Feed budget for 1 pig farrow-to-finish

This can be calculated by combining the feed budget for weaned pigs and growing pigs.

Table 4. Feed budget for 1 pig farrow-to-finish.

	Sow Feed	Pig Feed	Total
Corn, lb	119	533	652
Soybean meal, lb	29	118	147
Base mix, lb	5	14	19
Total, lb	153	665	818

In this example we assumed a 270 lb weight gain, thus the feed conversion ratio for the entire farrow-to-finish operation is:

$$818\ lb\ feed \div 270\ lb\ gain = 3.03$$

The above examples show how feed budgets can be generated and feed conversion calculated. It should be noted that the above are idealized examples. Actual production records show that feed conversion for the best niche herds is closer to 3.3 and others are considerably greater.

Additional Resources

Iowa Pork Industry Center.
109 Kildee Hall. Iowa State University, Ames, IA, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Environmental Needs of the Pig

IPIC NPP210 2007

An animal's environment is all of the external influences on the animal. The key components of a pig's environment are thermal, social, dietary, and management levels. These components interact with each other and the pig to create production conditions. By understanding the environmental needs of a pig and using strategies to provide the best environment, optimal production can be reached. Diet and management are addressed in sections 300 and 700 of this handbook; thermal and social components of pig environment are discussed here.

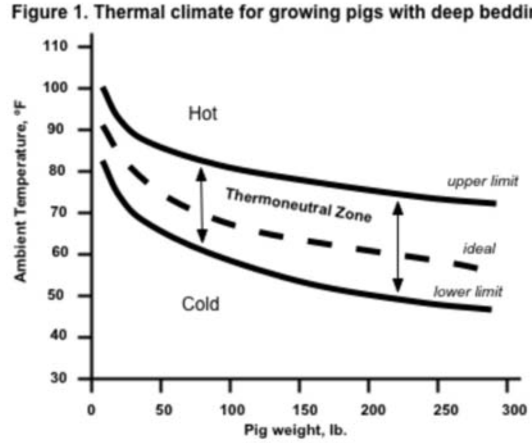
Thermal Environment

Thermal environment is created by the interaction of air temperature, moisture, and airflow. These factors are in turn impacted by a wide variety of factors such as size and number of animals, the degree of insulation within the building, the body condition of the pigs, the presence or absence of bedding, and other physical characteristics of the pigs and the housing system. The ideal air temperature for optimal production depends on the size of the pig and changes in air flow and floor characteristics (Table 1).

Table 1 illustrates the effect that bedding can have on a given pig. For example, in a building with no drafts, a 200 lb pig with deep bedding will experience the same thermal conditions at an air temperature of 55 ºF as the same pig would at an air temperature of 78 ºF if kept on a wet, solid concrete floor. Given the wide range of temperatures that the Midwest experiences throughout the year, this has practical implications for managing the thermal environment experienced by pigs.

Table 1 projects temperature for theoretically ideal conditions that are not always achievable in production settings. Fortunately, pigs are highly adaptable and will perform well within a range of temperatures. This range is called the thermoneutral zone. The thermoneutral zone (TNZ) is the range of ambient temperatures at pig level within which a pig can maintain normal body temperature (102.2 ºF) through control of sensible heat loss (Figure 1).

Figure 1. Thermal climate for growing pigs with deep bedding.



Adapted from Whittemore's Science and Practice of Pig Production, 2006 ; Life Cycle Swine Production, 1996.

Within the TNZ pigs effectively control heat loss by regulating blood flow to skin, modifying behavior such as huddling in groups or burrowing into available bedding, and shifting posture to affect the percentage of skin in contact with a given surface. For example, as ambient temperature nears the upper boundary of the TNZ, a pig will maximize the rate of blood flow to the skin and position itself to maximize contact with the air or flooring whichever is cooler. In most production settings this results in the pig lying fully on its side and preferentially seeking cooling drafts and wet concrete or manure. Alternatively, as ambient temperature draws near the lower boundary of the TNZ, pigs will reduce blood flow to the skin, huddle closely together, burrow into available bedding, and alter posture to minimize heat loss.

If temperatures fall below the TNZ, heat production by the pig must be increased through shivering or other means. Pigs with free access to feed will eat more feed and grow more slowly or less efficiently if temperatures are below the TNZ. If temperatures continue to fall, the ability of the pig to maintain body temperature may be overwhelmed and death could result. Alternatively as temperatures rise above the TNZ, pigs will greatly reduce feed intake, increase water consumption, and pant. If temperatures remain above the TNZ for extended periods of time, the pig's ability to cool itself may be overwhelmed and death may result.

Table 1. Ideal temperature for pigs of different body weights as impacted by ventilation rate and flooring type. It is assumed that growing pigs are fed *ad libitum*[1].

Weight of pig	Deep bedded, no draft	Deep bedded, moderate draft	Solid, wet, concrete floor, no draft	Solid, wet, concrete floor, moderate draft
Nursing pigs				
< 4 lb	> 90 ºF	> 100 ºF	NA	NA
< 12 lb	85 ºF	96 ºF	NA	NA
< 25 lb	70 ºF	79 ºF	NA	NA
Growing pigs				
20 - 35 lb	65 ºF	73 ºF	NA	100 ºF
35 - 65 lbs	60 ºF	68 ºF	90 ºF	100 ºF
65 - 130 lbs	58 ºF	65 ºF	85 ºF	96 ºF
130 -280 lbs	55 ºF	62 ºF	78 ºF	88 ºF
Gestating sows				
feed restricted, individuals	58 ºF	62 ºF	83 ºF	93 ºF
in groups	53 ºF	60 ºF	75 ºF	84 ºF
Lactating sows	55 ºF	62 ºF	78 ºF	88 ºF
Boars	58 ºF	65 ºF	83 ºF	93 ºF

[1]Adapted from Whittemore's Science and Practice of Pig Production, 2006.

Air Quality and Humidity

Fresh air is essential to keep pigs healthy and vigorous. Cool and dry is greatly superior to warm and wet. A warm, moist space is the perfect environment for disease organisms to thrive and propagate. The challenge for pig producers during cold weather is to keep buildings appropriately warm for the pigs while preventing moist air from accumulating causing humid conditions.

Warm air holds more moisture than cool air. In fact every 18 ºF increase in air temperature doubles the water holding capacity of the air. To keep the indoor environment dry in winter, cold dry air needs to come in from the outside. By adding cold dry air to the indoor environment the overall humidity decreases. The trick is to do this without causing a draft. Cold drafts are stressful to pigs and will reduce growth rates.

Social Environment

Social environment consists of the stimuli that form the means of communication between individual pigs. Groups of pigs will form a hierarchical social order. Typically order is maintained not by dominant animals relying on aggression, but rather by subordinate animals avoiding confrontation. This hierarchy may need to be reaffirmed or altered by occasional acts of aggression, but in general vocal and postural threats will usually maintain a stable social order within a group of pigs.

Mixing groups of pigs requires that the social order be re-established and typically results in temporary aggression between pigs, stress for the entire group, and decreased performance until the order of dominance has been re-established. Ideally, growing pigs that are farrowed in one room would be weaned together and kept as a single group until they reach market weight. In some situations this is not practical. If groups of unfamiliar pigs must be mixed, there are several strategies to minimize stress and negative impacts on performance (Table 2).

Pigs are social, inquisitive animals that seek out and investigate new animals, fresh bedding, people, and objects— including workers attempting to service or repair equipment and the tools they bring with them. Pigs tend to reflect the mood of those who are working with them, a critical point for all stockpeople to remember. It is important for stockpeople to physically walk through pens of growing pigs and gestating sows on a daily basis. This familiarizes the pigs with their caretaker and lowers the stress of moving or handling the pigs.

Table 2. Strategies to minimize stress when mixing unfamiliar groups of pigs.

Growing Pigs
Form groups as young as possible.
Move all pigs into an unfamiliar pen or barn within hours of each other.
Mix relatively equal-sized groups of animals of similar body weight.
Allow extra space, if possible.
Spray pigs with a common scent.
Sows
Form cohort groups of sows at weaning.
A mature boar with the sows can help minimize sow-to-sow fighting.
Do not mix groups of sows during implantation (8–25 days after mating).
Add new bedding with the introduction of new sows to a group.
Feed sows so that all sows can eat at the same time without interruption.
Allow extra space, if possible.

Pigs maintain distinct locations within their pen for feeding, sleeping, interacting with other pigs, and defecating. There must be enough flexible space within a pen for shy pigs to avoid dominant pigs, or in the event of a fight, use as an escape. Space needs change with group size. In general, larger group sizes require less space per pig because the area needed for escape is spread across more individuals. Providing pigs with insufficient space to meet these needs will result in stressed pigs, dirty pens, and less than optimal performance. Most niche pork markets have established guidelines for stocking density of pigs. A general rule of thumb for determining the maximum number of pigs for a given area is that when all the pigs are standing at least one half of the lounge area is visible, and when all the pigs are lying down one third of the floor space should be visible. Also, adequate space at feeders and waterers is essential for optimal production. One feeding space for every 4 to 6 pigs is generally adequate. Younger pigs will adjust to solid feed more rapidly if groups of pigs can eat simultaneously. Water flow rates and quality characteristics are discussed in leaflet number 310.

Modifying Environment

Table 3 summarizes pig behavior under different thermal environments and strategies that can be used to optimize production conditions. Providing adequate amounts of bedding and sufficient space is critical for pig production. Bedding allows pigs greater control of their thermal environment. A bedding pack will slowly decompose, providing a source of heat as well as a place for pigs to burrow into away from drafts. For hot temperatures pigs will spread out away from each other and lounge on top of the bedding pack, on wet concrete feeding floors, or in the wet dunging area of the pack.

Pigs are better equipped to handle cold weather than hot weather. When temperatures are cold, pigs will eat more feed and huddle together. While more feed energy may be devoted to maintaining body temperature, pig growth in bedded systems is generally not severely impacted by winter temperatures of the Midwestern U.S.

The exception is the very young and small pigs. Pigs are born with little fat to insulate themselves, and if not protected from drafts and given a warm dry place to nest will not easily survive. The farrowing house is an important part of the niche pork production chain. Providing well insulated, draft-free buildings for farrowing as well as creating warm microclimates for the young pigs is essential for optimal production.

Table 3. Pig behavior and stockman strategies to optimize performance under different ambient temperatures[1].

Too Hot
Pigs will:
Lie apart
Maximize contact with concrete
Use dunging areas for lounging to cool themselves
Create wallows
Become more irritable and aggressive
Pant
Decrease feed intake
Increase water consumption
Stockman can:
Allow more space per pig
Wet concrete floors
Increase airflow (volume and speed)
Spray pigs with water
Spray bedding with water
Insulate buildings
Too Cold
Pigs will:
Huddle together
Burrow into bedding
Increase feed intake
Extremities (ears and tail) may become frost-bitten
Stockman can:
Reduce draft
Provide additional bedding
Provide compositing bedding pack
Provide supplemental heating for newborn pigs
Insulate buildings
Increase stocking density:
Allow pigs to huddle together
Avoid a small number of pigs in a pen

[1]Adapted from Whittemore's Science and Practice of Pig Production, 2006.

One strategy that many niche pork producers utilize is low-capital cost facilities. However, using an uninsulated, drafty building for farrowing in the middle of winter usually does not lead to favorable results. Warm temperatures are critical for the very young pig. It may require more capital to modify an existing facility or build a new room or barn that is well-insulated and draft free, but savings in reduced energy costs to maintain suitable temperatures should not be ignored. A more detailed discussion of farrowing set-ups for niche pork production is included in leaflet number 220 of this handbook.

Hot weather reduces pig performance more than cold weather. Warm temperatures typically do not result in death losses, but reduce feed consumption and can disrupt pig flow because of lower conception in the breeding herd. The first line of defense against heat stress is providing adequate amounts of fresh, clean drinking water. Waterers should be checked frequently. Leaflet number 310 of this handbook addresses water supply.

Decreasing the number of pigs per pen is also a strategy for confronting warm temperatures. This reduces the number of pigs in the total air space of a building and thus reduces the heat generated by the animals. Increasing the rate of air movement through the building also assists pigs in cooling themselves. Pigs do not sweat, but evaporative heat loss is possible and will cool the pig. Pigs in heat stress may pant, a sign that other cooling strategies have failed and stockman intervention may be necessary.

Pigs larger than 150 pounds begin to feel the effects of heat stress at about 80 ºF. If temperatures remain above 85 ºF for more than short periods of time, substantial losses in performance and reproductive efficiency may result unless some type of cooling relief is provided.

Pigs do not dissipate enough moisture from their skin to effectively cool themselves. Evaporative cooling is an effective strategy for cooling pigs if wetting and adequate air movement occurs. In practice this may require periodic sprinkling of the pigs or wetting of a concrete surface that pigs have access to during summer months. Pigs should be allowed to dry off between sprays. Typically timers on spray lines are set at 1 minute on to 10 minutes off with nozzle flow rates set at 1 gallon per minute. In cases where airflow is limited, sprinkling of pigs should be done sparingly. Otherwise the relative humidity of the building will increase dramatically, compounding the negative impacts of hot temperatures.

The pasture wallow is a historic strategy for addressing summer heat. In addition to the evaporative cooling that occurs, the mud pack acquired helps protect the skin from sunburn. If pigs are kept outdoors on pasture or in lots, shade is usually necessary.

Table 4. Shade recommendations for outdoor pig production[1].

Type of Pig	Shade space	
Sow	15-20	square feet/sow
Sow and litter	20-30	square feet/sow
Pig < 100 lb	4	square feet/pig
Pig ≥ 100 lb	6	square feet/pig

[1] Adapted from Pork Industry Handbook PIH-55. 2002.

Table 5. Pasture recommendations for outdoor pig production[1].

10 gestating sows per acre
7 sows with litters per acre
100 growing pigs < 150 pounds per acre
50 growing pigs > 150 pounds per acre

[1] Adapted from Pork Industry Handbook PIH-55. 2002.

Additional Resources

Carr, John. 1998. Garth Pig Stockmanship Standards. 5M Enterprises Ltd. Sheffield, UK.

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Iowa State University Extension, 2002. Pork Industry Handbook. Iowa State University. Ames.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

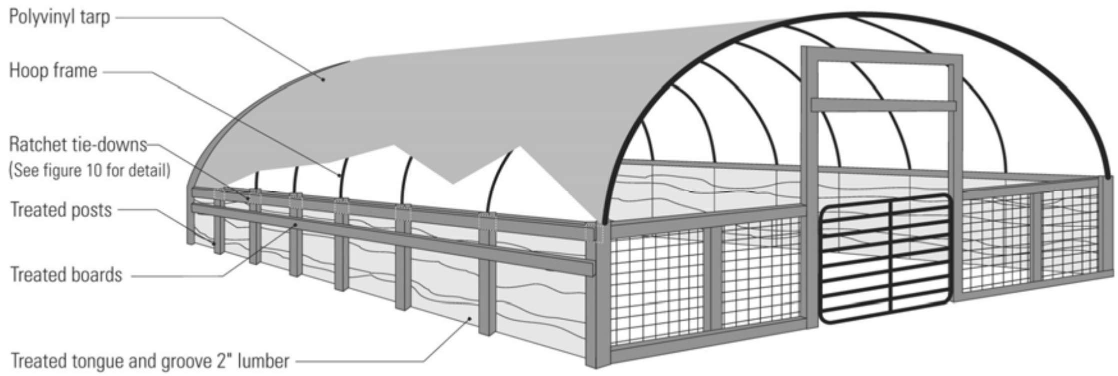
Housing Options

IPIC NPP220 2007

Pigs are adaptable animals and will thrive in a variety of housing systems. A key to successful pig raising is to meet the environmental needs of the pig while minimizing costs associated with the housing system. Leaflet numbers 210, 230, and 510 of this handbook address the environmental needs of pigs, bedding management, and scheduling of pig flow respectively. This leaflet addresses bedded housing options commonly used by niche pork producers.

Hoop barns are versatile, low-cost structures that are typical of deep-bedded systems.

Figure 1. Common components of hoop barns.



© MWPS (Midwest Plan Service), Iowa State University, Ames, IA. www.mwps.org.
Used with permission: *Hoop Barns for Grow-Finish Swine AED 41*.

Other structures are also suitable for deep-bedded systems, but all tend to incorporate the following:

- Low capital investment in facilities, thus allowing more space per pig and increased time between groups of pigs.
- Flexible and adjustable floor layouts.
- Designs that facilitate and utilize the natural behaviors of the pig rather than control and limit activity.
- Create a physical environment in which stockpeople enjoy working.

Breeding and Gestation

Successful mating is necessary to maintain consistent pig flow through facilities. The sow can perform well across a broad range of environmental conditions. Often the same facility that is used for breeding also will be used for gestation. Reproductive management is addressed in section 400 of this handbook. Important considerations for the breeding facility include:

- Individual sows must be easily observed so that estrus and pregnancy can be detected.
- If using natural insemination, the floor surface must provide traction.
- If using artificial insemination, a narrow holding area is usually necessary to allow for safe and timely insemination of the sow.
- A cooling system (sprinklers and/or fans) to reduce heat stress in summer.

Gestation facilities should have the following:

- A way to control feed intake -- individual feeding stalls, keeping sows in groups of 3 to 5, body-length partitions at the feeding trough, or high-bulk, low-energy diets are commonly used strategies.
- Easy sow movement from breeding to gestation and from gestation to farrowing.
- Adequate number of pens to avoid the mixing of unfamiliar sows during implantation -- a 21-day period beginning one week after insemination.
- Sows must be easily observable so that oncoming farrowing or return to estrus can be detected.

Historically, gestating sows were kept on pasture or in barns with outdoor access. Existing facilities often can be used to meet the needs of gestating sows. If new facilities must be built, hoop barns are low-capital investment facilities that work well for many niche market pork producers. Example layouts of hoop barns for gestating sows are included as Figures 2 – 5.

Figure 2. Feeding stalls on the west side of the structure.

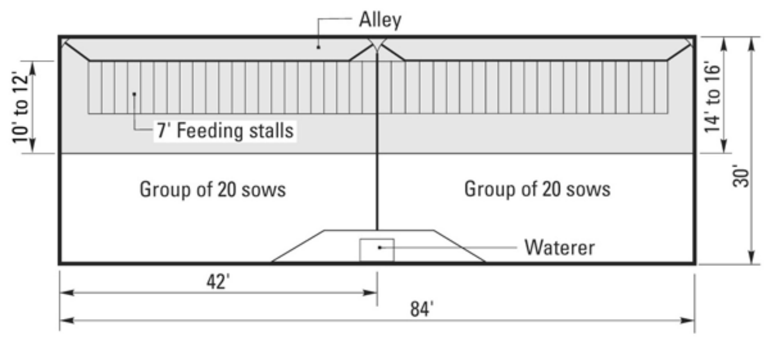


Figure 3. Feeding stalls on the south end of structure.

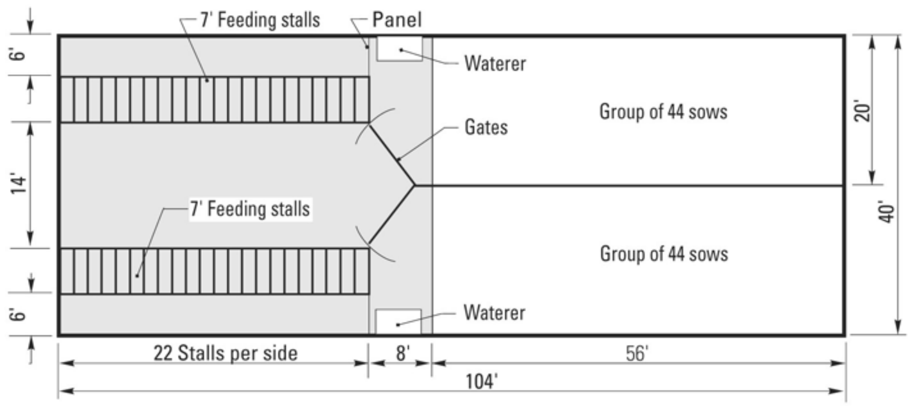
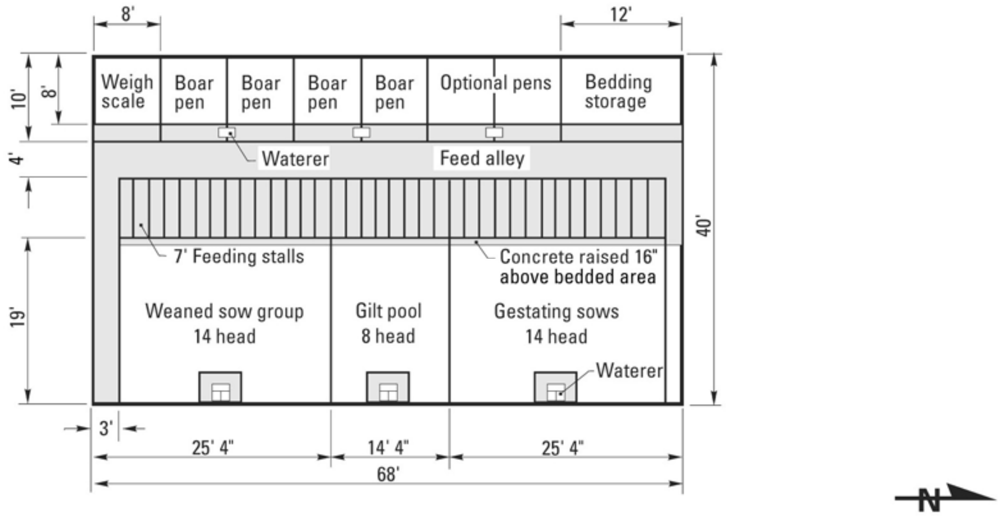
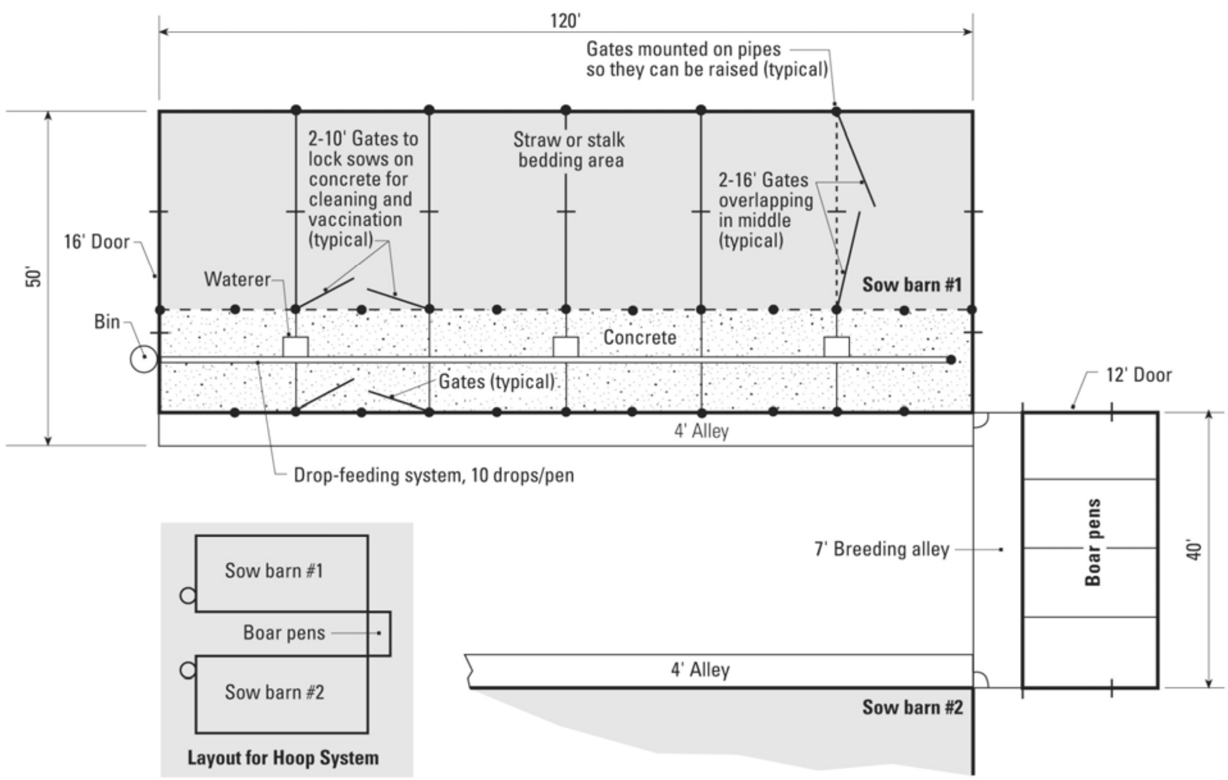


Figure 4. University research and demonstration layout for a small herd with space for boars, breeding, and bedding.



©MWPS (Midwest Plan Service), Iowa State University, Ames, IA. www.mwps.org. Used with permission: *Hoop Barns for Gestating Swine AED-44.*

Figure 5. Hoop system using two barns for sows and one barn for boars.



©MWPS (Midwest Plan Service), Iowa State University, Ames, IA. www.mwps.org. Used with permission: *Hoop Barns for Gestating Swine AED-44.*

Farrowing

Meeting the needs of pigs in the farrowing facility can be challenging because the thermal comfort zone of the mature sow and the newborn pig are very different. Most naturally-raised pork markets prohibit the use of farrowing crates. Alternative farrowing systems with bedding can be successfully used if a balance is struck between the needs of the sow and the litter:

- Room temperature should be maintained above 65 ºF if possible.
- Piglets should be provided a draft-free, protected area that can be warmed with supplemental heat, usually heat lamps and hovers. Hovers are often made of plywood and are used to enclose and trap heat in a smaller area that only the young pigs have access to.
- To avoid being crushed by the sow as she is lying down, piglets must have a space that the sow cannot access.
- Individual space for farrowing should be provided for each sow in the room.
- Keeping the very young pig (<10 days old) inside the farrowing stall or hut reduces the risk of chilling and injury from other sows.
- The age of the piglets within a room should be very similar, 7 days is the maximum recommended spread. This insures that older pigs do not steal milk from younger pigs.
- Group lactation, where several sows and litters are allowed to mingle after the pigs are 10 days old, is often practiced.
- A creep area is often provided during group lactation to provide feed and supplemental heat for the young pigs.
- Providing more space per sow allows her to better regulate her body temperature and prevent crushing of her litter.
- During lactation, sows should always have free access to clean water.
- The room must be easily cleaned. Periodic washing and disinfecting of this facility followed by adequate time for the room to thoroughly dry before the next group of pigs is farrowed is critical in maintaining herd health.

Figure 6. Room set-up in a building retrofitted with free stalls.

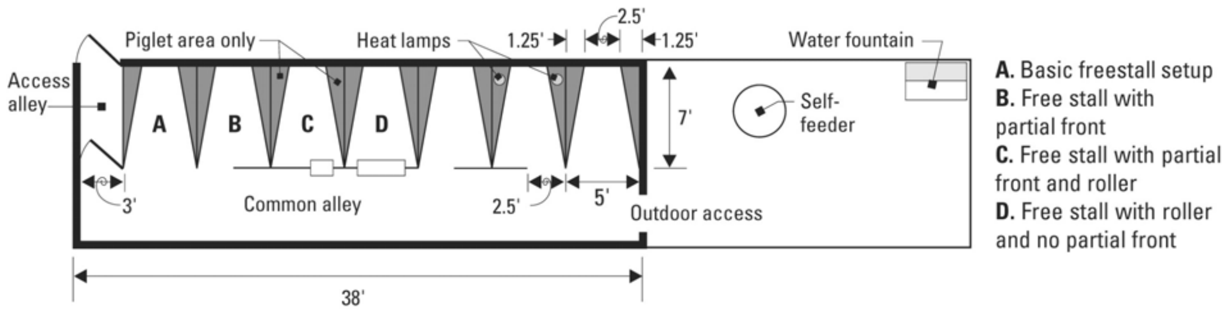


Figure 7. Retrofitted 1960's-style farrowing barn.

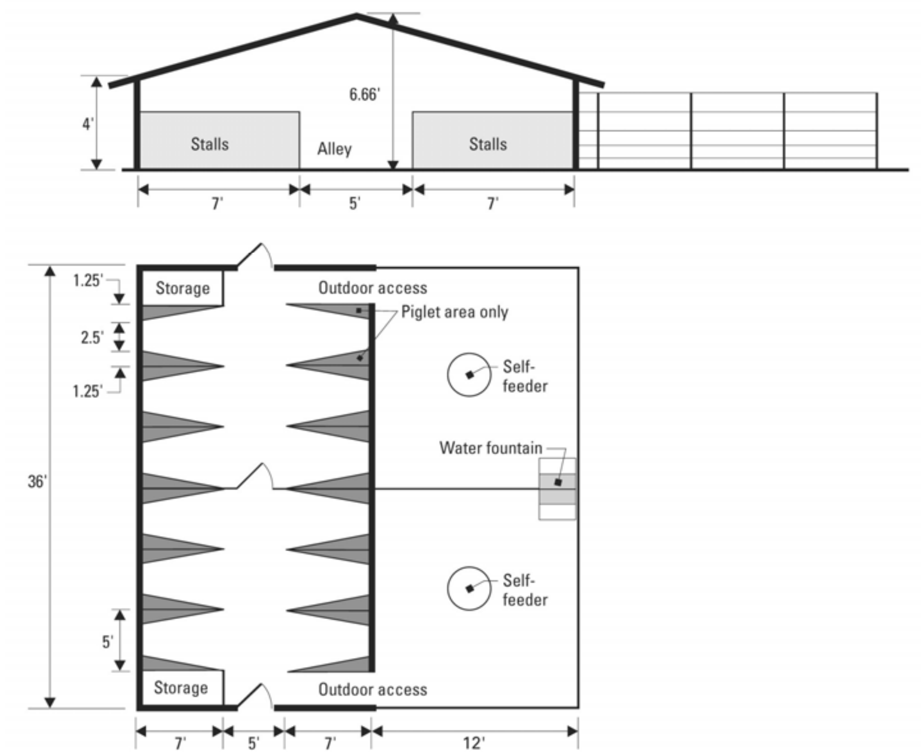
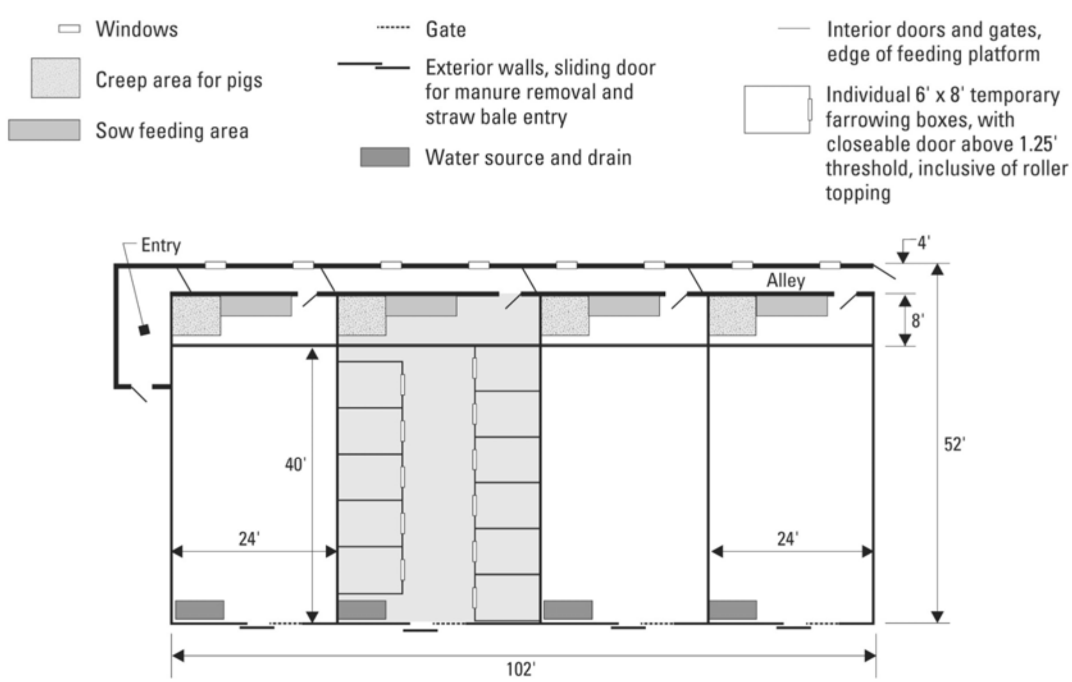
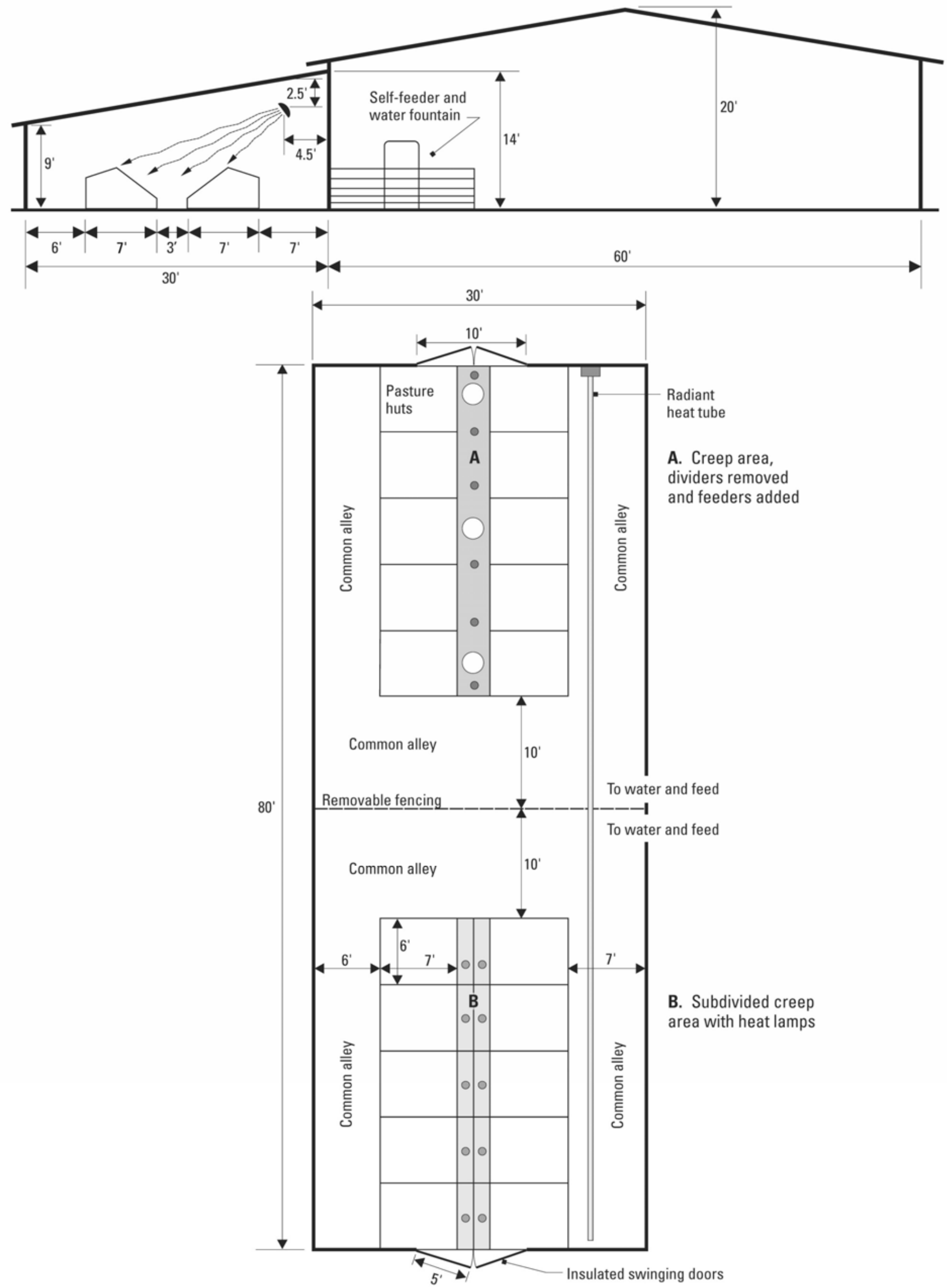


Figure 8. A Swedish System



Used with permission: *Alternative Systems for Farrowing in Cold Weather AED-47*.

Figure 9. Pasture huts with radiant tube heating.



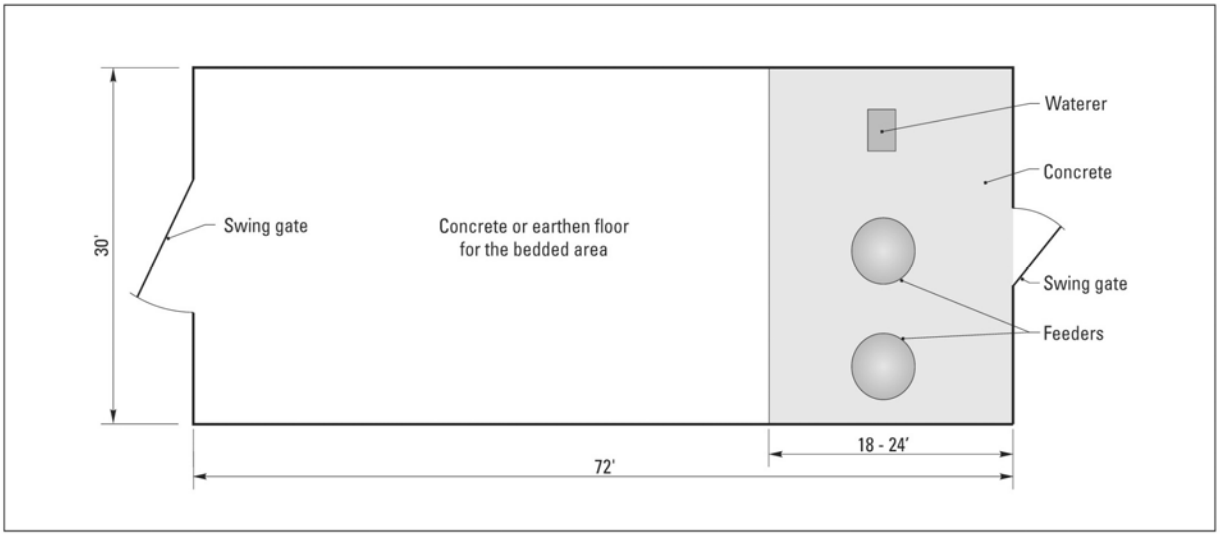
Used with permission: *Alternative Systems for Farrowing in Cold Weather AED-47*.

Growing Pigs

Growing pigs will thrive in diverse housing systems that include outdoor feeding floors, remodeled buildings, and hoop barns. Minimizing size differences within a group of pigs helps meet the environmental needs of the growing pigs. Growing facilities should:

- Allow pigs distinct areas for eating, sleeping, lounging, and defecating.
- Be managed using all-in-all-out strategies — a group of pigs is brought to the facility; no pigs are added to the group while they are growing; after pigs are sold, the building is cleaned and a fresh bedding pack and a new group of pigs is brought to the facility.
- Enable sorting and loading of pigs to occur with minimal stress and effort.
- Have a feeding, watering, and cooling system that is appropriate for the size and number of pigs.
- Have feeders positioned to allow easy feed delivery, usually on concrete pads or wooden platforms.
- Have maintained access roads for vehicles and machinery.

Figure 10. Typical layout for a grow-finish hoop barn.



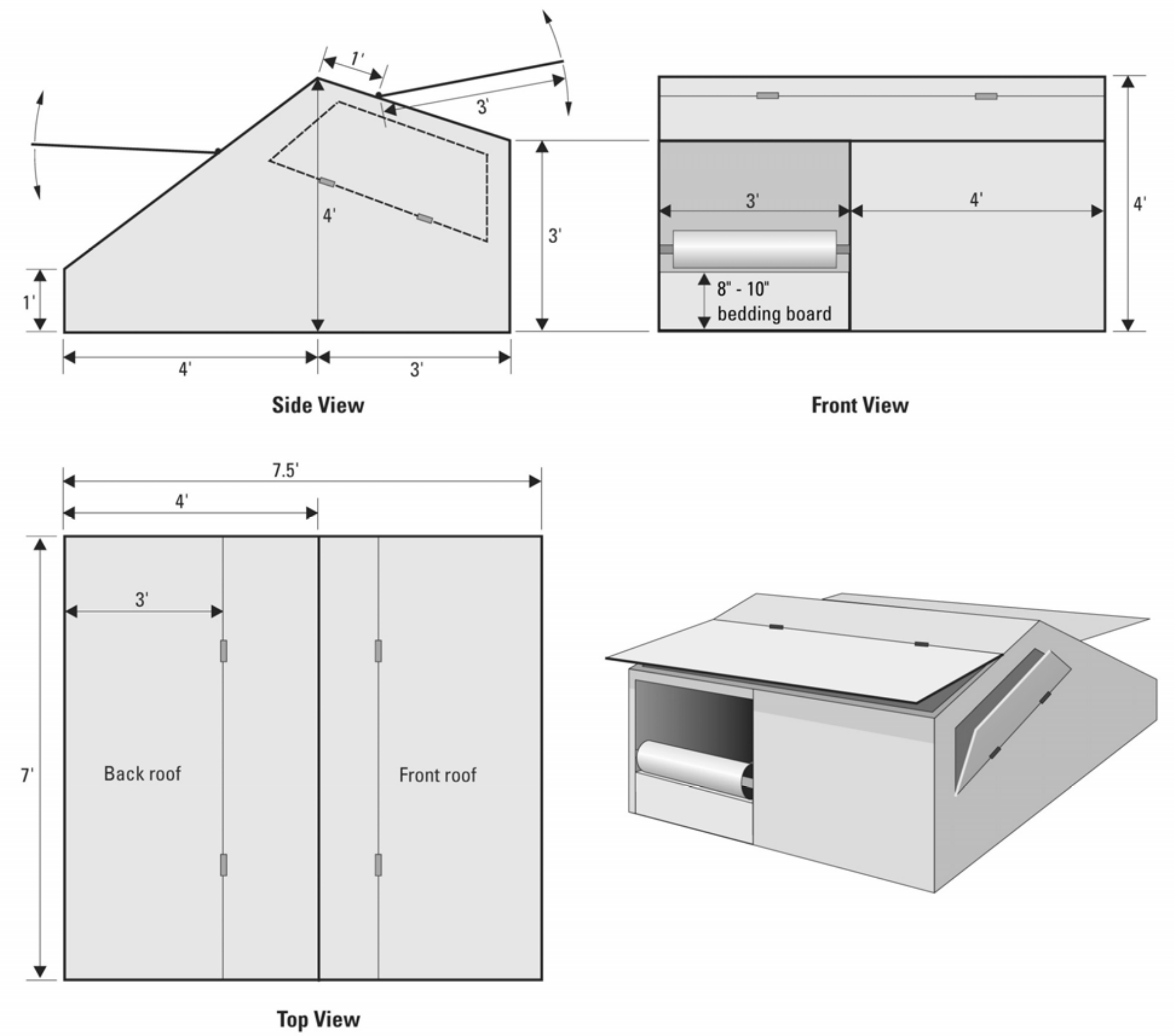
Pasture systems

Historically, many pigs were raised seasonally and on pasture. Although pastures require land and may not be suitable for optimal winter production, they can be successfully used by niche pork producers if the following guidelines are followed:

- Well-drained, sandy soils work best for pastures for pigs.
- Pigs should be placed on established sod, or temporarily in paddocks on harvested crop fields.
- Pastures should be rotated to prevent parasite build-up, vegetation destruction, and soil erosion.
- Fencing plan should be flexible to match vegetative growth and number of pigs; electric fencing systems are particularly adaptable to pig production.
- Pasture space recommendations depend on rainfall, soil types, and degree of vegetative cover, and should be adjusted to match local conditions.
- Provide adequate shade and dry resting areas.

- If allowed, nose rings may prevent severe damage to pasture vegetation.
- Electric fencing and all-terrain vehicles are useful technologies for pasture pork production.
- Predators such as birds of prey, coyotes, and dogs can be a concern in pasture systems.

Figure 11. Typical dimensions of a modified A-frame farrowing hut.



© MWPS (Midwest Plan Service), Iowa State University, Ames, IA. www.mwps.org. Used with permission: *Alternative Systems for Farrowing in Cold Weather AED-47*.

Additional Resources

Brumm, Michael, C., Jay D. Harmon, Mark S. Honeyman, James B. Kliebenstein, Steven M. Lonergan, Rebecca Morrison, and Tom Richard. 2004. Hoop Barns for Grow-Finish Swine. Agricultural Engineers Digest, AED–41. Midwest Plan Service. Ames, IA.

Harmon, Jay D., Mark S. Honeyman, James B. Kliebenstein, Tom Richard, and Joseph M. Zulovich. 2004. Hoop Barns for Gestating Swine. Agricultural Engineers Digest, AED–44. Midwest Plan Service. Ames, IA.

Lammers, Peter J., Mark S. Honeyman, and Jay D. Harmon. 2004. Alternative Systems for Farrowing in Cold Weather. Agricultural Engineers Digest, AED–47. Midwest Plan Service. Ames, IA.

Midwest Plan Service. 1983. Solar Livestock Housing Handbook. MWPS-23. Ames, IA

Midwest Plan Service. 1987. Structures and Environment Handbook, 11th Edition. MWPS-1. Ames, IA.

Midwest Plan Service. 1989. Farm and Home Concrete Handbook. MWPS-35. Ames, IA.

Midwest Plan Service. 1992. Swine Farrowing Handbook: Housing and Equipment. MWPS-40. Ames, IA.

Midwest Plan Service. 1997. Swine Nursery Facilities Handbook. MWPS-41. Ames, IA.

Midwest Plan Service. 2001. Swine Breeding and Gestation Facilities Handbook. MWPS-43. Ames, IA.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Bedding Management

IPIC NPP230 2007

Bedding is a critical component of most niche pork production systems. Pig comfort is increased with well-managed bedding packs. Bedding allows pigs to alter the temperature they experience. Areas within a bedding pack will begin to compost and can become very warm, a great advantage in winter. Alternatively, other spots remain cooler and spreading out into those areas allows pigs to cool themselves. Bedding provides a combination of potential benefits to sows and growing pigs such as nutrition, thermal regulation, physical comfort, and environmental enrichment.

Managing bedded systems optimally requires experience, but the following guidelines are useful starting points:

- Clean bedding should always be used, bedding that is dusty, like soybean stalks, may contribute to respiratory problems.
- Enough bedding should be used so that the surface underneath the bedding pack remains dry.
- Additional bedding should be added as dunging areas form to prevent sloppy areas from developing.
- Pigs with bedding should remain clean. Dirty-looking pigs suggest more bedding is needed.
- Excess moisture can leach nutrients out of the bedding pack.
- Bedding should be excluded from areas designated for feeding and watering.
- Bedding should be removed from pens after each group of pigs.
- Sow gestation facilities should be completely cleaned and re-bedded regularly.
- Bedding use during the summer is approximately one-third less than during winter.
- The mixture of bedding and manure may accumulate to a depth of three to four feet during the winter in some areas of growing pig barns.

Cornstalks and small grain straw is the most common type of bedding used, although other materials are also acceptable. Table 1 provides estimates of bedding use by different types of pigs. Sawdust, woodchips, shredded paper, etc. can be used as bedding with the critical considerations being absorbency and the material's structure when wet. For example, shredded paper is very absorbent, but tends to become a solid mat when wet. This solid mat can be difficult to remove. Alternatively, wood chips maintain their structure after wetting but are less absorbent than other materials. Mixing different bedding materials can help overcome some of these problems.

Successfully keeping sows with litters of pigs in bedded systems requires attention to detail. The bedding must remain dry to avoid chilling the pigs. Also, the use of heat sources such as heat lamps can be a fire hazard in systems that use bedding, particularly straw or cornstalks. While external heat sources are typically necessary for winter farrowing and for the very young pig, caution should be practiced. Every effort should be made to keep the supplemental heat away from the sows to minimize fire risk. Wood chips or shavings are less flammable than loose straw and are used by some producers during farrowing. Wood chips may create a bio-deck, with urine and feces collecting in the lower layer of material while the upper layer remains dry and comfortable. Saw dust or very fine wood shavings are very absorbent and may cause the newborn pig to bleed excessively through the naval cord.

Table 1. Estimated amount of bedding needed for various types of pigs[1].

Type of Pig	Type of Bedding	Average amount of yearly bedding
Sow and Litter	Shredded corn stalks	200 lb per sow
Birth to 5 week weaning	Oat straw	180 lb per sow
	Barley straw	240 lb per sow
	Wood chips*	185 lb per sow
	Shredded paper	250 lb per sow
Growing pigs	Shredded corn stalks	200 lb per pig
Wean to market	Oat straw	180 lb per pig
	Barley straw	240 lb per pig
	Hardwood sawdust*	335 lb per pig
	Pine sawdust*	200 lb per pig
Gestating sows	Corn stalks	2500 lb per sow space
	Oat straw	2250 lb per sow space
	Barley straw	3000 lb per sow space

[1]Based on AED 41, AED 44, and ASR 2153.

*Wood products should be used with caution. Wood chips and sawdust exposed to bird droppings need to go through a heat cycle to avoid transmission of avian tuberculosis to pigs.

Additional Resources

Brumm, Michael, C., Jay D. Harmon, Mark S. Honeyman, James B. Kliebenstein, Steven M. Lonergan, Rebecca Morrison, and Tom Richard. 2004. Hoop Barns for Grow-Finish Swine. Agricultural Engineers Digest, AED–41. Midwest Plan Service. Ames, IA.

Harmon, Jay D., Mark S. Honeyman, James B. Kliebenstein, Tom Richard, and Joseph M. Zulovich. 2004. Hoop Barns for Gestating Swine. Agricultural Engineers Digest, AED–44. Midwest Plan Service. Ames, IA.

Voyles, Reggie and Mark S. Honeyman. 2006. Absorbency of alternative livestock bedding sources. A.S. Leaflet R2153. Iowa State University Animal Industry Report 2006. Iowa State University Extension, Ames.

Manure and Mortalities

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP240 2007

Manure and mortalities are inevitable in pig production. Both can be valuable sources of nutrients for crop production but require careful management to avoid negative consequences. This leaflet addresses manure and mortality management strategies that are appropriate for niche pork producers.

Manure

Bedded systems typical of niche pork production systems result in large volumes of manure and bedding mixtures. Handling this material can require a great deal of time and labor. A standard skid loader may not be sufficient to remove a large bedding pack. Producers who use hoop barns typically find that a front-wheel assist tractor with grapple fork attachment on the front-end loader is the best equipment to use.

Pig manure is a valuable source of nutrients for crops and should to utilized as a resource rather than perceived as a waste product.

There are several challenges to utilizing manure and bedding mixtures taken directly from pens or buildings:

- Variable nutrient content of the manure makes it difficult to estimate fertilizer value accurately.
- Physical characteristics of bedding such as cornstalks may create spreading problems.
- Irregular manure distribution may create problems in minimum tillage cropping systems.
- Large amounts of organic matter are returned to crop land, but unstabilized carbon in bedding can reduce nitrogen availability during the year after application.

Composting manure is a strategy that effectively addresses the above concerns. Composting is the aerobic decomposition of organic materials. For complete composting to occur, a temperature range of 110–149 ºF within the compost is necessary. These high temperatures allow the destruction of weed seeds and pathogens.

Swine manure from hoop barns can compost well if the drier and wetter parts of the bedding pack are layered in the compost pile. With periodic turning, completely composted material is odorless, fine-textured, and low in moisture.

The equipment, space, and labor needed to convert large amounts of bedding and manure into finished compost may not be practical for some producers. Fortunately, the process of composting is continually occurring in bedded systems. Piling manure and bedding in simple windrows or piles of 5–7 ft high and 10–15 ft wide allows partial composting to occur and greatly reduces the volume of material to be delivered to crop land. In a two to three month period, volume and weight of the composting material can be reduced by 50–60% depending upon precipitation.

Land Application

Manure should be applied to crop land based upon nutrient content of the material and crop nutrient needs. Site-specific manure analysis allows more accurate prediction of the value of the manure and bedding as fertilizer for crops. Composting reduces the nutrient variability of the manure and bedding mixture and allows more uniform land application.

It is important to remember that the cumulative losses of nitrogen from bedded systems tend to be higher than from slurry manure systems. Phosphorus and potassium are better conserved although loss of these elements will occur in outdoor composting systems if runoff and leaching is not limited. Immobilization of nitrogen by the carbon-rich manure and bedding pack can be avoided by composting. However, with adequate cropland available, manure and bedding from fall cleanouts applied fresh to fields and then incorporated into the soil results in more total nutrients being delivered to the cropland (Table 1).

Table 1. Characteristics of fresh and composted bedded manure from swine finishing hoops[1].

	Pounds per ton		Percent[2]	
	Mean	Range	Mean	Range
Fresh hoop manure				
Dry matter	700	540-1180		
Nitrogen[3]	15.4	8-25	2.2	1.5-2.8
Phosphorus[3]	6.9	5-8	1.0	1.5-2.8
Potassium[3]	15.1	12-21	2.1	1.7-2.4
Compost				
Dry matter	1020	650-1530		
Nitrogen[3]	19.6	13-35	1.9	1.2-2.8
Phosphorus[3]	11.9	9-25	1.2	0.9-2.2
Potassium[3]	20.1	19-36	2.0	1.0-3.0

[1] Adapted from AED 41.
[2] Dry matter basis
[3] All nutrients are reported on an elemental basis (N, P, K; not NH_3, P_2O_5, or K_2O).

Mortalities

While health and husbandry practices minimize pig mortality, inevitably there is some death loss on pig farms. Disposing of these mortalities can be accomplished through rendering, incineration, burial, and composting. Storing and transporting carcasses results in risks of disease. Incineration generally is not practical for most niche market pork producers and burial may require excessive amounts of time, labor, and/or machinery. Some producers will use a series of post holes for burial of dead piglets, but burial is not a practical option during the winter months.

Composting mortalities is an attractive option because it allows the capture of the nutrients within the mortality while minimizing health risks for the operation.

Mortalities can be disposed by composting as long as the carcass is well covered on all sides. Generally 18 in of compost on the bottom, sides, and top of mortalities is sufficient to eliminate odors and avoid attracting scavengers. A pig carcass will typically degrade within 3–6 weeks depending upon the size of the animal and characteristics of the composting pile.

The resulting compost can be applied to crop land as regular manure and bedding compost. Some states have specific rules or guidelines for composting mortalities so it is important to check for regulatory compliance.

Additional Resources

Anonymous. 2001. Livestock and Poultry Environmental Stewardship Curriculum. CSREES, USDA, EPA, NAAC. Midwest Plan Service. Ames, IA.

Brumm, Michael, C., Jay D. Harmon, Mark S. Honeyman, James B. Kliebenstein, Steven M. Lonergan, Rebecca Morrison, and Tom Richard. 2004. Hoop Barns for Grow-Finish Swine. Agricultural Engineers Digest, AED–41. Midwest Plan Service. Ames, IA.

Eghball, Baham, and Ruihong Zhang. 1998. Composting Manure and Other Organic Residues in the North Central Region. North Central Regional Extension Publication number 600.

Iowa State University Extension, Iowa Manure Management Action Group http://extension.agron.iastate.edu/immag/default.htm

Iowa State University, Department of Agricultural and Biosystems Engineering. disSolving Swine Mortality Problems. http://www3.abe.iastate.edu/PigsGone/index.htm

Iowa Department of Natural Resources. Animal Feeding Operations. http://www.iowadnr.com/afo/appcert.html

Midwest Plan Service. 1992. On-Farm Composting Handbook. NRAES-54. Ames, IA.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Nutrients for Pigs

IPIC NPP310 2007

Like all animals, pigs need nutrients for life. Pigs are typically provided nutrients as a mixed and balanced diet. Diets that are insufficient or excessive cause unsatisfactory performance. Because 60-70 percent of production cost is feed costs, understanding the basic nutritional needs of the pig and how to meet them is important. To determine the appropriate diet for a given pig, body size, productivity, genetic potential, and environmental conditions must be considered. This leaflet discusses the nutritional requirements of pigs in terms of four broad categories: water, energy, amino acids, and vitamins and minerals.

Water

Drinking water, offered free choice, is usually the major source of water for pigs. Important considerations for drinking water are quality, delivery rate, and drinking spaces needed.

Waterers should be checked daily. Damaged and dirty waterers should be repaired or cleaned immediately. Trough waterers commonly are used by niche producers and may become clogged with bedding or feed if not cleaned regularly. Water quality assessments should be performed as part of site selection for pig production (Table 1). Corrective measures such as filters or additives may be effective in some cases of poor quality water.

If water pressure is not sufficient in nipple waterers (Table 2), pigs will compensate by spending more time drinking. However, if there are not enough drinking spaces in a particular pen, some pigs will be deprived of water. It is recommended that at least two sources of water be provided to pens of pigs. This way even if one waterer becomes clogged or dominated by a few animals, the other still will be available for use.

Table 1. Water quality assessment factors for pig drinking water[1].

Measure	Safe Level (ppm)
Total dissolved solids	3000
Nitrates	100
Nitrites	10
Sulfate	1000
Calcium	1000

[1]Adapted from Swine Nutrition 2nd edition, 2001.

Table 2. Flow rate and pigs per drinking space[1].

Size of Pig	Flow rate (pints/min)	Pigs per 12 inch trough
15-50 lb	2-3	40
50-150 lb	3-4	25-35
>150 lb	4	25
Lactating sow	5	12

[1] Adapted from Garth Pig Stockmanship Standards, 1998.

Symptoms of water deprivation in pigs[1].

- Reduced feed intake.
- Crowding around waterer.
- Pigs agitated and irritable.
- Tail biting.
- Diarrhea in piglets.
- Increased heart rate and body temperature.

[1] Adapted from Swine Nutrition 2nd edition, 2001.

As temperatures increase, water consumption increases. While it is of little practical use to precisely calculate water requirement for pigs with a goal of minimizing water consumption, Table 3 provides guidelines that might be beneficial when sizing well pumps or planning water use.

Table 3. Predicted water intake by pigs[1].

Type of Pig	Gallons per day
Lactating sow	6.5 – 11
Gestating sow	2.5 – 5.3
Growing pigs < 40 lb	Dry feed intake x 1.3 [2]
Growing pigs > 40 lb	Dry feed intake x 1.6 [2]

[1] Adapted from Whittemore's Science and Practice of Pig Production. 3rd edition, 2006.
[2] See IPIC NPP330 2007: Feed and Growth.

Energy

Pigs need energy to grow. Energy in pig diets usually is supplied by carbohydrate sources such as corn or small grains. Corn and other feed grains provide energy as starch.

Fats and oils (or lipids) provide dense sources of energy that also are readily utilized as energy by pigs. Pound for pound fats provide 2.25 times more energy than carbohydrates. Factors such as cost and meat quality implications should be considered when using fats and oils.

The energy concentration of a diet determines feed intake. Pigs eat feed until they have consumed adequate energy to meet their daily needs. If pigs are fed low energy diets, their gut capacity may limit growth. This typically is not a concern for producers feeding corn-soybean meal diets, but might become an issue when feeding forages to growing pigs.

Amino Acids

Amino acids are necessary for pigs to build muscle tissue. Amino acids are obtained from proteins in feed. There are 20 different amino acids that are required to make muscle. The pig cannot manufacture 10 of these amino acids. Pigs must gain these amino acids by eating feeds that contain them. Amino acids that must be eaten are called essential amino acids. Amino acids are required in proportion relative to each other. Supplying 19 amino acids in excess but not enough of the remaining one will limit growth and production. The amino acid found in least abundance relative to the pig's requirement is called the first limiting amino acid. In typical pig diets, lysine is usually the first limiting amino acid, followed by tryptophan, threonine, and methionine.

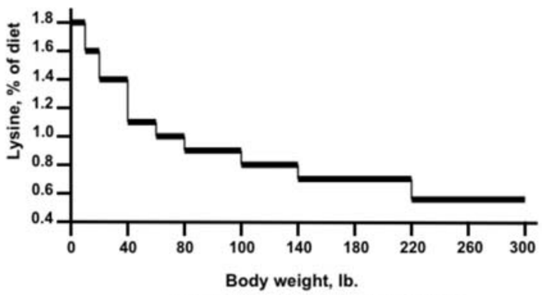
Crude protein is not a true measure of amino acid content of a feed. Rather it is a measure of the amount of nitrogen present in a particular sample. Crude protein can be used as a preliminary estimate of the amino acid content of a feed.

Not all amino acids present in a feed are available to the pig. If subjected to high heat, protein and starch will become indigestible by pigs. Heat damaged corn or soybean meal should be avoided for this reason.

Feed intake is determined by the energy concentration of the diet. Sufficient amino acids must be present in the diet to support muscle growth at the level of feed consumed. For pigs less than 110 pounds, the pig's ability to deposit muscle generally exceeds its ability to consume sufficient feed to meet those needs. Thus pigs less than 110 pounds should be fed diets with more concentrated levels of amino acids than older pigs. The lysine requirement of pigs as a percentage of the diet is shown in Figure 1.

Protein fed in excess of the needs of the pig is excreted as urea. Once excreted, urea is broken down by microbes into ammonia and other forms of nitrogen. Feeding excess protein to pigs is an inefficient way to increase delivery of nitrogen to crop land. While energy feeds (corn) are typically the main component of diets, protein feeds (soybean meal) also are a major part of the diet. Matching amino acids supplied with muscle growth allows for less costly diets to be formulated.

Figure 1. Lysine requirements of pigs, % of diet.



Adapted from Life Cycle Swine Nutrition, 1996.

Vitamins and Minerals

Vitamins and minerals also are required by pigs. Most feed suppliers offer vitamin and trace mineral mixes that have been formulated to meet the requirements of pigs at different stages of growth. Careful attention must be paid to storing vitamin and mineral premixes because their effectiveness may decrease if not stored in accordance with manufacturers' instructions.

Macro-minerals important to pig producers are calcium, phosphorus, and sodium. Calcium and phosphorus are linked. Both are major components of bone. Calcium and phosphorus are deposited in bone at a ratio of 2.2:1. Availability of these minerals depends on the feed source as well as mineral status of the body. In general, the ratio of dietary calcium to available phosphorus should not exceed 2.5:1.

Phosphorus is found in many feeds. Unfortunately plants typically store phosphorus in an inaccessible form -- phytate. Pigs do not make the enzyme phytase and therefore cannot use much of the phosphorus found in grain. Inorganic sources of phosphorus such as dicalcium phosphate are readily available to the pig, however they can be costly. Synthetic phytase is available and can be fed in some niche markets. Including synthetic phytase in pig diets allows pigs to utilize the phosphorus naturally found in feeds and in turn reduces the need for including phosphorus supplements and ultimately reduces phosphorus excretion.

Sodium is usually supplied as common salt. Salt is widely used in diets at the level of 0.3%. Although salt is relatively inexpensive, dietary levels of common salt above 1% may cause salt toxicity, especially if water is restricted, and should be avoided.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Jurgens, Marshall H. and Kristjan Bregendahl. 2007. Animal Feeding and Nutrition 10th Edition. Kendall/Hunt Publishing Company. Dubuque, IA.

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

Morrison, F.B. pre–1950. Feeds and Feeding. The Morrison Publishing Company. Ithaca, NY.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Feedstuffs for Pigs

IPIC NPP320 2007

Balanced pig diets contain two main components -- energy and amino acids. Many feedstuffs are appropriate for use in pig diets. However, corn-soybean meal diets are the most common. Corn is an excellent source of energy for pigs, and most other energy feedstuffs are priced relative to corn. The amino acids of soybean meal complement corn's amino acids resulting in a diet that matches the nutritional needs of the pig well. Table 1 presents suggested maximum levels of different feedstuffs in pig diets.

Energy Feeds

Corn is the major energy feed fed to pigs. Other energy feeds are priced relative to corn and often are more variable in their quality. Potential benefits of homegrown alternative energy grains include adding another crop to the crop rotation, providing a source of bedding other than cornstalks, and possibly greater net yields than corn.

$$Net\,Yield = \frac{Total\,Useful\,Outputs}{Total\,Inputs}$$

Small grains such as oats, barley, wheat, and triticale are the most common alternative energy grains. These crops are harvested earlier than corn, allowing manure to be spread on fields before corn harvest. In Iowa, these crops tend to yield less than corn both in terms of bushels per acre and pig available calories per bushel, and usually are limited in their use.

Processing coproducts such as vegetable oils, dried distillers grains with solubles, corn gluten feed, and corn gluten meal can replace some corn in pig diets. If allowed, animal fat is another excellent source of energy for the pig. Economics generally determine the use of these feedstuffs for pigs. Table 1 presents suggested inclusion levels for a number of energy feeds.

Protein Feeds

Protein feeds are used to supply amino acids in pig diets. Soybean meal is by far the most common feedstuff used to supply pigs with essential amino acids. Alternatives such as whole soybeans, field peas, alfalfa meal, canola meal, linseed meal, sunflower meal, whey, fish meal, plasma protein, and meat and bone meal exist. However, most niche markets prohibit the use of feeds from fish or animal tissue.

Field peas, alfalfa meal, canola meal, linseed meal, and sunflower meal are not common in pig diets in the Midwest, and the characteristics of these feedstuffs are not as well known as soybean meal. Whole soybeans must be cooked or extruded to make the amino acids available to the pig. Whey protein is commonly used in young pig diets but economics limit its use in other diets. Table 1 details suggested levels of several protein feeds.

Dried distillers grains with solubles and corn gluten feed have large amounts of crude protein; however, the availability of the amino acids present in those feeds may be limited. Corn gluten meal has improved amino acid availability, but typically is not economical to feed to pigs. The protein in corn is low in lysine, a critical amino acid for pig muscle growth. Corn-based protein feeds need to be supplemented with a source of lysine.

Crystalline forms of some amino acids are available for feeding to pigs. Check with your market before using crystalline amino acids in pig diets to insure compliance with niche market guidelines. Generally, crystalline amino acids are more expensive than soybean meal, but allow more precise diet formulation. Crystalline amino acids usually are more digestible than other forms of amino acids and can be used to precisely match amino acid content of the diet with needs of the pig, thereby reducing the crude protein content of the diet. As discussed in leaflet 310 of this handbook, dietary amino acids in excess of need are not used by the pig but rather are excreted in the urine.

Feedstuffs and Pork Quality

Maintaining pork quality is critical, and feedstuffs influence meat quality. Fat quality is a major component of pork quality. Fat quality is defined in terms of physical and nutritive characteristics. Major issues relating to fat quality include soft fat, off-flavors, and impact of the composition of pork fat on human health.

Soft fat is a major concern to meat processors because it can cause problems in meat processing. These problems result in lower processing yields and reduced value which impact pork producers. Soft fat becomes rancid with off-flavors more quickly than normal fat. Additionally, extremely soft fat may be oily, a characteristic that is considered very undesirable by most consumers. Vegetable oils and coproducts with high levels of vegetable oil reduce the firmness of pork fat. At dietary inclusion levels of less than 10% oil, pork quality generally is not impacted. Pigs fed corn-soybean meal diets have good fat quality, although there is evidence that including barley in the diet may lead to an even higher quality fat in terms of firmness and color.

Fish oils and meals are very susceptible to rancidity and the development of off-flavors. Feeding fish oils or fish meals may result in fishy taints in the meat. Although usually prohibited by niche markets, if allowed fish oils and meals should be used at low levels and with caution. Table 1 values for fish meal and fish oil have resulted in satisfactory performance and fat quality.

There is a close relationship between the composition of dietary and body fat in the pig. Thus it is relatively easy to manipulate pork fat composition by changing the type of the fat fed to the pig. High levels of saturated fat have been associated with cardiovascular disease in humans. There is interest in increasing the intake of "healthier" fats by humans through manipulation of the diets fed to pigs. Omega-3 fatty acids have been associated with a beneficial effect on cardiovascular diseases. Feeds high in omega-3 fatty acids such as flax, linseed meal, or linseed oil may increase the amount of omega-3 fatty acids in pork fat. Research suggests that feeding flax at levels below 15% improves omega-3 fatty acid content of pork fat without negatively impacting pork fat quality.

Forages

Forage and pasture historically have been vital components of pig production. While less commonly used today, there remain benefits to including forages in pig diets. Forages can replace some grain and protein supplements in pig diets. It is important to remember that the digestibility of the amino acids and energy in forages tends to be less than the digestibility of feeds such as corn and soybean meal. Forage fiber may reduce diarrhea problems in young pigs. Sows fed high amounts of forage can access self-feeders without becoming excessively fat. This simplifies feed management for the gestating sow herd and may improve sow welfare.

Because of their high fiber content, and limited availability of energy and amino acids, forages should not be fed at high levels to lactating sows and young pigs. Gestating sows are the best type of pig to feed forages. Growing pigs can perform acceptably on pasture if supplemented with concentrated feeds. If forages are fed, gradually increase the amount of forage fed to pigs over 40 pounds in weight. Pigs will utilize more nutrients from forages following a two-month adaptation period. Digestibility of forages also increases with maturity of the pig.

Human Food Waste

Although pigs fed a corn-soybean meal diet perform well, pigs are omnivores and can use a wide range of feedstuffs. They may perform valuable functions as recyclers of nutrients found in food that is no longer fit for human consumption. Pigs will use the nutrients found in dried bakery wastes and rejected fruits and vegetables. Processed foods such as candy, popcorn, potato chips, cereal, and pasta that failed to meet specifications or have passed a manufacturer's expiration date also can be fed to pigs. Table scraps and other food wastes from restaurants, schools, and other institutions can be used by pigs. However, raw garbage should not be fed to pigs. If table scraps and food wastes contain animal products they may not be acceptable in some niche markets. Check both marketing guidelines and state regulations governing feeding human food wastes to pigs to insure compliance.

Additional Resources

Honeyman, Mark S., Peter J. Lammers, and Sherry Hoyer. 2007. Feeding Bioenergy Coproducts to Swine: Distillers Dried Grains with Solubles (DDGS). IPIC 11a. Iowa State University Extension. Ames.

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Jurgens, Marshall H. and Kristjan Bregendahl. 2007. Animal Feeding and Nutrition 10th Edition. Kendall/Hunt Publishing Company. Dubuque, IA.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

Morrison. pre–1950. Feeds and Feeding. The Morrison Publishing Company. Ithaca, NY.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

Thacker, P. A. and R. N. Kirkwood. 1990. Nontraditional feed sources for use in swine production. Butterworth. Stoneham, MA.

Table 1. Feedstuff inclusion level for satisfactory growth and performance[1].

	Percentage of diet			
	Sows		Growing Pigs	
Feedstuff	Gestation	Lactation	≤ 40 lbs	≥ 40 lbs
Alfalfa meal, dehydrated	0-50	0-10	0	0-5
Alfalfa hay	0-60	0	0	0-15
Barley	0-90	0-85	0-25	0-95
Corn	0-90	0-85	0-25	0-95
Corn, dried distillers grains w/ solubles	0-40	0-20	0-10	0-30
Corn, gluten feed	0-90	0	0	0
Corn, gluten meal	0-5	0-5	0	0-5
Corn, silage	0-60	0	0	0-15
Field peas	0-15	0-15	0-15	0-30
Grass hay	0-15	0	0	0-5
Grass–legume hay	0-30	0	0	0-10
Legume, haylage	0-60	0	0	0-15
Oats	0-90	0-15	0-15	0-40
Skim milk, dried	0	0	0-20	0
Sorghum	0-90	0-85	0-45	0-95
Soybean meal	0-10	0-25	0-45	0-40
Soybeans, full-fat cooked	0-15	0-30	0-60	0-50
Soybean oil	0-8	0-8	0-8	0-8
Sunflower meal	0-10	0	0	0-10
Triticale	0-90	0-40	0-25	0-40
Wheat	0-90	0-85	0-45	0-90
Whey, dried	0-5	0-5	0-30	0-5

Feedstuffs that are commonly prohibited by niche market requirements

	Percentage of diet			
	Sows		Growing Pigs	
Feedstuff	Gestation	Lactation	≤ 40 lbs	≥ 40 lbs
Animal fat	0-10	0-10	0-10	0-10
Blood meal	0-5	0-5	0-5	0-5
Fish meal	0-10	0-10	0-10	0-5
Fish oil	0-5	0-5	0-5	0-3
Meat and bone meal	0-10	0-5	0-5	0-5
Poultry by-product meal	0-5	0-5	0	0-5

[1] Based on Life Cycle Swine Nutrition, 1996 and Nontraditional feed sources for use in swine production, 1990.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Relative Value of Feedstuffs

IPIC NPP330 2007

There are many ways to calculate the relative value of feedstuffs for pigs. The 2007 Pork Industry Handbook article “Relative value of feedstuffs for swine” (PIH 07-06-03) is particularly useful for producers. Metabolizable energy, digestible lysine, and available phosphorus are three essential and costly components of pig diets that can be used to determine relative value of alternative feeds. Solving simultaneous equations to estimate the value of metabolizable energy (ME), digestible lysine (dig. Lys), and available phosphorus (Avail P) in three reference feeds with known market prices is one method for calculating the value of an alternative feedstuff.

The basic equation utilized is as follows:

$$(ME)X + (Dig.\ Lys)Y + (Avail.\ P)Z = Relative\ \ Value,\ \$/cwt$$

Where X, Y, and Z are the values for ME, dig. Lys, and Avail. P, respectively. For example, using corn, soybean meal (sbm), and dicalcium phosphate (dical) as the three reference feedstuffs the equations become:

(ME, Corn) X + (Dig. Lys, Corn) Y + (Avail. P, Corn) Z = Price Corn, $/cwt

(ME, SBM) X + (Dig. Lys, SBM) Y + (Avail. P, SBM) Z = Price SBM, $/cwt

(ME, Dical) X + (Dig. Lys, Dical) Y + (Avail. P, Dical) Z = Price Dical, $/cwt

Metabolizable energy, digestible lysine, and available phosphorus for a variety of feedstuffs can be found in the references listed in this publication. Inserting table values into the equations for the three feedstuffs results in the following equations:

1551 X + 0.17 Y + 0.04 Z = Price Corn, $/cwt

1442 X + 2.41 Y + 0.20 Z = Price SBM (44% CP), $/cwt

0 X + 0 Y + 18.5 Z = Price Dical, $/cwt

The price of feedstuffs should be the most current market price available. If we assume the following prices we can solve for X, Y, and Z in a multiple step process:

Corn = $3.50 per bushel or $6.25/cwt

SBM = $220.00 per ton or $11.00/cwt

Dical = $470.00 per ton or $23.50/cwt

First solve for Z using the equation for dicalcium phosphate.

$0 X + 0 Y + 18.5 Z = \$23.50$

$18.5 Z = 23.50$

$Z = 1.27$

Next plug the value of Z into the equations for corn and soybean meal

$1551 X + 0.17 Y + (0.04)(1.27) =$ Price Corn, \$/cwt

$1551 X + 0.17 Y + 0.05 = 6.25$

$1551 X + 0.17 Y = 6.20$

$1442 X + 2.41 Y + (0.20)(1.27) =$ Price SBM (44% CP), \$/cwt

$1442 X + 2.41 Y + 0.34 = 11.00$

$1442 X + 2.41 Y = 10.66$

Finally solve the two equations for the two unknowns:

$1551 X + 0.17 Y = 6.20$

$1442 X + 2.41 Y = 10.66$

$$1551 X + 0.17 Y = 6.20$$
$$1551 X = 6.20 - 0.17 Y$$
$$X = \frac{6.20 - 0.17 Y}{1551}$$

$$1442 X + 2.41 Y = 10.66$$
$$1442 \times \frac{6.20 - 0.17 Y}{1551} + 2.41 Y = 10.66$$
$$5.76 + 0.16 Y + 2.41 Y = 10.66$$
$$2.57 Y = 4.90$$
$$Y = 1.91$$

$$X = \frac{6.20 - 0.17\ Y}{1551}$$

$$X = \frac{6.20 - (0.17 \times 1.91)}{1551}$$

$$X = \frac{6.20 - 0.32}{1551}$$

$$X = 0.004$$

Using the reference prices of $3.50/bu for corn, $220/ton for soybean meal, and $470/ton for dicalcium phosphate results in the following values:

X = 0.004

Y = 1.91

Z = 1.27

Once the value of X, Y, and Z have been determined they can be used to determine the value of an alternative feed, as shown for barley:

$$(Barley\ \ ME)X + (Barley\ \ Dig.\ Lys)Y + (Barley\ \ Avail.\ P)Z = Value\ \ of\ \ Barley,\ \$/cwt$$

$$(1320 \times 0.004) + (0.45 \times 1.91) + (0.11 \times 1.27) = Value\ \ of\ \ Barley$$

$$5.28 + 0.86 + 0.14 = \$6.28\ /cwt\ \ Barley$$

From this example we conclude that if barley can be obtained for less than $6.28 per cwt it is economically advantageous to use barley in the diet. If the price of barley is more than $6.28 per cwt using purchased barley is not beneficial.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Purdue University Extension, 2007. Relative Value of Feedstuffs for Swine, The New Pork Industry Handbook–07-06-03. Purdue University. West Lafayette, IN.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Feed and Growth

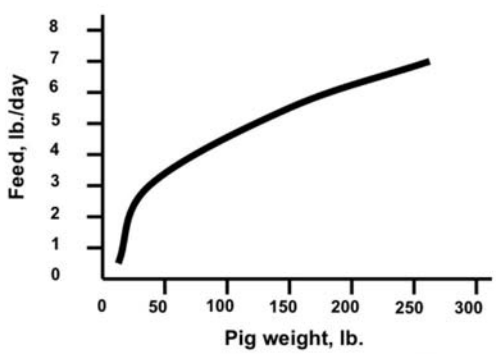
IPIC NPP340 2007

Growing pigs typically are on self-feeders and can eat as much feed as they want. The following relationships are true for pigs on self-feeders, or in other words pigs fed ad libitum.

Feed Intake

As pigs grow, daily feed intake increases (Figure 1). The energy-to-amino acid ratio of the diet should be adjusted as pigs grow so that nutrients are supplied to match performance needs.

Figure 1. Daily feed intake.



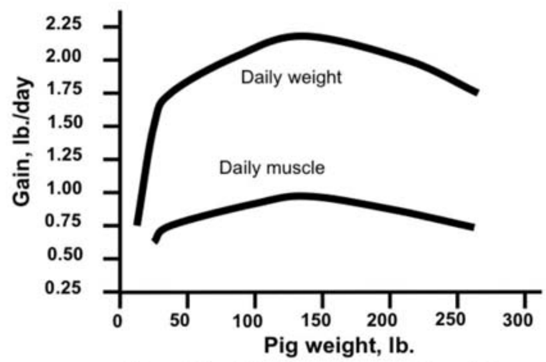
Adapted from Life Cycle Swine Nutrition, 1996.

A pig's feed intake is controlled by the energy density of the feed. If fibrous feeds are added, pigs will eat more feed. If fats or oils are added, pigs will eat less feed. Pigs that are cold will eat more feed than pigs that are comfortable, and pigs that are hot will eat less. Gender affects feed intake in pigs that are larger than 50 pounds. Barrows will eat more feed than gilts. Sick pigs will eat less than healthy pigs.

Average Daily Gain

Young pigs grow very rapidly. Rate of gain declines as the pigs grow beyond 150 pounds. Daily muscle gain is similar but not identical to daily gain (Figure 2).

Figure 2. Daily weight and muscle gain.



Adapted from Life Cycle Swine Nutrition, 1996.

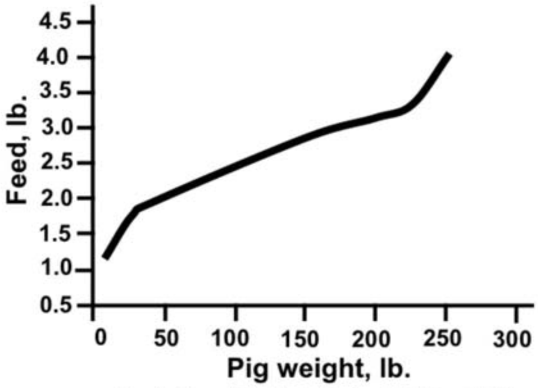
In addition to muscle, the pig is adding size and weight to its organs, fat reserves, and bones.

Average daily gain (ADG) is largely a result of feed intake. After 50 pounds, barrows eat more feed daily than gilts and usually gain weight faster. Genetics also influences ADG with some breeds and lines growing faster than others, often because they eat more feed.

Feed Conversion

Small pigs convert feed into body weight very efficiently. As pigs grow, it takes more feed per unit of gain (Figure 3). Nearly four times the amount of feed is needed for a 250 pound pig to gain one pound of body weight as compared to a 10 pound pig gaining the same amount. This is because the larger pig has more body weight to maintain than the smaller pig. Total feed intake relative to maintenance needs decrease as the pig grows in size, thus a 250 pound pig must eat more feed than a 10 pound pig to gain the same amount of weight.

Figure 3. Feed required per unit of gain.



Adapted from Life Cycle Swine Nutrition, 1996.

Leaner pigs are more efficient at converting feed into weight. Gilts are leaner than barrows and tend to have better feed conversion. Pigs that are cold will use more feed to maintain body temperature than pigs that are comfortable. Sick pigs will not convert feed to gain as effectively as healthy pigs. Feed intake, average daily gain, and feed conversion are optimal when pigs are healthy, comfortable, and cool. Table 1 provides estimates of growth, feed consumption, and feed conversion for pigs.

Table 1. Estimated growth, feed consumption and conversion for pigs[1].

Age, d	0	50	100	160
Weight, lb	3	50	175	265
Feed intake, lb/d	0.5	3.2	6.0	7.0
Gain, lb/d	0.3	1.8	2.1	1.75
Feed : Gain	1.1	2.0	3.0	4.0

[1] Adapted from Life Cycle Swine Nutrition, 1996.

Additional Resources

Carr, John. 1998. Garth Pig Stockmanship Standards. 5M Enterprises Ltd. Sheffield, UK.

Cole, D. J. A. editor. 1971. Pig Production. The Pennsylvania State University Press. University Park.

Holden, Palmer J. and M. E. Ensminger. Swine Science 7th Edition. 2006. Pearson Education Inc. Upper Saddle River, NJ.

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Jurgens, Marshall H. and Kristjan Bregendahl. 2007. Animal Feeding and Nutrition 10th Edition. Kendall/Hunt Publishing Company. Dubuque, IA.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Sow Feeding

IPIC NPP350 2007

Growing pigs usually are usually fed with self-feeders. Managing sow feeding is more of a challenge. In the wild pigs consume large amounts of poor quality feeds and need a large gut to efficiently use the nutrients. Corn-soybean meal diets are highly available, concentrated feeds. Pigs fed this type of diet grow rapidly. This is an advantage in young pigs but a disadvantage in sows. Sows have more gut capacity than needed when fed a corn-soybean meal diet. Sows would like to eat more feed than necessary and if allowed to will become fat and less productive.

Gilt Development

Many niche producers raise their own replacement gilts. In most cases gilts are kept with groups of finishing pigs and have unlimited access to growing pig diets. It is important that developing gilts receive enough amino acids, particularly lysine to develop muscle tissue. Gilts should consume enough energy to build backfat reserves. Balancing calcium and phosphorus in developing gilt diets is important for good bones. Obtaining adequate backfat, muscle, and skeletal development in gilts prior to mating is essential for sow longevity. General targets for gilt size at first mating are:

- 290 lb liveweight.
- 220 days old.
- 0.8 inches of backfat at approximately 2.5 inches from the midline on the last rib.

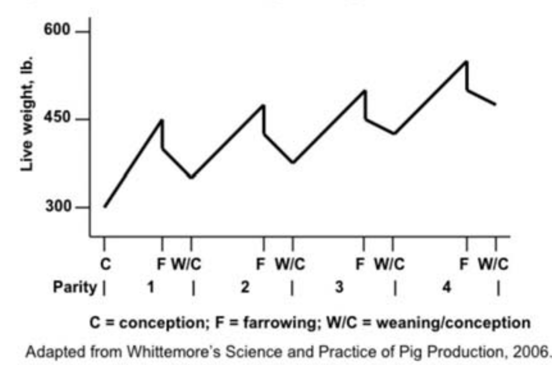
Gestation Feeding

Feed during gestation is used to grow the fetal pigs, maintain and grow sow muscle tissue, and replenish sow fat reserves lost during previous lactations.
Gestation diets should be designed to:

- Maximize number of pigs per litter.
- Optimize birth weight of the pigs.
- Minimize the wean-to-conception period.
- Maximize sow feed intake during lactation.
- Optimize sow longevity and lifetime productivity.

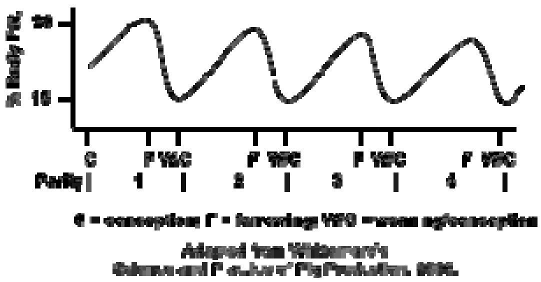
Over a productive lifetime, a sow will fluctuate in body weight and fat reserves. Over time a sow will gain weight. It is desirable that weight gain be controlled and that fat reserves be maintained. If properly fed, a sow will grow larger as she ages but not necessarily fatter or much thinner (Figures 1 and 2).

Figure 1. Pattern of sow weight change.



Adapted from Whittemore's Science and Practice of Pig Production, 2006.

Figure 2. Pattern of sow body fat change.



If a gestating sow is allowed to consume as much corn–soybean meal diet as she desires, she will become too fat. Fat sows are costly to pig operations. Impacts of sows that are overweight:

- Higher feed costs due to more feed intake.
- Sows that are excessively fat have difficulty becoming pregnant, maintaining pregnancy, and delivering large vigorous litters.
- Overweight sows are more stressed by summer heat than normal.
- Fat sows are less nimble and more likely to crush their young.
- Overweight sows wean lighter litters due to poorer milk production.

Most gestating sows should be limit-fed. Individual feeding stalls allow group housing of large numbers of sows but individualized control of feed intake. Sows can also be kept in small (3-5 sows) groups of similar body condition and fed accordingly. It is difficult to control feed intake in large groups of sows with simple floor feeding, although spreading feed out over a wide area may be one strategy to minimize competition between sows.

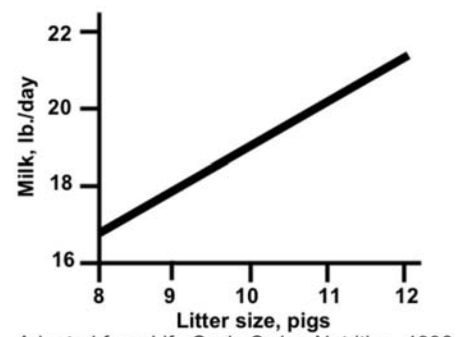
Interval feeding, or feeding sows on alternating days is another feeding strategy that some producers use. Individuals should consult the feeding guidelines of their niche market because some prohibit skip–day feeding.

Gestating sows can utilize forages. Forage containing diets are less digestible and more bulky than corn–soybean meal diets. Thus a sow can eat more of a diet that contains forages without becoming overly fat. Leaflet number 370 of this handbook presents seven diets containing high amounts of forage plus several diets suitable for supplementing sows on pasture. High forage diets may not flow through a self–feeder and so feeders will need to be checked and adjusted accordingly.

Lactating Sows

As shown by Figures 1 and 2, sows will lose weight during farrowing and lactation. This is the weight of the young pigs, but also the body weight (mostly fat) used to produce milk for the litter. As litter size increases, so does milk production (Figure 3).

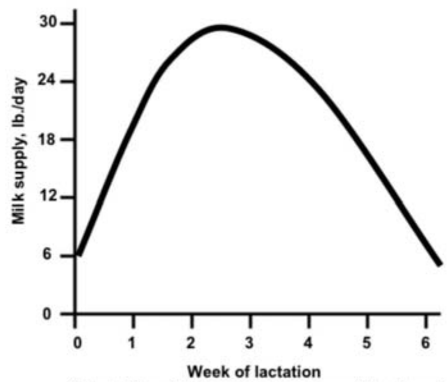
Figure 3. Litter size and milk production.



Adapted from Life Cycle Swine Nutrition, 1996.

Milk production typically peaks about 21 days after farrowing. Performance during lactation is partly dependent on how much body fat reserves were stored during gestation.

Figure 4. Milk production by week of lactation.



Adapted from Whittemore's Science and Practice of Pig Production, 2006.

A nursing sow will have a difficult time consuming enough feed to meet both the demands of milk production and body maintenance. If not fed properly lactating sows will become too thin.

Excessively thin sows

- Have difficulty breeding back and maintaining pregnancy.
- May lose muscle tissue resulting in pre–mature culling.
- May have difficulty maintaining body temperature in cold weather.
- Are more susceptible to shoulder sores, wounds, and problems with their feet and legs.

Lactation diets should be formulated to maximize milk production and minimize loss of muscle in the sow. This is accomplished by increasing the amount of feed fed to the sow while also increasing the amino acid content of the diet. Feed intake is critical for the lactating sow. It is desirable to have lactating sows consume as much feed as possible. Immediately following farrowing the sow's feed intake should be limited, but rapidly increased over the next three to seven days to full feed. This strategy will maximize feed intake over the entire nursing period.

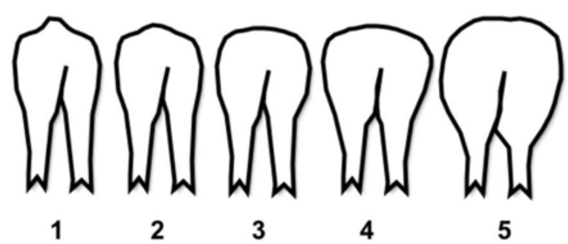
Group lactation with sows on a self–feeder is an effective strategy for maximizing both piglet growth and sow feed intake. If sows are not on a self feeder, they should be fed two to three times daily. Litters that are combined for group lactation should be as close to the same age as possible (< 7 day age spread). Producers usually start group lactation at about 7 days of age and it continues through weaning.

Maximizing nursing sow feed intake

- Keep sows cool—the room temperature should be around 60-65ºF.
- Provide plenty of clean, fresh water.
- Supply fresh feed.
- Greatly reduce or eliminate forage in diet.
- Feed moist or wet feed.
- Encourage sow exercise.
- Do not keep sow in a small pen.

Figure 5 shows examples of sow condition score from the rear view. Table 6 provides descriptions of sow body condition score. Sows should be at a body score of 3 at farrowing and will likely be near a score of 2 at weaning.

Figure 5. Sow Body Condition Score



Adapted from Garth Pig Stockmanship Standards 1998.

Table 6. Sow body condition score[1].

Score Number	Condition	Shape of body	Description
1	Emaciated	Hips and backbone are visible	Emaciated sow, backbone very prominent
2	Thin	Angular with prominent backbone	Sow is thin, hips and backbone noticeable and easily felt
3	Normal	Tubular	Ideal condition during lactation and at weaning. Hips and backbone only felt with firm pressure
4	Fat	Bulging tube	Slightly overweight, hips and backbone cannot be felt
5	Overfat	Bulbous	Sow is very fat, hips and backbone heavily covered

[1] Adapted from Garth Pig Stockmanship Standards, 1998.

Additional Resources

Carr, John. 1998. Garth Pig Stockmanship Standards. 5M Enterprises Ltd. Sheffield, UK.

Karriker, L., L. Layman, A. Ramirez, D. Miller, K. J. Stalder, P. Holden, and A. DeMirjyn. 2006. Sow body condition scoring guidelines poster In: National Hog Farmer blueprint. No. 42 in a series. National Hog Farmer. Prism Business Media. Overland Park, KS 66212-2216. 51:Insert.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Advanced Sow Nutrition

IPIC NPP360 2007

Feeding sows for niche pork production is different than in conventional systems. The biggest difference is lactation length. Commodity pork systems typically wean sows at 21 days. This is much shorter than the 35-42 day lactation that most niche markets require. Because of this longer lactation period, special attention should be paid to the diets for sows in niche pork production.

Lactation Feeding

The first step is to determine the proper diet for the sow that is nursing a litter of pigs. Feed intake should be measured and diets formulated based on number of pigs nursing and pounds of feed consumed. In general, the more feed a sow eats the less nutrient dense the diet. A general rule of thumb is that sows need 35-40 grams of lysine per day for a litter of 7-8 pigs. Sows with more than eight pigs will be producing more milk and 50 grams of lysine per day is recommended.

A diet formulated for 12 pounds daily intake should be different than a diet formulated for 20 pound daily intake. Sows that nurse for only 21 days have difficulty consuming an average of 12 pounds per day. Sows that nurse for 4 to 7 weeks can have average daily feed intake of 20 pounds per day. Thus, diets for sows with later weaned pigs can be less nutrient dense and usually less costly because of increased sow feed intake.

For example: *If you want sows to consume 45 grams of lysine per day, what % lysine is needed in the diet?*

If a sow consumes 12 pounds per day for the first three weeks of lactation, she consumes 5448 grams of feed per day.

$$12\ lb/day \times 454\ grams/lb = 5448\ grams/day$$

$$\frac{45\ grams\ of\ lysine\ daily}{5448\ grams\ of\ feed\ daily} \times 100 = 0.82\%\ lysine$$

If the sow eats 16 pounds daily, she consumes 7264 grams of feed/day, and only 0.62% lysine is needed to provide 45 grams of lysine daily.

$$16\ lb/day \times 454\ grams/lb = 7264\ grams/day$$

$$\frac{45\ grams\ of\ lysine\ daily}{7264\ grams\ of\ feed\ daily} \times 100 = 0.62\%\ lysine$$

If a sow eats 12 pounds daily the first three weeks and then 16 pounds per day for the next four weeks, she will consume on average 14.3 pounds per day. In order to consume an average 45 grams of lysine per day while nursing for the entire seven week lactation period the diet should be formulated to have 0.69% lysine.

$$14.3\ lb/day \times 454\ grams/lb = 6492\ grams/day$$

$$\frac{45\ grams\ of\ lysine\ daily}{6492\ grams\ of\ feed\ daily} \times 100 = 0.69\%\ lysine$$

Larger litters demand more milk from the sow. Sows nursing larger litters need more amino acids to maintain weight and muscle mass for rebreeding. Life Cycle Swine Nutrition, PM 489, 1996 provides several reference tables that more fully describe the interaction between feed intake and nutrient requirements in sows. While lysine has been the focus of the previous examples, the levels of other amino acids, calcium, phosphorus, trace minerals, and vitamin mix should also be adjusted based upon daily feed intake.

Gestation Feeding

The object of feeding a gestating sow is to get her into the right condition for producing many large litters of healthy pigs over a long lifetime. The ideal gestation sow condition just prior to farrowing is 2.5 to 3.5 on the body condition scale presented as Figure 5 and Table 1 in leaflet number 350 of this handbook.

Sow body condition score should be determined at weaning and sows allotted to feeding group based upon body condition. Sow condition should be assessed regularly and adjustments to feed allowance made accordingly. An overweight sow is less mobile, more uncomfortable in the heat, more likely to crush piglets, and less productive in term of both farrowing rate and number of pigs born alive.

It is easy to overfeed a gestating sow. In commodity pork production, sows are weaned about 21 days after farrowing and tend to be very lean or thin. In these situations it is common to give gestating sows more feed in order to return body fat reserves to normal. In niche pork production, lactation length is longer, daily feed intake is greater, and sows tend to be weaned in better body condition. If the diet is not adjusted to match the body condition of the sow, she may become fat. Pasturing sows or adding forages to the gestation diet enables sows to feel full without producing overly fat sows. Feeding sows forage is discussed in leaflet number 320 of this handbook and diets for supplementing pastures are presented in leaflet number 370 of this handbook.

A final consideration for gestating sows is the temperature of the housing system. Sows kept in cold housing that is typical of niche pork production will need additional feed as temperatures drop. A common rule of thumb is to increase feed allowance by one pound for every 12 ºF drop in temperature below the thermoneutral zone. Without bedding, the lower edge of the thermoneutral zone is about 55 ºF for sows, but will be 15 to 20 ºF less in a draft free, dry, deep-bedded housing system. If sows are housed in groups in relatively draft free buildings with plenty of dry bedding, additional feed should be offered when temperatures near 30 ºF.

Additional Resources

Carr, John. 1998. Garth Pig Stockmanship Standards. 5M Enterprises Ltd. Sheffield, UK.

Cole, D. J. A. editor. 1971. Pig Production. The Pennsylvania State University Press. University Park, PA.

Holden, Palmer J. and M. E. Ensminger. Swine Science 7th Edition. 2006. Pearson Education Inc. Upper Saddle River, NJ.

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Jurgens, Marshall H. and Kristjan Bregendahl. 2007. Animal Feeding and Nutrition 10th Edition. Kendall/Hunt Publishing Company. Dubuque, IA.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Example Pig Diets

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP370 2007

This leaflet gives 36 example pig diets. Most are complete but some have been formulated to supplement pasture. Example diets are shown for pigs 10 pounds to market weight. Diets shown are only examples and should be changed more often to more closely match diet with needs of the growing pig. Gestation and lactation diets are given for sows. Working boars weighing less than 600 pounds should receive the same diet as lactating sows. For larger boars, the gestation diet may be appropriate.

Table 1 provides reference corn-soybean meal diets for growing pigs and sows. Table 2 details diets that include dried distillers grains. Alternatively cooked soybeans are added to diets in table 3. Diets in table 4 combine dried distillers grains and cooked soybeans. Tables 5, 6, and 7 provide suggested pasture supplements for growing pigs and gestating sows. Table 8 has examples of bulky, high forage diets for gestating sows. Trace mineral and vitamin pre-mixes are presented in Iowa State University Extension's Life Cycle Swine Nutrition, PM 489, 1996.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Jurgens, Marshall H. and Kristjan Bregendahl. 2007. Animal Feeding and Nutrition 10th Edition. Kendall/Hunt Publishing Company. Dubuque, IA.

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

Morrison. pre–1950. Feeds and Feeding. The Morrison Publishing Company. Ithaca, NY.

National Research Council. 1998. Nutrient Requirements of Swine 10th Edition. National Academy Press. Washington, DC.

Table 1. Reference diets for pigs.

	Growing pig body weight				Sow diets	
Ingredient, lb.	10-30	30-80	80-160	>160	Gestation	Lactation
Corn	358	649	766	850	863	688
Soybean meal	460	320	210	130	100	275
Dried whey	150	0	0	0	0	0
Limestone	7.20	8.50	8.70	9.00	10.00	7.85
Dicalcium phosphate	19.75	15.25	9.50	6.00	20.00	21.00
Salt	0	4.10	3.50	3.20	3.50	4.40
Trace mineral	2.50	1.65	1.30	1.00	1.00	1.15
Vitamin pre-mix	2.55	1.50	1.00	0.80	2.50	2.60
Total, lb.	1000	1000	1000	1000	1000	1000

Adapted from Life Cycle Swine Nutrition, 1996.

Table 2. Example diets including dried distillers grains with solubles (DDGS).

	Growing pig body weight			Sow diets	
Ingredient, lb.	30-80	80-160	>160	Gestation	Lactation
Corn	579	621	680	758	658
Soybean meal, 48% CP	305	180	100	80	260
DDGS	85	175	200	125	45
Limestone	8.50	8.70	9.00	10.00	7.85
Dicalcium phosphate	15.25	9.50	6.00	20.00	21.00
Salt	4.10	3.50	3.20	3.50	4.40
Trace mineral	1.65	1.30	1.00	1.00	1.15
Vitamin pre-mix	1.50	1.00	0.80	2.50	2.60
Total, lb.	1000	1000	1000	1000	1000

Adapted from Life Cycle Swine Nutrition, 1996.

Table 3. Example diets including cooked, full–fat soybeans.

	Growing pig body weight			Sow diets	
Ingredient, lb.	30-80	80-160	>160	Gestation	Lactation
Corn	589	716	830	853	668
Soybean meal, 48% CP	130	60	50	65	225
Cooked, full–fat soybeans	250	200	100	45	70
Limestone	8.50	8.70	9.00	10.00	7.85
Dicalcium phosphate	15.25	9.50	6.00	20.00	21.00
Salt	4.10	3.50	3.20	3.50	4.40
Trace mineral	1.65	1.30	1.00	1.00	1.15
Vitamin pre-mix	1.50	1.00	0.80	2.50	2.60
Total, lb.	1000	1000	1000	1000	1000

Adapted from Life Cycle Swine Nutrition, 1996.

Table 4. Example diets including dried distillers grains with solubles (DDGS) and cooked, full–fat soybeans for pigs.

	Growing pig body weight			Sow diets	
Ingredient, lb.	30-80	80-160	>160	Gestation	Lactation
Corn	534	635	770	798	650
Soybean meal, 48% CP	135	71	80	60	238
DDGS	75	100	80	60	25
Cooked, full fat soybeans	225	170	50	45	50
Limestone	8.50	8.70	9.00	10.00	7.85
Dicalcium phosphate	15.25	9.50	6.00	20.00	21.00
Salt	4.10	3.50	3.20	3.50	4.40
Trace mineral	1.65	1.30	1.00	1.00	1.15
Vitamin pre-mix	1.50	1.00	0.80	2.50	2.60
Total, lb.	1000	1000	1000	1000	1000

Adapted from Life Cycle Swine Nutrition, 1996.

Table 5. Suggested pasture supplement for growing pigs (40-125 lbs).

	Pasture Type		
Ingredient, lb.	Legume	Grass	Grass-legume
Corn	1486	1423	1450
Soybean meal, 48% CP	464	514	493
Limestone	4	15	10
Dicalcium phosphate	26	28	27
Salt	10	10	10
Trace mineral	5	5	5
Vitamin pre-mix	5	5	5
Total, lb.	2000	2000	2000

Adapted from Pork Industry Handbook 07-06-04, 2007.

Table 6. Suggested pasture supplement for growing pigs (> 125 lbs).

	Pasture Type		
Ingredient, lb.	Legume	Grass	Grass-legume
Corn	1600	1538	1566
Soybean meal, 48% CP	346	396	375
Limestone	5	16	10
Dicalcium phosphate	29	30	29
Salt	10	10	10
Trace mineral	5	5	5
Vitamin pre-mix	5	5	5
Total, lb.	2000	2000	2000

Adapted from Pork Industry Handbook 07-06-04, 2007.

Table 7. Suggested pasture supplement for gestating sows.

	Pasture Type		
Ingredient, lb.	Legume	Grass	Grass-legume
Corn	1756	1371	1521
Soybean meal, 48% CP	173	525	372
Limestone	0	16	24
Dicalcium phosphate	0	64	59
Monosodium phosphate	47	0	0
Salt	12	12	12
Trace mineral	6	6	6
Vitamin pre-mix	6	6	6
Total, lb.	2000	2000	2000

Adapted from Pork Industry Handbook 07-06-04, 2007.

Table 8. Example high forage diets for gestating sows.

Ingredient, lb.	1	2	3	4	5	6
Corn	1201	799	599	1179	266	415
Soybean meal, 48% CP	205	122	80	239	112	68
Limestone	32	14	5	14	5	–
Dicalcium phosphate	–	–	–	50	12	–
Monosodium phosphate	44	47	48	–	–	11
Salt	8	8	8	8	2.4	3
Trace mineral	5	5	5	5	1.2	1.5
Vitamin pre-mix	5	5	5	5	1.2	1.5
Alfalfa hay, ground	500	1000	1250	–	–	–
Grass hay, ground	–	–	–	500	–	–
Corn silage, 45% DM	–	–	–	–	1600	–
Legume haylage, 33% DM	–	–	–	–	–	1500
Total, lb.	2000	2000	2000	2000	2000	2000

Adapted from Pork Industry Handbook 07-06-04, 2007.

Crossbreeding and Hybrid Vigor

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP410 2007

How pigs perform is the result of two influences: genetics and environment. The genetics or heredity of a pig sets the upper limit or potential of its performance. The environment of a pig sets the actual level of performance. Environment includes the pigs' surroundings, the feed, and the diseases it encounters. The genetics of a pig are passed from the boar and sow that produce the pig. The pig producer has two primary tools to influence the genetics of a pig: selection and hybrid vigor.

Selection is the process of picking which breeds or lines of pigs to use and which individuals within the breed to mate.

Breeds

There are eight major U.S. swine breeds plus several minor breeds. There are also many lines that have been developed by commercial swine companies. The three white breeds, Yorkshire, Landrace and Chester White are known for maternal traits, i.e., they excel as sows with large litters. The five dark breeds, Duroc, Hampshire, Poland China, Spotted and Berkshire, are known for carcass or terminal traits, i.e., they excel as boars to produce market pigs. In niche markets, Berkshire and Duroc breeds are often used because they excel in meat quality traits.

Breed Attributes[1]

There is considerable variation within a breed, however there are some differences between breeds.

- **Berkshire** Better in conception rate, intramuscular fat, and pork quality. More backfat.
- **Chester White** Better in conception rate, litter size weaned, and growth rate.
- **Duroc** Better in growth rate, intramuscular fat, and pork quality. More backfat.
- **Hampshire** Less backfat and lean pork.
- **Landrace** Better in litter size weaned, litter weight. More backfat.
- **Poland** More backfat.
- **Spotted** Better in growth rate.
- **Yorkshire** Better in litter size weaned, litter weight, and growth rate.

[1]Based on NC-103 and NPPC NGEP, 1995.

Heritability of traits

Individual boars and sows pass on traits to their offspring based on the heritability of the traits (Table 1). The maternal/ reproductive traits have low heritability about (5 to 30%). The growth traits are moderately heritable (24 to 30%), and the carcass traits have high heritability (40 to 60%). Pork quality traits are moderately heritable (15 to 30%). Traits with a low heritability change more slowly due to selection than traits with a high heritability.

Heterosis

Hybrid Vigor (or heterosis) is the improved performance of offspring compared to the average of their parents. Hybrid vigor is maximized by crossing different breeds or lines. This is known as crossbreeding. Hybrid vigor is greatest for reproductive and early pig survival/growth traits. Most sows and market pigs in the U.S. are crossbred pigs.

Table 1. Estimates of heritability of traits[1]

Reproductive traits	
Conception rate	30%
Pigs born alive	10%
Litter birth weight	30%
Prewean survival	5%
Pigs weaned	7%
Weaning weight	17%
Rebreed Interval	23%
Growth traits	
Average daily gain	30%
Feed/Gain	30%
Average daily feed intake	24%
Carcass traits	
Backfat	50%
Loin muscle area	45%
Lean percent	48%
Pork quality traits	
Pork color	28%
Muscle pH	21%
Drip loss	16%
Tenderness	26%

[1]Adapted from PIH 06-01-05.

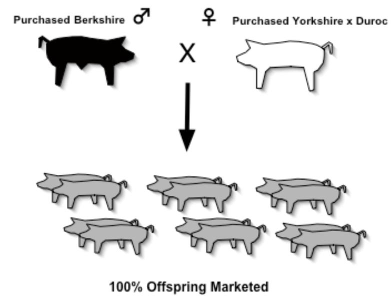
Crossbreeding Strategies

Crossbreeding systems are designed to maximize hybrid vigor. Crossbred sows are especially advantageous with better conception rates, more pigs born and weaned, and heavier litters than purebred sows. For extensive niche pork production settings (outdoor or in hoop barns), a crossbred sow with some dark breed ancestry may be more rugged and durable than an all-white sow. There are three basic crossbreeding systems.

1) Terminal System

Terminal cross systems usually use a boar (purebred or crossbred) on crossbred sows of different breeds. All the pigs are marketed. Replacement gilts are purchased. For example a Berkshire boar mated to a Yorkshire x Duroc sow would produce pigs that are ½ Berk, ¼ York, ¼ Duroc (Diagram 1).

Diagram 1. Terminal Cross



<u>Advantages</u>

Simple to manage
100% hybrid vigor
Genetically uniform pigs from year to year
Crossbred sows
Uses breeds where their strengths exist (terminal or maternal)
Works well for small herds

<u>Disadvantages</u>

Replacement gilts must be introduced to the herd (usually purchased)
Gilt availability
Gilts may introduce disease
Gilt cost

2) Rotation System

Rotation cross systems involve rotating breeds of boars each generation. Usually two, three, or four breeds are used in rotation. When the rotation is complete, the first breed in the rotation is used again and the sequence repeats. Replacement gilts are saved from the pigs and bred to the breed of boar next in the sequence. A typical 3-breed rotation used by niche pork producers is a Berkshire/Yorkshire/Duroc sequence (Diagram 2).

Advantages

Simple to manage
Replacement gilts are produced in herd
Crossbred sows
Boars or semen are only addition to the herd
Less risk of bringing disease into herd
Works well for small herds

Disadvantages

Less than 100% hybrid vigor
- 2-breed has 67% PHV
- 3-breed has 86% PHV
- 4-breed has 92% PHV

(PHV = possible hybrid vigor)

Less genetically uniform pigs from year to year
Breeds must be dual-purpose (both terminal and maternal)

3) Combination or Rotaterminal System

By combining the terminal and rotational systems, the advantages of both can be achieved. A few of the sows are bred rotationally to maternal boars to produce replacement gilts, and the rest of the sows are bred to terminal boars to produce market pigs.

Advantages

Replacement gilts are produced within the herd
Crossbred sows
Boars or semen are only addition to herd
Less risk of bringing disease into herd
100% hybrid vigor in market pigs
Uses breeds where their strengths exist (terminal or maternal)

Disadvantages

Somewhat complicated to manage
Requires about 200 litters per year to work
Less than 100% hybrid vigor in sows
Less genetically uniform pigs from year to year and within a year
Maternal white barrows and cull gilts may require a separate market

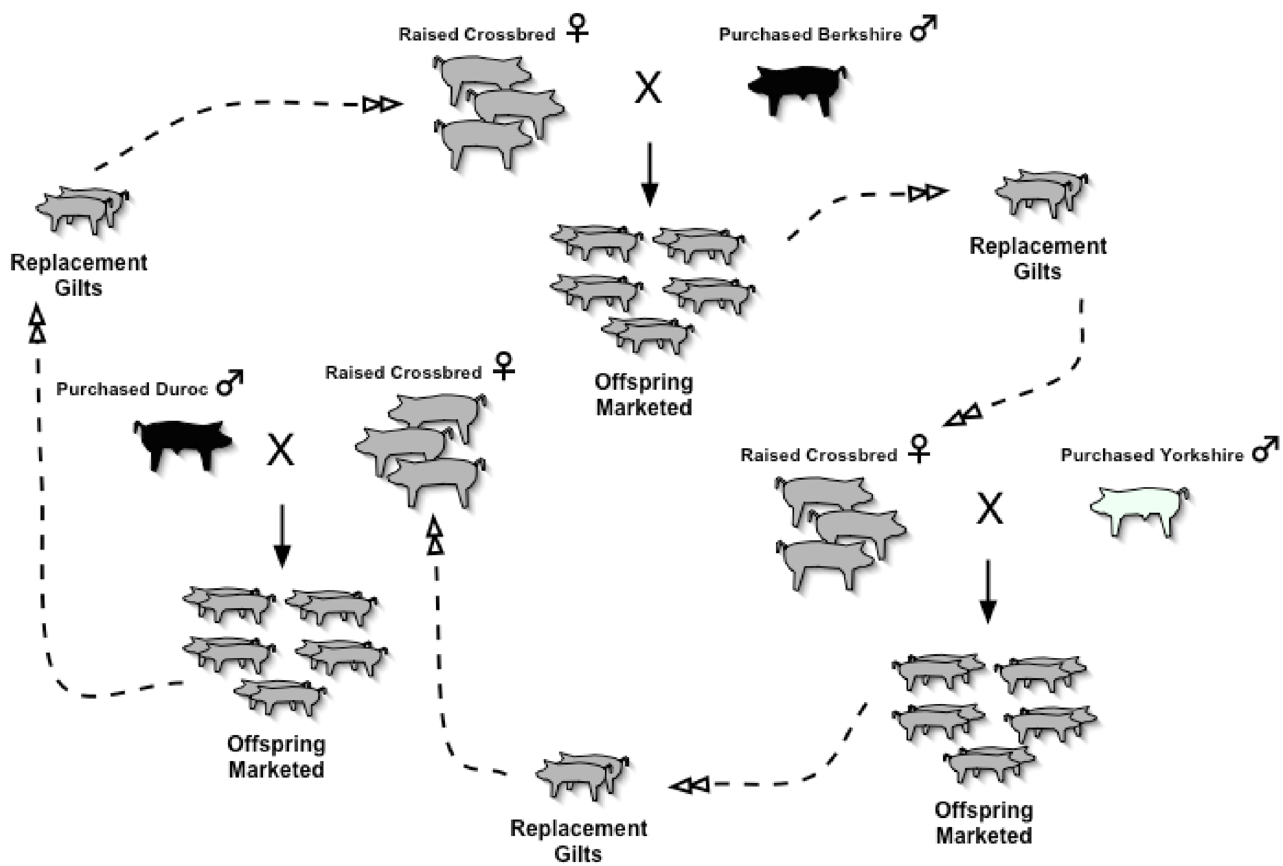
Each system has its own advantages and disadvantages. Beginning niche pork producers should use either the terminal or rotation approach, based on whether they plan to raise or purchase replacement gilts. Remember to always isolate incoming breeding stock for 30-60 days and consult with your veterinarian about tests and vaccinations before mixing the new stock with your herd.

Additional Resources

Iowa Pork Industry Center. 109 Kildee Hall. Iowa State University, Ames, IA, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

U.S. Pork Information Gateway
http://pork.porkgateway.org/web/guest/home

Diagram 2. Rotation System



Replacement Gilts and Sow Longevity

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP420 2007

The future of the sow herd is based on replacement gilts. They are also half of the genetics of the market pigs. Many niche pork producers raise their own replacements. Some buy them from other farms or companies. Regardless of source, selecting quality gilts is important for the success of the pig farm.

Puberty/boar exposure/mating

Gilts reach puberty about 160-190 days of age. Puberty can be delayed by high temperatures. Puberty is encouraged by exposure to a mature boar. Gilts are usually mated at the second or later estrus after puberty.

Feeding

Replacement gilts usually are selected when they are around four or five months of age. Gilts are then removed from the finishing pens for a 2–3 month acclimation period. High lean gilts may be continued on a full feed. Moderately lean (fatter) gilts should be limit fed 4.5–6 pounds of corn-soybean meal diet daily (0.8% lysine).

Selection

Choosing which gilts to keep for replacements is an important decision. Gilts should be chosen for long-term good mothers. There are four selection criteria: structure, underline and vulva, size and fitness, and litter size and weight.

1) Structure

Bone structure and feet/leg structure are indicators of whether a gilt will be durable and sound. Sows must be able to walk, carry a pregnancy, support a boar, and carefully stand and lie down among her piglets. Soundness is heritable.

The front legs should have a long stride and slope to the shoulder. Front toes should neither point in or out, but straight ahead. Toes should be about the same size, indicating even wear and correctness. Rear legs should be slightly sloping, and neither cow-hocked nor very straight. All feet should have some slope and flex in the pasterns.

The gilt should have a wide ribcage, large body cavity, and moderately heavy bone. Legs should be set wide apart. Adequate muscling and fatness should be evident. Gilts with some fatness have been shown to last longer in the herd and breed back more quickly.

2) Underline and Vulva

Underline and vulva are indicators of reproductive soundness. An underline should have at least 12 well-spaced functional nipples. The vulva should be normal size and shape, and not tipped up.

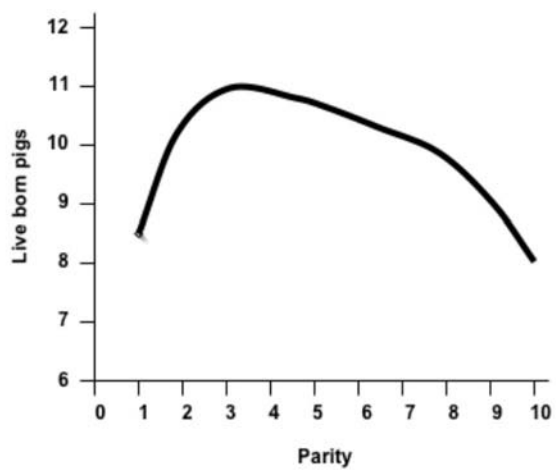
3) Size and Fitness

Size and fitness are indicators of growth and appetite. Gilts that eat more, grow faster, and tend to be fatter. Both are valuable heritable traits.

4) Litter Size and Weight

Litter size and weight are very valuable traits, even though they are lowly heritable. Try to select gilts from large litters (many pigs and heavy pigs) if records are available.

Figure 1. Number of live born pigs by parity of sow.



Sow longevity

Sows that are productive and stay in your herd are the most profitable. It takes the first litters to pay for the cost of the replacement gilt. Litter size increases for the first three parities, is maintained until parity 5 or 6, and then gradually declines (Figure 1). Thus it is advantageous to keep sows in good condition and productive for as long as possible, at least through parity 5 or 6.

Reasons for sow culling (1960 to 2000):

- Reproductive failure (29%)
- Old age (17%)
- Small litters (12%)
- Feet and leg disorders (11%)
- Death (7%)

Some of these causes are under the control of the producer. Every effort to keep sows in correct body condition (not too thin or too fat) should be made. Sow condition can be managed during gestation feeding. Thin sows can be fed extra. Fat sows should be fed less.

Older sows have higher immunity to diseases than younger sows. This is valuable for healthy pigs throughout the herd. Sows with an overly aggressive disposition can cause injury to the stockperson and should be culled.

Keeping a cohort group of sows is a good idea, but it usually is not achievable. Conception is never 100% on working farms, and in order to keep farrowing group size consistent, other sows and/or gilts will need to be added to a group of sows over time.

Mixing sows can be difficult because older larger sows will dominate younger smaller sows. Also, sows that are not familiar will fight to establish dominance. The best time to mix sows is at weaning. When sows are mixed provide extra space and plenty of feed and water. Keep young sows separate from the older sows for the first gestation, farrowing, and lactation, if possible. Mix them with the older sows at weaning of the first litter.

Table 1. Basic pig reproduction numbers.

Age at puberty	Approximately 170–120 days of age for gilts
Estrus cycle	21 ± 2 days
Estrus duration	About 40 hours in gilts and 55 hours in sows
Ovulation	Occurs 30–40 hours after onset of estrus (about 2/3 into estrus)
Target insemination times	12 & 24 hours after onset of estrus for gilts 24 & 36 hours after onset of estrus for sows
Gestation length	114 ± 3 days (3 months, 3 weeks, and 3 days)
Typical weaning age	From 10–70 days; usually 35–42 days for many niche markets
Wean-to-breed interval	About 3–6 days or more, longer lactation leads to shorter breeding interval; if sows are very thin this interval is longer

Additional Resources

Iowa Pork Industry Center. 109 Kildee Hall. Iowa State University, Ames, IA, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Stalder, K. J., D. P. Miller, C. Johnson, T. J. Baas, N. Berry, D. West, and A. E. Christian. 2005. Selecting for reproductive trait soundness in replacement gilts. Replacement Gilt Selection Guidelines Poster Series. National Pork Board, Des Moines, IA.

Stalder, K. J., D. P. Miller, C. Johnson, T. J. Baas, N. Berry, D. West, and A. E. Christian. 2005. Selecting for feet and leg soundness in replacement gilts. Replacement Gilt Selection Guidelines Poster Series. National Pork Board, Des Moines, IA.

Stalder, K. J., D. P. Miller, C. Johnson, T. J. Baas, N. Berry, D. West, and A. E. Christian. 2005. Conformation, structural soundness. Replacement Gilt Selection Guidelines Poster Series. National Pork Board, Des Moines, IA.

Stalder, K. J. , C. Johnson, D. P. Miller, T. J. Baas, A. E. Christian, N. Berry, and T. V. Serenius. 2005. Pocket guide to structural, feet and leg, and reproductive soundness. National Pork Board, Des Moines, IA.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Estrus

IPIC NPP430 2007

Estrus is the period of sexual receptivity and ovulation when a female pig will conceive if inseminated. When a female pig is in standing heat or estrus, she is ready to be bred or inseminated.

Estrus detection

The first step to successful pig reproduction is detecting estrus. There are several signs (in order of appearance):

- Reddening and swelling of the vulva.
- Vulva mucous discharge.
- Riding or mounting other sows.
- Seeking a boar.
- Standing heat with erect ears and arched back with rigid, motionless posture.

Ovulation occurs 30-40 hours after onset of estrus (about 2/3 into estrus). Estrus signs are much stronger in the presence of a mature boar.

Check for estrus in early morning after feeding when the sows are active. Bring the boar to the sows for the heat check and then remove him until the next check. Start exposing gilts to boars on a daily basis when they are added to the breeding herd. Expose sows to boars the day after weaning and each day until signs of estrus. Then start a breeding time schedule. Exposure should be for short intense periods each day (15-30 minutes each time). House the boar separately from sows. Continuous fence line exposure to the boar will lessen estrus activity by the sows.

Synchronizing estrus

It is advantageous to have estrus occur at about the same time for a group of sows or gilts because then they will be bred at the same time and will farrow together. Their pigs will become a group of pigs that are about the same age and can be managed together with the same feed, same housing, same marketing, etc.

Estrus occurs when the hypothalamus, the pituitary gland, and the ovaries communicate in a coordinated fashion to start a hormonal cascade that results in ovulation. These organs communicate through varying levels of hormonal signals. Synthetic means of altering hormonal signals in the pig are available and may be allowed by some niche markets. PG600® is a pharmaceutical that induces estrus in the pre-pubertal gilt. Matrix® is an orally active synthetic compound for synchronizing estrus in mature gilts and sows. Prior to using these or other products make sure they are not prohibited by your market. For appropriate use and dosage guidelines, consult your veterinarian.

Synchronizing estrus in gilts before puberty

- Exposure to a mature boar for at least 5 to 10 minutes daily.
- Inject with PG600® (if allowed by your market).
- Move or mix the gilts.

Synchronizing estrus in gilts after puberty

- Exposure to a mature boar for at least 5 to 10 minutes daily.
- Feed Matrix® (if allowed by your market) for 14 days and stop. Estrus occurs 4 to 9 days later.

Synchronizing estrus in sows

- Weaning at the same time. Estrus will occur 3 to 7 days after weaning.
- Exposure to a mature boar for at least 5 to 10 minutes daily.
- Feed Matrix® (if allowed by your market) for 14 days and stop. Estrus occurs 4 to 9 days later.

Additional Resources

Cole, D. J. A. editor. 1971. Pig Production. The Pennsylvania State University Press. University Park, PA.

Flowers, William, A. 2006. Synchronization of Estrus in Swine. Pork Information Gateway 08-06-01. Available at http://www.porkgateway.org/c/document_library/get_file?repository_id=1&file_path=%2F&file_name=08-06-01g_c052006.pdf

Holden, Palmer J. and M. E. Ensminger. Swine Science 7th Edition. 2006. Pearson Education Inc. Upper Saddle River, NJ.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Mating or Insemination

IPIC NPP440 2007

Pigs are prolific animals. A sow is able to carry more than 2 litters of pigs annually and wean over 10 pigs per litter, ultimately producing more than 20 pigs per year. Managing pig reproduction is a key part of a successful niche pork operation.

Natural mating

Some producers use boars to mate sows. House the boars separately from the sows. Putting the boar with the sow to be bred (hand mating) allows for maximum boar use and more precise information on breeding dates. Some producers prefer to put the boar in with a group of sows (pen mating). Pen mating has the advantage of less labor, but has the disadvantages of more sow and boar injuries, less predictable breeding dates, increased risk of boar overuse, and generally lower conception rates.

Artificial insemination

Many producers use artificial insemination (AI) to breed sows. AI allows a producer to access more superior boars than they could otherwise. It also allows large numbers of sows to be bred in a short time. Using AI allows the producer control of breeding dates and subsequent pig flow.

Most producers purchase extended semen, although semen can be collected and extended on farm. AI supplies and boar semen can be purchased from boar studs. Have semen delivered at least weekly during breeding time. Handle semen with care. Remember, it is alive. Store extended semen at 64 ºF until ready for use.

AI technique

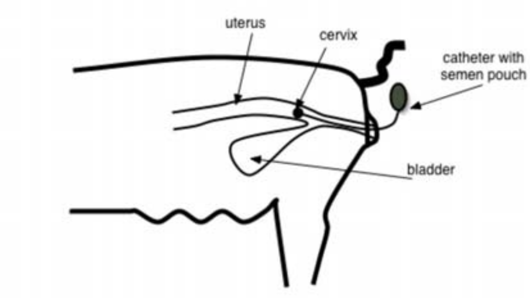
Mature boars are needed for estrus synchronization and detection. Check for estrus every day in early morning after feeding when sows are active. Keep records of the first sign of estrus. Insemination time is 12 and 24 hours after onset of estrus for gilts, and 24 and 36 hours after onset of estrus for sows.

Some boar studs also offer AI schools, although the technique can be learned easily from another producer or veterinarian.

In brief:

1. Wipe the vulva with a dry paper towel to clean away any dirt that may contaminate the head of the catheter.
2. Apply pressure to sow’s back.
3. Insert catheter into the vulva.
4. Angle the catheter up approximately 45º to avoid the bladder.
5. Insert catheter further into the reproductive tract until a firm resistance is felt.
6. Pull the catheter slightly back to lock catheter into the sow’s cervix.
7. Allow semen to be drawn in, or squeeze in very slowly (allow 2-3 minutes).
8. Bind or hold the catheter to prevent flow-back of semen.
9. Leave the catheter in the sow for another 5 minutes to continue cervical stimulation, maintain uterine contractions, and maximize semen uptake.
10. Remove catheter slowly.

Figure 1. Diagram of artificial insemination technique.



Inseminate the sow with a boar near her head if possible. The boar's presence encourages a strong estrus response and often will help the insemination process by causing the sow to draw the semen into the reproductive tract and minimize flow-back. In group sow housing arrangements, the boar can be penned in a small pen next to the sows during breeding. The sows in heat will come to the boar and can be put into a breeding stall for insemination.

Alternatively, two breeding stalls can be fixed facing each other with the boar in one and the sow to be bred facing the boar in the other. Breeding stalls can be made from gestation stalls. Put the breeding stall in a separate area from the sow group so other sows do not disrupt the breeding process and do not get too accustomed to the boar before breeding. Producers with feeding stalls may use them for breeding stalls.

Breed all sows twice about 12 hours apart. Some producers continue to breed the sow as long as estrus lasts. Litter size does not increase with more than two inseminations, but conception rate may improve depending on the accuracy of estrus detection.

Additional Resources

Iowa Pork Industry Center. 109 Kildee Hall. Iowa State University, Ames, IA, 50011. 515-294-4103.
in Iowa: 1-800-808-7675
http://www.ipic.iastate.edu/about.html

U.S. Pork Information Gateway
http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Boar Fertility

IPIC NPP450 2007

When boars are relied on for mating, fertility is paramount. Boar fertility should be checked periodically. This is done by collecting an ejaculate and examining it under a microscope. Boar semen should be milky white, not pink or yellow. Sperm should swirl under the microscope with minimal broken tails or dead sperm.

Boar fertility is reduced because of overuse and high temperatures. For optimum levels of sperm per mating, boars should be mated no more than 1 to 2 times daily or 5 to 7 times per week. In pen mating settings, a young boar is needed for every 2 to 4 sows, and an older boar is needed for every 3 to 5 sows for a 7-10 day breeding period. Some producers rotate boars, which allows each boar time to eat and rest before resuming breeding activities. The lower value is for young boars (8-12 months old) and the upper value is for older boars (>12 months old)

Fertility is reduced markedly about 5-6 weeks after fever or hot ambient temperatures. Efforts to keep boars cool are important. Count the boar's respiration rate to see if he is suffering heat stress. Normal respiration is 25-30 breaths per minute Respiration rates greater than 40-50 breaths per minute signal that cooling is needed immediately. During heat stress 75-100 breaths per minute are possible. Cooling efforts include shade, sprinkling and access to wet concrete flooring in the shade. Do not move, mix, or mate boars during hot weather (> 85 ºF).

Boar Management Summary[1]

1. Purchase boars early (at least 45-60 days before breeding). Consider purchasing boars as 50-75 pound feeder pigs.
2. Use selection criteria that match your goals.
3. New boars can bring new diseases to your herd. Buy from healthy herds.
4. Isolate the boar for at least 30 days before mating.
5. Practice-mate the new boar to gilts.
6. Check semen quality.
7. Have enough boars for your herd. This will improve conception rate and litter size.
8. Keep boars cool. Do not mix young and old boars.
9. Write down breeding dates and details.
10. Remember to vaccinate and de-worm boars on the same schedule as sows.
11. Feed boars 5-6.5 pounds of your sow lactation diet daily.

[1]Adapted from PIH 08-02-02

Additional Resources

Purdue University Extension, 2007. Relative Value of Feedstuffs for Swine, The New Pork Industry Handbook—07-06-03. Purdue University. West Lafayette, IN.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Scheduling Pig Flow

IPIC NPP510 2007

Scheduling pigs in groups or batches of the same age (and hopefully the same weight) is desirable because all-in–all-out can be practiced to stop disease spread, pigs can be fed optimally to meet their needs, labor and management can be streamlined, facilities can be kept full (not half empty or overcrowded) and marketings can be planned. Groups of market pigs are primarily set by the breeding dates of sow groups that farrow them. Several factors determine the schedule of pig flow.

Factors determining pig flow schedule:

- Reproductive cycle: Gestation length 114 days +/- 3-4 days, Estrus cycle 21 days +/- 2 days.
- Weaning age*: from 10 to 70 days, for niche production usually >35 days.
- Wean-to-breed interval: about 3-6 days or more (shorter time the longer lactation, longer time when sows are very thin).
- Farrowing rate*: the percentage of sows that farrow compared to those sows available for breeding (analogous to ultimate conception rate).
- Breeding span*: the number of days that a group of sows is allowed to be mated.
- Number of pigs weaned per litter*: varies widely from 1-15 pigs; a good goal is 8-10 pigs.
- Clean up days*: time allowed to clean facilities and let them sit empty.
- Growth rate*: pigs go to market at approximately 180 days of age.
- Facility capacities*: number of farrowing spaces per group, number of farrowing rooms, nursery and finishing pig capacities (groups and number of groups that can accommodated at one time).

*Factors noted with an asterisk are at least somewhat controlled by the producer. Many of these factors may also be specified by niche market requirements. All these factors contribute to the Interval Between Farrowing or IBF.

Example Systems

There are three basic systems followed by pork producers. These of course are often adapted to match the operation.

1) One Litter

This approach farrows only gilts once per year. The sows are sold after weaning their first litter or after they are dried up. They are not farrowed a second time. Replacement gilts are saved and bred to farrow at the same time the next year. It is typically used with pasture or outdoor production. This system has the advantage of simplicity and keeping groups of pigs separated seasonally, but has the disadvantages of farrowing gilts: smaller litters, lower immunity, non-synchronized estrus, and cost of developing gilts. This system is most profitable when there is a good market for the weaned sows.

2) Two Litter

This system farrows a group of sows twice per year about six months apart, traditionally spring and fall, but other seasons will work. With planning the farrowings can be spaced six months apart and occur at the same time each year, if desired. This system allows the sows to be rebred and to produce many litters (2/year).

3) Multiple Groups

Two or three sow groups can be kept on one farm to produce four or six batches of pigs per year. One farrowing facility could handle 3 sow groups/6 farrowings per year with typical 40+ day weaning age (Table 1). More farrowing facilities would be needed for farms with four or more sow groups.

Example schedule

An example of a pig schedule is shown in Table 1. It is based on a 10-11 day breeding/farrowing period and a 43-44 day weaning age for the oldest pigs and a 33-34 day weaning age of the youngest pigs. After weaning, the sows are allowed to cycle once (21 days or 3 weeks) before they are rebred. The schedule can be used for 1, 2, or 3 groups through the same farrowing/lactation facility. There are at least three days between weaning date and the next farrowing. A software program that generates breeding/farrowing schedules is available from the Iowa Pork Industry Center. Contact your ISU Extension swine field specialist for more information.

Other Strategies

It is important to have full farrowing groups to keep pig flow and income steady. One common problem of small producers is breeding failures resulting in less than full farrowing groups. Here is a simple approach to keep farrowing groups full that uses extra gilts to keep the groups full.

Make replacement gilt selection from market pigs the same day that you wean pigs from the sows. Choose plenty of gilts, more than you will need. Expose the gilts to a boar every day. Tag and record every gilt that comes into standing heat/estrus. Send the gilts that do not cycle in 10 days to market. In the next cycle, breed the gilts with the sows that were weaned 21 days earlier. Make sure to sort off plenty of gilts to ensure a full farrowing group, even if farrowing rate is low. Pregnancy check and sell extra gilts (even if pregnant) as heavy market pigs. If you want 20 sows to farrow, try to have 20 to 22 pregnant at the pregnancy check.

Another strategy in sow management and pig flow is to "self-feed" during the long lactation. The dark breed sows may come out of lactation too fat. Use gestation and the skipped heat cycles to bring sows back into condition. Limit their feed during this period, but keep them satisfied by feeding high forage diets (ground hay for example). A sow that is moderately thin (having a 2+ condition score) at farrowing will be hungry during lactation and will eat more feed when she needs it.

Table 1. Example pig schedule.

	Group 1	Group 2	Group 3
3wk after wean date	6-Oct	22-Nov	29-Jan
Start breeding	10-Oct	26-Nov	2-Feb
End breeding	20-Oct	6-Dec	12-Feb
Farrow date	**1-Feb**	**20-Mar**	**27-May**
End farrow	11-Feb	30-Mar	6-Jun
Wean @ 43 day lact	16-Mar	2-May	9-Jul
Skip 3 wk start heat checking	6-Apr	23-May	30-Jul
Start breeding	10-Apr	27-May	3-Aug
End breeding	20-Apr	6-Jun	13-Aug
Farrow date	**2-Aug**	**18-Sep**	**25-Nov**
End farrow	12-Aug	28-Sep	5-Dec
Wean @ 44 day lact	15-Sep	1-Nov	8-Jan
Skip 3 wk start heat checking	6-Oct	22-Nov	29-Jan
Repeat dates next yr			

Additional Resource

U.S. Pork Information Gateway
http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Target Annual Production

IPIC NPP520 2007

Annual pig output should be set after considering several factors. The greater the production intensity (i.e., the more pigs produced on a farm), the more difficult it becomes to raise pigs without antibiotics. Seasonal production works well in a small niche system because it is essentially an all-in–all-out system with major herd health benefits.

Capacity of facilities is the main constraint that sets the maximum output for the farm. Facility utilization (or how full facilities are and how frequently they are filled) also is a factor. Wean-to-finish facilities should have at least two turns per year. The number of pigs raised in your operation per year influences both non-feed costs and overall income levels. Using only part of existing facility capacity can lead to reduced income, especially if investment in facilities is substantial. Exceeding the capacity of facilities tends to increase stress and disease pressure.

Case study: Determining output target return for management and labor.

In this example, an operation has one hoop barn (175 market pigs), one old barn (160 market pigs), an older shed (75 breeding animals) plus a pen for some cull pigs, and a farrowing/lactation facility (20+ sows and litters).

The plan for this operation is to farrow two groups of sows twice per year, one for the hoop (175 pigs) and one for the old barn (160 pigs). Farrowings are November 1 and December 15, and again April 11 (without skip heat) and June 15 (with skip heat) (leaflet number 510). These four farrowings will fill the barns twice annually. The operation wants to make $30,000 over cash costs as a return to labor and management.

First, the return per pig should be calculated:

$$260 \text{ lb pig} \times \$0.48/\text{lb} = \$125 \text{ Gross Income}$$

$$\$125 \text{ Gross Income/pig} - \$55 \text{ Feed Cost/pig}$$
$$= \$70/\text{pig Return over Feed}$$

$$\$70/\text{ pig Return over Feed}$$
$$- \$25/\text{pig Operating and Depreciation Costs}$$
$$= \$45/\text{pig Return to Labor}$$

The number of pigs needed to achieve the desired income is then determined and compared to available pig spaces.

$$\frac{\$30{,}000 \text{ Desired Income}}{\$45/\text{pig Return to Labor}} = 667 \text{ pigs}$$

$$(175 \text{ pigs} + 160 \text{ pigs}) \times 2 \text{ turns/yr} = 670 \text{ pigs}$$
$$\text{Pigs in Hoop Barn} + \text{Pigs in Old Barn}$$

In this example the producer has enough pig spaces to meet target annual income, if the cost and income estimates are correct.

Determining the cost of missing production targets

Assume that the costs listed above are accurate for producing 667 pigs. What are the consequences if production drops to 500 pigs? As Table 1 details, the costs allocated to a single pig must increase. This results in an increased cost of production despite an overall reduction in feed costs due to fewer pigs produced. If the cost structure is sized to match 667 pigs and only 500 pigs are produced, the 167 missing pigs will increase the cost of the operation by $23 per head.

Marketing 500 pigs instead of 667 reduced the total return by $11,348, or nearly $70/pig. Every litter of 8 pigs under this scenario is worth $560. Because matching annual output to cost structure is so critical for success, efforts should be made to insure that enough pigs are available to meet the production target.

Given this above example, it pays to have enough sows pregnant at the right time. Consider improving reproductive performance by hand-mating, artificial insemination, or improving the pen breeding system. Breeding extra gilts or sows that otherwise would be culled is another strategy to guarantee you have enough bred sows to farrow in a group.

Having extra gilts and sows for a short time in a niche system will not cost as much as missing production targets. Gilts and sows can be housed in low cost facilities. The extra feed fed to a group of sows that is larger than it needs to be for 3-5 weeks while pregnancy is established is small. After enough sows in a group have been confirmed pregnant, the extra gilts or sows can be sold.

Additional Resources

Iowa State University Extension. 2007. Ag Decision Maker. Iowa State University. Ames.

Table 1. Cost per pig under two production levels.

	667 hd	500 hd	Difference
$30,000 Target Return,$/hd	45	60	15
$ 6,670 Fixed Costs, $/hd	10	13	3
$10,000 Operating Costs, $/hd	15	20	5
Non-Feed Costs, $/hd	70	93	23
Feed Costs, $/hd	55	55	0
Total Costs, $/hd	125	148	23
Market weight, lbs.	270	270	0
Breakeven Price, $/cwt	**46**	**55**	**9**

Table 2. Potential return under two production levels.

	667 hd	500 hd	Difference
$ 6,670 Fixed Costs, $/hd	10	13	3
$10,000 Operating Costs, $/hd	15	20	5
Non-Feed Costs $/hd	25	33	8
Feed Costs $/hd	55	55	
Total Costs $/hd	80	88	8
Total Costs $/farm	53,360	44,000	9,369
Market weight, lbs	270	270	
Price, $/lb	0.46	0.46	
Income, $/hd	124	124	
Total Income, $	82,708	62,000	20,708
Total Return, $	29,348	18,000	-11,348
Labor, hr	1500	1500	
Hourly income, $/hr	**20**	**12**	**-8**

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Pork Quality

IPIC NPP610 2007

Pork quality is a critical part of most niche pork markets. The quality of pork is the result of a combination of genetic and environmental factors. There are four major criteria used in measuring pork quality: color, marbling, water-holding capacity, and ultimate pH.

Pork Quality Criteria[1]

1) Color

Generally darker pink pork is preferable. The minimum is a bright reddish pink (3.0 on the scale shown), although some markets prefer slightly darker (4.0-5.0). A number scale often is used.

Pork Color Scale

- 1.0 Pale pinkish gray to white
- 2.0 Grayish pink
- 3.0 Reddish pink
- 4.0 Dark, reddish pink
- 5.0 Purplish pink
- 6.0 Dark purplish red

2) Intramuscular Fat or Marbling

The streaks of fat within pork are called marbling or intramuscular fat. It is the fat that provides much of the flavor in pork. Target level for nutrition, flavor, and health is 2-4 percent.

3) Water-Holding Capacity or Drip Loss

The amount of moisture in pork that is lost when it is cut is called water-holding capacity or drip loss. Loss often increases when color is pale or pH is low. Lower values indicate less loss which is preferable. Losses should not exceed 2.5 percent.

4) Ultimate pH

The acidity of pork measured 24 hours after slaughter is called Ultimate pH. It is a predictor of drip loss. A higher pH indicates better water-holding capacity and better eating pork. A target range of 5.6-5.9 ultimate pH for pork has been set. Some markets may prefer higher levels.

[1]Adapted from Measuring Pork Quality, 1999.

Influences on Pork Quality

Pork quality is influenced by genetic and environmental factors. Some of the environmental factors are on-farm and some are at the packing plant.

Heritability of Pork Quality Traits

Pork quality is moderately heritable, i.e., quality traits may be improved by selective matings. See leaflet number 410 of this handbook for heritability estimates and additional discussion of pig genetics.

There are two known genes that are negative to pork quality: the halothane (or stress) gene and the Rn gene. Swine breeding stock should test negative for these two genes.

Handling and Stress

The stress of sorting, loading, and hauling pigs can have negative effects on pork quality. This stress should be minimized, but cannot entirely be avoided. Short-term stress before slaughter can result in pale soft pork with greater drip loss. Long-term stress can cause dark, firm, and dry pork. Handling and chilling and other activities at the packing plant can also impact quality, so talk with your packer.

Strategies for reducing stress and maintaining pork quality:

- Spend time with pigs prior to sorting day. This will reduce the pigs' fear of humans.
- Be patient and quiet. Move slowly. Let the pigs set the pace.
- Pigs reflect the stockman's disposition. Stay calm.
- Keep pigs in a group. Isolation stresses pigs.
- Pigs follow other pigs.
- Work pigs early in the morning, particularly during hot weather.
- In hot weather, sprinkle pigs in transit.
- Take pigs off feed but not water about 12 hours prior to slaughter.

Additional Resources

Iowa State University Extension, 1999. Measuring Pork Quality. IPIC 7.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Matching Carcass Specifications of Your Market

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP620 2007

Most niche markets have carcass specifications and reward producers who meet those criteria. Docks or sort loss -- reduction in the price paid for a particular pig that does not meet size or carcass quality specifications -- also are used. Common market criteria include fat thickness, meat quality characteristics, and carcass weight. Meat quality as it relates to genetics and feeding program has been discussed in leaflet number 410 and section 300 of this handbook respectively. Consistently producing pigs that meet the market criteria is one strategy a producer can use to insure that they receive the maximum premium from each pig.

Optimizing Backfat Thickness

Backfat can be influenced by pig gender, nutrition, and genetics. Barrows grow faster and naturally carry more backfat than gilts. A pig will become leaner and more muscular if extra amino acids are fed in the diet. Overfeeding amino acids will make the pig leaner because excess protein is converted to energy less effectively than starch. Amino acid feeds tend to be more costly than other feeds. If there is a dock for pigs that are too lean, care must be taken not to over feed amino acids.

Genetics is the primary influence on backfat thickness. Some breeds are known for less backfat while others produce fatter carcasses. Genetic choices should be made with a goal of improving how well the pigs match the market's criteria.

Carcass Weight

Production practices that improve pig uniformity in the pen should be adopted. Some niche markets have narrow target weight grids, and it is difficult to minimize sort losses unless pigs are similar in size. It can be difficult balancing the number of pigs ready for market with the buyers' demand for pigs in a given week. Constant communication between producer and the niche pork buyer and scheduler is critical for supply to match demand. Strategies to minimize size variation within a pen and thus reduce sort loss include:

- Market optimal loads -- evaluate the costs and benefits of marketing smaller loads more often. Compare the cost of discounts from selling pigs outside of the target range with the increased cost of more trips with fewer animals.
- Bunching pigs at farrowing -- begin with a pen-sized group of pigs of the same age.
- Improving herd health reduces the number of slow growing pigs that are potentially too small for market.
- Improve genetics -- maximizing heterosis will improve the vigor of the pigs and potentially reduce sort loss.
- Make use of scales when sorting.

Dressing Percentage

Optimum weight is a matter of growing pigs to the correct weight determined by the marketing grid. Because market pigs are sorted by live weight, and most grids are measured in carcass weight, it is important to accurately estimate dressing percentage. Dressing percentage, or carcass yield, is determined by dividing the carcass weight by live weight. Carcass weight is the weight of the meat and bone that remain after the head, organs, feet, and skin have been removed. In the United States, the estimated baseline dressing percentage for commodity pork is 74%. This baseline is of limited value to niche pork producers and should be replaced with a farm specific estimate as soon as possible.

Two independent factors affect dressing percentage: gut fill and carcass conformation.

1) Gut Fill

Gut fill literally is the weight of the gut and other organs that are removed from the pig carcass. How much the pig eats and drinks before being weighed live directly influences dressing percentage. A long transport time will increase dressing percentage as the stomach contents are emptied during the trip. A slight amount of tissue shrink may occur after about 12 hours without water. Tissue shrink will negatively affect the carcass weight, and should be avoided.

2) Carcass Conformation

Carcass conformation depends upon the structure and size of the pig. Short, stocky pigs tend to have higher dressing percentages. Pigs that are heavily muscled tend to have a higher dressing percentage. Pigs finished in cold environments usually eat more feed, often increasing stomach capacity. This in turn lowers the dressing percentage. Similarly, pigs fed forages will also develop larger guts and this results in lower dressing percentages.

Additional Resources

Iowa State University Extension, 1999. Measuring Pork Quality. IPIC 7.

Purdue University Extension, 2007. The New Pork Industry Handbook. Purdue University. West Lafayette, IN.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Stockmanship

IPIC NPP710 2007

Pig handling and care affects productivity. The buildings and facilities commonly used by niche pork producers may not allow close regulation of environment and pigs. Rather, these systems rely on the adaptability of the pig and the skill of the stockperson to accurately read pig behavior.

Bedding plays a critical role in pig comfort in most niche production systems and is addressed in leaflet number 230 of this handbook. Pig housing and handling facilities should be designed to complement pig behavior. Adapting facilities and stockperson attitude to match the natural behavior of pigs is advantageous, particularly in the areas of mating sows, farrowing litters, and sorting or moving of market pigs. If a task is too difficult or distasteful for stockperson or pig, the task may not be performed well over the long-term.

Mating and Breeding

Sows and boars can easily harm stockpersons. Sows and boars must be respected, but should not be feared by or taught to be fearful of humans. Flight zone is the space that a pig will attempt to maintain between itself and a person. In sows and boars, the flight zone should be zero. Both animal and stockperson must be comfortable in close proximity with each other. Reproductive performance is superior on farms where the sows are not afraid of their caretakers. Calm behavior by the stockperson will translate into calm behavior by the pigs. Sudden movements and loud noises should be avoided.

Farrowing

Farrowings should be attended by stockpersons to insure maximum survival of newborn pigs. The entire birth process will last between two and five hours. Time between the births of individual pigs will range from few minutes to one hour.

In most cases pigs are born with no assistance from stockpersons.

Newborn pig care consists of three considerations:

1) Breathe

Check newborn pig for breathing. If pig is not breathing, wrap hand around pig's muzzle to form a cone and gently force air into the lungs. Expel air from lungs by squeezing rib cage. Repeat.

2) Nurse

Piglets should ingest colostrum moments after birth. Colostrum is rich in energy and disease fighting antibodies. Help pigs find a working teat as soon as they are born.

3) Prevent Chills

The newborn pig has almost no fat to insulate against cold or drafts. Pigs should be dried and placed at the sow's udder immediately after birth. Positioning heat lamps or pads to provide supplemental heat is desirable, but caution needs to be taken to avoid fire hazards.

A goal should be to provide minimal assistance at farrowing. However, stockpersons should be prepared to assist. Sows may tire giving birth to large pigs or litters. If labor (nesting, restlessness, abundant milk, straining) is observed but no pigs born within 1 hour, or if 20 minutes pass between births, the sow should be examined and assistance provided.

Oxytocin is a naturally occurring hormone which stimulates uterine contractions and milk letdown. Injectible forms of oxytocin are available for use in pigs. Consult your veterinarian for proper use of this hormone. Before using any substance be sure to confirm that it is acceptable to your niche market.

Manual Delivery Technique

- Thoroughly wash hands, arms, and the sow's vulva area with warm water and antiseptic soap.
- Plastic sleeves are available and are recommended. Insert arm into plastic sleeve and thoroughly wash sleeved arm.
- Apply lubricant liberally to sleeved arm and hand.
- Gently insert cupped hand and forearm through the sow's vulva and determine how the pig is presented.

Head first delivery: Normal delivery position

- Grasp the ridge of the nose with your thumb and insert your index finger in mouth behind the needle teeth, pinch thumb and index finger together and gently pull.
- Grasping the pig by placing your thumb under the chin and index finger in its mouth is also effective.
- If the sow's pelvis is large enough and her uterus is well dilated, you may be able to pass your hand over the pig's head. Place your index and middle fingers behind the pig's ears and press your thumb against the lower jaw.

Breach delivery: Pig's rump is over rim of sow's pelvis and pig's hocks and legs are forward.

- Gently slide cupped hand through the vulva and vagina until contacting a pig.
- Gently hook fingers around the pig's hocks and simultaneously push the pig's rump and pelvis forward with your thumb.
- This action will allow you to pull the back legs and to deliver the pig.

Do not force your arm too far into the reproductive tract or damage to sensitive tissue may occur. Be patient and gentle when assisting with delivery. Young pigs easily can be injured or the sow's reproductive tract damaged if care is not taken. Delivery instruments should be used with caution. Timely delivery is essential because one or more viable pigs could die due to farrowing complications. If pigs begin to decompose within the sow, they will poison the sow. The placenta usually is expelled from the sow within four hours of the last pig birth and is a good signal that delivery is complete. Sows will eat fresh placenta and make it difficult for a producer to know whether the placenta was passed.

Lactation

Nursing follows a consistent cyclic pattern in pigs. Approximately every hour either the sow or pigs will initiate nursing. The sow will roll on her side and expose her udder, accompanied by slow grunting which calls the entire litter of pigs. The piglets will assemble at the udder and begin to aggressively nose and butt the udder. The sow will grunt faster and louder and the pigs will begin to suckle. Only after all pigs have established their position and stopped squealing will milk be released by the sow. Milk flow lasts about 15 seconds followed by swallowing and noisy suckling by the pigs. Once the released milk has been drained from the teats, the pigs begin to butt the udder again, but the sow terminates nursing by rolling onto her udder.

Teat order is established within the first three days and piglets will defend their teat at the udder. Milk flow is stimulated by suckling, thus unused sections will regress. The cyclic nature and short duration of nursing in pigs makes it particularly important for teat order to be established and maintained. Fans or other noises in the farrowing house can disrupt nursing cycles and cause some pigs to miss a meal. Pigs that miss a nursing cycle are not fed until the next nursing bout. Nursing in a group lactation room is usually synchronized, thus preventing pigs from one litter stealing the milk from another.

Lactating sows consume large amounts of water. Clean and fresh water should always be available. When pigs are 3-7 days old they will begin to drink water. Be sure to provide a way for the young pig to consume water while it is still nursing.

Weaning

Most niche markets require a weaning age of 35 days or older. This is an advantage for the newly weaned pigs. Weaning is one of the most stressful times for mammals. The young abruptly must shift from a diet of milk to a diet of feed. This transition can be eased by creep feeding. Weaning older pigs also allows the gut time to mature and become better able to digest the nutrients found in typical pig diets. Making sure that newly weaned pigs find and consume water and feed is the key task for the stockperson during this phase.

When weaning, the sow should be removed from the pigs. Ideally a group of pigs that were born at the same time will be weaned at the same time and become a group of market pigs. If groups of growing pigs need to be mixed, weaning is the best time to do so.

Market Pigs

After pigs have been weaned and have established eating patterns it may be tempting to place the animals on a self-feeder and ignore them until it is time to market them. This is not good stockmanship. Pens of growing pigs and particularly their waterers and feeders should be checked daily. Pigs should be observed for normal behavior and sick or injured animals treated immediately. A pen or lot designated for sick animals should be maintained for animals needing treatment. If observation of all pigs in a pen is possible without entering the pen, stockpersons should walk through the pen weekly to familiarize the pigs with their presence. When checking pigs, take note of the following:

- ♦ Are the animals crowding into a corner, or spread out and calm?
- ♦ Are any animals breathing heavily or coughing?
- ♦ Are stress behaviors such as tail-biting occurring?
- ♦ Has the dunging area shifted or grown in size? If so, is this because of a draft, overcrowding, too little fresh bedding, or some other cause?

When sorting and loading pigs, workers should remain calm and avoid making loud noises and sudden movements. Electric prods are prohibited by many niche markets. Hog paddles and whips should be used with care to avoid injuring the pig or bruising the carcass. Solid panels should be used to direct pig movement. Pigs prefer to move in groups, so sorting multiple animals at once may be less stressful for both pig and worker. During hot weather, pigs should be moved and handled in the cool part of the day. Sprinkling pigs in transit can relieve heat stress.

Additional Resources

Anonymous. 2007. See what you feel—assisted delivery of piglets. GSW 07002. National Hog Farmer and Purdue University.

Kyriazakis, Ilias and Colin T. Whittemore editors. 2006. Whittemore's Science and Practice of Pig Production 3rd Edition. Blackwell Publishing. Ames, IA.

National Pork Board. 2007. Pork Quality Assurance Plus™ Producer Certification Manual. Available at http://www.pork.org/Producers/PQA/PQAPlus.aspx.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Raising Healthy Pigs

IPIC NPP720 2007

Healthy pigs are key to successful niche pork production. Healthy pigs grow faster and are more efficient in converting feed to gain. Farms with healthy pigs have fewer cull and dead pigs. The veterinarian is an important partner in raising healthy pigs. It also is essential for stockmen to know the visual differences between healthy and sick pigs (Table 1) and to observe pigs regularly.

Table 1. Visual differences between healthy and sick pigs.

Healthy Pigs	Sick Pigs
Active	Listless
Curious	Uninterested
Hungry	Off–feed
Clean and dry	Rough hair with dirty rears

Checklist for Raising Healthy Pigs

Segregate age groups of pigs.
This keeps age-related diseases from spreading through your herd. Separate pens are the minimal separation and separate buildings or sites are better. Keep sows and boars separate from younger pigs after weaning. Small herds can practice segregation seasonally. For example, a farm may only farrow twice each year or a feeding floor may be empty for a couple months in the summer.

De-worm and de-mange regularly.
In bedded, solid floor, or pasture systems worms are a continual threat. Consider worming monthly. Several excellent de-worming products are available as feed or water additives or as injectables. Consider rotating products to prevent resistance. Mange eradication is possible using injectable ivermectin, but every pig on the farm must be correctly treated. Consult with your veterinarian or animal health supplier.

Practice cleanliness and sanitation.
Keep manure spread or stockpiled in a designated area. Clean up spilled feed or grain and junk piles. Most pathogens need moisture to live. Clean, dry surfaces, exposed to sunlight (if possible) are an effective way to reduce pathogens. Time between groups also can help.

Change clothes and boots when returning to your farm.
Provide boots to visitors.

Establish regular veterinary visits.
Use your veterinarian as a consultant not just as a rescue when disease strikes. Work at preventing diseases not just treating them.

Quarantine new pigs to your farm and buy clean, tested stock.
Most diseases are transmitted pig-to-pig. A 30+ day isolation of new stock allows time for testing and acclimation.

Practice all-in–all-out.
This will improve herd health, sanitation, and marketing. The worst practice is to keep the small slow-doing pig (potential disease shedder) and put it with younger pigs.

Vaccinate comprehensively.
Work with your veterinarian to create a

vaccination program for your herd and stick with it. Always record treatments -- date, dose, and pigs treated. Consider leptospirosis and parvo vaccines for the breeding herds. Consider erysipelas and mycoplasma vaccines for all pigs.

Manage vaccines.
Keep vaccines cool, not frozen. Modified live vaccines are inactive if frozen. Some older refrigerators may cycle below 32°F in the back. Read label for application method, dosage, and expiration dates.

Proper injection technique.
Use shorter smaller needles for smaller pigs and for subcutaneous injections (as opposed to intramuscular). Change needles every 10 injections or by litter. Never reuse a bent needle. Inject in the proper site (flank for subcutaneous and neck for intramuscular). Dispose of sharps properly.

Make sure every newborn pig nurses.
A sow's first milk (colostrum) after farrowing contains antibodies which provide protection from disease for the new pigs.

Keep older sows.
Older sows produce more antibodies than young sows.

Provide plenty of clean, fresh water.
Use plenty of clean, dry bedding, and minimize environmental stress.
Do not crowd pigs. Low stress pigs have a better immune status.

Dispose of all dead pigs promptly.
Consider composting.

Isolate sick or injured pigs to allow them to recover.

Practice continuous rodent control.

Keep cats away from pigs, feed, and bedding.

Keep wild animals and birds away from pigs as much as possible.

Additional Resources

Cowart, Ross P. and Stan W. Casteel. 2001. An Outline of Swine Diseases, A Handbook 2nd Edition. Iowa State University Press. Ames.

Exner, R. (editor). 2007. Managing for Herd Health in Alternative Swine Systems. Practical Farmers of Iowa and Iowa State University. Available at www.pfi.iastate.edu/pigs.htm.

Hill, John and David Sainsbury editors. 1995. The Health of Pigs. Longman Scientific and Technical. Essex, UK.

National Pork Board. 2007. Pork Quality Assurance Plus™ Producer Certification Manual. Available at http://www.pork.org/Producers/PQA/PQAPlus.aspx.

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Feed Costs

IPIC NPP810 2007

Feed cost usually is the largest cash expense and will have a major impact on total cost. Feed costs are typically 2/3 or more of the total cost of producing pigs. Feed cost is affected by feed conversion and diet cost. Both the price of the feed and the amount of feed needed to raise a pig are important in calculating the overall feed cost of pig production.

The variation in feed cost between operations can be the difference between success and struggle. Many niche operations have low overhead and low debt loads that together make feed a greater percentage of cash costs than those of conventional systems. Therefore, managing feed for low cost while maintaining adequate performance is critical. Feeding programs for niche markets should be designed for acceptable growth rates, carcass quality, and reduced cost of gain. Managing for maximum lean gain may not be the goal.

Feed Conversion

Feed efficiency (defined as pounds of feed per pound of gain or feed conversion) is one of the most important pieces of information in a record keeping system. If you do not keep any other records, at least track pounds of pigs produced and pounds of feed fed to determine the feed conversion value for the operation.

Feed conversion is influenced by several factors:

- Environmental conditions: Cold pigs eat more feed than comfortable pigs and use the extra feed for maintenance, not growth.
- Diet formulation: Diets should match pig needs for optimal conversion.
- Quality of feed ingredients: Grains should be free of mycotoxins, and not damaged by heat or moisture.
- Genetic potential and hybrid vigor: Genetics set the upper limit on feed conversion.
- Sow productivity: A sow that produces 14 pigs per year eats almost as much feed as a sow that produces 20 pigs per year.
- Feed wastage: The amount of feed that is provided but not consumed by pigs greatly influences feed conversion.
- Death loss and health status: Pigs that die eat feed up until death but result in no saleable gain.

Feed Budgeting

In order to set a realistic feed conversion goal, records are a must. Tracking feed usage also allows producers to detect real, but perhaps visually imperceptible, changes in feed use. This can alert producers to changes in herd health, the impacts of new genetics or management techniques, or areas that need closer attention. Leaflet number 840 of this handbook provides examples of feed budgets.

Feeding pigs based on a certain amount of feed use is another strategy for reducing feed costs. Rather than estimating pig weight and changing diets accordingly, diets are switched after a certain amount of each diet is consumed.

For example, assume you switch diets when the pigs reach 80 lb and your records show that your feed conversion ratio for 50 to 80 pound pigs is 2:1. A pen of 80 pigs with an average start weight of 50 lb would need 4,800 lb of feed.

$$80 \ \ pigs \ \ x \ \ 30 \ \ lbs \ \ gain \ \ x \ \ \frac{2 \ \ lb \ \ feed}{1 \ \ lb \ \ gain}$$

$$= 4{,}800 \ \ lbs \ \ of \ \ Feed$$

Thus, the pen of pigs would be supplied with 3,000 lb of the diet formulated for pigs weighing 30 to 80 lb and when that feed is consumed you would begin feeding the next diet formulation.

Purchased Ingredients

Feeding grains that you have grown and processed yourself may be advantageous, but ingredients like soybean meal, dried whey, and mineral and vitamin supplements usually are purchased. Homegrown alternatives to these ingredients may be possible but should be evaluated carefully. A realistic value should be placed on the convenience and services provided by feed suppliers. Comparison shopping should be done periodically and comparisons should be made on uniform measures of value. For example, comparing one product's lysine level with another product's crude protein level is not a good comparison because you are looking at two different measures. Periodically review feed formulations and evaluate the cost effectiveness of the feed program. Investigate buying ingredients in bulk rather than as bagged feeds and consider joining with other producers to qualify for volume discounts.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Purdue University Extension, 2007. Relative Value of Feedstuffs for Swine, The New Pork Industry Handbook–07-06-03. Purdue University. West Lafayette, Indiana.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Improving Feed Conversion

IPIC NPP820 2007

Feed conversion is calculated by dividing the amount of feed fed by the amount of pig weight gain.

$$\textit{Feed Conversion} = \frac{\textit{Pounds of Feed Fed}}{\textit{Pounds of Gain}}$$

Improving feed conversion is a matter either of decreasing the amount of feed fed or increasing the amount of gain, or a combination of both.

Minimizing Feed Waste

Not all the feed placed in a feeder will be eaten by the pig. Records show that more than 30% of the feed fed can be wasted. Detecting feed waste can be difficult—up to 10% feed wastage is almost undetectable on a feeding floor. Properly managing feeders minimizes feed waste before it occurs. Stale feed in the feeder trough is usually rejected by pigs. The pigs will root the stale feed out of the trough in order to get to fresh feed. Saliva from the pigs will mix with feed and tend to slow down feed flow; thus, daily observation and adjustment of feeders is absolutely necessary.

Managing feeders to minimize feed waste:

- Open feeder just enough to start feed flow.
- Use rod to pull feed into pan.
- Your goal is to cover 1/3 (ONLY 1/3) of the feeding pan with feed.
- Check and adjust feeders daily.
- Maintain feeders in good working order, repair any holes, and replace worn out parts promptly.

Another way to limit feed waste is to limit-feed pigs. While most growing pigs in the U.S. are fed with self-feeders, most pigs in Europe are limit-fed. Limit-fed pigs are fed small amounts of feed multiple times a day. They are fed only what they will clean up between feedings. Typically pigs are fed 3-4 times per day on a clean feeding floor. Limit-fed pigs have an improved feed conversion rate, although limit feeding can be difficult with large groups and could result in uneven pig size.

Properly matching diets with the size of the pigs is a final strategy to minimize feed waste. As discussed in section 300 of this handbook, under- or over-feeding of different nutrients requires the pig to adjust feed intake and metabolism to compensate. For example, if protein is overfed, pigs must break down the extra protein into energy. This increases the energy spent simply digesting the feed and results in poorer feed conversion. The extra protein has been utilized less effectively for energy than it would have been for muscle growth. This is a form of feed wastage. Most of the impact of diets mismatched with pig needs is on growth rate, but feed conversion is about 60% correlated with growth rate.

Sow Productivity

In farrow-to-finish operations, sow productivity may have a substantial impact on feed conversion. A sow producing 10 pigs per year will eat almost the same amount of feed as a sow producing 18 pigs per year. Assume a sow eats 3,000 lb of feed in a year and produces 2 litters of pigs. If only 10 pigs are sold per sow, each pig must pay for 300 lb of sow feed. If 18 pigs per sow are sold annually, each pig must account for only 167 lb of sow feed. This has a dramatic impact on overall herd feed conversion.

Similarly, the difference between producing two litters of 5 pigs annually and one litter of 10 pigs affects overall feed conversion. If only one litter of pigs is farrowed annually, lactation feed would be significantly reduced. Sows that are not pregnant or nursing can be maintained on much less feed than a sow that is nursing.

On the other extreme, litter size can influence the young pig's ability to survive and thrive. It has been shown that some sows are physically capable of producing up to 18 live pigs per litter. However with increasing litter size, the weight of each pig decreases. Newborn pigs that are born small are at a disadvantage and are more likely to be crushed by the sow and become chilled, and they do not grow as rapidly.

The goal for niche market producers should be to have sows that will consistently farrow a litter of 9-12 vigorous pigs with an average birth weight of about three pounds.

Sow Feeding

Gestating sows have the potential to eat large amounts of feed. However, overfeeding gestating sows is detrimental to sow and pig productivity. Piglet crushing and sow mortality rates increase as sows become overly fat, especially in warm conditions. Milk yields also can decrease, triggering starve-outs and unthrifty, low viability pigs that are more susceptible to disease problems. A good strategy to satisfy the appetite of a gestating sow without excessive weight gains is to feed a low-cost, high-fiber feed.

Tracking feed use by gestating sows is important. Remember, you manage what you measure. Some farms that have begun to measure sow feeding have found that they are actually overfeeding each sow 3 to 4 lb per day. This is almost a doubling of gestation feed use that is not only unnecessary but detrimental to the overall performance of the pig herd.

Feed particle size

Digestive enzymes work on the surface area of feed particles. If feed particle size is too big, there is insufficient surface area for the digestive enzymes to work and the feed is not well-utilized by the pig. If feed particles are too small, they can lead to ulcers in the pig and bridging in the feeders. The goal for feed particle size is a medium grind, 700 µm (micron) diameter or about 0.03 in. An acceptable range for feed particle size is 650 to750 microns. Feed particle size should be measured regularly. Kansas State University provides detailed equipment list and instructions at the following Web site:
http://www.asi.ksu.edu/*DesktopModules/ViewDocument.aspx?DocumentID=2771*

If feed particle size is outside of the acceptable range, adjustments should be made on the grinding equipment such as rotating or replacing worn hammers, rollers, or screens.

Other Factors

- Environment: The environmental conditions that a pig confronts determine the functional limit to growth and thus affect feed conversion. Cold weather will increase the amount of feed needed to simply keep the pig warm. Muddy and cold conditions also can increase the amount of feed needed for body maintenance. Heat will reduce feed intake and may affect feed conversion.
- Genetics: Pig genetics set the upper limit to growth. Animals that are leaner and grow faster will have more potential for better feed conversion. However, it is important to match the genetics of the pig with the environmental conditions

and the meat quality expectations of the niche market.

- Herd health: Sick pigs do not eat as much as healthy pigs. As feed intake decreases, growth rate slows. Feed conversion is poorer because more feed nutrients are used for fighting disease and maintaining body function and less for growth.
- Mycotoxins and anti-nutritional factors: Toxins from molds and other microorganisms will reduce feed intake, growth rate, and feed conversion. In some cases they can be toxic to pigs. Similarly, feeds that are not well digested by pigs will lower feed conversion. A balance between feeding a low cost but less digestible diet and a more expensive but better utilized diet must be found. Feed ingredients should be free of contaminants and readily utilized by the pig.
- Age at weaning: Pigs weaned at 21 or 24 days will grow faster in the finishing phase than pigs weaned at 10 or 14 days. The improved growth rate in finishing results in an improved feed conversion for the entire lifetime of the pig. Most niche markets require a weaning age of greater than 35 days.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Kansas State University Extension. 2007. Measuring feed particle size. http://www.asi.ksu.edu/*DesktopModules/ViewDocument.aspx?DocumentID=2771*

Lewis, Austin J. and L. Lee Southern editors. 2001. Swine Nutrition 2nd Edition. CRC Press. Boca Raton, FL.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Reducing the Cost of Pig Diets

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP830 2007

The cost of pig diets is set by the cost of ingredients. It also can be influenced by feeding the correct diet to the pigs based on genetic growth potential.

The size variation in the pen also impacts feed cost. The size of pig will change nutrient requirements with smaller pigs requiring more nutrient dense diets. A producer is overfeeding the larger pigs and/or underfeeding the smaller when there is wide variation in pig size within a pen. Either case can be costly.

It is possible that a lower cost diet with a poorer feed efficiency may have a more competitive feed cost per pound of gain. Actual data from nine niche swine operations showed these operations paid an average $133.40 per ton of feed (not organic feed) with a 4:1 feed conversion ratio. The average cost of gain can be calculated:

$$Feed\ \ Cost\ \ per\ \ lb\ \ of\ \ Gain\ = \\ Feed\ \ Conversion\ \ Ratio \times Diet\ \ Cost$$

$$Feed\ \ Cost\ \ per\ \ Head\ = \\ Feed\ \ Cost\ \ per\ \ lb\ \ of\ \ gain \times Gain$$

Table 1. Feed cost calculations for 4 case study farms.

	Case Farm			
Measure	1	2	3	4
Feed conversion	4.0	4.2	3.6	3.4
Diet cost, ¢/lb	5.25	8.59	5.60	7.92
Gain, lb	270	270	270	270
Feed cost/gain, $/head	57	97	54	73
Difference, $/head	+ 3	+ 43	–na–	+19

In this example, Case Farm 4 had the best feed conversion, yet feed cost per gain for that operation was above average. Case Farm 1 had the lowest priced feed and a 4:1 feed conversion resulting in a feed cost of gain of $57/head ($21/cwt) or $16/head less than average. Farm 3 had the best feed cost of gain because it was able to put together the best combination of feed conversion and diet cost.

Baseline Feed Budget

A baseline feed budget enables producers to evaluate the impact of changing feed prices, and the impacts of changing feed conversion and herd productivity. Before an additional product that may improve performance is added to the diet or a lower cost feed ingredient is used, the cost effectiveness of that change can be compared.

Table 2 presents a baseline feed budget using typical 2005 feed costs and assumes a feed conversion of 3.48 for a 270 lb pig.

Table 2. Baseline feed budget to produce one, 270 lb pig[1].

Ingredient	Quantity	Price[2]	Cost/hd
Corn	785 lb	$0.032/lb	$25
Soybean meal	130 lb	$0.09/lb	$12
Base mix	25 lb	$0.25/lb	$6
Total	940 lb	$91.48/ton	$43

[1] Assumes feed conversion of 3.48 farrow–to–finish (including sow feed) and 17 pigs/sow/yr.
[2] Typical feed costs for 2005.

In this example, 14 bushels of corn (785 lb/56 lbs per bu.) are used by each 270 lb pig. Thus each hundredweight of gain requires about 5 bushels of corn. Therefore, for each \$0.10/bu increase in corn price, the cost of production increases by about \$0.50/cwt.

$$\frac{14\ bu\ corn}{2.7\ cwt} = 5.2\ bu/cwt$$

$$5.2\ bu/cwt \times \$0.10/bu = \$0.52/cwt$$

Similarly, a \$10/ton increase in soybean meal increases the cost of production by about \$0.24/cwt.

$$\frac{130\ lb\ SBM}{2.7\ cwt} = 48.15\ lb/cwt$$

$$48.15\ lb/cwt \times \frac{\$10/ton\ SBM}{2000\ lb/ton} = \$0.24/cwt$$

In 2005, average farrow-to-finish niche market herd feed costs were \$65 per pig. Differences in feed conversion, sow productivity, and price of ingredients will change the relative impacts. Niche producers should use records from their own operation to develop a baseline feed budget for their operation and evaluate the impact of changing feed prices, feed conversion, and sow productivity.

Matching Pig Requirements to the Market

Formulating a diet based on growth rate means less protein is needed in the diet for a slower growing pig. Feeding slower growing pigs a diet with excess protein will not make them grow faster. Protein in excess of need for growth is used as energy but it is used less efficiently than starch. Overfeeding protein does not affect growth rate, but does result in leaner pigs. This may be counter productive for a niche market that is looking for a fatter pig.

Because many niche pork markets have a goal of producing a pig with more than average fat, there is an opportunity for some herds to reduce feed cost. Expensive feed ingredients designed to maximize lean growth may not be desirable in some niche systems because lean hogs may be discounted. Protein level should be set to maintain adequate growth rate, but additional protein is not useful at levels that make the carcass leaner.

In contrast, a typical diet for lean commodity pigs usually has nutrient safety margins in the diet to insure maximum lean growth rate potential from the feed. Because of this, extra protein is not wasted on a conventional pig because it tends to make a carcass leaner.

Weight Variation in Feeding Pen

Large weight variation in the pen and/or misestimating the weight of the pigs can add expense to feeding a pig. Missing the pig's requirement will either increase the cost of diet or decrease performance. Having small pigs in a pen with larger pigs is a problem. Formulating the diet for the small pigs will increase the feed cost of the larger pigs.

However, consistently underfeeding the nutrient requirement of the smaller pigs may slow their growth rate even more. If the small pigs are small because of a disease setback or because of small birth weight, more nutrient dense diets are not likely to help them grow much faster. However, if the small pigs in the pen are healthy and small because they are younger, they will respond favorably to more nutrient dense diets.

Facilities and Overhead Costs

Facilities and overhead costs also impact the financial decision of the level of nutrients in the diet. Operations with limited finishing space and/or higher value facilities will be impacted financially by slower growth rate, but increasing daily gain has little value to operations with excess finishing space and/or depreciated facilities. If fast growth rates are not beneficial, feed cost can usually be reduced by formulating for a slower growth rate. Again, records are necessary to make this determination.

Creep Feed Cost

Minimizing the cost of creep and nursery feeds is a strategy to reduce feed cost in niche market herds. Baby pigs cannot digest soybean meal very well. When pigs are weaned at less than three weeks, they need a complex diet of milk products and other highly digestible feedstuffs that is very expensive.

Niche market producers who wean a bigger pig at an older age have the opportunity to use a less expensive feed because the piglets rely on sow's milk longer. This allows the pig to become acclimated to soybean meal while still consuming sow milk. Feeding the piglet a simple corn-soybean meal-whey low-cost creep feed while they are nursing will acclimate the pig stomach to soybean meal protein. The creep feed can continue to be fed after weaning.

Growth Promotants

Extra products such as zinc oxide, copper sulfate, or probiotics sometimes are added to pig diets as a tool for aiding herd health and/or animal performance. These products need to be evaluated periodically on a case-by-case basis for effectiveness and cost/benefit ratio. Keeping and understanding financial and production records are critical in making decisions regarding adding extra products to enhance performance and health. Extra products should increase operational throughput by increasing breeding productivity, decreasing death loss, or increasing growth rate.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Purdue University Extension, 2007. Relative Value of Feedstuffs for Swine, The New Pork Industry Handbook–07-06-03. Purdue University. West Lafayette, IN.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

Feed Budgets

IPIC NPP840 2007

Tracking feed usage is an important part of record keeping. Feed costs are typically 2/3 or more of the total cost of producing pigs, so even a small change in feed costs can affect profitability. Without accurate feed records, it is impossible to evaluate diet changes that result in a lower cost diet but may affect pig growth. Leaflet number 370 of this handbook provides example pig diets. For the following examples, diets will be summarized and feeding phases will be simplified.

Table 1. Reference diets for pigs.

	Growing Pig Body Weights			Sow Diets	
	30-80	80-160	>160	Gestation	Lactation
% Corn	65	77	85	86	69
% Soybean meal	32	21	13	10	28
% Base mix	3	2	2	4	3
Phase Name	**1**	**2**	**3**	**G**	**L**

Adapted from Life Cycle Swine Nutrition, 1996.

For these examples the following production assumptions are made:

- Sows farrow 2 litters of pigs per year.
- Lactation length is 42 days.
- Each sow produces 18 weaned pigs per year.
- Average pig weight at weaning is 40 lb.
- Pigs are sold at 270 lb live weight.
- Gestating sows receive 5 lb of feed per day.
- Lactating sows average 16 lb of feed per day.
- Sows maintain a constant body weight.
- Phase 1 pigs have a feed conversion of 2:1.
- Phase 2 pigs have a feed conversion of 2.5:1.
- Phase 3 pigs have a feed conversion of 3.5:1.

Feed Budget to Produce 18 weaned pigs

<u>Gestation Feed</u>

$365 \ \ days/yr - (2 \ \ lactations \times 42 \ \ days/lactation) = 281 \ \ days$

$281 \ \ days \times 5 \ \ lb/day =$ **1405 lb gestation diet**

$1405 \ \ lb \ \ gestation \ \ diet \times 86\% \ \ corn = 1208 \ \ lb \ \ corn$

$1405 \ \ lb \ \ gestation \ \ diet \times 10\% \ SBM = 141 \ \ lb \ \ SBM$

$1405 \ \ lb \ \ gestation \ \ diet \times 4\% \ \ base \ \ mix = 56 \ \ lb \ base \ \ mix$

Lactation Feed

$2 \ \ lactations/yr \times 42 \ \ days/lactation = 84 \ \ days$

$84 \ \ day \times 16 \ \ lb/day =$ **1344 lb lactation diet**

$1344 \ \ lb \ \ lactation \ \ diet \times 69\% \ \ corn = 928 \ \ lb \ \ corn$

$1344 \ \ lb \ \ lactation \ \ diet \times 28\% \ \ SBM = 376 \ \ lb \ \ SBM$

$1344 \ \ lb \ \ lactation \ \ diet \times 3\% \ \ base \ \ mix = 40 \ \ lb \ \ base \ \ mix$

Table 2. Feed to produce 18 weaned pigs.

	Gestation	Lactation	Total	Per Pig
Corn, lb	1208	928	2136	119
Soybean meal, lb	141	376	517	29
Base mix, lb	56	40	96	5
Total, lb	1405	1344	2749	153

Each pig weighs 40 lb, thus the whole herd feed conversion for producing weaned pigs in this example is:

$153 \ \ lb \ \ feed \div 40 \ \ lb \ \ gain = 3.85$

Feed budget to raise 1 pig from 40 lbs to 270 lbs

Phase 1

$80 \ \ lb \ \ end \ \ wt - 40 \ \ lb \ \ start \ \ wt = 40 \ \ lb \ \ gain$

$40 \ \ lb \ \ gain \times \frac{2 \ \ lb \ \ feed}{1 \ \ lb \ \ gain} =$ **80 lb Phase 1 feed**

$80 \ \ lb \ \ P1 \ \ feed \times 65\% \ \ corn = 52 \ \ lb \ \ corn$

$80 \ \ lb \ \ P1 \ \ feed \times 32\% \ \ SBM = 26 \ \ lb \ \ SBM$

$80 \ \ lb \ \ P1 \ \ feed \times 3\% \ \ base \ \ mix = 2 \ \ lb \ \ base \ \ mix$

Phase 2

$160 \ \ lb \ \ end \ \ wt - 80 \ \ lb \ \ start \ \ wt = 80 \ \ lb \ \ gain$

$80 \ \ lb \ \ gain \times \frac{2.5 \ \ lb \ \ feed}{1 \ \ lb \ \ gain} =$ **200 lb Phase 2 feed**

$200 \ \ lb \ \ P2 \ \ feed \times 77\% \ \ corn = 154 \ \ lb \ \ corn$

$200 \ \ lb \ \ P2 \ \ feed \times 21\% \ \ SBM = 42 \ \ lb \ \ SBM$

$200 \ \ lb \ \ P2 \ \ feed \times 2\% \ \ base \ \ mix = 4 \ \ lb \ \ base \ \ mix$

Phase 3

$$270 \ lb \ end \ wt - 160 \ lb \ start \ wt = 110 \ lb \ gain$$

$$110 \ lb \ gain \times \frac{3.5 \ lb \ feed}{1 \ lb \ gain} = \textbf{385 lb Phase 3 feed}$$

$$385 \ lb \ P3 \ feed \times 85\% \ corn = 327 \ lb \ corn$$

$$385 \ lb \ P3 \ feed \times 13\% \ SBM = 50 \ lb \ SBM$$

$$385 \ lb \ P3 \ feed \times 2\% \ base \ mix = 8 \ lb \ base \ mix$$

Table 3. Feed to feed 1 pig from 40 lbs to 270 lbs.

	P1	P2	P3	Total
Corn, lb	52	154	327	533
Soybean meal, lb	26	42	50	118
Base mix, lb	2	4	8	14
Total, lb	80	200	385	665

Thus the feed conversion ratio for 230 lb of gain in this example is:

$$665 \ lb \ of \ feed \div 230 \ lb \ gain = 2.89$$

Feed budget for 1 pig farrow-to-finish

This can be calculated by combining the feed budget for weaned pigs and growing pigs.

Table 4. Feed budget for 1 pig farrow-to-finish.

	Sow Feed	Pig Feed	Total
Corn, lb	119	533	652
Soybean meal, lb	29	118	147
Base mix, lb	5	14	19
Total, lb	153	665	818

In this example we assumed a 270 lb weight gain, thus the feed conversion ratio for the entire farrow-to-finish operation is:

$$818 \ lb \ feed \div 270 \ lb \ gain = 3.03$$

The above examples show how feed budgets can be generated and feed conversion calculated. It should be noted that the above are idealized examples. Actual production records show that feed conversion for the best niche herds is closer to 3.3 and others are considerably greater.

Additional Resources

Iowa State University Extension. 1996. Life Cycle Swine Nutrition. PM-489. Iowa State University. Ames.

Iowa State University Extension. 2007. Ag Decision Maker. Iowa State University. Ames.

Non-feed Costs

Authors
Peter J. Lammers
David R. Stender
Mark S. Honeyman

IPIC NPP910 2007

Niche market producers must have a higher return per pig sold in order to make a living selling fewer pigs. Non-feed costs can quickly grow out of balance in a small operation. Efforts need to be made to stay on budget. Non-feed costs are managed by spending less, by producing more, or by some combination of both.

Successful niche pork producers find the optimal levels of labor, scale, and efficiency for their operation. Each operation is unique; however, there are some considerations that all producers should take into account.

Labor and Management

When determining where to devote labor resources, it is critical that both financial budgets and personal interest/skills be considered. The pig herd should be sized to match available labor, interest, and skills. Technique and skills will improve and adapt over time. It is critical that the people working with the pigs want to do the work, especially if farm employee labor will be relied on for success of the operation.

Balancing work and personal time is important and may be difficult. For many niche producers their choice to raise pigs in this manner is as much a lifestyle choice as a business decision.

Maintaining an acceptable level of income is critical for the long-term survival of an operation. It also is important that producers balance the demands of the farm with personal and family goals.

Pig operations should be sized to match available labor. Insufficient labor—both in terms of manpower and hours in the day—results in important tasks that are not done correctly or in a timely manner. This ultimately will hurt the productivity of the pig herd and result in higher production costs per pig. Finding the optimal herd size for available labor is critical for success in niche pork production.

Pig production can be scheduled to adjust for seasonal work loads. For example, a farm needing extra labor in spring and fall for planting and harvesting can farrow pigs in the winter and summer, thus spreading the workload throughout the year.

Recording how you spend your time on a daily basis may seem trivial, but critically examining how you spend your workday enables you identify areas in need of adjustment. For jobs like handling pigs or manure, well-designed facilities or adequately-sized equipment can make dramatic differences in the time required.

Capital Costs

Niche pork producers often have lower capital or fixed costs because they use older or lower cost buildings and equipment. This impacts the importance of productivity. For example, the cash cost of not filling to capacity a new building that has an outstanding loan is greater than the cost of not completely filling an older building that has already been paid for.

Niche producers often take advantage of the lower fixed costs of their buildings and allow them to sit empty between groups of pig or provide more space per pig. Both situations can improve herd health, and ultimately the profitability of the farm. This is difficult to do with higher cost, new facilities that still have outstanding debt.

Before purchases are made, the value of time along with the potential impact of the purchase on returns should be considered.

Questions to ask before making purchases:

- Does the purchase fit the scale of the operation?
- What is the cash cost?
- Will the purchase pay for itself through improved production or reduced labor?
- Will the purchase retain its value or will this depreciate?
- How quickly will this purchase depreciate?
- Can I repair or maintain the purchase myself?
- Is the purchase durable and easy to use?
- Is the purchase critical for the operation, useful but not essential, or something I want but that is not related to the operation?
- Does this fit within the context of the long-term farm plan?
- If labor is saved, how will I use the extra labor?

Remember to make use of cash flow budgets to evaluate purchasing decisions.

Fixed Costs

Debts or costs that must be paid regardless of production are known as fixed costs. They are summarized by the acronym DIRTI:

- **D**epreciation: Most things that are purchased decline in cash value over time.
- **I**nterest: Interest on a loan does not change if production stops.
- **R**epairs: Buildings and equipment must be maintained regularly regardless of production fluctuations.
- **T**axes: Taxes on property depend on the value of the property, not necessarily the income generated by a property.
- **I**nsurance: Insurance premiums are usually paid on an annual basis, while production may fluctuate monthly.

Missing your target output impacts your fixed costs. If your buildings can house 1000 pigs and only 800 pigs are produced, fixed costs per pig will increase by 20%.

The same is true for each group through the system. If a hoop barn holds 180 pigs and only 140 pigs are fed (because not all the sows that were bred farrowed), fixed costs per pig will increase by 28% for the group. The increase occurs because there are fewer pigs over which to spread the fixed costs.

Operating Budget

Expenses that are incurred only if production occurs are labeled variable costs or operating expenses. Feed costs are by far the largest portion of operating expenses and they are addressed in section 800 of this handbook. Labor and management is another operating expense. Labor and management are considered throughout the entire handbook.

For this discussion, the following expenses are considered operating expenses:

- Fuel
- Utilities
- Vaccines
- Veterinarian
- Interest on operating loans
- Bedding
- Land or building rent

The economic strategy of a niche producer is to make more money on fewer pigs. Although niche producers usually receive a higher price for their pigs, profit margins also are affected by operating expenses. Production efficiencies can be found at any scale and successful niche producers schedule pig flow to optimize production. For example, trucking a partial load of pigs to market may or may not make sense depending upon the cost of transportation and the market discount for pigs that are too light or too heavy. Unused vaccines that cannot be stored are another example. It may be more cost effective to purchase a smaller bottle that is more expensive per dose but will be entirely used than to purchase a larger bottle that is less costly per dose but will be mostly discarded.

Additional Resources

Iowa State University Extension. 2007. Ag Decision Maker. Iowa State University. Ames.

U.S. Pork Information Gateway http://pork.porkgateway.org/web/guest/home