Application of HACCP principles in dairy herd health and production management

The hazard analysis and critical control point concept has been applied on dairy farms to provide more efficient control through proactive monitoring, write Conor McAloon, resident in bovine health management, Dr Paul Whyte, senior lecturer, and Dr Michael Doherty, professor of large animal clinical studies, Section of Animal Health and Animal Husbandry, School of Veterinary Medicine, University College Dublin

Dairy farming has changed dramatically in the past few decades. Despite an increase in the global demand for dairy products, increasing production costs have led to declining profit margins. Dairy farmers have responded by intensifying production. Consolidation of farms has led to a decline in the number of farms while the average herd size continues to increase. Production diseases and declining fertility associated with intensification has a negative impact on both profitability and welfare. The motivation towards improved farm efficiency has led to the development of herd health programmes that aim to improve farm profitability through the reduction of clinical and subclinical disease. Primary benefits in animal productivity and welfare are targeted; however, from a food safety point of view, herd-based preventative medicine leads to healthier animals that are less likely to harbour zoonotic pathogens and require fewer antimicrobial treatments.

Across Europe, herd health programmes have been in operation since the 1980s and have been designed to target this emerging perceived need of the dairy industry. However, uptake has been variable and the Lowe Report,

published by the Department for Environment, Food and Rural Affairs (Defra) in the UK in 2009, highlighted a perception among farmers that veterinary input was still too focused on individual animal care and neither added value nor targeted farm profitability. Indeed, the term 'herd health' has also become increasingly ambiguous and is commonly used interchangeably to describe vaccination and health plans, the investigation of specific herd problems or any aspect of veterinary medicine that considers preventative measures. The University College Dublin (UCD) herd health group refers to the herd health cycle (Figure 1) as a model for how preventive and production medicine may best be applied on farm in order to increase efficiency and improve farm profitability.

QUALITY CONTROL PROGRAMMES FOR DAIRY FARMS

It is envisaged that in order for herd health advisers to have a sustained contribution in preventing disease and improving productivity on farm, they must have a positive input in the long-term monitoring phase of the herd health cycle (Figure 1). It is therefore necessary that tools are developed in this area to facilitate meaningful input from veterinary advisors.

Conventional herd health programmes involve a considerable degree of retrospective data analysis, though this alone may not be sufficient to prevent disease or increase productivity on farm. Several advocates of the herd health concept have, therefore, suggested that concepts of production management applied in areas outside of the conventional veterinary sphere may be adaptable and applicable to dairy farms. An evaluation of the applicability of three common quality control concepts – good manufacturing practices (GMP), hazard analysis and critical control point (HACCP) and ISO-9000 – concluded that a HACCP-like approach would yield the best options in the context of animal health, animal welfare and food safety.[1]

Indeed, it is interesting to note that the UCD fertility programme which has evolved over several years into an advanced herd health programme now closely resembles a HACCP-based programme, despite not being designed as such. In addition, the introduction of the European Commission 'Hygiene Package' legislation in 2004, has advised member states to "encourage operators at the level of primary production to apply such (HACCP) principles as far as possible".

The HACCP concept has since been adapted for use on dairy farms as an evolution of herd health management systems to help provide more efficient control through proactive monitoring rather than retrospective performance analysis.

ON-FARM HACCP

Much of the discussion to date has been concerned with the extension of HACCP principles along the food chain, with a particular focus on zoonotic pathogens and foodborne hazards. Generally speaking, such discussions

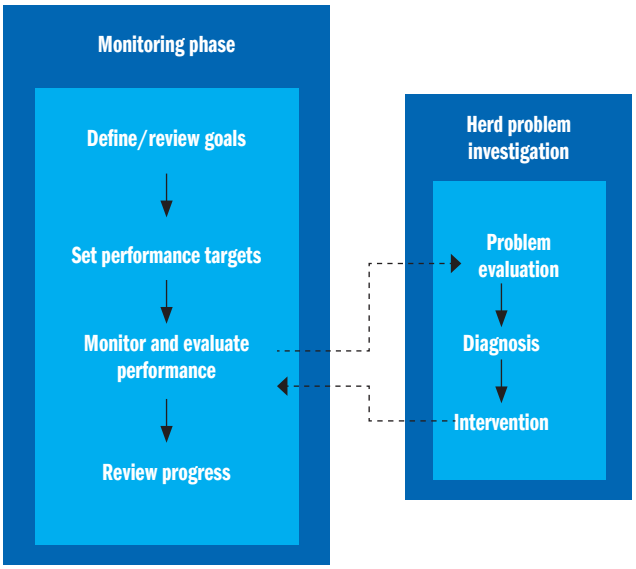

Figure 1: The herd health cycle, adapted from Sekiya et al, 2013.[2]

have been theoretical rather than based on farm trials. It is important to note that many foodborne hazards may not be associated with clinical disease or obvious direct costs to the farmer, and the benefits of such programmes are, therefore, sometimes unclear to the primary producer.

It follows that in the absence of a financial incentive to implement HACCP-based programmes that target food safety, farmers are unlikely to implement such programmes voluntarily. However, programmes that are designed with a herd health focus, targeting the prevention of diseases associated with economic loss to the producer, may be more likely to be implemented. Benefits in welfare and food safety are, therefore, likely to be gained as a consequence of targeting farm profitability.

HACCP was initially developed to help ensure safety of food for early space flights as a proactive alternative to end-point testing. The term is synonymous with food safety but is, in its general form, a logical system of control based on the identification and prevention of potential problems at each stage of production. It can therefore be applied to any form of production where a greater level of control over the production process is required.

The dairy herd health group at UCD has a strong research focus and has been active in the development and application of HACCP-based management programmes on dairy herds such as mastitis control and, more recently, through the control of paratuberculosis on infected dairy herds.[3]

The identification of critical control points (CCPs) as areas where risk of exposure to the hazard of interest can be reduced to an acceptable level are central to the HACCP concept. CCPs are identified through systematic consideration of both the production process and infection process. It is important to note that this approach is not expected to yield new risk factors for the transmission of well-known diseases; however, the concept of assessing

Table 1: Critical control points in the control of paratuberculosis in infected dairy farms, as identified by McAloon et al, 2015.[3]

CCP	Control measures	Monitoring	Verification	Target Critical limit	Corrective actions
1. Peri-parturient area management	Cleaning, bedding	Hygiene scoring	Percentage of coat scores >2	<5% >20%	Increase cleaning and bedding frequency
2. Calving	ID and movement of close-up cows to calving pen Segregation of test positive cows	Calving location	Percentage of calvings occurring in dry pen Number of unknown or high-risk calvings in general calving area	0% >5% 0 1	Improve frequency/accuracy of close-up cow inspections Re-evaluate testing plan, improve visual identification aids
3. New-born calf management	Prompt calf removal	Time spent in calving pen	Number of calves spending >60 minutes in calving pen	0% >10%	Increase calving cow inspection frequency
4. Colostrum management	Udder preparation	Colostrum TBC/TCC	Percentage of samples > 100,000/10,000cfu/ml	<10% >25%	Review colostrum harvesting protocol

performance through structured monitoring of the implementation of specific control measures may be useful on farms where a level of control above and beyond existing methods might be desired.

CONTROL OF PARATUBERCULOSIS AS AN EXAMPLE

Bovine paratuberculosis is a disease characterised by chronic granulomatous enteritis which manifests clinically as a protein-losing enteropathy causing diarrhoea, hypoproteinaemia, emaciation and, eventually, death. Adverse effects on animal productivity in terms of lower milk yield, reduced value for culled animals, possible adverse effects on fertility and losses due to continued spread of infection are key drivers in the attempt to control the disease at farm level. In addition, some research exists to suggest that the aetiologic pathogen, *Mycobacterium avium* subspecies *paratuberculosis* (MAP), may pose a zoonotic risk, with many believing MAP could play a role in at least some cases of Crohn's disease in humans.

Paratuberculosis is challenging to control in infected herds owing to limitations of diagnostic tests, long incubation period of the disease and prolonged survival of the organism in the environment. Even with the implementation of an effective control programme, improvements may not be seen on the farm for many years and it is therefore difficult to monitor progress of control programmes or to assess the effectiveness of implemented control measures.

It is yet to be determined how these challenges of disease control may influence farmer attitude and morale. This is particularly important given that most simulation models have highlighted that those control efforts which arguably require higher levels of farmer involvement and motivation, ie. closing of infection routes, tend to be some of the most important in reducing the incidence of disease.

Analysis of objective data collected on farm allows implementation of control measures to be evaluated. This allows for ongoing, in-depth monitoring of key points during the production process, facilitating more accurate identification and quantification of risk.[4] In addition, the analysis of quantitative data facilitates target and goal setting in the short-to-medium term.

QUALITATIVE VERSUS QUANTITATIVE MONITORING

A HACCP-based approach focuses control at a small number of CCPs which can be monitored using objective, quantitative outputs. In the list of CCPs identified in the recent MAP study (Table 1), the absence of several known control recommendations is notable. For example, the source of milk fed to calves is not considered a CCP. The feeding of milk replacer in infected herds (with respect to paratuberculosis control) is an example of a qualitative management change and, therefore, does not require focused monitoring and control at this point. As a result, this control measure is considered a HACCP prerequisite for the control of paratuberculosis in infected dairy herds.

PERFORMANCE VERSUS ACTIVITY–BASED MONITORING

The development of HACCP-based control programmes in dairy herds exercises the key herd health principle of assessing performance rather than activity. For example, in a recent study, the hygienic harvesting of colostrum was identified as a CCP for the control of paratuberculosis on infected dairy herds. Specifically, faecal contamination of colostrum at this stage was identified as an area where calves were likely to be exposed to the hazard (MAP).

In a conventional programme this risk factor would be evaluated by assessing activity or 'what is being done', that is 'How is colostrum being collected?' However, in a HACCP-based programme, total bacterial counts from colostrum samples allow us to monitor faecal contamination of colostrum, thereby allowing us to assess performance or 'what is being achieved' with regard to this particular control point.

In an on-farm, HACCP-based system, monitoring is the

responsibility of the farmer. Monitoring data is collected on an ongoing basis, capturing performance at specific CCPs over time on the farm. Veterinary input is focused on analysis of on-farm monitoring records, facilitating assessment of performance on the farm over time, rather than subjective assessments made during a one-off visit to the farm. Early data from using this system would suggest that actual on-farm performance can vary considerably from farmer perception of performance. Research into the development of HACCP-based control programmes on farms is increasingly popular. However, implementation of such programmes requires high levels of motivation and genuine buy-in on the part of not only the herd owner, but all farm workers. Paratuberculosis appears to be a particularly emotive disease for dairy farmers in Ireland and herd owners dealing with heavily infected herds tend to be well motivated towards control. HACCP-based control programmes may, therefore, be more applicable to control of this disease than to others. However, the concept exercises the key herd health principle of performance rather than activity-based assessment and aspects of the HACCP concept may be applicable on farms where a full programme is not appropriate.

REFERENCES

1. Noordhuizen J, Metz J. Quality control on dairy farms with emphasis on public health, food safety, animal health and welfare. Livest Prod Sci 2005; 94(1): 51-59
2. Sekiya M, Zintl A, Doherty ML. Bulk milk ELISA and the diagnosis of parasite infections in dairy herds: a review. Ir Vet J 2013; 66(14): 10.1186
3. McAloon CG, Whyte P, More SJ et al. Development of a HACCP-based approach to control paratuberculosis in infected Irish dairy herds. Prev Vet Med 2015; 20(2): 152-161
4. Gardner I. Testing to fulfill HACCP (Hazard Analysis Critical Control Points) requirements: principles and examples. J Dairy Sci 1997; 80(12): 3453-3457