Using Records to 
Optimize Breeding Herd Productivity and Weaned Pig Cost

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The weaned pig output of a sow farm is dependent upon getting sufficient number of females bred, having high enough farrowing rates so that the target farrowings/week are achieved, and optimizing born-alive litter size and preweaning mortality. The gilt pool is the fuel for the breeding farm. Without sufficient gilts, service targets cannot be made and weaned pig volume and the number of farrowings that occur fall correspondingly. The gilt pool also has significant effects on the efficiency of breeding herd performance. There are more gilts being bred and farrowed than any other parity. Thus, when gilt litter sizes and farrowing rates are high, herd performance typically is competitive. This paper focuses on how to use records to optimize farm throughput (i.e. number of weaned pigs/unit time) in a multi-farm system as well as to improve the efficiency by which the breeding herd produces weaned pigs (i.e. pigs weaned/sow/year). Because the breeding herd is typically a cost center for the finishing herd, the paper also discusses the factors that, in addition to weaned pig volume, affect the cost of producing a weaned pig.

1. Objectives of the Breeding Herd

1.1 Production of Weaned Pigs

**Efficiency of Production.** Breeding herd reproductive efficiency is most commonly measured in terms of the number of pigs weaned/sow/year (PSY). There are two ways of expressing PSY. Pigs weaned/inventoried female/yr (PWIFY) includes all females that have been inventoried in the records of the herd, including gilts and sows. Pigs weaned/mated female/yr (PWMFY) includes gilts after they have been mated as well as sows. Because the denominator is larger, PWIFY is usually less than PWMFY and is always less than or equal to PWMFY. As the interval from entry to service increases or the replacement rate of a herd rises, the variance between PWIFY and PWMFY increases. Similarly, the difference between the two measures of PSY increases as the interval from entry to removal of gilts and the preservice removal rate increases.

PSY is driven by two factors: the number of litters/sow/year (LSY) and the number of pigs weaned/litter (PWL). Similar to PSY, LSY can be expressed either in terms of the total number of females inventoried in the herd or the number of mated females. LSY in comprised of the number of nonproductive days/sow/year (NPD), lactation length (LL), and gestation length (GL), according to the following formula:

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LSY = \frac{(365-NPD)}{(GL + LL)}
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The parameter NPD is typically expressed on an inventoried female basis. It is comprised of 8 subcomponents: entry-to-service, entry-to-removal (by culling or death), weaning-to-service, weaning-to-removal, service-to-detected open (by ultrasound, recycle, visual detection, failure to farrow), service to removal, detected-open-to-reservice, and detected-open-to-removal NPD. Nonproductive days reflect intervals and counts of females passing through those intervals. For example, entry-to-service NPD are a measure of the entry-to-service interval, as expressed in days, and the number of gilts entering the herd during a period of time, as reflected in replacement rate.

PWL can be expressed in terms of the number of pigs weaned/sow farrowed (PWSF), the number weaned/sow weaned (PWSW) and the number weaned/litter weaned (PWLW). Because of the denominator effect, PWSF is typically less than either PWSW or PWLW. Similarly, PWSW is usually less than PWLW. PWL reflects the number of pigs born alive/litter (PBA) and the number of preweaning deaths/litter (PWD). Born-alive litter size reflects the total number of pigs born alive (TPB) corrected for the number of pigs dying during the birth process, called stillbirths (SB), and the number dying prior to the onset of farrowing, called mummified pigs (MUM).

1.1.2 Throughput. The output of a breeding herd is most commonly measured in terms of the number of pigs weaned per unit time, typically pigs weaned/week. Weaned-pig output can be manifest as an absolute number or as a percentage of a budgeted value. Along with weaned-pig cost, weaned-pig output is one of the most common endpoints of breeding herd throughput. Weaned-pig output is driven by weaned-litter size (i.e. number of pigs weaned/litter weaned) and the number of litters weaned per unit time. In turn, litters weaned/week is driven largely by number of females served/week.

The number of females served into a breeding group is dependent upon the size of four subpopulations in the herd: (1) weaned sows, (2) opportunity sows, (3) females that return to estrus following mating (recycles), and (4) gilts in the available pool. The opportunity sow pool is comprised of sows that have not returned to heat within seven days, called late weaners (LW), sows that have been weaned prior to 14 days of lactation, called early weaners (EW), sows that have aborted (ABORT), females that have been found to be negative by ultrasound tests of pregnancy or visual examination for pregnancy (PCN), and females available to be bred if needed but otherwise destined to be culled, called active culls (AC). As shown below, the steps that must be taken to achieve breeding targets are highly dependent upon the gilt subpopulation. In order for service targets to be consistently met, record systems must be established that capture pertinent endpoints.

1st Calculate the budgeted number of farrowings/week. Calculating the budgeted weekly farrowings is necessary in order to achieve the desired utilization of farrowing facilities, and to determine the farrowing group size and “flow” of females through the farm. Budgeted farrowings should consider the percentage of farrowing sows that are early and zero weaned. Key factors influencing budgeted farrowings include: (1) stage of gestation that females are loaded into farrowing, (2) desired lactation length, and (3) number of rooms to farrow each week. Targets for number of farrowings/week are greater than
budgeted numbers and are usually determined by having females loaded into farrowing at a later gestation date, having them weaned at a shorter lactation length, and by farrowing more rooms of sows weekly.

2nd Do a “gilt needs projections” for the farm. Gilt needs projection computations are necessary so that sufficient gilts are available to meet service targets throughout the year. Establishing the gilt needs for a farm is dependent upon the budgeted replacement rate for the herd, the seasonal change in farrowing rates, and the number of females that have already been served into existing service groups (i.e. the size of holes in breeding groups that must be filled). Note, because PCP and post ultrasound fallout rates fall when females are mated during the summer, more females have to be mated. Until the sizes of recycle and opportunity sow pools increase in response to the seasonal drop in fertility, the sow herd inventory must be grown by increasing the size of the gilt pool, if service targets are to be achieved.

3rd Set up the gilt development system. The “flow” of gilts through the gilt development system must be established to ensure that the changing needs for gilts are met throughout the year while achieving (1) the budgeted age at first service, (2) the budgeted age at entry into the gilt development system and/or the breeding herd, and (3) the proportion of gilts mated after their first heat (i.e. skip heats). The schedule for delivering gilts into a farm or its gilt development system depends upon their entry age, the duration of time that gilts need to be housed in gilt facilities, the size of gilt facilities, and the number of gilts required to fully fill a transport vehicle.

4th Set service targets. Service targets must be set dynamically according to anticipated changes in farrowing rate. Seasonal changes in fertility are abrupt, often occurring within 2 to 4 weeks. New Fashion Pork, Inc, (NFP) uses % budgeted services as a bonus incentive for its breeding departments. Thus, we reset service targets monthly. Records of ultrasound diagnostic tests can be used to predict farrowing rates based upon 28-day ultrasound tests and the percentage of females falling out between the 28-day test and farrowing (% fallout).

5th Organize the breeding barn. Barn organization is essential if all subpopulations of females are to be easily found and available as needed. Gilts should be organized in pens or stalls by age and/or the occurrence of skip-heat events. Females that have been skip heated must be clearly identified as to the week that they will return to heat. The breeding barn must be set up with an “opportunity sow area” where each type of opportunity sow (e.g. LW, EW, PCN, ABORT, AC) is clearly identified. Recycles must be pulled from their old group in the gestation snake as they are found in heat and replaced in the breeding line or with their new service group in the gestation snake. Open spaces in the gestation snake must be promptly filled with pregnant females from the parking area as soon as animals are detected open.

6th Develop weekly service budgets. Service budgets are a weekly plan for how budgeted number of services will be achieved. The plan is developed weekly late in the week prior to when females are to be bred. It should project the overage/underage for number of
females likely to be bred based upon (1) the number of weaners predicted to return to estrus following weaning, (2) the number of available gilts (including skip-heat gilts) predicted to come into heat, (3) the number of served females likely to return to service (recycles) and (4) the number of opportunity females projected to return to heat during the following week. Weekly service budgets must be monitored closely (e.g. at quarterly intervals) to ensure staff compliance. In order for them to be useful, breeding barn staff must be forced to use service budgets. This can be accomplished by periodically checking how close the service budgets prepared one week actually match what was mated on the following week.

7th Monitor the breeding system. The breeding system should be monitored weekly to ensure that budgets and targets are being achieved and that subpopulations are being managed as planned. The monitoring of gilt-related activities is particularly important, since this is the one subpopulation, of the four subpopulations in the service pool, which can be most easily manipulated in order to achieve service targets. There are several areas warranting special attention. Are the budgeted numbers of gilts being served each week? Are gilts being mated at the budgeted age? Are sufficient gilts being skip heated before they are bred? As discussed below, a gilt availability report will need to be designed to enable the viewer to efficiently and effectively manage the gilt pool.

1.2 Weaned Pig Quality

The quality of lots of weaned pigs is typically measured in terms of average weaning weight. As producers attempt to improve the performance of the growing pig, their record systems are increasingly being used to track the number of pigs that (1) are not weaned at a certain minimum weight, (2) have defects (e.g. hernias, injuries), (3) have been castrated, (4) do not show signs of disease, and (5) are free of diseases potentially impacting their performance during the growing phase.

1.3 Herd Health

With the co-emergence of high health breeding herds and the pathogen Porcine Reproductive and Respiratory Disease Virus (PRRSV), disease became “king.” Herds periodically become unstable, from a health standpoint, resulting in fluctuations in weaned pig output and quality. Level of immunity to most diseases varies over time in a herd. The presence of subpopulations of females in the herd that are in different phases of the reproductive cycle contributes to temporal variations in herd immunity.

The gilt is the most important cause of herd health instability. Shedding gilts carry pathogens into the herd with them thereby exposing naïve individuals in the herd. Naïve gilts can be exposed post entry to shedding sows in an unstable herd. Either way, infusing gilt into a herd is similar to “pouring gasoline onto a fire.”

In an effort to better understand and control diseases, producers have begun developing databases that capture routine serology and post mortem information. For example, NFP monitors its sow herds quarterly, taking samples from females that have been bred 1, 4, 7,
11 and 15 weeks and sows that have been lactating for 1 week. In a similar cross-sectional sampling frame, groups of unbred gilts are subsampled every 3 weeks from the time they enter the gilt development unit (GDU) through the time that they are mated.

2. Measures of Performance

2.1 Budgets and Targets

Budgeted numbers refer to what you project that a farm will do. Because they are readily achievable, they are usually the numbers that are used in forecasts for lenders and owners. Budgeted numbers are also the numbers used to compute input use rates. Targeted numbers are what a farm strives to achieve. They should be “a reach;” that is, not readily achievable, but achievable with reasonable extra effort. Both budget and target numbers should be calculated for endpoints used to measure how well gilts are being managed.

2.2 Gilt Pool Management Endpoints

There are several endpoints used to assess how well farm staff members are managing a herd; several relate to how gilts are managed and others pertain to the entire population of females. Relative to gilts, some endpoints assess how well either chronological or physiological age is being managed. Some assess how well farm staff members are managing the inventory of gilts in the farm or its gilt development unit. Other endpoints can be used to assess how quickly gilts are bred or made available to be bred.

2.2.1 Age-related Endpoints. Several endpoints can be used to assess how well the system is being executed to optimize the maturity of the gilt when first mated. These include:

- age at first service
- % gilts served greater than the budgeted minimum age
- % gilts served that have a skip heat event
- age at 1st skip heat

2.2.2 Inventory Management Endpoints. Several endpoints can be used to assess how well gilt inventories are being managed. These include:

- total number of gilts in the gilt pool
- % total female inventory in herd that are unbred gilts
- number of gilts in gilt pool that are available to be bred (i.e. size of available gilt pool)
- ratio of number of available gilts to number needing to be bred. If all available gilts are cyclic this ratio would be 3:1. Typically, when available gilts are a blend of cyclic and acyclic gilts, this ratio will be greater than 4.5.
- % replacement rate
- % gilts entering a herd that are removed prior to service
- % selection rate (the proportion of gilts entering a gilt development system that eventually make it into the breeding herd)
2.2.3 Intervals Relating to Gilt Management. The key endpoint used to assess how quickly the gilt becomes productive is entry to 1st service interval. It can be decomposed into its two components:
- entry-to-available interval
- available-to-1st-service interval (days from becoming available until served)

2.3 Productivity Endpoints

2.3.1 Prime Numbers of Productivity. Prime numbers are those that cannot be readily decomposed into component parts. They are the key drivers of herd productivity. Prime numbers of productivity that are commonly assessed include born-alive litter size, preweaning mortality and farrowing rates. While being a prime number for the breeding herd, at large, preweaning mortality is seldom a problem for first-litter sows and, thus, is not a prime number used to assess gilt performance in isolation from the remainder of the herd.

2.3.2 Sow Longevity. The number of litters a sow has before she exits the herd, either by dying or culling, has a major influence on the genetic cost for producing the weaned pig. Through its effect on the herd’s parity distribution, it also affects the efficiency of production (e.g. pigs weaned/litter, farrowing rate, born-alive litter size. There are at least four endpoints that can be used to monitor sow longevity:
- pigs born alive/sow lifetime
- pigs weaned/sow lifetime
- litters farrowed/sow lifetime
- parity at removal

3. Establishing the Correct Gilt Flow for a Farm

Gilt flow into the farm is the primary determinant of the number of females available to meet service targets. Computer models are very useful in figuring out gilt flow for a farm and size of gilt development facilities needed. Being relatively easy to construct using spreadsheets, they should consider the desired delivery frequency in the computation of the number of gilts needed in each delivery. To do this meaningfully, gilt flow models should also consider:
- budgeted age at which gilts are delivered into the gilt development system
- budgeted age at which gilts will exit the gilt development system
- budgeted age at which gilts enter the breeding farm
- budgeted age at first service
- time post mating that gilts will be put in gestation snake
- expected removal rates prior to service (after gilts have entered the herd)
- expected selection rates during development
- changes in replacement (infusion) rates during the year
- facility sizes (including the sizes of (1) the gilt development unit, (2) housing after entry into the breeding herd but prior to being made available, (3) housing after being
made available, and (4) housing from when gilts are bred until they are placed in the gestation snake

• budgeted floor space allowance by age of gilts

4. Informatics

There are several essential elements to the effective monitoring of performance.

4.1 Data Capture

The breeding herd is comprised of subpopulations. Females in the herd are either bred females presumed to be pregnant, open females thought to be non-pregnant, and lactating sows. There are four major open female types in the breeding herd: weaner, recycle, opportunity and unmated gilt. The opportunity female category is comprised of late weaners (not in heat by seven days after weaning), early weaners (weaned less than 14 days of lactation), pregnancy check negatives, and abortions.

Information on fertility and litter size should not only be captured by parity but also by subpopulation. In addition, several bits of information must be captured on individual gilts, including: dates of birth, entry, skip heats, service, treatments with PG600, and removal.

4.2 Projection of Gilt Needs

Projections must be done for a period as far in advance as possible. It is desirable that projections be done for a time period beginning when gilts are dedicated to a sow farm until they are available to be bred into a service group. Accurate group sizes are typically available for (1) gestating (16 weeks), (2) lactating (3 weeks), and (3) weaned groups (1 week). Thus, gilt needs projections can only be done accurately for 20 weeks in advance.

4.3 Monitoring of Gilt Availability

In order to improve the efficiencies associated with gilt performance, management must ensure that sufficient gilts are available at the desired age and after having the targeted number of skip-heat events. In well-managed systems, just having enough gilts to achieve service targets is not enough. The gilts must be old enough, from both a chronological and physiological standpoint.

4.4 Monitoring of Gilt Handling

How gilts are being handled by farm personnel should also be considered, including such things as the proportions of gilts being (1) bred too young, (2) culled prior to breeding, and (3) treated with PG600.

4.5 Monitoring of Gilt Performance
All competitive computerized information systems report litter size and fertility by parity. This allows the gilt’s biological performance relative to other parities to be easily assessed. NFP uses a template, called “Ultrasound Diagnostic Record” to determine how the gilt differs from other parities in various measures of fertility, including pregnancy check positive rates at 4 and 7 weeks of gestation, rates of pregnancy when visually examined at 11 weeks of gestation, and farrowing rates.

5. In-the-barn Information Systems

Real-time information management is only possible when the in-the-barn systems tell the farm staff (1) when an event has occurred or a date has arrived keying an action by a technician and (2) what management practice must be performed on the gilt at that time. While a computerized information system is a necessary tool for managing the breeding herd, it must be supplemented by in-the-barn information systems. The design of these systems is critical to their usefulness.

5.1 Gilt Identification

A simple method for permanently identifying gilts according to their birth or entry date is helpful for managing gilts in the barn. NFP uses a 6-digit slap tattoo number in which the year and week of a gilt’s birth or entry date is included in her identification number. For example, “033124” would mean that gilt #124 entered the herd on the 33rd week of Year 2000. By having entry or birth date information in the gilt’s permanent identity, the technician has access to information that allows them to more effectively manage individual animals.

5.2 Stall and Crate Cards

NFP uses a different breeding stall cards for each of the four major female types (weaner, recycle, opportunity, and gilt). The stall cards allows females to be managed real-time (i.e. in the barn), such that anyone looking at a the card (1) has immediate access to pertinent lifetime information (e.g. entry dates, skip heat dates, PG600 treatments) and (2) knows when certain actions need to be taken (e.g. dates when PG600 treatments should be given, when females should be placed in “stress pens,” when females should be removed from the herd for failure to farrow following service. NFP also uses different colors of cards for the different types of opportunity females (late weaners, early weaners, females found not pregnant, aborted females, and females identified for culling).

The farrowing crate cards used by NFP allow the user to easily understand in chronological order the events that occurred to a sow and her litter (e.g. foster on/off, nurse off, piglet death). While capturing farrowing and weaning data, it also captures qualitative information on the sow and litter at birth and at weaning. A system of colored cards is also used to identify nurse sows and at-risk pigs and litters.

5.3 Data Capture Forms
Forms used to capture breeding information, regardless of where they are being used in the breeding herd, should capture requisite data simply and accurately to allow for subsequent entry into a computerized information system. Forms should also lend themselves to being easily used by farm staff to visually examine data as they attempt to manage subpopulations of females.

5.4 Group Numbering

Sows are identified according to the week of the year in which they are served (i.e. 1-52). As with sow service groups, NFP identifies each group of entering gilts with a number consistent with either the week or 1000-day date that the gilt group enters the herd. For example, Group 41 refers to the group that entered on Week 41 of the year. Group 357 refers to the group that entered on Day 357 of the 1,000-day calendar. Group numbers are used to sort gilt information so that individual group performance can be tracked.

6. Projection of Gilt Needs

6.1 Application

NFP uses a customized spreadsheet application, called the “Gilt Needs Projections” to determine dynamically how to vary rates of gilt introduction into a herd. Projections are run monthly.

6.2 Basis for Projections

Steady state needs for replacement gilts are dependent upon:
- budgeted replacement rate
- herd’s breeding female inventory
- post entry selection rates
- proportion of gilts not cycling following entry
- age when gilts enter the farm

6.3 Factors Influencing Gilt Needs

Several factors cause fluctuations in gilt needs:
- seasonal changes in fertility, percent of entering gilts served, age of puberty, and synchrony of puberty
- group-to-group variations in weaning group size
- changes in the budgeted age when gilts become available
- changes in replacement rates (as occurs with the implementation of a parity correction plan)
- non-seasonal temporal variations in fertility

6.4 Gilt Needs during a New Herd Start-up
The ramping up a start-up herd or the repopulation of a new herd requires the consideration of several additional variables. In planning the infusion of gilts into a new herd, NFP uses a custom template, called “Gilt Needs Projections for a New Herd.” In addition to the above inputs, it considers:

- timing and sizing of gilt deliveries to ensure that service targets are met
- staging of gilt deliveries to ensure that gilts are mated after being skipped heat and above a minimum age
- establishing ongoing regular replacement rates after startup is complete

7. Monitoring Gilt Pool Management

NFP captures its gilt information in a commercial software program, called PigCHAMP. It then exports that data to a custom designed database system called the “Gilt Availability Report.” This report allows the monitoring of how gilts are performing after they have been delivered into the herd. It measures endpoints weekly over time following the periodic introduction of gilt groups.

- % gilts served at greater and less than targeted minimum age
- % gilts treated with PG600
- % gilts served and % remaining to be served
- % gilts with skip heat event and age of 1st skip heat
- % gilts culled or dying

It also allows the user to make decisions “on the fly” as to how the gilt pool should be managed in order to achieve service targets. That is, what you can change in gilt pool management to make sure that you achieve service targets while maximizing gilt maturity.

8. Cost Management

8.1 Key Factors Influencing Weaned Pig Costs

Several factors influence the cost of the weaned pig. Since most costs of production for the breeding herd behave as fixed costs, volume of pigs weaned is the most important determinant. In general, as the number of pigs weaned increases, the cost of production decreases. Farm staff influence several costs, commonly called controllable expenses. Key controllable expenses for the breeding herd included:

- sow feed cost, primarily through the amount of gestation feed provided each sow
- semen cost, through the number of matings/service, the farrowing rates, and weaned litter size average
- gilt genetic cost component, through breeding herd replacement rates, sow lifetime productivity (pigs marketed/sow/lifetime)
- labor cost, through staffing levels of farms, annual replacement rates of staff, wages (including salary, fringe, bonuses, and other incentives)
- utilities, through the use of propane/natural gas to heat farrowing rooms
- health product cost, through compliance with vaccination schedules and use of drugs.