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pork industry handbook

Michigan State University Extension

Multi-Site Pork Production

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Introduction

The development of multi-site production programs to enhance health has been a major driver in reshaping the swine industry. The ability to assemble and maintain isolation for groups of uniformly-aged pigs on multiple sites during their growth periods has demonstrated substantial economic and production benefits, and assisted in the adoption of other profitable management activities such as phase and split-sex feeding and improved marketing strategies (Table 1). It has facilitated the separation of facility and pig ownership from production functions within the traditional farrow-to-finish spectrum, and enabled its fragmentation into breed-to-wean and wean-to-finish specialties.

Table 1. Estimated value of various production practices.

Parameter	Gross improvement / pig
All-In All-Out	$2.00 - 3.00
Segregated production	$1.00 - 2.00
Early weaning	$0.50 - 1.00
Phase feeding	$2.00
Split-sex feeding	$2.00
Total	$7.50 - 10.00

Adapted from Shantz, 1996

These technologies have been presented under a range of names; Segregated Early Weaning (SEW), Modified Medicated Early Weaning (MMEW), All-In All-Out (AIAO), Age Segregated Rearing (ASR), Isowean, and Multi-site production. However, the underlying concepts for each are consistent; age segregation of groups, uniform health status at group formation, reduced transfer of disease organisms from one generation (group) to another, and facility/personnel specialization. Each of these concepts will be dealt with separately.

Age Segregation

Age segregation of groups is another descriptor for AIAO production. It is the formation of discreet groups of swine held together at separate sites to reduce disease transmission to and within the group. This method of pig flow has supplanted the traditional continuous flow, wean-to-finish operations that were increasingly constrained by chronic respiratory and enteric disease complexes as well as by financial and labor limitations as they grew in size and production intensity. This technology is rooted in the understanding that the pig is a major source of infectious organisms to other pigs, that age transitions increase/decrease susceptibility to specific organisms, and that mixing different aged pigs facilitates disease transfer. It also recognizes that groups of pigs reach an immunological and physical "steady-state" which can be described as a point at which the resident animals are infected with the common organisms, have developed immunity, and are not routinely shedding the offensive organisms. This is the reason that isolation and internal and external biosecurity are important components of a herd health program.

Younger animals are generally less infected with chronic disease-causing organisms than older swine under similar management. Therefore the practice of mixing groups of 30 lb. to 50 lb. pigs has been largely supplanted with mixing at a weaning age of less than 21 days, preferably in the 16 to 17 day range. The recognition of intergenerational transfer of diseases prior to weaning has encouraged the separation of adult and growing pigs at earlier ages and modifying weaning ages depending on the organisms to be controlled. By reducing the spread of disease from adults to their offspring and managing the offspring to minimize additional exposures during the grow-finish period, many of the chronic production-limiting bacterial conditions have been reduced, and finishing performance enhanced.

Age segregation of adult swine is less important because the need to reduce disease transmission between animals is less pronounced. A goal in managing adult breeding swine is to maintain the group in a "steady-state" for the known diseases within the herd. Under most conditions, isolation and acclimation periods preceding the entry into the breeding herd are used to establish and maintain herd health. The isolation period, usually 15 to 45 days in duration, is used to determine if in-coming animals harbor harmful organisms. Based on observations and testing during isolation, a decision is made to allow or disallow entry.

An acclimation period follows the successful completion of isolation, and may be from 30 days to more than 150 days in duration. During this period, new animals are exposed to the flora of the herd and develop their immune responses. Some producers have determined that purchase of early weaned or grower weight breeding stock best meets their isolation/acclimation needs, *particularly when dealing with Porcine Reproductive and Respiratory Syndrome (PRRS).* When acclimation is completed correctly, in-coming stock have recovered from any clinical manifestations of disease, have established immunity, and will not be shedding at introduction to the breeding herd. This reduces the risks of clinical disease in the breeding herd and provides immunity that can be passed to the offspring.

With multi-site production, separation of adult and growing swine is required. Breed-to-wean facilities contain adults for breeding, gestating, and nursing piglets. Weaning age may vary depending on the herd health and other production considerations, but the nursery and finishers are not located at the same geographic location. The wean-to-finish period is from approximately three weeks of age to 250 or 260 lb. and will take 23 to 25 weeks under normal growth conditions. This period may be on a wean-to-finish building site, or with separate nursery and finisher sites. An advantage of the wean-to-finish site is that pigs do not need to be moved from a nursery and the nursery can be cleaned and disinfected.

The nursery-grower period is typically six or seven weeks with the remainder of the time in finishing. This allocation can be modified to meet the needs of the production system, including use of a single wean-to-finish building for the entire period. Multi-site technology places a premium on uniform growth to facilitate scheduling of facilities, and considerations have to be taken for the inevitable slow growers, such as shipping them to specialty markets or a parallel operation that can continually receive slow growers until they reach a marketable condition. In any case, care must be taken to ensure that appropriate antimicrobial withdrawal periods have been followed.

Whether nursery-to-finish or wean-to-finish protocols are used, once a group of weaned pigs has been assembled, a common health level will be achieved over a several week period. This common level will change when new organisms are introduced or the immunity levels of pigs within the group are compromised to a point enabling resident microflora to proliferate into clinical disease. A narrow range of age and weights within a group is ideal for the development of this static situation and for reducing the potential for management-related stressors.

As the age spread approaches 14 days, difficulties related to group management become evident. Age ranges of one week or less are quite workable under normal conditions, even for groups of commingled weaned pigs. As the age within a group expands to two weeks, it is difficult to maintain the same microflora, and environmental and dietary needs become quite different. The desired group size can be achieved by multiple additions provided the age range is minimized. Alternatively, groups can be assembled from multiple breed-to-wean units provided they are matched for age and health status. When combining pigs of different groups, it is important that all pigs be weaned at the same age when added to the room. For example, all pigs should be weaned at 16 or 17 days at the time they are added. Some pens should be left vacant for segregation of unthrifty or lightweight pigs requiring closer observation, longer periods on expensive starter feeds, or closer environmental controls. These limitations become a major consideration when developing an appropriate weaning schedule and post-weaning management strategies.

Health Status

Pigs normally are free of many chronic pathogens prior to and, in many cases, at birth. This knowledge gave rise in the 1950's to the SPF (specific-pathogen-free) program, which relied on Cesarean section and isolated rearing from birth, to break the transfer of disease from sow to piglet. Early wean technology is an attempt to control chronic swine diseases by stopping their spread from dams to offspring without going to the expense of performing hysterectomies or Cesarean sections.

Weaning age has a significant effect on the transfer of disease organisms between pigs and on their reaction to these organisms. Prior to about 21 days of age, passive immunity transferred to nursing pigs in colostrum and milk offers protection from many common diseases present in the breeding herd. This natural protection degrades over a predictable, but organism-specific, period. Advantages exist for putting weaned pig groups together before this natural immunity has waned.

This passive protection, coupled with the microbial stability of age segregated groups, has allowed production efficiencies in the presence of chronic respiratory and enteric pathogens. In these instances, the *host (pig) defense responses and pathogens* develop a health status that can be maintained unless environmental, management, or immune system stressors create an imbalance leading to disease expression. Such stressors and disease expression can occur at any age up to market weight; and in some cases, may have a more severe impact in older animals than during the post-weaning period. Therefore, age segregated animals should be considered "higher risk" to immune stressors and be subjected to higher levels of biosecurity and husbandry practices than conventional swine.

Weaning prior to 21 days reduces the intergenerational spread of many bacteria, particularly those causing chronic respiratory diseases. Similarly, most common viral agents are not transferred unless the sow is recovering from a clinical illness and shedding virus during lactation. Conversely, if shedding occurs prior to weaning, vertical transmission of bacteria or viruses to nursing pigs is likely. This may lead to infection, but not clinical disease and these infected pigs act as carriers and initiate horizontal transmission to pen mates in the nursery.

Selecting an early weaning age depends on two items. First, what pathogens are to be controlled or eliminated? Second, what are the goals of weaning age selection – pathogen control or elimination? Elimination requires a significantly younger weaning age than for disease control, generally a maximum of 10 days of age or less. Control can be achieved with an 18 to 20 day maximum weaning age. Specific weaning dates are being developed for individual pathogens through field observation and experimental transmission studies. Table 2 lists guidelines as to maximum weaning ages for various organisms. It should be used as a starting point for deciding the appropriate strategy of a production system. Each situation may be different depending on the total disease load in the herd and the specific organisms involved. There are bacteria that cannot be controlled by weaning at any age.

Table 2. Maximum weaning ages to control or eliminate pathogens.

Pathogen	Weaning age
Pseudorabies (PRV)*	< 21 days
Porcine Reproductive and Respiratory Syndrome (PRRS)*	< 21 days
Transmissible Gastro Enteritis (TGE)*	< 21 days
Swine Influenza Virus (SIV)*	< 21days
Bordetella bronchiseptica	10-14 days
Actinobacillus pleuropneumoniae – Elimination	< 10 days
Actinobacillus pleuropneumoniae - Control	16-18 days
Leptospira sp.	10 days
Mycoplasma hyopneumoniae - Elimination	<10 days
Mycoplasma hyopneumoniae - Control	14-17 days
Pasteurella multocida - Elimination	< 10 days
Pasteurella multocida - Control	< 21 days
Salmonella choleraesuis	< 14 days
Serpulina (Treponema) hyodysenteriae	< 21 days
*Streptococcus suis II***	< 1 day
*Hemophilus parasuis***	< 1 day

* Not applicable during clinical outbreaks in farrowing location
** No known effective weaning age to stop transmission

McKean, J. (1995), Yeske, P. (1997), Thacker, B. (1997)

In all cases, the weaning age suggested is the maximum age for all litters that make up a group. Cross-fostering and other management practices must be modified to ensure that the maximum age selected is not exceeded. Older pigs, even though they may be of similar size to their younger pen mates, may have a different pathogen load capable of compromising the health of the entire group. This is of great concern where multiple sources are mixed at weaning, or with longer periods for assembling the group. Another concern in selection of weaning age is the detrimental effects that weaning at 10 to 14 days of age has on subsequent breeding herd performance, including longer return to estrus, reduced farrowing rates, and smaller litter sizes. Understanding and successfully manipulating these complex interactions is one of the challenges of multi-site management systems.

Production gains from multi-site production can be realized in several ways. First, the reduced transmission of bacterial and viral organisms decreases the presence of chronic diseases such as PRRS, PRV, mycoplasmal pneumonia, atrophic rhinitis, and swine dysentery. These diseases can be controlled by the management system without preventive or therapeutic drugs and vaccines.

Second, physiologically, a lack of stimulation of the nervous and immune systems reduces the production of cytokines that act directly to suppress the production of growth hormone. Therefore, pigs not required to mount a substantial immune response to disease, or to stressors such as chilling or overcrowding, will not experience the reduced feed intake and growth rates that occur in diseased or stressed pigs. In addition, more feed is converted to muscle, in part because increased growth is taking place in younger animals.

Third, the presence of elevated growth hormone repartitions the carcass components to be leaner and to reduce fat production, thus increasing the lean growth efficiency. It also enables a producer to more precisely predict, and meet, the nutrient requirements for optimal growth and efficiency. These benefits can be demonstrated in an Iowa State University study

Table 3. Health status and animal performance.

Health status	High	Low	Difference
Initial weight, lb	13	13	
Final weight, lb	60	59	
ADF, lb	2.16	1.89	+0.27
ADG, lb	1.49	1.05	+0.44
F/G	1.44	1.88	-0.37
Final weight, lb	245	245	
Days	126	161	-35
Feed, lb	641	733	-92
Backfat, in.	0.97	1.23	-0.26
% Muscle	57.0	52.3	+4.7

Stahly (1995)

comparing "high health" and "low health" barrows from weaning to 245 lb. (Table 3). "High health" piglets were weaned and moved from a continuous flow herd to a disinfected site, while "low health" animals were left in the continuous flow herd. During the nursery phase "high health" pigs ate more feed, grew faster, and were more efficient. Finishing "high health" pigs, reached market weight 35 days faster, required 92 lb. less feed per animal to reach the 245 lb. market weight, and had leaner carcasses.

It has been estimated that savings due to improved feed efficency, increased rate of gain, and carcass premiums would amount to as much as $18 per head marketed.

Facility/Personnel Specialization

Multi-site production can take various forms depending on the needs and resources of the producer(s). This technology can be used effectively by a wide range of producers, either individually or as groups. Sites can be selected locally or in dispersed configurations. Sizing each site will depend on the production system and financial resources available. With the development of multi-site production, ownership of the swine can be separated from ownership of the buildings and the labor supply. This separation has encouraged new business relationships including contract production, production partnerships, equity/stock ownership by non-producers, and enhanced interstate pig movement. The various stages of production can be placed to take advantage of local resources including biosecurity offered by low swine density, available labor, land prices or suitability, feed availability and costs, access to markets, and ability to recycle manure nutrients in an environmentally sound manner. These factors have lead to a major restructuring of the North American pork industry, with pigs farrowed in Manitoba or North Carolina as likely to be finished in Iowa or southern Minnesota as pigs farrowed in Iowa.

Multi-site principles of age segregation, early weaning, and AIAO allow a wide range of production and ownership configurations to be successful. To obtain the benefits of this technology, larger production systems are needed than in the traditional single-site continuous flow systems. Typical multi-site system configurations include a breed-to-wean facility and either nursery and finishing barns or wean-to-finish buildings.

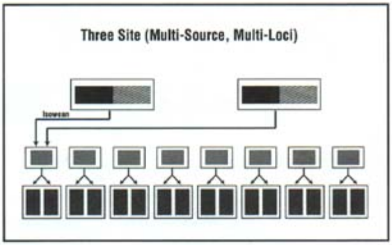

Figure 1. Three site production.

Multiple breed-to-wean facilities can be coordinated to supply nursery or finishing facilities if individual producers are not sufficiently sized to fill the pig flow needs (Figure 1). The AIAO production requires substantially more coordinated and consistent production than does continuous flow production. Therefore, when putting a multi-site system together, consideration must be given to appropriate site sizes and numbers to facilitate pig flow. It may be desirable to think about future expansion interests during this developmental phase.

Facilities design within a system can take a variety of permutations. Multi-site production systems may employ a series of nurseries and finishers or wean-to-finish barns depending on the producer preferences. They may also use traditional pen sizes with 20 to 25 head per pen or large pens of 100 to 500. The essential requirements are to meet the physical needs of the pigs at each stage of production. Temperature and ventilation requirements (PIH-60), space allocations (PIH-55), feed and water availability for the age of pigs, and location of the facility are the primary considerations.

Feeding Management

When selecting feeding equipment, consider the needs of the newly weaned pig and the 60 lb. pig. The feeder should meet the needs of both animals. Newly weaned pigs tend to eat at the same time. Use feeders that provide space for at least half of the newly weaned pigs to eat at any one time. Tray dividers will prevent small pigs from getting into the feeder. Select feeders that can be easily removed so they may be washed. Weaned pigs may be fed on boards on the floor the first few days.

Self-feeders should be easily adjustable, they need to be adjusted on a daily basis as pigs become accustomed to them or if the diet form changes from pellet to meal. Feeder location may need to be a compromise. Locating them next to the aisle facilitates adjustment and handfeeding. However, this must be compared to the cost of installing feed delivery lines to additional rows of feeders.

In addition to designing diets and feeding programs for the multi-site nursery and finisher, feed handling and storage must be defined. The approximate quantity of feed per 100 pigs and days in each stage listed in Table 4 can be used to estimate bulk feed storage needs and the approximate days required.

Table 4. Expected feed usage and days.

Weight range	10-15 lb	15-20 lb	20-50 lb	50-260 lb
Feed/100 pigs	1,000 lb	1,200 lb	5,100 lb	68,000 lb
Days	11	7	24	122

MCS5 (1998)

Biosecurity Concerns

Area biosecurity is a consideration producers should review when locating new facilities. These considerations should include isolation from other aged or health status swine; control of human traffic; minimization of contact with rodents, birds, and other wildlife; and physical separation of buildings sufficient to minimize aerosol transmission of pathogens between buildings (including connecting hallways).

Because of the flexibility of siting decisions enabled by multi-site production, it is appropriate to consider the location of other swine units in the selected area. It is possible to have multi-site production on one location if proper biosecurity practices are followed. Certain disease organisms, including PRV and PRRS, are capable of being transmitted by aerosol to nearby facilities under certain environmental conditions – cool, overcast, and damp, with mild to moderate winds. These aerosols follow the normal airflow patterns, so prevailing winds and the topography of the area greatly effect the efficiency of this transfer. Generally flat ground with minimal tree populations or bodies of water will support transmission for longer distances than hilly, forested ground. However, air patterns through valleys may concentrate aerosols and encourage their movement to unexpected locations.

Multi-site production requires the transportation of pigs between sites, and this is a major source of biosecurity breaches. Accommodation must be made for the routine cleaning and disinfecting of transport vehicles. Work plans and loading facility design should minimize the contact of people in the sending and receiving facilities with the transport vehicles or personnel. Similarly the design of the loading facilities should eliminate the return of pigs to the sending facility during loading. A protocol should be developed for the truckers to minimize the potential for contamination during the transport process, particularly when stopping for rest or food.

The control of people traffic between units and the ability to maintain isolation are critical to the success of this isolation. Maximizing the benefits of multi-site production requires that animal caretakers not go from one building to another without a change of clothes and boots. Consider showering before entering the next unit. Generally younger pigs are most at risk and should be seen first. Isolating the nursery from other hog buildings enhances biosecurity. Care to avoid transmission of manure on boots or clothing, on equipment, and in transport vehicles will reduce the opportunities for disease organism spread. Control people delivering feed and other supplies by keeping them out of the facility.

Weaned pigs have proven to be remarkably resilient in the transport process. Limited research indicates that a temperature of 80°F ± 15° is a useful target in transporting these pigs (H. Xin, 1999 . Warming the transport in cold weather to 80°F prior to loading and the provision of bedding and protection from drafts in transit will support the pigs' thermal needs. Experience indicates that effective heat removal without causing drafts during transport in warm climates is more problematic than cold weather transport. For long distance transport (over 16 hours), provision of fresh water will help maintain hydration and pig condition.

Pig Flow Considerations

Successful adoption of multi-site technology requires that minimum sized groups be produced to enable economic pig flow and facility utilization. Pig flow considerations are predicated on the group size, length of holding in each facility, expected performance, and configuration of the system. The key to proper pig flow is to size the various production units to produce or maintain the same number of pigs per period.

A focal point for planning pig flow in a farrow-to-finish system is the number of pigs weaned per period or group. This number is impacted by number weaned per female and the number farrowed in the period. To maintain the number of sows farrowed, seasonal breeding variations must be taken into account. Herd history is an invaluable predictive tool for this determination. In some cases, it may be appropriate to maintain a larger gilt pool and breed greater numbers than needed, then when pregnancy checks are made to abort gilts in excess of the number needed for the intended farrowings. Although this adds costs of gilt maintenance and hormonal therapy, some of these costs are recouped from better system-wide facility utilization and an expected increase in litter performance from the aborted females in their next litter.

Smaller producers who cannot produce economically sized groups can utilize multi-site technology by combining with others to produce appropriately sized groupings. Each producer's farrowings must be scheduled to provide the desired number of weaned pigs per period for the group. Different producers may deliver pigs to the nursery or wean-to-finish barn each period. A nursery may be filled over a two week period without adversely impacting performance. Efforts should be made to ensure that the source herds maintain similar health programs and source their replacement stock from the same locations. These strategies will minimize the variations of health at commingling, and aid in maintaining finishing performance.

An agreement between cooperating producers regarding minimum health and performance standards is necessary for this type of system to function. As the number of producers increases, it becomes more difficult to maintain the discipline within the system unless economic incentives and disincentives are built into the original cooperative agreement. Success will be dictated by strict adherence to the maintenance of health practices, minimum weight, and maximum age constraints and scheduling of the cooperating producers.

In nursery-to-finish and wean-to-finish systems, the capacity is dictated by building constraints. In wean-to-finish systems, it is possible to increase the initial stocking density and then move a portion of the pigs to a different finisher after five to six weeks. This strategy increases the utilization of the building space without significantly impacting pig performance. It enables the use of a combination of wean-to-finish and finish-only buildings within a system. With a fixed number of weaned pigs per period, this strategy may require an initial stocking period proportionately longer than when filling the barn all at one time. In some batch systems this would be unacceptable because of the age spread, but if weekly production is sufficient, up to a 200 percent stocking density is possible without adversely affecting pig performance for the first few weeks. Plans must be developed for each system based on the resources available.

Summary

Multi-site technology has many positive attributes that can assist pork producers in increasing their competitiveness. This increased competitiveness is derived by reducing production losses caused by chronic disease conditions, reducing medication costs, and enabling these pigs to maximize their genetic potential for lean growth. Many of these benefits can be obtained even when disease organisms are not completely eliminated, but are in balance with the pig. However, all of these benefits can be lost if these high health pigs come in contact with other swine. As with all disease control efforts, the benefits derived are influenced by quality management and adherence to basic principles of the multi-site technology.

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