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Population-based problem solving in swine herds

Dale D. Polson, DVM, MS, PhD; William E. Marsh, PhD; Gary D. Dial, DVM, PhD, MBA

Summary

Because of their analytical training, practitioners are in a unique position to serve pig producers. However, to meet the needs of a dramatically changing industry, the veterinary profession must adopt a business-oriented problem-solving approach to client service. The key ingredients of this approach are understanding the interrelationships among production system components, and applying appropriate techniques to identify problems and make financially sound decisions. This paper discusses the current literature in problem solving and applies it to pork production.

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To be effective, swine practitioners must be systematic and comprehensive problem solvers who can understand and operate within the complex biological and economic systems that comprise pork production today. Producers now demand that practitioners supplement basic 'reactive' services — identifying, diagnosing, and treating disease in groups of animals — with more 'proactive' advisory services that prevent disease and manage its impact within the entire production system. In addition, producers demand that practitioners financially justify their recommendations.[1]

Contemporary pork production is a business, driven by structural changes within the food animal industry;[2–6] management, technology, and scale changes within individual herds;[1,3–5] and changes in the recognition and resolution of disease.[1,7–9] All businesses, regardless of the type of industry, must make decisions that facilitate conversion of inputs into outputs through a production system.[9–15] The goals of any business — including pork production — are to:

- generate profits,
- maximize security (minimize risk),
- maximize prestige, and
- minimize costs.[16,17]

To continue to be relevant to the pork industry, the swine practitioner of today and tomorrow must be able to serve as a vital member of the business team.

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Veterinarians tend to rely on clinical experience to estimate the financial impact of their recommendations. Clinical experience has been closely linked to diagnostic competence,[18] and it is reasonable to believe that experience predicts competence in evaluating, selecting, and implementing appropriate management interventions. However, clinical experience alone cannot help a practitioner accurately determine the financial worthiness of a particular recommendation in a particular herd.

Increasingly, practitioners must turn to current concepts in problem solving to augment the precision of their estimates of the financial impact of their recommendations. This paper will review the problem-solving literature and discuss its application to pork production systems.

Problem solving in pork production

In today's pork industry, problem solving must include:

- identifying significant (negative) changes in population performance in a timely fashion;
- quantifying the biological and financial impact of these changes;
- diagnosing likely causes and contributing risk factors,
- enacting some form of intervention; and
- continuing to monitor biologic and financial performance.[13,15,19–28]

Financial evaluation techniques can be used to plan and control pork production systems.[29–31] However, these techniques have yet to be widely adopted by veterinarians at the individual herd level, probably because:

- food animal production systems are made up of many interrelated elements, thus the relationships among the components of pig production systems are complex;[9,32,33]
- there are no standardized, practical methods to easily identify and prioritize production problems and associated risk factors in pig production systems; and
- the relative biological and financial merits of the many possible interventions have not been well researched.

Although the primary goal of swine research—both biological and financial—is improved system performance, study of these biological processes has traditionally focused on one individual component of the system rather than the system as a whole.[34] To be efficient and successful, problems solvers must be able to envision pork production as a whole system and understand the interfunctioning among the components of that system. Experimental analysis of a small number of factors under highly controlled conditions is useful if the limitations of this approach are appropriately acknowledged and understood. Improving the efficiency of one component of an animal production system, however, may not improve the performance of the system as a whole.[9] It is essential to understand the entire production system to attain optimal performance overall.

More recently, research has investigated the ways in which the components of biological systems interact.[35–40] For example, in the last 2 decades, there have been a number pragmatic investigations into the relationships among measures of breeding herd performance.[12,28,36,38,39,41–47] These studies have established an initial quantitative assessment of the relationships among production measures. To date, however, no investigators have thoroughly and systematically evaluated swine breeding herd productivity, largely because the industry lacks a sufficiently large and detailed research database with which to collect and analyze the information required to conduct such an evaluation.

The role of information in the problem-solving process

Problem solving is integral to effective management. Management is the process that converts information into action.[48] Information is the "raw material of management"[49] — collecting information is the first step in epidemiologic investigation[50,51] and problem-solving.[48,49] Information is thus the key to an effective decision-making process.[1,52–55] To facilitate effective management, information should be as reliable and objective as possible and appropriate for assessing the performance of the various components of the production system.

Accumulating information without extracting the knowledge it contains, however, has been referred to as "numerical illiteracy."[56] To be of value in decision making, information must be analyzed, interpreted, and assimilated; i.e., data and information must be processed into useful knowledge. In pork production systems, specifically, information is crucial to being able to diagnose problems in herd productivity. Effective problem-solving in pork production requires production and financial data, herd- and animal-specific demographic data, and reliable cost estimates.

One of the most effective ways to turn raw herd data into meaningful information is to establish production benchmarks for a herd. Morris[57] was the first to suggest ways to monitor and use production information in a herd. He introduced the concept of "performance-related diagnosis," where abnormal (unacceptable) productivity was measured by "performance indicators." In Morris's system, production problems were identified by continuous evaluation of "diagnostic indicators." Knowing the important risk factors that relate to each of the various diagnostic indicators allowed the problem solver to set priorities and plan interventions. A diagnostic indicator expressed the ratio of an output measure—such as pigs-weaned-per-female-per-year (PWFY) and pigs-weaned-per-farrowing-crate-per-year (PWCY)—to some limiting resource or factor, typically based on a physical entity (e.g., sows and gilts, farrowing crates) and/or over a specified time period (e.g., a year). Morris suggested that diagnostic indicators reveal when output or efficiency fall below an acceptable standard. Total-born litter size, preweaning mortality, average weaning-to-first-service interval, lactation length, weaning-to-service rate, and service-to-cull rate are examples of diagnostic indicators in pork production systems.

Production benchmarks, then, quantify what is "normal" for a specific herd. Problems in a production system are indicated by a deviation in performance from what is expected, or considered "normal."[57] The definition of "disease" has expanded to include not only clinical and subclinical conditions, but significant deviations from expected productivity performance, which may ultimately be caused by management inefficiency rather than disease.[57] Subclinical "disease" and production inefficiencies are now recognized to be the most significant sources of impaired productivity.[1,9,57,58] Practitioners operating under this expanded definition of disease must not only identify disease, they must consider multiple intervention alternatives and determine their relative benefits and costs.[7] Increasingly, "health" is now defined as achieving targeted productivity.[9]

Assessing this kind of "disease" or "illness" is only possible by comparing herd performance to population "norms" or standards of health.[59,60] Without clinically evident disease, actual production performance must be compared with production benchmarks, also called "targets"[52,57] and "goals,"[13,57] to identify problems with suboptimal performance.[61] Indeed, the term "subclinical" must be redefined, because it could be argued that subclinical disease is nothing more than clinical disease that is more difficult to detect with commonly used diagnostic tests. Thus, detecting "subclinical" disease becomes a matter of incorporating the appropriate epidemiologic analyses to identify the problem and then diagnosing the causative and contributing factors.

How to set production benchmarks

The next challenge, then, is deciding how to set the production benchmarks for an individual herd. Should benchmarks be derived from the herd in question, from an industry standard, or from some combination of these data sources?

Lloyd, et al.,[62] have suggested that the best baseline for target setting is the herd's own production values. Historical information from the herd can be used to calculate prior probabilities for each performance parameter. If prior probabilities are not available, one must base the standards on subjective probabilities,[10] i.e., make an "educated guess."[11] This guess can be supported by information from the futures markets and the scientific literature. Ignoring levels of industry performance and focusing solely on a herd's own data to establish production expectations, however, may leave the herd's management at a serious competitive disadvantage with the rest of the industry and at risk of failure.

Breeding herd performance norms and targets have been widely distributed.[1,36,38–40,42,63–72] Some of these studies used either survey or database information on which to base target values.[36,38–40,70–72] Because performance among herds and over time within a herd is inherently variable, standard production values derived solely from multiple herd data may be an inappropriate source of information for input, output, and production standards.[52,62] However, it is important to remember that standard values derived from a collection of herds can be derived from a situation in which there were or could be no control groups. The validity of these standards assumes that a given herd's performance baseline (i.e., reference level) is achieved in an environment relatively free from serious production problems.

Production standards obtained from a database consisting of "like" herds could be used for comparison with a herd in which production problems exist. Large pork production databases can be extremely useful in identifying subsets of contemporary herds that are sufficiently similar to the specific herd in question. A large number of herds from which sufficient demographic information is collected may be useful for selecting appropriate production standards.

Meredith[52] suggested that production targets be based both on data from within the herd and data from other similar herds. He suggests continuously monitoring breeding herd productivity by comparing a herd's production parameters to:

- within-herd retrospective data,
- data from herds with similar resources,
- data from herds with dissimilar resources, and
- theoretical potential productivity (Figure 1).

Diagnosing productivity problems

Using benchmarks to signal productivity problems is complicated by the fact that biological production systems, including swine herds, are inherently variable.[73,74] The major challenge in diagnosis of production problems is differentiating between the inherent variability one would normally expect in a biologic system and deviations from the benchmarks that represent "real" problems with productivity. Given the intrinsic variability in herd performance, it is more appropriate to compare actual performance to a range of expected performance. This range would be bounded by specification limits — the upper and lower ends of expected performance.

A number of researchers have described techniques for evaluating the statistical validity of changes in productivity.[73–76] The statistical objectives of target and interference level selection are to choose levels that can be used to determine, by statistical inference, whether or not a change in a population sample is merely biologic "noise" or indicates a true change in the population as a whole.[57,74] Meredith[52] has suggested that the statistical approach is superior to the typically subjective method of differentiating between normal variability and true deviation from benchmarks.

Yet, even the use of such classic methods using target and interference levels to attempt to account for inherent variability is an invalid method. Such an approach constitutes us telling a pig production process what it can and cannot do, rather than listening and understanding what it is actually doing. Instead, the methods developed by Shewhart,[77] referred to as statistical process control, hold the most promise for identifying nonrandom or abnormal variation and off-target performance to enable practitioners to diagnose the factors to which this unpredictable variation can be attributed.

Once herd performance standards have been set, the herd must be continuously monitored for real deviations from those standards. If such deviations occur, they must be diagnosed.[9,12,78] The literal translation of the Greek word for diagnosis is "through thinking,"[18] implying that arriving at a diagnosis is not an end in itself, but simply part of a broader process: to facilitate management of business operations through problem-solving. The primary objective of diagnostic activity is not to identify the causes of disease but to facilitate management of the problem being diagnosed.[18,79,80]

While effective diagnosis can enhance the problem-solving process, it is not necessary in order to achieve solutions.[79,80] Production-limiting problems are often resolved without knowing the specific cause(s). This is particularly true in the case of newly emerging diseases, such as porcine reproductive and respiratory syndrome (PRRS), for which effective control programs were implemented in herds before the causative agent was identified.[81] However, knowing specific causes expedites problem-solving—productivity problems are most efficiently resolved when managers know they exist[9,82,83] and know why they are happening.[49] Diagnosis can help the manager select more "appropriate" interventions; i.e., those that are likely to improve profitability at an acceptable level of risk. Methods to identify and rank production problems and to link these problems with risk factors have vast potential for clinical application.

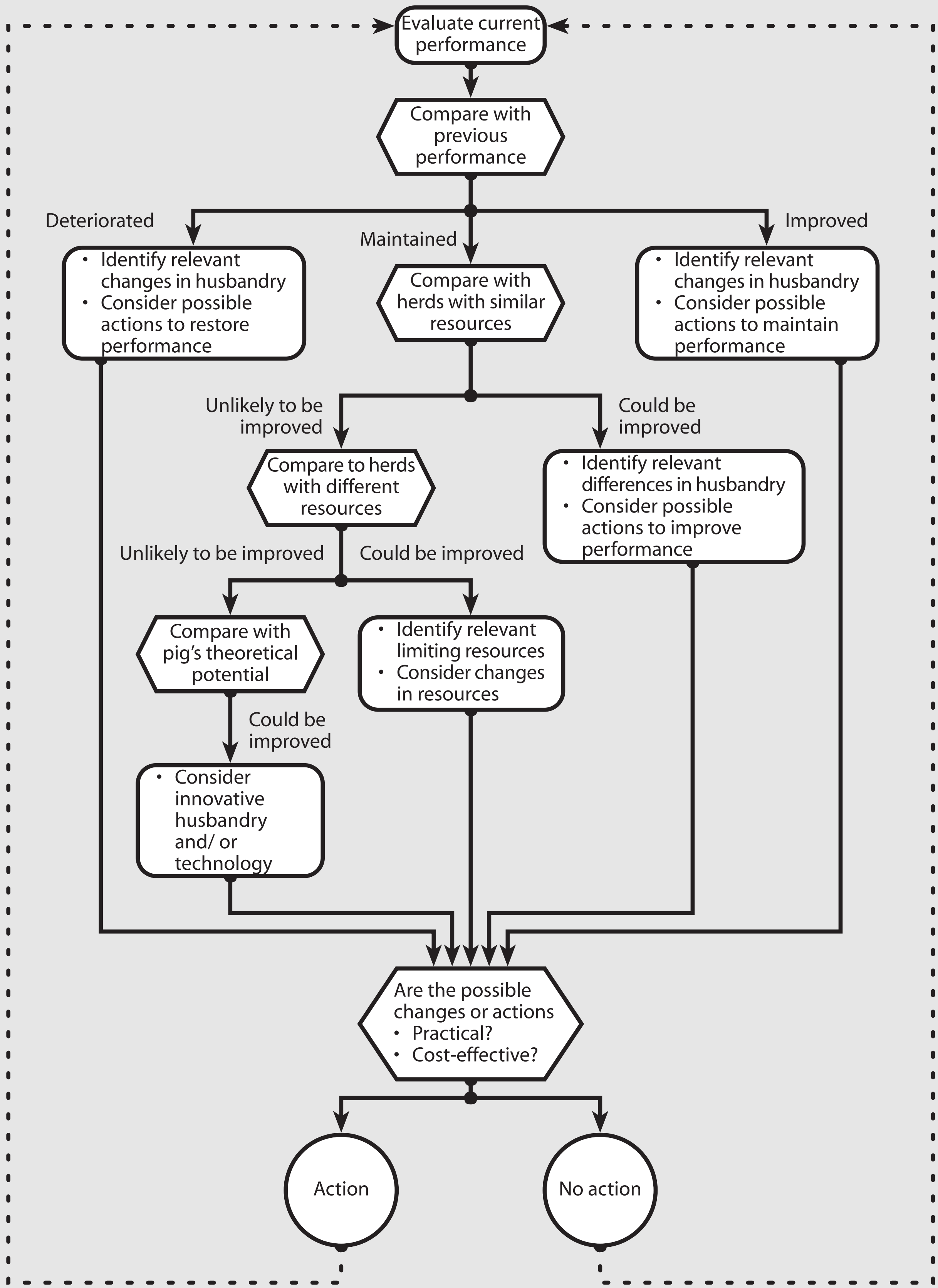
One recent example of this type of analysis was conducted by Dee, et al.[84,85] The authors describe the biological and financial results of nursery depopulation (ND) for 34 herds as a method for controlling the effects of postweaning PRRS. A distribution of performance effects and margin-over-variable-costs (MOVC) per herd compared before and after ND demonstrated a range of possible responses across a relatively wide range of herd types. Studies of this kind, along with an individual evaluation for each herd, are the most appropriate way to predict the range and financial impact of the intervention.

While it is important for problem solvers to be able to distinguish deviations in production benchmarks from normal variability with some degree of confidence, the practical and financial aspects of herd management must also be considered.[57] For a competitive business, interventions are irrelevant if they are not likely to improve profits.[52]

To be considered "appropriate," selected production standards should not only be statistically meaningful,[52,74] they should also reflect financially meaningful changes in productivity[52,57,74] and be achievable to prevent herd worker discouragement.[36,52,86] Satisfying all three of these different objectives requires a balance between having statistical confidence that changes are real, what is achievable within the herd's production constraints, and what is financially relevant.

Computerized tools exist to facilitate financial analysis of pig herd management decisions;[35,87] however, few veterinarians and producers have yet adopted them.

Figure 1



A systematic approach to the assessment of herd performance redrawn from Meredith, 1983.[52]

Husbandry is defined here as management, housing, environment, nutrition, genetics, and health control measures taken.

Resources are the "fixed" aspects of husbandry: e.g., capital investment, personnel, herd size, weaning age, housing system, geographical location, genotype, and pathogens present in the herd.

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Conclusions

In research or practice, veterinarians can no longer afford to believe that if the parts of a production system are well looked after, the whole will take care of itself.[34] Veterinarians must learn to evaluate the entire production system in an objective and systematic fashion, and applied research must conceptually and pragmatically examine the issues that impede our understanding of what makes the system function. Veterinarians must acquire and practice a blend of animal health with epidemiological and financial skills if the services they offer are to meet the needs of food animal industries in the future.[53,62]

Veterinarians involved in problem solving must also keep the personal goals and values of their clients in mind. Swine producers have many different reasons for wanting to improve suboptimal performance, including personal reasons distinctly separate from the pursuit of profitability in their business. For veterinarians to assist clients in achieving their business goals, they must view problem-solving as enabling a broader purpose—facilitating overall management of system operations and decision-making.

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