

Characterizing Subpopulations to Reduce Attrition

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■ Introduction

Records can be used in the number of ways. Most often records are used at upper levels of management, often to make economic decisions or to monitor the progress of the farm in meeting its targets. Unfortunately, such methods of using records have resulted in a type of monitoring that has emphasized very little of the decisions that need to be made at the farm level.

As TQM management disciplines have often reported, most of the improvement in the process should be made at upper levels. Concerns such as the quality of inputs, the availability of adequate labour to manage those inputs have often been emphasized. Yet we need to be able to identify methods of differentiating pigs to ensure that the maximum resources are placed at the correct level and for the correct pigs.

Such is the case in the day-to-day management on pig farms. We can make generalized rules of how farms should be managed, yet we miss the differentiated rules for pigs of different backgrounds. In this paper we will look at two examples of pig level management and recording that requires looking at subpopulations of pigs.

The analysis that we need to do in more detail is a two-step approach of characterizing populations into subsets and then attributing scale of failure to those subsets. We then have two methods of managing failure within a population. The first is to reduce the risk of failure in one or more of the subsets. The second method is to reduce that proportion of the population that is more likely to fail.

■ Reducing Nursery Attrition

Let's take two types of pigs that enter a nursery. The first type of pig dies at a rate of 10 percent. This second type of pig dies at a rate of 2 percent. If the proportions are equal, the overall mortality rate is 6 percent. If the first type of pig was removed, either by treatment or by simply avoiding it, the overall mortality rate could be reduced by 4 percent. This is called, in epidemiologic terms, the population attributable fraction (Bruzzi et al, 1985). The ratio of mortality rates between the first and second types of pigs is called the odds ratio, in this case 5 to 1.

There is a problem in our records that most often our records are recorded at group levels. Thus we often see variation in factors such as mortality rates and yet have a difficult time attributing a specific cause to this mortality. The most common method is to open up the pigs that die and find a pathogenic agent where possible. Interestingly enough, especially in the cases of nursery mortality, the agents identified are often ubiquitous and their control is often frustrating.

Our aim in our research is to identify the risk factors that result in higher levels of mortality. It is our contention that variation in the levels of risk susceptible subpopulations are more likely to be the cause of variation in overall mortality rates than the actions of specific agents. The aim of management in nurseries is thus to identify risk factors and control them and address them efficiently. In comparison to sow records, we are at a real deficit in growing pig records due to the fact that we do not record information at the individual level. We have found that there is a great deal of information available to better manage pigs if subsamples are monitored in such a manner (Larriestra et al, 2002).

In our studies we have estimated that the odds of being lightweight at exit can be 3 1/2 times as high if the pigs are light at entry (less than 8 pounds). Of course there is variation from farm to farm and group to group in that relationship, and this relationship needs to be tested on individual systems. Yet this relationship is only significant if a significant proportion of pigs entering the nursery are at risk. If the aim is reduce overall lightweight pigs the first question has to be whether risk factors are present and are varied. We find that the level of lightweight pigs at entry varies greatly between nurseries. Pressures in the sow unit can result in pigs being weaned early or other pressures such as trucking schedules or bonuses can also be a concern.

With an overall rate of light weights of 14 percent at exit, a prevalence of 11 percent at entry and an odds ratio of 3.5 for the relative risk of pigs light at entry being light at exit, the population attributable fraction can be back calculated as:

$$\text{Actual rate} - \text{rate in pigs not at risk} = \text{PAF (Kleinbaum et al, 1982)}$$

The rate of mortality in the pigs not at risk is:

$$\text{Actual rate/ (\%of pigs not at risk and + \% pigs at risk X odds ratio)}$$

In this case the calculation is:

$$14\% / (89\% + 11\% \times 3.5) = 11\%$$

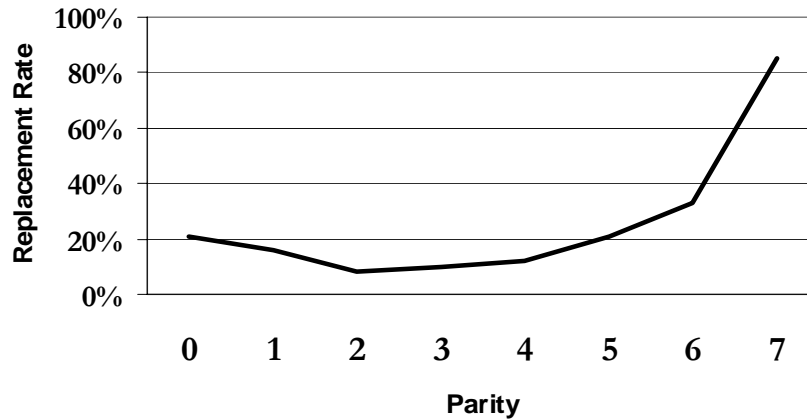
The population attributable fraction is 14 percent minus 11 percent or 3%. The population attributable fraction increases as either the risk experienced by lightweight pigs increases or the prevalence increases. In our experience the risk is relatively stable while the prevalence of lightweight pigs at entry is often increasing.

Once such a focus is made and the odds ratios are identified the control measures are relatively easily identified and controlled at the farm level. First, more records are kept as to the level of incoming pigs at risk. Secondly, pigs at risk are segregated and given added therapy and adequate resources such as heat and digestible feed.

Moreover, other risk factors are beginning to be identified. They include the parity of the dam at birth and at weaning, the gender of the pig and the age of the pig as well. Together they provide a much better potential method of control of attrition of the population in the nursery than many broad therapies.

■ Reducing Sow Attrition

Let's consider the problem of high replacement rates in sow herds. An overall aim is to reduce culling rates and thus reduce the demand for replacement animals. A second issue is mortality rates, however we will focus on culling in this example. A directive can go down from management the culling rates should be dropped from 50 percent per annum to 40 percent per annum. However, culling rate is a management level index with very little use in day-to-day management. There are many reasons to cull sows, and, from week to week, many of them are viable reasons. Often with a simple directive we end up with lopsided parity profiles that have many young and many old sows due to restrictions on culling. To decrease replacement rates the overall aim is to decrease the culling of low parity sows. The controllable factor at employee level is the average parity of removed sows, not the annual number of sows removed (Deen et al, 2002).

Figure 1: Removal rates by parity

For the sake of consistency we will be looking at culling on a parity cycle basis rather than an annual basis. Such a level, in most herds, approximates the annualized culling rate divided by the average number of litters per sow per year.

This is a similar approach in analysis to the approach with nursery pigs and risk factors. The only qualification is that not only are there unequal risks between parities, as well as unequal proportions of the population, there are also unequal costs among parities being removed.

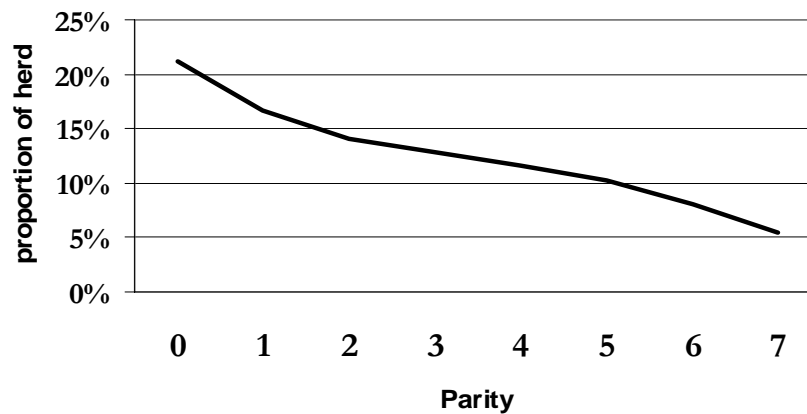
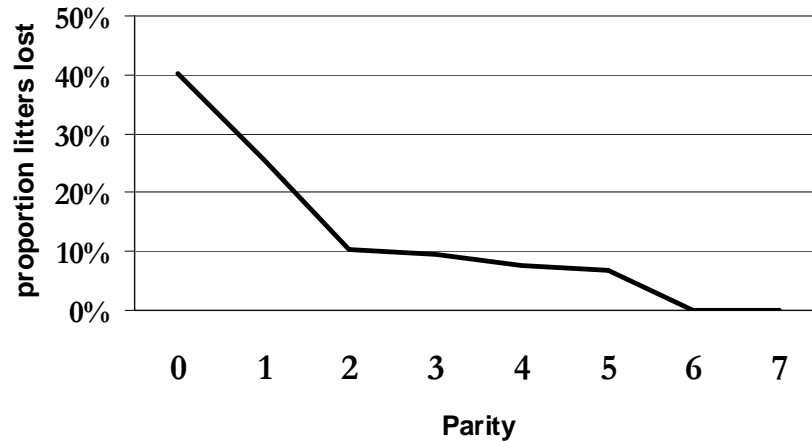
Figure 2: Proportion of herd in each parity

Figure 3: Proportion of potential litters lost by parity

Figures 1, 2 and 3 show the culling rate by parity, the proportion of population removed by parity, and the litters lost with the assumption that each sow removed could have reached 6th parity. Although culling rates are relatively low in the lower parities compared to higher parities, when we looked at the proportion of the herd in each of those parities, and then weighted the losses in each of those parities by the loss of potential production, it is almost inevitable that the majority of the emphasis should be placed on the first two parities in the herd when controlling culling rates.

The next question is equivalent to the question of the population attributable fraction. Where is the risk and what constitutes the effect of reducing that population at risk? In this case we can only increase the population at risk by maintaining them in the herd. We must recognize them as the major concern and then put in place control factors that will reduce the risk of removal.

We argue that most of that emphasis should be placed at the level of the herdsman. To achieve this the measurable index and the focus must be named correctly. Average parity removed is one such measure because it takes into account the weighting of the population towards the younger animals. A better measure is simply measuring the proportion of sows that are removed that are gilts or first parity sows. This should be kept below 20 percent of sows removed. We must differentiate the allowable reasons for removal in the early parities. Primary among these is the removal for reproductive reasons. Although reproductive failure can be repeatable in lower parities, the costs of removal outweigh, in most cases, the costs of increased risk of reproductive failure.

■ Summary

Though disparate examples, the aim in this paper is to exhibit the need to break down population estimates into subpopulations with specific risks and costs. When we do this we can see that there are solutions that involves managing the population as well as managing the risks. The management protocols should be differentiated for different populations. In the case of sows this means that herds persons should be focusing on younger parities. In the case of nursery management we must focus on riskier populations of pigs including lightweight pigs.

■ References

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