MAKING DECISIONS ABOUT NEW TECHNOLOGIES ON THE DAIRY

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INTRODUCTION

Dairy producers and their advisors are confronted with a bewildering number of potential decisions or choices on a yearly, monthly, weekly, or even daily basis. These range from decisions relating to larger capital investments (e.g., a new milking center or conversion to automatic milking systems, a new transition cow barn, a new calf barn) to more modest capital investments (e.g., rumination tags, implementation of long day lighting, implementation of cooling in lactating and/or dry cows) to adoption of management practices (e.g., varying milking frequency, adjusting dry period length, adding an extra colostrum feeding or additional daily feeding to calves) to nutritional management decisions. Nutritional management decisions are also numerous and can relate to bigger picture decisions related to forage strategy or source, selection of dry and transition cow nutritional management strategies, or the decision to supplement specific nutrients or improved forms of nutrients or feed additives.

So, how can one sort through the decision-making process? My first recommendation is to develop a systematic process for decision-making. In the remainder of this paper I will attempt to outline elements that I think should be considered as parts of this decision-making process.

ELEMENTS OF THE DECISIONMAKING PROCESS

What is the "Reward-Risk"?

This phase is conventionally termed "risk-reward", but I have inverted this intentionally as I think that the conventional manner in which we express this tends to subconsciously focus one on the risk rather than the potential reward. In order to consider the "reward-risk" we should consider the statistical concepts that Dr. Dave Galligan and colleagues at the University of Pennsylvania applied to the types of decisions that we make in dairy management (Galligan et al., 1991). They defined Type I error as the risk of an economically unprofitable outcome following the decision to implement a management practice or use of a product and Type II error as the risk of loss of potential profit by failure to adopt a particular technology or management practice and gave examples of how they would apply these concepts in the decision of whether or not to feed sodium bicarbonate and whether or not to administer rbST. From summaries of research studies they determined mean responses and variation around them, determined break-even responses based upon input costs and output values, calculated the frequencies of all possible responses, and then modeled the economics associated with both types of error, with additional sensitivity analysis conducted based upon variance for both input costs and output values. For these particular examples, they determined that the Type II economic risk far exceeded the Type I economic risk.

I think that it is important to consider that the importance of Type I vs. Type II error in decision-making depends upon the particular type of decision to be made that in turn relates largely to the size of the investment and/or magnitude of commitment. As an example, in the case of large capital investments such as new milking centers or conversion of a herd from conventional milking systems to automatic milking systems, Type I error risk is the larger concern because in these cases Type I errors may meaningfully decrease profitability and/or put the dairy farm business at risk. In my opinion, Type I error risk should also receive primary consideration in the decision for a farm to plant non-GE crops as described in Joe Lawrence's paper later in this conference, for significant pest or other crop system issues for which these technologies provide protection can have great impacts on overall profitability. For other management decisions (e.g., herd health and reproductive protocols, decisions to vary dry period length, nutritional strategies as will be discussed below), Type I errors are likely less of a problem and changes can be made relatively easily if it is determined that desired outcomes are not being achieved.

In general, I think that most decisions involving nutritional management are more at risk for Type II errors than Type I errors; however, my sense is that we generally focus more on the Type I risk than the Type II risk in these decisions. This is probably in large part because the input costs for adoption of a particular technology or nutritional strategy are easily determined and the specific response/value derived is often more challenging to determine, at least at the individual farm level given all of the other dynamic factors that can also influence outcomes of interest.

CONSIDERATIONS FOR ADOPTION OF MANAGEMENT PRACTICES OR NUTRITIONAL STRATEGIES AND TECHNOLOGIES

Of course, if we apply a purely Type II-centric decision-making approach, we may adopt many management practices, nutritional strategies, and technologies – some of which will yield returns on the farm. There are a few things that I think should be considered when evaluating ***which*** adoption decisions to make.

Biology and Potential Mode of Action

In my opinion, understanding the biology and potential mode of action is critical. Of course, some things are quite well understood (e.g., rbST, milking frequency, controlled energy strategies for dry cows, application of DCAD in dry cows, responses to AA) and other emerging or integrative areas are less well-understood (e.g., gut integrity/leaky gut, oxidative metabolism, immune/inflammatory mechanisms). This does not de-emphasize the importance of these latter areas, rather it is important to recognize that we are still defining these areas and how to best modulate them in a positive manner through management and/or nutrition.

Develop a “Constellation of Evidence”

I think that decisions to adopt technologies have more certainty for success when responses are supported from various angles. Things that should be considered in the “constellation of evidence” are:

- -- Biology and potential mode of action (see above)
- -- Research and demonstration
  - -- Controlled, peer-reviewed University or Research Center work
  - -- Replicated (within dairy) commercial farm-based studies
  - -- Replicated (across dairies) commercial farm-based studies/demonstration
  - -- Meta-analytic approaches
- -- Practicality of implementation
- -- Experience

Controlled, peer-reviewed research should form the basis for determining potential responses and defining mode of action; however, this work can be complemented nicely with commercial-farm based studies or demonstration. Furthermore, meta-analytic techniques are being applied increasingly to areas (e.g., effects of monensin on metabolism – Duffield et al., 2008) in which there is a body of research that can be summarized using these approaches.

I would like to offer some “watch-out’s” relative to assessment of controlled studies, based upon nearly 25 years of experience and perspective gained over that timeframe doing these types of controlled studies in transition cow nutrition and management. First, many studies still are not well-replicated (we now strive for 25 to 30 cows per treatment in transition cow studies in which we are trying to make inferences relative to performance). As such, outcomes can be particularly influenced by decisions that the investigators make relative to cow removal prior to analysis because of adverse health events. There are several recent examples of studies in which either large numbers of cows were removed from the dataset or cows were selectively removed for the same disorder from some treatments but not others, with potentially important consequences for the results and conclusions of the studies. A second “watch-out” relates to performance of controls. We strive to have studies in which the control group performance is representative of how cows perform on well-managed commercial farms. There are recent studies in which the performance responses to treatment were very large, but the control group was clearly compromised for whatever reason and performing well below what might be expected on a commercial dairy. A third “watch-out” relates to the discussion of what is “biologically or economically significant” versus “statistical significance”. Again, in studies that have relatively low replication, a difference that would be considered very meaningful at the farm level may not be statistically significant. A good example of this relates to work that several groups, including our own, did a number of years ago looking at continuous lactation (zero dry period). Cows with zero days dry generally made 1.5 to 3 kg/d less milk in the subsequent lactation but differences were not statistically significant. Finally, are the results internally consistent within study (i.e., do changes in blood chemistry and/or body weight and body condition score line up with the responses in milk yield, milk composition, and dry matter intake observed?).

Projected Economic Returns

Of course, projected returns are a key consideration for adoption of technology. In addition to the approach that Galligan et al. (1991) illustrated, partial budget analysis to include changes in revenue or other benefits and changes in investment or inputs to determine marginal returns can be conducted. Within each of these, clear conveyance of the anticipated changes, consideration of whether the numbers and assumptions are hard or soft (level of certainty) is important. Furthermore, sensitivity of the final outcome to variation in response or changes in the input costs/output value should be evaluated.

Managing Expectations

Not every decision is going to be a home run, or even a hit. If there is heterogeneity in responses across studies on a topic, it should be represented in some manner. In my opinion, this helps to build credibility and take focus away from specific responses observed in an individual study and put it more on the pattern of responses seen across multiple studies.

What is the "Opportunity Cost" for Labor and Management?

Owners and managers on-farm as well as their advisors should keep in mind the opportunity cost for labor and management relative to adoption of management practices or technologies. This consideration will help to prioritize and keep focus on whether there are other management practices that would yield more potential return for the effort required to implement.

TWO EXAMPLES – INCREASED MILKING FREQUENCY AND MONITORING AND TREATMENT OF HYPERKETONEMIA

Assessment of 4X/2X Milking Strategies

A number of studies over the past 20 years have focused on increased milking frequency (IMF) of cows during the first 21 or so days postcalving. Following the original work in Israel in which cows milked 6X for the first 42 d postcalving maintained milk yields about 5 kg/d higher after return to 3X milking compared with cows milked 3X starting at calving, several studies evaluated 4X/2X milking schemes (fresh cows were generally milked first and again last in a 2X milking schedule) in University herds and on commercial dairy farms. These studies generally demonstrated carryover responses ranging from 2 to 4 kg/d of milk (Hale et al., 2003; Fernandez et al., 2004; Dahl et al., 2004 Wall and McFadden, 2007; Soberon et al., 2010; Soberon et al., 2011). The only study that demonstrated negative production responses to IMF was that of Van Baale et al. (2005) involving 6X/3X milking; however, they determined that on the large commercial dairy in which they conducted the research, cows milked 6X were away from the fresh pen for milking more than 6 h per day, which likely had severely negative impacts on time budgets of those cows. Further, in our commercial farm-based work (Soberon et al., 2011), in general, the farms that had better management of stocking densities in the fresh pen and better transition management overall had better responses to IMF, although all farms in that dataset had a positive response to IMF.

Partial budget analysis suggested increased net revenue of about $80 per cow for adoption of 4X/2X milking, with most of the increased input cost associated with the increased feed requirements to support the additional milk yield. Changes in feed cost would be directly proportional to responses. Despite this, there has been very little adoption of this management practice on dairies milking 2X. Perhaps this is a perception of opportunity cost of labor and management, lack of confidence of seeing a response despite the available information, or simply lack of willingness to adopt a practice that will increase owner/manager labor on many of these dairies.

Monitoring and Treatment of Hyperketonemia

Following commercial-farm based research that established associations between cow- and herd-level prevalence of hyperketonemia (subclinical ketosis) and increased incidence of clinical disease, decreased milk yield, and impaired reproductive performance (Ospina et al., 2010a; 2010b, 2010c), McArt and coworkers conducted studies on four farms in New York and Wisconsin to determine the epidemiology of subclinical ketosis as well as the outcomes of intensive testing and treatment strategies using handheld BHBA meters and propylene glycol drench as a treatment regimen (McArt et al., 2011; 2012a; 2012b). They demonstrated increased milk yield, decreased DA, decreased herd removal, and increased first service conception rate for cows detected and treated with propylene glycol. Further economic analysis of varying intensities of testing with associated propylene glycol treatment yielded net returns ranging from $7 to $11 per cow for herds with 40% incidence (~ 2X prevalence) and greater returns for herd with higher prevalence and incidence. Although the economic returns of intensive diagnostics and associated treatment are favorable, there is likely an opportunity cost of management and labor that should be considered. At a minimum, schemes such as the one in Figure 1 that Ospina et al. (2013) proposed to monitor prevalence with management decision-making based upon prevalence can be very effective ways to monitor and manage hyperketonemia in a targeted manner.

SUMMARY AND CONCLUSIONS

Decision-making at the herd level can be complex for both dairy producers and their advisors. Having a process that is systematic and that considers multiple aspects and implications of decisions can lead to better decision-making overall. Producers and their advisors should weigh the “reward-risk” of decisions, and not let concern about making Type I errors result in greater losses through Type II errors related to failure to adopt technologies or management practices. Developing a “constellation of evidence” consisting of biological mode of action, research and demonstration to support, likelihood of effective implementation, and experience can help to determine which adoption decisions to make, keeping in mind management systems, practicality, and opportunity cost for labor and management.

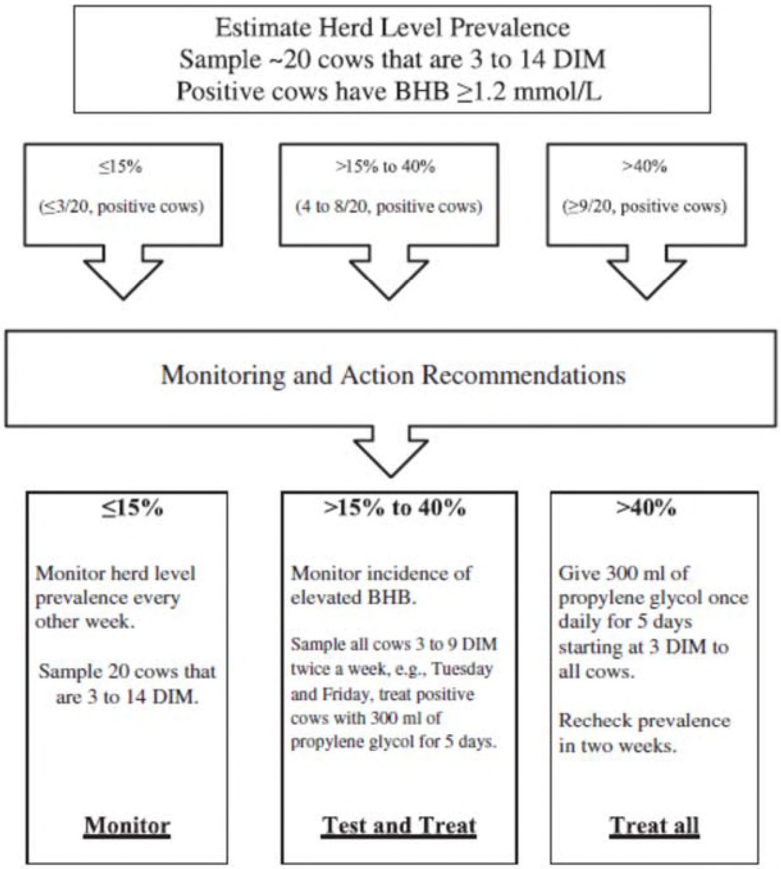

Figure 1. Testing scheme for prevalence of hyperketonemia in fresh cows with associated recommendations for monitoring and treatment. From Ospina et al., 2013.

REFERENCES

Bar-Peled, U., E. Maltz, I. Bruckental, Y. Folman, Y. Kali, H. Gacitua, A. R. Lehrer, C. H. Knight, B. Robinzon, H. Voet, and H. Tagari. 1995. Relationship between frequent milking or suckling in early lactation and milk production of high producing dairy cows. J. Dairy Sci. 78:2726-2736.

Dahl, G. E., R. L. Wallace, R. D. Shanks, and D. Lueking. 2004. Hot Topic: Effects of frequent milking in early lactation on milk yield and udder health. J. Dairy Sci. 87:882-885.

Duffield, T. F., A. R. Rabiee, and I. J. Lean. 2008. A meta-analysis of the impact of monensin in lactating dairy cattle. Part 1. Metabolic effects. J. Dairy Sci. 91:1334-1346.

Galligan, D. T., W. Chalupa, and C. F. Ramberg, Jr. 1991. Application of Type I and II errors in dairy farm management decision making. J. Dairy Sci. 74:902-910.

Fernandez, J, C. M. Ryan, D. M. Galton, R. W. Everett, and T. R. Overton. 2004. Effects of milking frequency during early lactation on performance and health of dairy cows. J. Dairy Sci. 87(Suppl. 1):424. (Abstr.)

Hale, S. A., A. V. Capuco, and R. A. Erdman. 2003. Milk yield and mammary growth effects due to increased milking frequency during early lactation. J. Dairy Sci. 86: 2061-2071.

McArt, J.A.A., D. V. Nydam, and G. R. Oetzel. 2012a. A field trial on the effect of propylene glycol on displaced abomasum, removal from herd, and reproduction in fresh cows diagnosed with subclinical ketosis. J. Dairy Sci. 95:2505-2512.

McArt, J.A.A., D. V. Nydam, and G. R. Oetzel. 2012b. Epidemiology of subclinical ketosis in early lactation dairy cattle. J. Dairy Sci. 95:5056-5066.

McArt, J.A.A., D. V. Nydam, P. A. Ospina, and G. R. Oetzel. 2011. A field trial on the effect of propylene glycol on milk yield and resolution of ketosis in fresh cows diagnosed with subclinical ketosis. J. Dairy Sci. 94:6011-6020.

McArt, J.A.A., D. V. Nydam, G. R. Oetzel, and C. L. Guard. 2014. An economic analysis of hyperketonemia testing and propylene glycol treatment strategies in early lactation dairy cattle. Prev. Vet. Med. 117:170-179.

Ospina, P. A., J.A.A. McArt, T. R. Overton, T. Stokol, and D. V. Nydam. 2013. Using nonesterified fatty acids and β–hydroxybutyrate concentrations during the transition period for herd-level monitoring of increased risk of disease and decreased reproductive and milking performance. Vet. Clin. Food Anim. 29:387-412.

Ospina, P. A., D. V. Nydam, T. Stokol, and T. R. Overton. 2010a. Association between the proportion of sampled transition cows with increased nonesterified fatty acids and beta-hydroxybutyrate and disease incidence, pregnancy rate, and milk production at the herd level. J. Dairy Sci. 93:3595-3601.

Ospina, P. A., D. V. Nydam, T. Stokol, and T. R. Overton. 2010b. Associations of elevated nonesterified fatty acids and beta-hydroxybutyrate concentrations with early lactation reproductive performance and milk production in transition dairy cattle in the northeastern United States. J. Dairy Sci. 93:1596-1603.

Ospina, P. A., D. V. Nydam, T. Stokol, and T. R. Overton. 2010c. Evaluation of nonesterified fatty acids and beta-hydroxybutyrate in transition dairy cattle in the northeastern United States: Critical thresholds for prediction of clinical diseases. J. Dairy Sci. 93:546-554.

Soberon, F., J. L. Lukas, M. E. Van Amburgh, A. V. Capuco, D. M. Galton, and T. R. Overton. 2010. Effects of increased milking frequency on metabolism and mammary cell proliferation in Holstein dairy cows. J. Dairy Sci. 93:565-573.

Soberon, F., C. M. Ryan, D. V. Nydam, D. M. Galton, and T. R. Overton. 2011. The effects of increased milking frequency during early lactation on milk yield and milk composition on commercial dairy farms. J. Dairy Sci. 94:4398-4405.

VanBaale M. J., D. R. Ledwith, J. M. Thompson, R. Burgos, R. J. Collier and L. H. Baumgard. 2005. Effect of increased milking frequency in early lactation with or without recombinant bovine somatotropin. J. Dairy Sci. 88:3905-3912.

Wall E. H., and T. B. McFadden. 2007. The milk yield response to frequent milking in early lactation of dairy cows is locally regulated. J. Dairy Sci. 90:716-720.