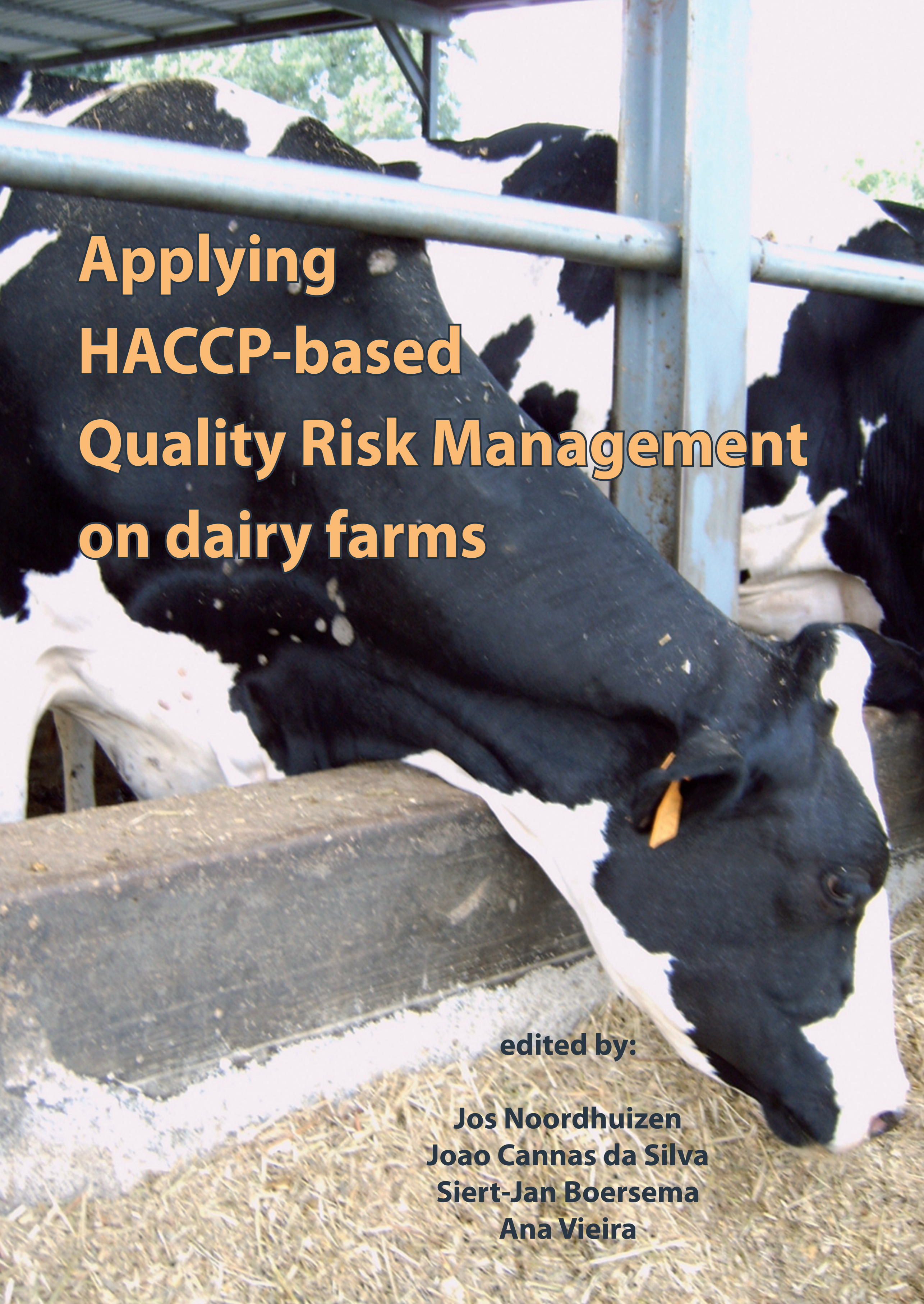


Applying HACCP-based Quality Risk Management on dairy farms

edited by:

Jos Noordhuizen
Joao Cannas da Silva
Siert-Jan Boersema
Ana Vieira

Applying HACCP-based Quality Risk Management on dairy farms

NACQA international

Applying HACCP-based Quality Risk Management on dairy farms

edited by:

Jos Noordhuizen

Joao Cannas da Silva

Siert-Jan Boersema

Ana Vieira

Wageningen Academic
Publishers

ISBN: 978-90-8686-052-4
e-ISBN: 978-90-8686-633-5
DOI: 10.3920/978-90-8686-633-5

First published, 2008

In memory of two outstanding veterinary pioneers and colleagues
Otto Radostits and Jim Jarrett,
whose primary interests were the veterinary profession and the dairy cattle sector

Contents

List of abbreviations

BCS	body condition score (a scoring method)
CCP	critical control point (control means here: mastering)
CMT	California mastitis test (for assessing somatic cell count in milk)
DM	dry matter (as a component of feed analysis)
FC	faeces consistency (a scoring method)
GAP	good agricultural practice
GDF	good dairy farming code of practice
GMA	good medicine application code of practice
GMP	good manufacturing practice
GVP	good veterinary practice
HACCP	hazard analysis critical control points
HFS	herd fertility scheme
HHPM	Herd Health & Production Management programmes
HTAP	herd treatment advisory plan
Lux	an index for light intensity in (animal) houses
NEB	negative energy balance (a physiological or pathophysiological state after calving in high yielding dairy cows)
POPA	point of particular attention (a critical point in the on-farm production process not meeting the formal CCP criteria). Also called "general measure of control" (GMC) or "critical management point"(CMP).
QRM	Quality Risk Management (programme)
RF	rumen fill (a scoring method)
SCC	somatic cell count (commonly in individual cow milk or bulk tank milk)
STEC	see VTEC
SWA	strengths and weaknesses assessment
SWOT	strengths, weaknesses, opportunities, threats (observational field survey on one or more particular farming domains)
TEC	teat end callosity (a scoring method)
TMR	total mixed ration
UHC	udder health control programme
VTEC	verocytotoxin producing *E. coli* (nowadays indicated as STEC: shigella toxin producing *E. coli*)

Preface

The main objective of the editors with this book is to support field veterinarians and other professionals, who are interested in adequately supporting the dairy farmers and herd managers, in their goal to implement a proper Quality Risk Management programme based on the HACCP (hazard analysis critical control points) concept and principles. Several text books dealing with theoretical concepts, principles and methods of HACCP are available elsewhere. The main focus of this book is, on the contrary, the practical situation on the dairy farm and the adoption of the HACCP-like Quality Risk Management programme by the dairy farmer in his (strategic) management for animal health and welfare, and public health and food safety.

The editors emphasise that the implementation of a HACCP-like Quality Risk Management programme is only properly feasible, if the coach-advisor is first appropriately trained and has acquired sufficient knowledge and skills in this domain. He/she should also be aware of the fact that additional skills are required in domains such as: behavioural economics, communication, marketing, management and entrepreneurship, farm economics and Quality Risk Management economics, domains which are addressed in the last chapters. Above all, he/she should have in-depth knowledge about the dairy sector and its developments, as well as about theoretical and – above all – practical zootechnics and veterinary medicine.

With regard to the dairy farmer (and his co-workers) it should be stressed that adoption of Good Manufacturing codes of Practice will facilitate the implementation of the Quality Risk Management programme based on the HACCP-concept. The same is applicable to veterinary Herd Health & Production Management programmes: once these are fully operational on the dairy farm and include good record keeping practices, it becomes much easier to implement a Quality Risk Management programme. In this book will be demonstrated the development of the HACCP-like Quality Risk Management programme for dairy farms through the field case examples that we present in the first series of chapters of this book; other chapters address the example applications of this programme on dairy farms open to the general public and on city farms, as well as on milking goat farms.

This book is a large extension and elaboration to the website www.vacqa-international.com. Some additional information and inventory sheets for determining strong and weak points (hazards and risks) on a dairy farm can be found on this site. Moreover, many different templates and records for an on-farm HACCP-like Quality Risk Management handbook can be downloaded for adjusting them to and applying them in your own particular situation.

The editors wish you fruitful reading and a proper knowledge acquisition, and, thereafter, an adequate and durable implementation of your Quality Risk Management programme based on the HACCP-concept and principles on (dairy) farms.

Jos P. Noordhuizen
Ecole Nationale Vétérinaire de Nantes, Nantes, France
University of Ghent, Merelbeke, Belgium
Ecole Nationale Vétérinaire de Lyon, Marcy l'Etoile, France

Joao Cannas da Silva
VACQA-International, Santarém, Portugal

Siert-Jan Boersema
Utrecht University, Utrecht, The Netherlands

Ana Vieira
VACQA-International, Santarém, Portugal

Chapter 1. Introduction

Quality has become a major driving force in many production enterprises. In the classical context, the quality concept addresses the product only. Quality as a subjective entity comprises both technical and technological characteristics, as well as emotional and ethical aspects. Many definitions of quality can be found in literature, each trying to address quality from one or more of the forenamed points of view. Most important is that a product should fulfil the demands put forward by the consumers and is attractive enough to be bought (Evans and Lindsay, 1996).

In dairy production, milk is a product with a long history of product quality testing, particularly with respect to, for example, cleanness, hygiene, microbiological contamination, somatic cell counts, and antimicrobial residues. Most of the regular quality failures in this area are caused by managerial faults, followed by cow problems (Animal Health Service Netherlands, 1981; Kivaria *et al.*, 2004). This has been the basis for the implementation of udder health control programmes by veterinarians in the 60's (Hassan, 2001; Kingwill *et al.*, 1970; Bramley and Dodd, 1984). These programmes focussed on weaker and stronger points on the dairy farm and their associated management issues in order to design a plan of action comprising elements in the domain of clinical and subclinical mastitis, drying off therapy and teat dipping, milking machine function and milking procedure. Later on, Herd Health & Production Management (HHPM) programmes have been introduced to support farm management in decision-making, to reduce (failure) costs and increase farm income (Brand *et al.*, 1996; De Kruif *et al.*, 2007).

Many things have changed in dairy husbandry over the last decades. Mixed farming has changed into mono-species farming, e.g. dairy cattle alone; changes from smallholder dairy farms to larger farm sizes; from family-run operations up to 150 cows to large dairy enterprises of more than 1000 cows. Labour productivity has increased mainly by a higher level of milking technology (milking machines, rapid exit systems, carrousel systems and milking robots), new feed technologies (total mixed rations; movable feed racks; concentrates dispensers), new technologies in land exploitation (GPS for harvesting and fertilising; wrapped bales; chopped silage systems), input of sires with high genetic merit, improved artificial insemination and embryo transfer procedures and an increase of the number of cows per man and per hectare (Schon *et al.*, 1992; Brand *et al.*, 1996). A consequence of this intensification has been the occurrence of so-called production diseases or management-diseases (mastitis; claw disorders; metabolic disorders; poor weight gain in young stock) and reduced reproductive performance figures at herd level. In different countries, *veterinary herd health and production management advisory services* for the different farming areas have been implemented by bovine practitioners and farmers to better deal with these diseases and disorders (Brand *et al.*, 1996). The herd, that is the population, has hence become the unit of interest, next to the individual animal.

Subsequently, the early detection of disease and, more in particular, of the risks contributing to disease occurrence at the herd level has become much more relevant (investing in disease prevention or health promotion) than diagnosing and treating diseased cows (disease losses) alone. The *farmers' attitude* regarding disease is changing towards more disease risk awareness. Therefore, that same dairy farmer needs support in disease risk identification and risk management for preventing diseases. Here lays an opportunity for the veterinarian with knowledge, skills and experience in risk management regarding animal diseases and total farm management.

During the last decades, the consumer has obtained a large influence on the *production process* on (dairy) farms through the retailers. Consumers, i.e. retailers, currently have a great impact on animal welfare, but also on animal health and food safety issues on farms. This is partly caused by animal disease outbreaks and subsequent disease eradication campaigns such as in the case of swine fever, blue tongue and foot-and-mouth disease during which – sometimes – thousands of animals were killed and of which the pictures travelled around the world. Partly this is caused by a changing attitude of citizens towards animal production ethics including welfare.

Since the year 2000 more emphasis is being put on the relevance of the dairy production methods as being pivotal for quality features like animal health, animal welfare, and public health including food safety. In Europe it has even been suggested through the General Food Law (EC regulation 178-2002) and in the latest Hygiene directives (852/853/854-2004 EC) that consumer protection (food safety) can be better achieved by controlling feed production according to Good Manufacturing Practice, food processing and distribution following HACCP principles, and through the adoption by (dairy) farmers of a HACCP-like (hazards analysis critical control points) programme to control the risks of disorders in animal health and animal welfare, as well as public health. The rationale behind this policy is in the fact that outbreaks of public health disorders, food poisoning and contamination had a great impact on public perception of safety: dioxins, lead-contaminated cattle feed, salmonellosis, cryptosporidiosis, leptospirosis.

The control of risks during the primary production process, e.g. on the dairy farm, will reduce the risks of contamination or infection through raw or processed products further down the dairy chain up to the consumer (Maunsell and Bolton, 2004). The control of foodborne diseases, like VTEC, salmonellosis, campylobacteriosis, and listeriosis should preferably be conducted at farm level. There are three reasons for this statement: (1) reservoirs of agents associated with the named diseases do exist on farms, (2) named diseases rarely result in signs which can be noted at meat inspection, (3) by identifying problem farms, action can be taken to prevent agents from entering the links further down in the food chain (Hancock and Dargatz, 1995; Notermans and Beumer, 2002).

Demands from retailers regarding product quality will further increase. During the last years, residue issues like those related to anti-parasitic products, Aflatoxin M_1, lead (Pb) and cadmium (Cd) have become relevant for retailers with respect to further product quality and food safety improvement.

Controlling forenamed risks should contribute to a reduction of the operational costs, i.e. economic losses, on the dairy farm. Currently, the dairy farm represents the link in the whole food chain which has not a quality assurance programme covering animal health and welfare or public health. The implementation of HACCP-like programmes on dairy farms may well represent the supportive tool dairy farmers are waiting for in order to upgrade their quality driven production methods (Noordhuizen and Welpelo, 1996). Dairy farmers have become more aware of the relevance of complying to quality demands from consumers, irrespective of the labour burden and many unclear issues the new legislation brings along.

Over the past decades, several initiatives have been taken to develop programmes to support the dairy farmer in his decision-making process. Examples are the udder health schemes named above, herd fertility programmes, and the veterinary Herd Health & Production Management (HHPM) programmes (Brand *et al.*, 1996). The latter programmes have proven to be economically successful in reducing overall farm operational costs and improve farm income (Sol *et al.*, 1984). These programmes focus on regular and routine monitoring of animals/herd, the animals' environment and the management, and the on-farm available data in order to evaluate herd and animal performance, and to detect pending problems at an early stage and conduct intervention. Many practising veterinarians, as well as other extension people, have established their position in supporting operational farm management as a farm consultant and advisor (Cannas da Silva *et al.*, 2006). It is very well possible that veterinarians can play a further role in dairy farm management advice through the application of Quality Risk Management programmes.

According to some authors, the HACCP-concept (*hazard analysis critical control points*) is best applicable on dairy farms to control the risks of animal health, animal welfare and public health, as compared to both Good Manufacturing Practice-like codes and the International Standardisation Organisation-9000-system issues (Noordhuizen and Welpelo, 1996; Cullor, 1995, 1997).

The main features of each and their differences leading to this conclusion are shortly presented in Table 1.1.

HACCP with regard to food safety has been defined as ‘a systematic approach to the identification and assessment of the microbiological hazards and risks associated with the manufacturing, distribution and use of a particular foodstuff and the definition of means for their control’ (Mayes, 1992). In the food industry, the HACCP-concept has developed into a universal method for the prevention of microbiological threats (Hudson,1991). HACCP has been included in the Codex Alimentarius in 1989 (Codex Alimentarius committee on food hygiene, 1991).

In 2004, the HACCP concept and principles have been incorporated into ISO-22000 in order to develop a more uniform international norm for food quality assurance in Europe and to create more unity in the use of HACCP-principles by the food producing and processing industry and retailers. The International Standardisation Organisation (ISO) developed a Food Safety Management System (FSMS) and called this ISO 22000. ISO 22000 is a combination of the quality management standard ISO 2001 and

Table 1.1. Short overview of differences between three quality control concepts (GMP, HACCP and ISO are explained in the text).

	GMP codes	HACCP	ISO-9000
Field of interest	Production process	Process + product	System as a whole
Type of approach	Top-down	Bottom-up	Bottom-up
Health status demonstrable?	No	Yes	Yes
Corrective actions specified?	No	Yes	No
Is documentation needed?	Yes, some	Yes	Yes, much
Is it simple to execute?	Yes	Yes	No
Is it highly farm-specific?	No	Yes	?
Is a lot of labour input necessary?	No	No	Yes
Is there a high degree of self-management involved?	No	Yes	-
What is the expected benefits to costs ratio?	Low	High	Moderate
Is there implicit potential to develop into a quality system?	No	Yes	Not applicable
Can it be functionally linked with quality assurance systems?	Poorly	Yes	Yes
Is it in principle fit for certification?	No	Yes	Yes

HACCP as described in the Codex Alimentarius (1991). This new norm is not meant to replace already existing quality assurance programmes and can be implemented in the management of companies in the whole food chain; from primary production towards retailers. As regards its content, ISO 2001 and ISO 22000 are very similar, although ISO 22000 is developed for mainly focussing on the food industry, whereas ISO 2001 was not developed for a specific industry. More than in HACCP, the focus in ISO 22000 is on policy, targets, internal and external communication, and planning. Even though, ISO 22000 is not yet compulsory to be implemented by industries in the food chain. This standard supports the constant improvement of industries' management through following the HACCP-concept and principles, and earlier ISO standards (NEN-EN-ISO, 2005). In this respect, the approach comes close to the earlier presented principles of total quality management, TQM (Schiefer, 1997).

The application of the HACCP-concept to animal health on dairy farms is a logical move because HACCP first of all focuses on microbiological hazards and risks as can be found in public health and animal health. Moreover, it focuses on hazards of a different kind like chemical and physical contamination of products, but also on disorders of another type like welfare disorders.

There are few publications on the application of the HACCP-concept on dairy farms. Examples are Bender (1994) on the more qualitative control of salmonellosis in dairy herds, and Hancock and Dargatz (1995) on the general HACCP implementation issues regarding public health and food safety hazards on farms. Recent publications are: Lievaart *et al.* (2005), Boersema *et al.* (2007), A. Vieira (personal communication).

The HACCP-concept comprises 7 principles and 12 developmental steps in which these principles have been included (Codex Alimentarius, 1991; FDA, 1999; Cullor, 1995, 1997). The 7 principles are particularly oriented towards risk assessment, risk management, specific documentation and verification procedures.

Risk identification and risk management are key issues in the HACCP concept. Therefore, we will first start with a chapter on the determination of strong-and-weak points on a dairy farm in several farming areas (Chapter 2). These strong-and-weak points assessments will lead to an inventory of risk conditions in a particular farming area; examples of such areas are: udder health, claw health, herd fertility, milk production & nutrition, the rearing of young stock. It is therefore paramount that a proper preparation of the veterinarian in the domain of risk identification takes place. For this purpose we handle the strong-and-weak points assessments as can be found on the website of VACQA-International. These assessments can also be dealt with in a stand-alone setting, i.e. without a Herd Health & Production Management programme or without a Quality Risk Management programme.

Secondly, because of the fact that the implementation of a HACCP-based Quality Risk Management programme needs a certain appropriate attitude and mentality towards ' quality', we will then address this attitude and mentality building through the presentation of guidelines and working instructions under the heading of Good Dairy Farming codes of practice in Chapter 3.

The different chapters on risk identification and good dairy farming codes of practice form the core business of the HACCP-like Quality Risk Management programme. The concept, the 7 principles and the 12 developmental steps for the design of a HACCP-like programme, will be elaborated in Chapter 4.

From that chapter onwards, we will detail the design of the HACCP-like programme by addressing the different steps and components in the different chapters and by presenting examples of field cases and HACCP-templates from the handbook to illustrate these design and implementation procedures. The chapters will follow the sequence of the contents of the HACCP handbook.

The elementary approach is as follows:

1. A Quality Risk Management programme based on the HACCP-concept can be best designed and implemented when beforehand the appropriate foundation has been laid. This foundation comprises: (1) a professionally executed veterinary Herd Health & Production Management programme; (2) the development and implementation of Good Dairy Farming codes of practice (guidelines and working instructions); or, preferably, (3) both. In any case, there should be a basic record keeping system available and updated on the farm in order to facilitate performance evaluation and events' assessment.
2. The starting point for the development of a Quality Risk Management programme on the basis of the HACCP-concept is either a complaint from the farmer about the performance of his herd, a deviation in herd performance as detected by the veterinarian in his Herd Health & Production Management programme, or the wish of the dairy farmer to be supported routinely in his quality control activities.
3. In all situations, an assessment of strengths-and-weaknesses (SWA) regarding animals and their environment, and the management is warranted. This SWA provides the basic elements for both operational veterinary Herd Health & Production Management and Quality Risk Management at a more tactical level. For Herd Health & Production Management (HHPM) programmes, it provides clear-cut issues for control and for intervention, for the Quality Risk Management (QRM) it represents the first analysis of hazards and associated risks. These features already show that activities in the areas of Good Dairy Farming (GDF), Herd Health & Production Management (HHPM), and Quality Risk Management (QRM) can and should be integrated as much as possible.

It can be concluded that veterinarians may play a role in these areas, because they are most strategically positioned in the field and have the best basic skills and knowledge to conduct such programmes. In many countries, veterinary Herd Health & Production Management programmes are operational; in other countries veterinarians largely contribute to dairy farm success by designing and implementing Biosecurity Assurance Plans (BAMN, 2000). The veterinary-zootechnical background of the veterinarian must be thorough and of high quality; a thorough training in individual animal medicine largely contributes to his standing (Cannas *et al.*, 2006). In some instances veterinarians contribute to the development of Good Dairy Farming guidelines. But before being able to integrate all forenamed components into an integrated Quality Risk Management programme based on the HACCP-concept and principles, it is required that he adopts and acquires new skills and knowledge before being able to function as a 'quality coach-consultant' on the dairy farm.

Chapter 2. Assessment of strengths and weaknesses

2.1. Introduction

In veterinary Herd Health & Production Management programmes it is common use to make an inventory of the herd performance status at the start of a programme as well as each 6 or 12 months as an evaluation of progress (Brand *et al.*, 1996; De Kruif *et al.*, 2007). The activities comprised under 'inventory' are often called 'monitoring'. Monitoring is an important component of Quality Risk Management programmes following the HACCP concept as well.

Monitoring is '*an act of conducting a planned sequence of observations or measurements of certain control parameters to assess whether a certain point in the production process is under control or functioning correctly*'.

It is highly indicated to conduct also an inventory (i.e. monitoring) regarding the prevailing risk conditions on the dairy farm in animals, their surroundings, the management and the farm records.

Such risk conditions can be found through a strengths-and-weaknesses assessment (SWA) on the farm. A SWA, as presented on the VACQA-International website, is an observational field survey on one or more particular domains of the farm, like udder health, claw health, milk production and nutrition, young stock rearing or herd fertility, with the aim to assemble the stronger and the weaker points regarding animal health, animal welfare, public health, and management. SWA addresses both the animals, their environment, the management and additional areas like veterinary surveillance and records. The choice of SWA depends on the problem area on the dairy farm: in case of mastitis problems, the SWA on udder health is taken; in case of lameness problems the SWA on claw health; in case of disturbed cow comfort or impaired welfare, the SWA for cow comfort & welfare is taken. From a psychological point of view it is highly recommended not only to look for weak points on the farm but also for strong points. The latter can be highly motivating to acquire farmer's cooperation in the follow-up of the SWA regarding advice or interventions. After a period of getting acquainted, different SWA can be handled at the same time to get an overview over the whole farm.

These SWA can contribute greatly to the development of Quality Risk Management programmes because they can easily form part of the hazard identification and risk assessment component, as well as the monitoring component of such HACCP-based programmes (see Chapter 4 and further).

In this chapter we will deal with the procedure to conduct a SWA in the domain of udder health on a dairy farm, as an example. In subsequent chapters the procedure of SWA will return. It should be born in mind that the SWA can also be used for evaluating the advice we have given earlier as well as evaluating the functioning of the HACCP-like programme.

2.2. Strengths-and-weaknesses assessment

A SWA can be conducted by using the scoring sheets which can be found and downloaded at www.vacqa-international.com. Figures 2.1, 2.2 and 2.3 show SWA print screen examples from this website. Figure 2.1 shows the general outline of the website with – at the left side – the contents of the site. Figure 2.2 and 2.3 present more details for scoring strong and weak points in udder health.

If the SWA sheets for a certain area are not available at this website, you may use the ones that are presented there as kinds of *templates* (examples) for developing such new ones for your own purpose.

Once this exercise has been conducted, you can discuss the outcome with other specialists, such as a nutritionist or farm economist, to obtain a second opinion.

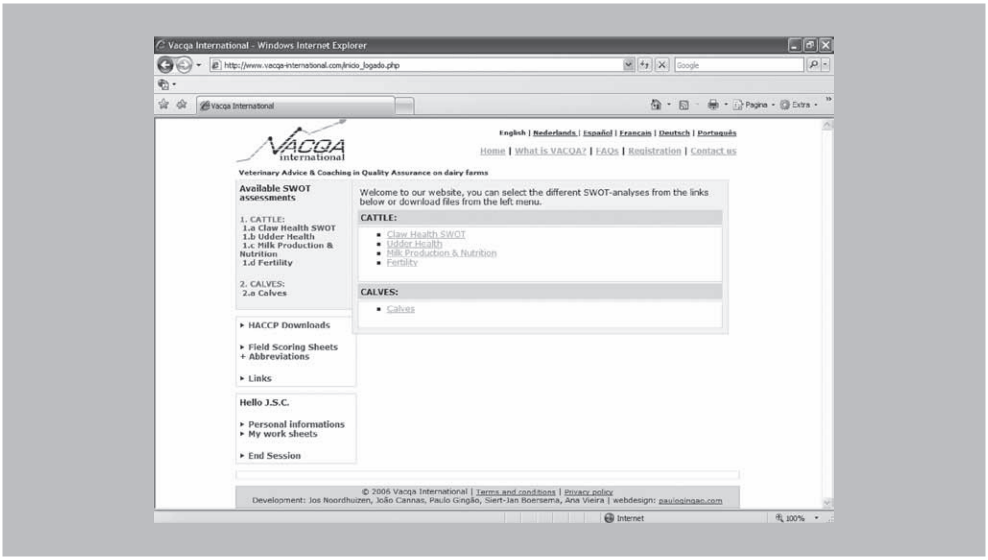


Figure 2.1. General outlines of the VACQA-International.com website (contents of the website on the left hand).

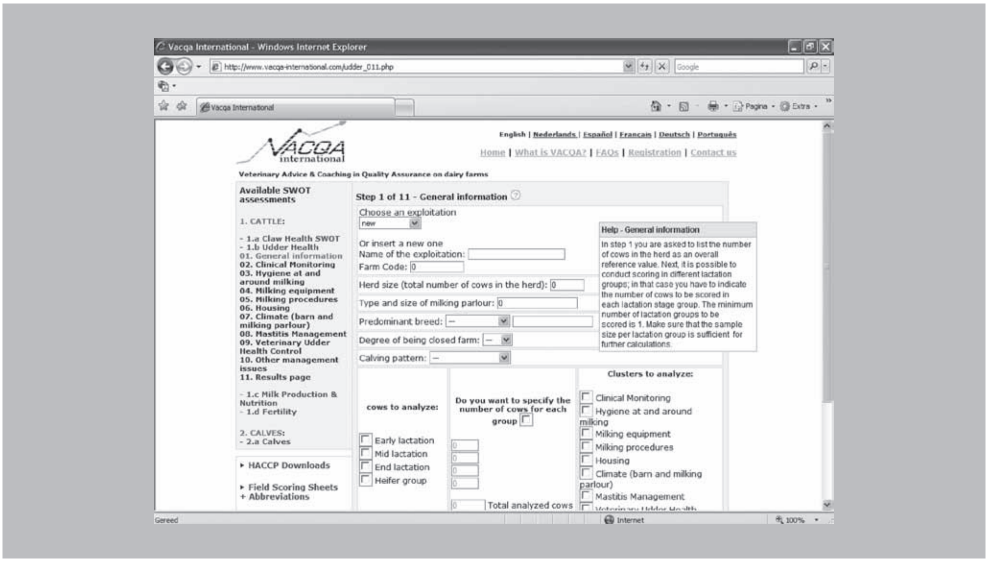


Figure 2.2. Example of a VACQA-International.com website screen, with scoring clusters for udder health (left side), an example of scoring items (middle of screen) and HELP-function (right hand) activated.

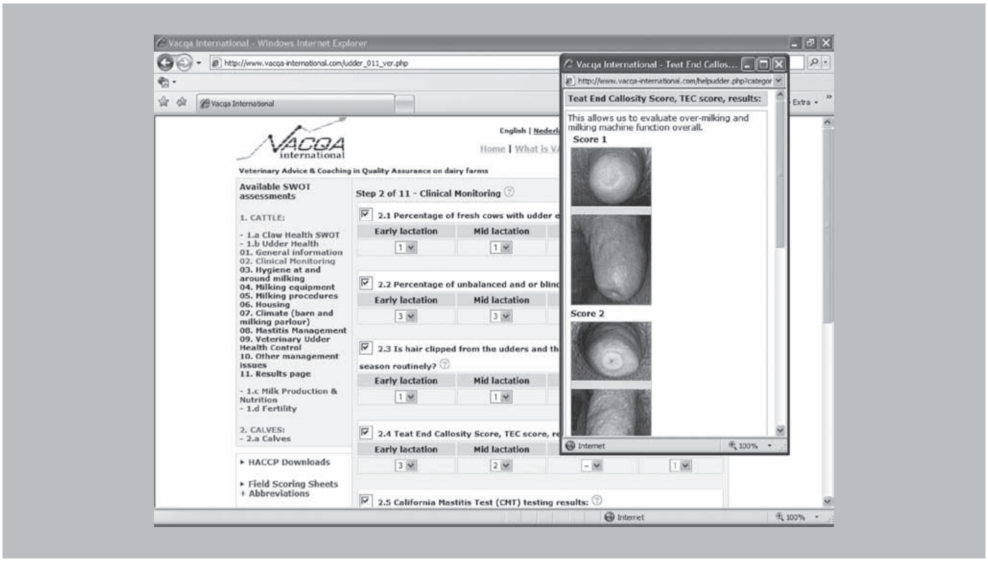


Figure 2.3. Example of a VACQA-International.com website screen for udder health, with scoring clusters (left hand), scoring items (middle) and support sub-screen (right hand) for teat end callosity scoring.

2.2.1. Handling SWA in practice, an example

Let us first see how SWA sheets operate in the field. For that purpose we will use the sheets for the area of udder health as they can be deduced from the forenamed website (Figures 2.1, 2.2 and 2.3).

The VACQA sheets for udder health comprise different categories of risks, so-called clusters. In order to keep a clear overview for the analysis, there were 9 clusters distinguished, comprising, for example, Clinical Monitoring, Hygiene, Housing, Milking Machine. Each cluster comprises between 4 and 14 items which can be scored as 'good', 'moderate' or 'bad'. The items scored as bad can be considered as risk factors contributing to one or more disorders of udder health, or as indicators for management failures. These udder health disorders are for example: udder infections/mastitis; udder contaminations leading to lowered milk quality (chemical; microbiological; physical in nature); teat lesions; specific zoonotic agents in udder or milk.

One can choose between scoring the herd as a whole or a sample of cows from the whole herd, or samples in different lactation stages (dry cows; early lactating cows; cows in mid-lactation; end lactation cows; heifers). For the purpose of illustration we will stick to whole herd scoring in our SWA sheets. Furthermore, one has to choose which clusters to score and which not. This depends on the farm-specific situation. It is possible that, for example, the cluster Veterinary Udder Health Control is not applicable to a farm; then, this cluster is eliminated from scoring. In each cluster one scores the items; it is however not compulsory to score all items. The items to be scored within a cluster also depend from the on-farm situation. In practice, the SWA procedure will always comprise an inspection tour on the farm premises and a discussion with the farmer and or farm workers.

Table 2.1 gives, shortly, the overall combined SWA scoring sheet for udder health scoring on a particular dairy farm. The results of the SWA should be interpreted correctly and integrated into a synthesis in order to be able to draw the proper conclusions. The presumed results from the SWA as addressed in Table 2.1 can be assembled and brought to the conclusions as listed in Table 2.2.

Table 2.1. The SWA for udder health on a particular dairy farm (clusters and scoring items are written in shorthand). (SWA= strengths and weaknesses assessment; G= good; M= moderate; B= bad).

	G	M	B
1. Clinical monitoring			
Fresh cows with udder oedema; metabolic disorders			
Unbalanced udder/quarters			
Hair clipping in wet season done			
Teat end callosity scoring results			
Most recent CMT scores			
Recent bulk tank cell counts			
Recent bulk tank bacteria counts			
Milk refusals by factory per year			
2. Hygiene at/around milking			
Hygiene score in waiting area			
Hygiene/cleanness in milking parlour			
Hygiene/cleanness of milking clusters			
Hygiene/cleanness of cows around milking			
Milkers wearing gloves at milking; personal hygiene			
3. Milking equipment			
Milking machine checks twice yearly			
Milking machine checks when functioning			
Faults of milking machine as reported			
How often are teat cup liners renewed			
How often is pulsator checked/cleaned			
How often is vacuum regulator checked/cleaned			
How many liner slips occur per 100 cows			
Is milk filter checked after each milking			
Is milking machine cleaned/disinfected properly			
Are cleaning products/detergents approved			
Is cleaning water temperature in order			
4. Milking procedures			
How is cow behaviour during milking			
Are mastitic cows milked after the others			
Are low SCC cows milked prior to high SCC cows			
Are teat cups/liners washed after a mastitic cow			
Is CMT, sampling & culturing done for subclinical mastitis			
Is pre- or post-dipping/spraying applied properly			
How is interaction between milker and cows			
Is udder preparation done properly			

Table 2.1. Continued.

	G	M	B
4. Milking procedures (continued)			
Is the prep-lag time of 45 to 90 sec respected			
Is vacuum shut off properly before cluster removal			
Is feed given immediately after milking to keep cows standing			
5. Housing conditions			
How is cow behaviour in waiting area			
Is there water/urine/manure in the waiting area			
How is the barn kept clean and dry			
Are cubicles sizes adequate; proper bedding material			
Are shoulder rails and brisket boards alright			
6. Climatic conditions			
Is light regimen in milking parlour appropriate			
Is ventilation in barn and milking parlour appropriate			
How is the humidity level in the milking parlour			
How is the temperature in the milking parlour			
7. Mastitis management			
Is fore-milking applied for mastitis detection			
Are aseptic measures taken at treatment			
Are mastitis working instructions in place			
Are udder health treatments recorded properly			
Are antimicrobial drugs properly stored			
Are mastitis cows properly identified and separated			
Is a Herd Treatment Advisory Plan operational/upgraded			
Is mastitis milk discarded as waste			
Is mastitis milk properly identified			
Is a mastitis cow CMT checked before milk delivery			
8. Veterinary udder health control			
Farmer participate in udder health scheme			
How often is udder health status analysed			
What is the yearly mastitis incidence			
Are milk samples taken for bacteriological culturing			
Is antibiotic sensitivity testing routinely done			
What is the % of cows with SCC > 200.000/ml			
What is the increase in % cows with SCC > 200.000			
What is the cure rate of clinical mastitis cases			
Does farmer require health certificates for newly purchased cows			
Are biosecurity measures taken for new cows/heifers			

Table 2.1. Continued.

	G	M	B
9. Other managerial issues			
milking time interval studies; ketosis/acidosis; minerals/vits; water quality (chemical; microbiological); CMT for subclinical mastitis; dry off procedure and therapy; production groups; dry cow groups; culling policy; culling rate			

Table 2.2. An example of presumed results from a SWA in 9 clusters for udder health as the area of concern (Note: only the items scored as 'bad' have been listed for illustration purpose).

Area of concern	Item scored as bad
Clinical monitoring	Some unbalanced udders Teat end callosity scores deviant Bulk tank somatic cell counts are regularly peaking
Hygiene	Hygiene score of cows in waiting area is poor Milkers are not wearing gloves at milking
Milking equipment	Cleaning water temperature is too low at start There are some liner slips Some teat cup liners with cracks
Milking procedures	Mastitis cows or high SCC cows not milked last No cluster cleaning between cows Teat dipping done incorrectly Prep-lag time often too short 1 towel for several cows
Housing conditions	Dirty waiting area and exercise areas Cows lay improperly in cubicles Bedding material in cubicles is poor (too little)
Climatic conditions	Ventilation is inappropriate; too much humidity and 'thick' air Milking parlour humidity and temperature are too high at milking
Mastitis management	Fore-milking not done routinely Treatment is not done aseptically No treatment advisory plan present No checks before delivery and no working instructions
Veterinary udder health control	No udder health control programme present Yearly incidence estimated as 30% No samples taken for culturing Info on other items is lacking
Other issues	Selective dry off treatment done

The interpretation of these sheets is as follows:

- First, there is no bacteriological profile available for the herd; hence, all treatments done are for the good or the bad. The clinical mastitis cases are estimated at 30% which is over the herd health target of <25% as is, for example, also handled in veterinary Herd Health & Production Management programmes (Brand *et al.* 1996; De Kruif *et al.*, 2007). The clinical mastitis situation can be considered a hazard in this example.
- There is a certain level of subclinical mastitis, given the somatic cell count rises in the bulk tank milk. There is no udder health control programme in place.
- Moreover, mastitis management is deficient: appropriate measures for curing and preventing mastitis are lacking. Selective dry cow treatment is inappropriate in this situation.
- Secondly, there are a few items which point to poor hygiene and poor management of housing & climate leading to poor cow comfort and possibly stress situations.
- Thirdly, milking machine function and milking procedures show some deficiencies which may well contribute to the occurrence of udder infections.

Then, based on the results of such scoring, the general farm inspection tour and the discussion with the farmer, a first operational *Plan of Action* with items for the short term and items for the longer term can be identified. This operational plan of action firstly deals with operational farm management issues. On the other hand, it can also be used in the context of a Quality Risk Management programme according to the HACCP concept as will be shown in subsequent chapters.

Next the results can be used for further defining the risks related to the hazard of concern (udder health problems in the example of Table 2.1) as well as the weighing of the respective risks. Further information on these principles and procedures can be found in Brand *et al.* (1996).

Which plan of action is exactly chosen depends on many issues: attitude of the farmer, his motivation for change, the communicative skills of the veterinarian, the decision process in the *Team*, the level of herd health targets.

Operational actions for the short term are:

- set practically feasible goals for udder health management on the farm, together with the farmer, for the coming 6 or 12 months;
- start sampling mastitis cow's milk for bacteriological culturing in order to design a proper herd treatment advisory plan, and a proper udder health control plan;
- check whether the pathogens detected at clinical mastitis are the same as those found in subclinical mastitis cases (by using the California Mastitis Test and culturing test-positive animals).

If these actions have been taken, one can proceed to the following actions as parts of the udder health management plan:

- start dry off treating all cows to be dried off, based on the results of the bacteriological culturing;
- adapt the milking procedure as much as possible: fore-milking to detect suspect/infected cows; use one dry towel per cow at preparation; monitor and when needed adapt pre-lag time; clean clusters between cows; conduct teat dipping properly;
- change the teat cup liners because there were some with cracks; check the warm water equipment for temperature standards and replace (parts of) it when needed.

Operational actions for the longer term are:

- talk to the farmer (and milker) about adopting another working practice, comprising hygiene at and around milking; prevention of liner slips;
- speak about adjusting climate control in order to increase ventilation in both the barn and the milking parlour;
- address the quality of the cubicles and bedding material; increase the volume of bedding material and clean up daily; adjust cubicles when needed;
- discuss about increasing hygiene and cleanness of exercise areas and waiting areas by e.g. increasing the frequency of the manure scraper to 6 times daily;
- since teat end callosity scores show deviant proportions, it is advisable to check the milking machine (again) but then under working conditions to see whether deficiencies can be found and which issues need adjustment. Check also the frequency and quality of herd claw trimming.

The short term and longer term actions are not separate issues; they are interrelated. The relevant point here is that short term actions have a higher priority. Moreover, often it will appear that longer term actions can only be taken on the basis of results of the short term actions. Longer term actions often will also take a longer time to accomplish, e.g. for the case of adjusting housing facilities. Finally, commonly farmers can handle only 5 actions, interventions or advises at the time. Therefore, they need coaching for improvement all the way through.

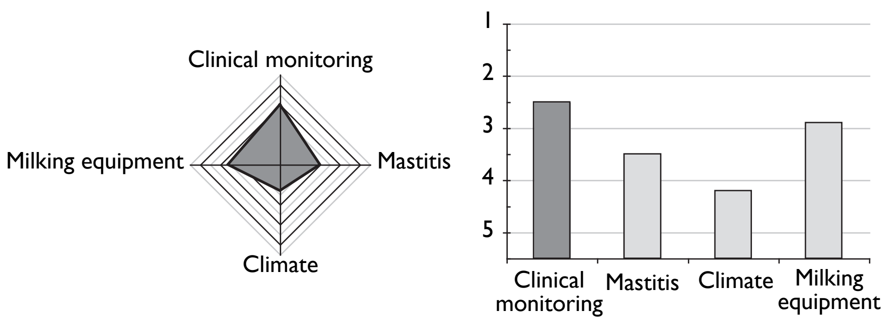
The first sampling round of cows with clinical mastitis showed that, for example, *Staphylococcus aureus* was the predominant micro-organism involved, followed by a few mixed streptococci infections and rare environmental pathogens like coliform bacteria. The *main hazard* for this area of udder health in this simple example, hence, has been established as being *Staphylococcus aureus* udder infections. Of course on most dairy farms there will be several hazards at the same time. For the purpose of simplicity in this chapter, we have retained only one hazard. Further and more complex hazard situations are addressed in following chapters where we present examples of a fictive Farm FX.

It is always possible that the SWA sheets do not show all prevailing risk factors on a farm. In those cases a much more detailed risk analysis has to be carried out. The same is applicable to the question which risk factor is more important than an other. This refers to the procedure of risk weighing, which is addressed in Chapter 6.

The findings from milk sampling and bacteriological culturing trigger for the design of a farm-specific *udder health control programme* and the establishment of a *herd treatment advisory plan* by the veterinarian. These two form the basis for further detailing of the Plan of Action. Execution of a plan of action warrants a coaching role from the veterinarian. Changes in routine management are often not easily adopted nor carried out; hence, one needs to invest time and communication to facilitate changes.

After the installation of the *udder health control plan* and a *herd treatment advisory plan*, it must be kept in mind that an evaluation should be done to investigate the effects of our interventions and advice. Such evaluations should be conducted regularly (every 6 or 12 months), and that is why implementing udder health (or other advisory) programmes is a matter of *coaching* the farmer and guiding him along the pathway to improvement. The forenamed SWA sheets can (at least) also be handled for this purpose of evaluation. Moreover, when the different scoring dates and results have been saved for each SWA, the spider-grams will easily show the progress on e.g. udder health control. Two examples of spider-grams are presented in Figure 2.4 and 2.5.

Early lactation

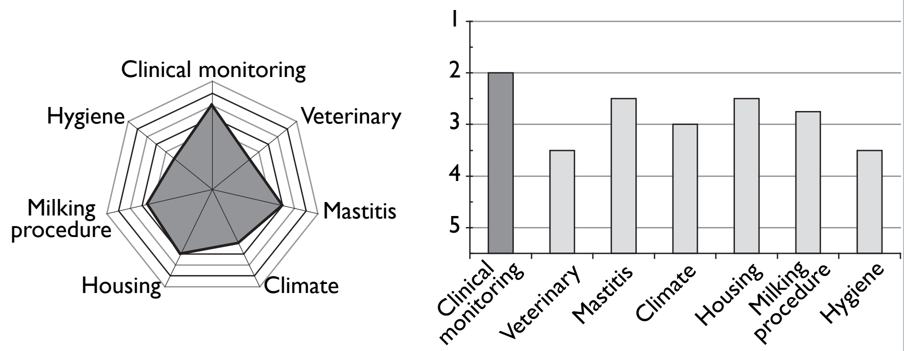


Items of particular attention

Milking equipment

- Were these machine checks conducted when the machine was at work (= ' wet check')?
- Are teat cup liners changed on regular schedule that follows manufacturer's specifications for number of milkings per liter?

Figure 2.4. An example of a graphical representation of SWA-scoring results on a particular dairy farm on date 1 ('spider gram'). Score 1= good; score 3= moderate; score 5=bad.



Items of particular attention

Hygiene at and around milking

- Is contamination of milk from milker's hands prevented by using rubber gloves or by applying high standards for personal hygiene in the milking parlour?: Early lactation

Milking procedures

- Are the clinically infected cows milked after the non-infected cows?: Early lactation

Figure 2.5. An example of a graphical representation of SWA-scoring results on a particular farm on date 2 ('spider gram'). Score 1= good; score 3= moderate; score 5=bad.

As a rule of thumb one has to keep in mind that a Plan of Action has to be regularly adjusted to new situations, for example after the first measures have been taken by the farmer.

2.3. Positioning the strengths-and-weaknesses assessment, SWA

This chapter has been positioned at the beginning of this book on purpose, because (1) SWA can be conducted during curative practice at any time on any dairy farm, (2) SWA is a formal component of Herd Health & Production Management (HHPM) programmes too (Brand *et al.*, 1996; De Kruif *et al.*, 2007), and (3) SWA can be considered as a preparatory stage to the development, introduction and implementation of HACCP-like Quality Risk Management (QRM) programmes on dairy farms. Risk identification is, next to hazard identification, a core component of the QRM programme.

When you would compare the stages as addressed in this chapter with (some of) the steps which will follow in the subsequent chapters on QRM, you will undoubtedly discover many similarities. Therefore, this chapter can be considered as preparatory and introductory to the development of the HACCP-like programme.

Chapter 3. Good dairy farming codes of practice

3.1. Introduction

In industrial enterprises, the implementation of good manufacturing codes of practice (GMP) has become a standard operating procedure. It is a way to clarify to the inside company stakeholders the vision on the company's attitude and mentality, and how the company workers must function, setting guidelines for all kinds of different issues, functions and processes. GMP refers to a certain mentality and attitude of working with the objective to reduce different kinds of mistakes and risks. Hence, they may also help in acquiring the trust of the company's customers.

GMP has become compulsory for animal feed producing companies, under EU rules like the General Food Law (EU regulation 178-2002) and the Hygiene directives (852/853/854-2004), in order to safeguard animals from becoming infected by undesired micro-organisms (e.g. *Salmonella* spp.) or contaminated by unwanted noxae (e.g. lead, aflatoxins) in feedstuffs.

For dairy farmers the development and implementation of good dairy farming codes of practice can be a part of veterinary *Herd Health & Production Management programmes*; they can, furthermore, also be a first step on the way to developing a *Quality Risk Management programme*. In these situations it can be highly worthwhile to invest in such codes of practice to get acquainted with the phenomenon, to experience whether the farm can benefit from using these codes of practice, and to make the farm workers more familiar with the use of such management instruments. In this way the codes of practice can be considered a foundation for Quality Risk Management programmes.

The FAO has issued a set of guidelines under the heading of Good Agricultural Practice, GAP, in order to improve economic, social and environmental sustainability for agriculture (FAO, 2003). GAP offers means to stakeholders involved to reach certain objectives of food security, food quality, production efficiency, and environmental benefits in the medium and long term. GAP may be part of a management strategy for on-farm decision-making and assessing on-farm practices in order to improve output and efficiency. GAP covers a whole range of guidelines. For animal production, health and welfare the Annex to GAP provides indicators to further develop codes of practice (Annex to COAG/2003/6/FAO).

3.2. Good dairy farming codes of practice, GDF

GDF is one component of Good Agricultural Practice (or good farming practice). GDF can be divided into several, further specified codes of practice. These codes will be referred to as '*guidelines*'. In Figure 3.1 some different codes of practice under GDF have been listed.

There are much more guidelines to be developed than those listed in Figure 3.1. Several farming areas can comprise their own guidelines. It will depend on the primary needs on a particular dairy farm whether or not such additional guidelines are needed to be developed. Further down we only show some examples of these guidelines. By using these examples as a template, you can more easily develop the specific guidelines that you need for a particular farm area.

The different codes of practice can be used to develop on-farm guidelines and operational working instructions. Especially in complex management systems, these practical guidelines and working instructions can assist in facilitating management and organisation on the farm. In order to be effective, these guidelines and working instructions should be complied with at any time by farmer and co-workers.

In the subsequent sections, we present the following guidelines and working instructions:
- Hygiene instructions for visitors (guideline), Box 3.1.
- Good housing hygiene of neonatal calves (guideline), Box 3.2.
- Good Medicine Application code of practice (guideline), Box 3.3.

The guideline on Good Housing Hygiene of Neonate Calves, as presented below in Box 3.2 was adapted after Boersema, 2007, unpublished data.

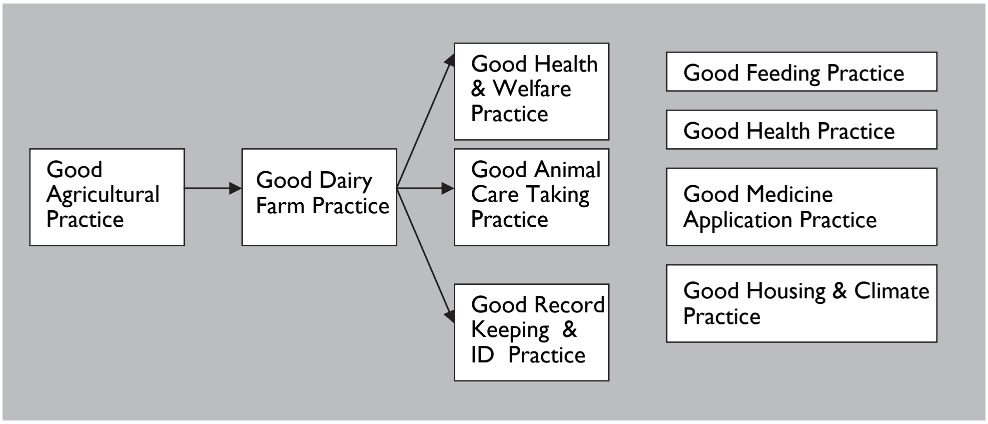


Figure 3.1. Overview of different codes of practice under the heading of Good Agricultural Practice (adapted after FAO, 2003).

Box 3.1. An example of a GDF guideline on a dairy farm: hygiene instructions for visitors.

Hygiene instructions for visitors

Welcome to our dairy farm!
We expect you to strictly follow the instructions on hygiene given below; thank you!

1. Cars and trucks.
   Use the indicated parking areas only (see dairy farm map at P).
2. Do change your boots and clothes in the hygiene barrier (see dairy farm map at HB) before entering our farm. Report your arrival by following the telephone instructions in the HB.
3. If you need to make contact with animals, take along disposable gloves from the stock in the HB. If you need utensils, take them too from the HB. Never use your own!
4. After having entered the farm, the farmer or a co-worker will tell you the working order of the farm and the issues of your concern. At all times, follow the hygiene instructions all the way.
5. Follow the routine working order of the farm as indicated by our co-worker. Use disinfection tubs whenever they are present; change boots/clothes and wash hands when indicated.
6. Do not make any unnecessary contact with our cattle, nor with pets or other animals present.
7. When your farm visit has ended, clean the boots, and put them together with the clothes in the indicated area of the HB. All materials introduced by you on our farm is considered as dirty and risky material, and cannot leave our farm (irrespective whether it was used or not). Wash your hands thoroughly before leaving the farm.
8. Record medicinal products used or delivered in the record system (medicine log) as is indicated in the HB.
9. Register your name and the time of your visit in the visitors log in the HB.
10. Delivered materials should be stored in the right place in the HB as indicated there.

Thank you for your visit to us and for complying to our hygiene rules! You have contributed to our efforts to minimise the risks of introducing pathogens to our dairy farm!

Preferably, guidelines should be designed for 1 page A4 formats in order to retain optimal readability, facilitate rapid and easy reading, and not hampering routine daily operational management too much.

Box 3.2. An example of a GDF guideline on a dairy farm: good housing hygiene for neonate calves.

Good housing hygiene of neonate calves

General hygiene rules:

- Animal care-taker has clean boots and clothes which are used for neonate calf housing only.
- Work with clean hands, or use gloves; wash hands regularly during the day.
- (Teat) buckets, thermometers, measuring devices and mixers are clean and disinfected before each use.
- After each feeding, the teat buckets, thermometers, measuring devices and mixers are cleaned and disinfected again and dried.
- Stomach tube feeders must be clean and disinfected before each use and disinfected between 2 calves.
- Overall feeding order must be from the youngest to the eldest calves.
- Feed the calves at fixed moments of the day; conduct the feeding always in the same way and in the same order by the same person, as much as possible with the same clean outfit.

Golden Rules:

- Remove straw and manure.
- Clear the walls and the floors with water under high pressure.
- Disinfect walls and floors with proper disinfectant (e.g. hypochloric solution).
- Rinse walls and floors with water thoroughly.
- Let it all dry or leave the hutch for at least one week empty.

Housing of neonate calves:

- Neonate calves should at least remain 7 to 10 days in individual hutches of sufficient surface and under optimal climate.
- Bring neonate calves in a clean, individual hutch with clean, dry and thick straw bedding.
- Neonate calves not meant for replacement rearing but for sale should be housed in another house.

In Box 3.3 we present the guidelines for Good Medicine Application for dairy farms; at the end of these guidelines several pictures are provided how to handle medicinal products. This guideline was originally developed in 2005 for Elanco Benelux by a consortium of people from veterinary practice and the Utrecht Faculty of Veterinary Medicine, The Netherlands (Fink-Gremmels, Hellebrekers, Theeuwes, Gruijs & Noordhuizen).

Box 3.3. Guidelines for Good Medicine Application code of practice (GMAP).

The GMAP is an essential component of any Quality Risk Management programme for livestock operations because hazards in the area of food safety and public health are associated with the use of medicinal products. The guidelines provided in GMAP are meant to reduce the hazards and risks associated with the application of medicinal products, and, hence, can be considered as management tools.

The current GMAP guidelines have been developed according to evidence-based medicine. The guidelines comprise 7 paragraphs:

1. storage and keeping of veterinary medicinal products (e.g. cooled or not);
2. probability diagnosis (based on anamnesis, clinical inspection, herd level or individual level, antibiograms);
3. choosing veterinary medicinal products (criteria, species, indication, efficacy, hazards, price);
4. careful application of NSAID's to limit inflammation processes;
5. technical application in detail (techniques, sites, hygiene, safety);
6. evaluation of the use of veterinary medicinal products;
7. using utensils like syringes and needles; waste management.

These 7 paragraphs will be dealt with in more detail here-after.

One should be aware of the fact that starting point for this GMAP is the fact that food animals are meant for human consumption, and that diseased livestock will probably be treated and hence represent a potential hazard for public health and food safety. A proper mentality and attitude regarding diseased food animals is paramount at reducing the risks mentioned.

Moreover one should be aware of the fact that there is an occupational risk too when treating your animals, either when injecting them or preparing water or feed medication. Contact of your skin with antimicrobial drugs or when inhaling medicinal products as powder may jeopardise your health, ultimately causing antimicrobial resistance or allergic reactions. The latter may lead to e.g. bacterial diseases which are no longer easy to treat effectively. Prudent use and precautions are paramount when applying such medicinal products.

In case of doubt, consult your veterinarian and physician!

»

Calamities:

If you injected yourself by accident a medicinal product, you should immediately consult your veterinarian and physician (GP). Make sure that you have the leaflet of that product at hand, as well as the syringe and needle.
If you have inhaled a medicinal product, you should immediately consult your veterinarian and GP. Make sure you have the leaflet of the product at hand.

Telephone number of veterinarian: ....
Telephone number of GP: ....

The above-named warning and the rules in case of calamities should appear on the front page of the on-farm GMA guideline.

The subsequent paragraphs will deal with the different issues of good medicine application on the dairy farm. It must be clear that prior to the field application of medicines, there is a process of purchasing medicinal products by the veterinary practice taking into account issues like pharmacology and pharmacokinetics, proper medical indications, prescription procedures, forma contracts between farmer and veterinarian or veterinary practice, and so on and so forth.

1. Storage of veterinary medicinal products
   - The leaflet of every medicinal product will tell you how you should store that medicinal product, e.g. cooled or not. You should check these prescriptions each time you receive new medicinal products, and act accordingly.
   - Never place medicinal products in direct sunlight or close to heating equipment. Do not place medicinal products in the cold with the risk of freezing. Once frozen, the medicinal products are no longer active.
   - The 'best before date' or preservability is determined by its active substance, nature of its composition, and package material. Obviously there is large variation between medicinal products. Preservability refers to chemical, physical and microbiological features. Again, the leaflet will indicate such things. Do not use medicinal products of which the expiration date has been passed!
   - After the first injection, the injection fluid can only be used for a limited period of time. The date of first injection must be written on the label of the flask. Normally, you will not use antibiotics later than 1 month after the first injection was given.
   - Make sure you have updated leaflets of all medicinal products at the farm, as well as stock records.

»

2. Probability diagnosis
   - Use medicinal products only when you have established that an infectious agent plays a role, and that a possible improving effect can be expected from a medicinal product or anti-parasitic product. A proper anamnesis, as well as a thorough clinical inspection is of utmost importance to arrive at a probability diagnosis.
   - You have to determine whether a herd problem or an individual problem is at hand. Commonly the discrimination level is at 10% diseased animals in a pen or herd. Herd level disorders can be a reason to start water or feed medication.
   - Be sure that at all times the results of laboratory examinations and postmortem are available to your veterinarian. They can be supportive in choosing the proper medicinal products.
   - Antibiograms, disease histories and virus-isolations of the most recent cases can also be supportive in choosing the proper medicinal products.
   - At each case you have to determine whether and if so, when, the veterinarian has to be consulted. A proper *Herd Treatment Advisory Plan* (HTAP) is a good tool to do so. When there is any doubt, you should always consult your veterinarian. See Annex 3B to see an example of a HTAP, a working instruction.
3. Choosing the medicinal product
   - The choice of the right medicinal product is defined by the species and the disease indication. This information can be obtained from the leaflet or the HTAP.
   - When choosing the product, the efficacy and side-effects are weighted too. In some cases, there are prescribed lists of allowed medicinal products for a certain species.
   - The price of a product can play a certain role but can never be a determinant of choice!
   - It is highly recommended that you make your veterinarian develop a *Herd Treatment Advisory Plan* (HTAP) and have it updated together every 3 or 6 months.
   - The hazards for yourself and your co-workers must be taken into consideration when choosing a medicinal product. Inhalation must be avoided at all means (wear mouth piece); skin contact must be prevented (wear gloves); accidental injection must be prevented too.
4. Application of NSAID's
   - NSAID's (non-steroid anti-inflammatory drugs) should also be put on the HTAP by the veterinarian, for example because they support the antimicrobial therapy, but also because they can improve the animal's welfare. Always start with taking the rectal temperature of animals before any treatment.
   - If NSAID's are considered for application, remember that they must be given at the early stages of the disease process, because then they have the highest effect. Generally speaking, main indications for applying NSAID's are disorders with pain (swelling) and fever; for example coliform mastitis with general disease signs.

»

5. Details of applying medicinal products
   - The ways of applying medicinal products are limited: some shall only by given by injection, while others shall only be given through drinking water or feed, or other topical application. Make your veterinarian design a *Herd Treatment Advisory Plan* and update this Plan together every 3 or 6 months. In Annex 3C and 3D examples are given of this type of HTAP. Moreover, the leaflet gives further details on e.g. injection site, route of administration (i.m., s.c., i.v.) and proper methodology to inject.
   - In cases where large volumes of injection fluids are administered, the veterinarian should also indicate on the HTAP how much can be injected at which sites at one time. Alternative injection sites left and right on the body are an option.
   - The HTAP should also comprise information about syringes and needles to use for injections, predominantly to avoid tissue damage.
   - Disposable needles should be collected after being used in a specific 'dump-box' with a small opening; do never throw such needles away in the dustbin!

The following paragraphs contain the different technical protocols (also named *working instructions*) for the different procedures of administering medicinal products.

5.1. Injection fluids
   - First clean your hands thoroughly before handling the medicinal products; put on gloves.
   - Take a clean new needle and the proper syringe, according to the instructions of your veterinarian (HTAP). Durable syringes are an option.
   - Check again whether you have taken the right medicinal product; check the date of first handling as written on the label.
   - Let a little air into the syringe.
   - Put a needle on the flask, the syringe on top of it, and get the fluid into the syringe until the proper dosage has been reached.
   - Eliminate the remaining air from the syringe.
   - Put the protection cap on the syringe immediately.
   - In case you have got some of the product on your hands, wash it off before proceeding.
   - Put the flask back in its storage place.
   - Carry the syringe and needles in a tray; never in your pocket or coat!
   - Determine the right injection site and proper direction of injecting on the animal; if needed, let someone else fixate the animal (your own health and safety are top priorities!).
   - Put the syringe on the animal and carefully empty the syringe.
   - Put syringe and needle in the appropriate dump-box.

»

- Durable syringes and needles must be put in a container marked 'dirty'; this container is emptied at the end of the day, cleaned and disinfected.
- After the administration, dispose of the gloves worn and wash your hands carefully.
- Conduct the recording procedures; respect the withdrawal period.
- Evaluate the effects of the treatments.

5.2. Administration of fluid medicinal products in drinking water or milk

- Check whether you have taken the proper medicinal product.
- Check the date of first handling the product as written on the label.
- Determine the proper dosage in relation to the number of animals to be treated. The veterinarian has documented this in the HTAP and information can also be found in the leaflet: dosage in mg/kg body weight or in mg per feeding per animal.
- Put on gloves and a mouth-mask when opening and handling the fluid, and when defining the right quantity. Any contact of you and the fluid must be avoided! Put the box back in its storage place.
- Mix the medicinal product through the feeding.
- Wash your hands thoroughly afterwards and clean them with a disposable towel or a newly washed towel; put the towel on the wash basket. Any contact with micro-organisms from the animal and yourself must be avoided!
- Conduct the appropriate recording procedure. Respect the withdrawal period.
- Evaluate the effects of the treatments.

5.3. Medicinal products in pellets or powder through drinking water or milk

- Check whether you have taken the right medicinal product.
- Check the date of first handling of the product as written on the label.
- Determine the appropriate dosage in relation to the number of animals to be treated. The veterinarian and the leaflet provide the information on mg/kg body weight or mg per feeding per animal.
- Put on gloves and mouth mask before proceeding. Any contact between you (inhalation) and the powder/pellets must be avoided!
- Open the packaging material, determine the dosage by weighing the powder or pellets, and mix the product in the mixing device.
- When mixing the product, preferably an air-outlet system should be operating in order to eliminate micro-clouds of powder from the air.
- After application, wash your hands thoroughly and dry them with a disposable towel or a newly washed unused towel which then must be put in the washing basket. Any contact between you and the powder, or microorganisms from the animals must be avoided.
- Conduct the appropriate recording procedure and respect the withdrawal period!
- Evaluate the effects of the treatments.

»

6. Evaluation of the treatment effects
   - It is highly indicated to evaluate the effects of treatment regularly because this can provides you with issues to improve medical treatment and even to reduce treatment costs. Conduct such evaluation together with your veterinarian.
   - The number of days between first observed signs of disease and start of the treatment can be parameters; the number of days between start of treatment and recovery is another parameter for dealing with treatment evaluations. It is advised to assign diseases to different clusters, like respiratory disorders, gastro-intestinal disorders, etc. The availability of results from laboratories and postmortems can be very helpful in these evaluations. Discuss with your veterinarian what can be done with the evaluation results.
7. How to handle utensils and equipment
   - Syringes and needles have been addressed above. In this paragraph we emphasise the relevance of properly handling disposables, durable utensils and equipment, and other materials.
   - Revolver-syringes and other durable syringes must be cleaned after being used, and put into boiling water for 10 minutes; durable needles the same. After cooling down these materials must be stored in a clean and closed storage place, or in disinfection solutions as indicated by your veterinarian.
   - Never use crooked or damaged needles; these must be put into the dump-box. If a needle gets crooked during treatment, replace it by a new one.
   - Here-after we present a series of pictures on what is good and what is poor in handling and administering medicinal products by injection and utensils. These are meant as a reminder and to avoid safety problems for yourself and the animals.

Your safety and your health always prevail!!

»

Storage of medicinal products

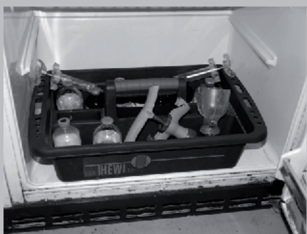

Not like this!


Not like this!


Not like this!


Rather like this!

Transportation of medicinal products on the farm


Carry medicinal products and syringes like this….

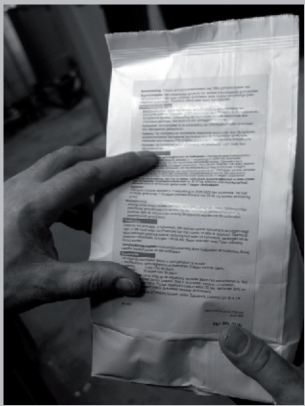

…. or like this!


Not like this, with too many different products, only one syringe, and one open needle!


Do NOT carry syringes with (open) needles in your pocket!

»

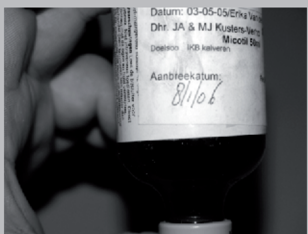
Choosing the appropriate medicinal product (diagnosis; indication; species; route of administration; volume)



Read the product leaflet carefully!

Read the product leaflet carefully for dosage and withdrawal period too! See also your HTAP!

Choosing the appropriate instruments (syringes; needles)



Make sure that you have noted the date of first injection on the label of the bottle with injection fluid.

Let some air in the syringe, take the bottle, inject the needle, inject the air in the syringe into the bottle, take the proper volume out of the bottle, eject the last bit of air, put the protection cap on the needle when you are to transport the syringe.

»

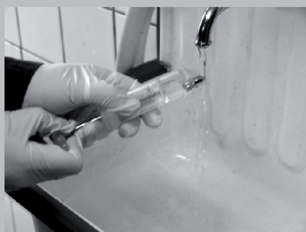
Site and direction of injections

Proper site and direction for injecting

Not like this!

... nor like this!

After the injection(s), dispose of needles properly, clean syringes, wash hands and clean them with a clean towel



Make sure that your recording of the use of medicinal products is done correctly!

3.3. Working Instructions, as part of the GDF guidelines

Working instructions can be developed for specific (problem) farming areas, additional to the guidelines. Working Instructions are management instruments which are one level more specified than guidelines. The latter address more general rules of attitude and mentality, while working instructions represent *technical instruction* notes and are linked to a certain guideline.

These working instructions serve the daily operational management in different domains. Examples of working instructions are: Prevention & Control of Diarrhoea in Neonate Calves; Optimal Heat Detection; Optimal Insemination Strategy; Optimal Use of Foot Baths; Optimal Milk Replacer Feeding; Optimal Handling of Cull Cows; Optimal Handling of Dead Animals; Herd Treatment Advisory Plan. The Herd Treatment Advisory Plan is a working instruction linked to the guideline of Good Medicine Application.

An example of a working instruction is given below (Box 3.4). It regards the working instruction for Cleaning the Hygiene Barrier at the entrance of the farm. This working instruction is related to the guideline on Hygiene Instructions for Visitors, given earlier (Box 3.1). This working instruction format can be used as a checklist at the same time; the responsible person signs it. After a certain month has passed by, the document is stored in the archives of documents (see Chapter 10).

Another working instruction example is the one on Diarrhoea in Neonate Dairy Calves, as listed in Figure 3.2. This example shows a different format than a 'full text instruction' as given earlier. It will depend on the dairy farmer which kind of format he prefers or which he feels is most effective for his particular situation.

A particular working instruction relevant with regard to optimal animal health and welfare, as well as to food safety risks (residues of antimicrobials) is the *Herd Treatment Advisory Plan,* HTAP. This HTAP should be present on all dairy farms, even on those without a Quality Risk Management programme. It must be designed as an integral part of a veterinary Herd Health & Production Management programme. Its main function is to provide the farmer with guidance in the choice of medicinal products for particular veterinary medical indications, while at the same time providing safety for the animal and the user. An example is given in Box 3.5.

The veterinary coach-consultant working in a Herd Health & Production Management programme or a Quality Risk Management programme should deliver this HTAP right at the start of these Herd Health & Production Management or Quality Risk Management activities, and update it at least once every 3 or 6 months.

Box 3.4. An example of a working instruction on a dairy farm: cleaning the hygiene barrier (HB).

Working instruction for cleaning of the hygiene barrier:

	Who is responsible?	
Daily cleaning:	Clean towels available	O
	Clean clothes available	O
	Boots are clean or cleaned	O
	Wash tub to be cleaned thoroughly	O
	Deliveries of medicinal and other products checked	O
	Clean materials are used according to instruction	O
Twice a week cleaning:	Dustbin is emptied, cleaned and dry	O
	Storage of needles and chemicals is emptied and cleaned	O
	The floor is cleaned, disinfected and dried	O
Once a week cleaning:	Check soap and disinfectant containers	O
	Clean walls, windows and doors	O
	Check visitors log on completeness	O
	Check the deliveries log on completeness	O
Once a month:	Clean the refrigerator	O
	Empty the whole HB area, clean, disinfect and dry	O
	Check the expiration date of medicinal/chemical products	O
	Renew the visitors log page	O
	Renew the deliveries log page	O
	If a shower is present and used in the HB, clean/disinfect it	O

In general, a HTAP should contain the following headings or items (see Box 3.5 and Annex 3.B, 3.C, 3.D):

- indications & diagnoses;
- first and second choice medicinal products per indication and per species (group);
- potential hazards, if any, for humans (e.g. prostaglandins; powder antibiotics);
- route of administration (e.g. intramuscularly);
- dosage;
- type of syringe and needle (if not the standard one of the farm);
- conservation & storage rules;
- withdrawal periods for milk and meat; record keeping rules;
- name, address and telephone number of veterinarian.

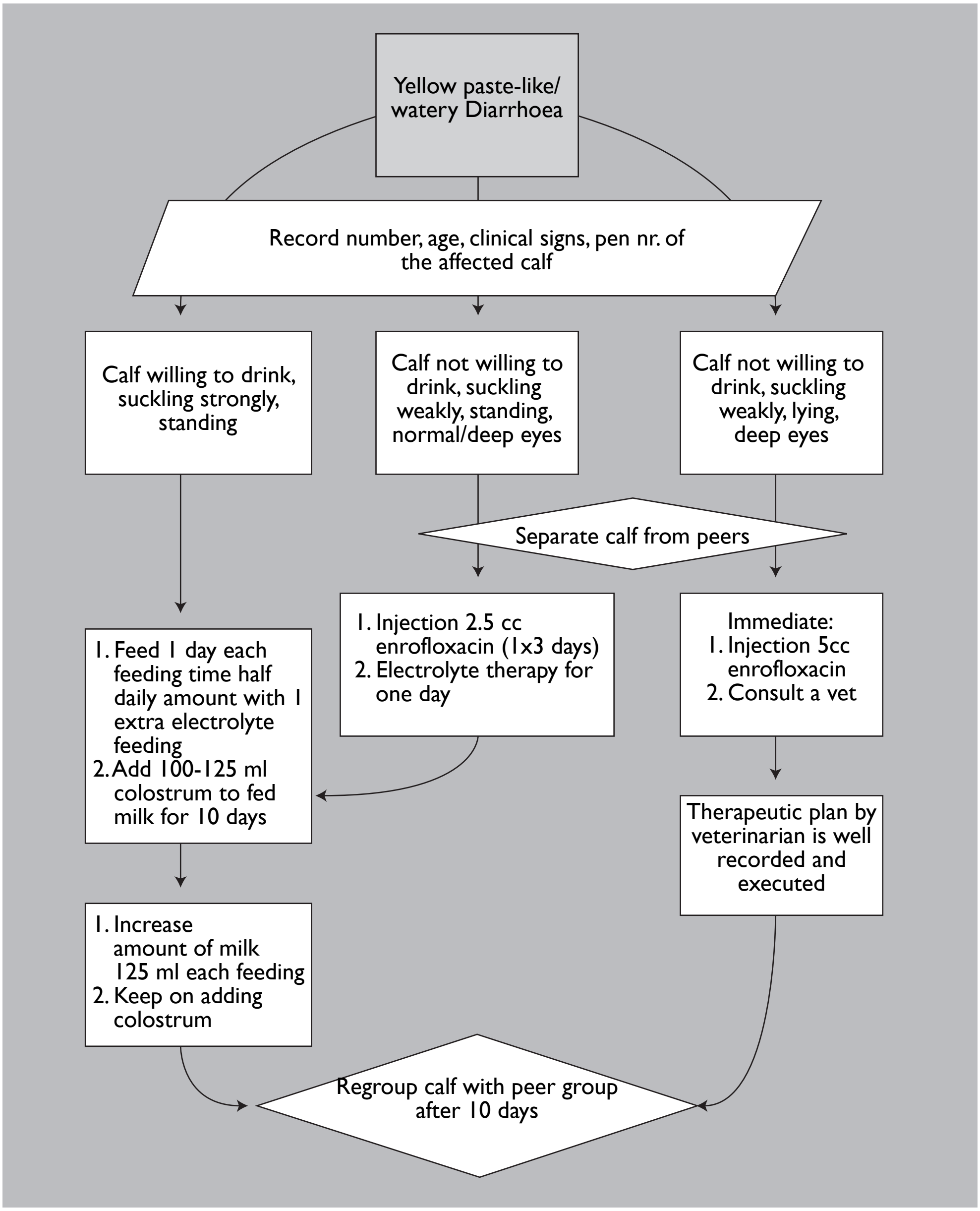


Figure 3.2. An example of a working instruction on a dairy farm: diarrhoea in neonate calves.

It should be clear that this HTAP is closely associated with the guideline of Good Medicine Application practice, presented earlier. In this guideline the farmer or his co-workers can find additional instructions about handling and cleaning utensils and

Box 3.5. An example of a HTAP on a dairy farm.

Herd Treatment Advisory Plan for 'Miscellaneous Disorders'

Farm code:	Veterinarian:
	Practice code:
	Practice telephone:
Last update:	Editor:

Disorder/disease:	Treatment/advice:	Withdrawal period		Remarks:
		Milk	Meat	
Dystocia (with damage to birth canal)	Hydrotherapy 10 min, 4 times/day.			
	Wide spectrum antibiotics A once daily at 5 ml/100 kg for 3 consecutive days; NSAID for 3 days	2 days	10 days	
Retained afterbirth (sick Cow, fever > 39.5°C, feed refusal, milk yield loss)	Call the vet for diagnosis. Separate the cow, give fresh water; check rectal temperature several times a day.			
	Insert capsules with antibiotics C, after cleaning perineum	3 days	8 days	
Retained afterbirth (cow not sick; temp < 39°C; no feed refusal; milk yield OK) .	Check rectal temp 2x/day.			
	If cow is suspect, apply antibiotic B for 3 days. Separate cow	2 days	10 days	

handling medicinal products. An example of a HTAP for 'miscellaneous disorders' is given in Box 3.5.

Such HTAP should further be developed for e.g. mastitis, for disorders in young stock rearing, for infectious diseases, for claw disorders, when such areas represent problem areas.

Other, highly important working instructions regarding animal health on the dairy farm can be found in the *Biosecurity Assurance Plan* (BAP). This BAP addresses the prevention of infectious diseases from entering the dairy farm, and, if present after all, the prevention of the spread of such diseases on the dairy farm premises. The core elements of the BAP are the risk identification, the risk management and the risk communication, followed by working instructions to deal with general risks (e.g. related to hygiene). BAP focuses on infectious diseases only; it comprises a physical management instrument to control the risks of the introduction and the spread of infectious diseases on the farm (BAMN, 2000).

The *Farm Quality Management Team* should first consider the relative relevance of the different infectious diseases in order to establish an order of importance. Then the BAP is designed around the high priority diseases. Such diseases may be viral (foot-and-mouth disease; brucellosis; tuberculosis; bovine virus diarrhoea; bovine herpes virus I causing infectious bovine rhino-tracheitis) or bacterial (salmonellosis; leptospirosis; mycobacteriosis causing Johne's disease; mastitis); they may also be related to animal health & welfare and/or to public health. The high priority diseases refer to those already prevalent on the farm and to those which the farmer desires to keep out of his farm, because of their economic impact or other reasons. This leaves aside the formal control and prevention procedures regarding highly contagious diseases like foot-and-mouth disease, although even for those diseases the farmer can take additional biosecurity measures to keep such diseases away from his premises (e.g. by stopping purchasing cattle, by installing hygiene rules for visitors, etc.).

Next, the *Team* must determine the most important domains of *exposure* to these pathogens. Such domains are commonly associated with:

- new entries into the herd (cattle; embryos; semen);
- feedstuffs (roughages; concentrates; by-products);
- drinking water (microbiological contamination);
- animal contacts (different age groups; different herds/farms; purchased cattle);
- wildlife contacts;
- rodents and pets;
- vehicles;
- people.

Next to exposure, the *Team* has to answer questions about *pathogen transmission* on the farm. These questions are related to the high priority diseases as determined earlier. Examples of transmission routes, pathogen shedding and survival in the environment are presented in Table 3.1 (adapted after BAMN, 2000).

In the third place, it is advisable to draw a farm map with all buildings, facilities and pasture plots, as well as a geographical map with the natural barriers and borders which may contribute in the prevention and reduction of infectious diseases. Such maps will assist in clarifying to the farm-workers where hazards and risks occur, and what options are feasible to avoid or reduce such risks.

Table 3.1. An example of various characteristics of transmission, incubation, shedding and survival for different cattle pathogens (adapted after BAMN, 2000).

	Example diseases				
Transmission routes	Staph aureus mastitis	Paratuberculosis Johne's disease	Bovine virus diarrhoea	Salmonellosis	Cryptosporidiosis
Faecal - oral		yes	yes	yes	yes
Nasal secretions, saliva	?		yes	yes	
Milk	yes	yes	yes	yes	
In utero		yes	yes	yes	
Sexual			yes		
Incubation period	days/months	years	5 to 10 years	1 to 4 years	days
Duration of clinical signs	days/years	weeks/ months	2 weeks	1 to 7 years	days-weeks
Duration of shedding	days/years	month/years	10 to 14 days	weeks/years	days
Survival in environment	?	months/years	< 14 days	months	1 year
Growth in environment	yes?	no	no	yes	

Fourth, the *Team* should conduct the risk analysis for determining and weighing the risk factors associated to the high priority diseases defined earlier. This exercise will result in risk conditions which are general in nature and risk conditions which are more disease-specific.

The general risk conditions can be converted into guidelines or working instructions for a certain domain. One general issue regarding infectious diseases is to limit the movements of animals of all ages on the dairy farm and limiting the contacts of animals with people, vehicles and vectors. In the context of biosecurity, all animal groups (different young stock age groups, dry cows, lactating cows) must be considered as separate management units; all contacts between these groups must be avoided!

It can furthermore be indicated to survey the movement lines of people, animals, feedstuffs, vehicles to find out where the '*hottest spots of crossings*' are on the farm. Those hot spots represent the areas where transmission of pathogens can more easily occur than in other places, for example through manure on boots, clothes, vehicles.

Many general risks can already be controlled by simple measures like purchasing semen or embryos from sources with good health reputation and or certificates; or purchasing feedstuffs from feed-mills applying good manufacturing practice to control e.g. salmonellosis; or buying cattle from herds with certain animal health certificates.

The fifth and final step in the designing of a BAP is the set-up of the BAP itself, taking into account the results of the preceding 4 steps, hence, the maps, the high priority diseases and their associated risk conditions, the exposure areas, the pathogen characteristics of transmission, shedding and survival. These issues will re-appear in the *working instructions*. There need to be working instructions for Hygiene of People Visiting the farm; Hygiene & Disinfection Schemes for Vehicles entering/leaving the farm; Handling of Purchased Cattle; Handling of Cull Cattle; Handling of Dead Cattle; etc. Specific risk conditions may require specific instructions; for example in the case of salmonellosis or mycotoxicosis in order to protect the people working on the farm from becoming infected or contaminated.

The different steps to be taken in designing a BAP are short-listed in Table 3.2.

Table 3.2. Short overview of the 5 steps in designing a biosecurity assurance plan.

Step 1	Inventory of hazards (infectious diseases) of the highest concern by Farm Quality Management Team
Step 2	Inventory of exposure assessment and transmission issues, related to results of step 1
Step 3	Drawing a dairy farm map and a geographical map of the dairy farm in its surroundings
Step 4	Conduct a risk analysis as associated with the selected hazards of concern; 'hot spots' inventory
Step 5	Formulate the biosecurity assurance plan on paper; design the necessary working instructions

3.4. Concluding remarks

Good Dairy Farming guidelines and working instructions, as well as biosecurity assurance plans are *management instruments*. They put together the update and relevant knowledge about the hazards and their associated risks regarding infectious diseases that have been prioritised on a specific dairy farm.

In some instances they may look redundant; but we should not forget that a dairy farmer has to handle hundreds of (part)-processes and functions during decision-making on his farm every day. Some will slip away, others will lack consistent attention. An instrument focussing his attention on particular problem areas will assist him in taking the proper measures and observe the relevant issues. This is even more relevant for dairy farms with more than one farm worker; on some farms the personnel situation may be quite complex and then it is paramount that every co-worker approaches a certain farming field in the same way as others. In the latter case it is a component of farm organisation.

During the process of assessing strong and weak points on a dairy farm (Chapter 2), the interpretation of the results and the design of an action plan, there will come a moment that –as part of that action plan- we need to develop and implement guidelines and working instructions for particular problem areas. These guidelines and working instructions assist in facilitating operational management on the dairy farm. The same applies for biosecurity assurance plans.

When – as a next phase – a dairy farmer desires to develop and install a Quality Risk Management programme, based on the HACCP concept and principles, it will be much more easy to convince the people working on the farm to comply to the rules set by such a programme, when these people have got used to the rules and instructions as issued by GDF guidelines. In other words, adoption is much quicker. Therefore, the development and implementation of GDF guidelines is often considered a founding phase prior to HACCP introduction. The proper attitude and mentality have then been built. This is the main reason why we have positioned this chapter after the monitoring of strengths and weaknesses on the dairy farm (Chapter 2), and before introducing the concept and principles of HACCP (Chapter 4).

Finally, you will find hereafter two elaborated examples of working instructions for a particular dairy farm FX with two problem areas: one in udder health & milk quality (Box 3.6); one in young stock rearing (Box 3.7). Dairy farm FX will be addressed in the subsequent chapters to illustrate the design and application of a HACCP-based Quality Risk Management programme.

Box 3.6. Working instruction for dairy farm FX with a problem in udder health and milk quality (adapted from Bray and Shearer, 1994).

Farm FX: Working instruction on 'Cleaning the milking machine'

Company:
Responsible person:
Aim of this working instruction:

Date of last revision:
Editor:

Daily
- Wash the outside of milk line, receiver jar and trap, and milking claws and hoses.

Every two weeks or 1200 milkings
- Replace teat cup liners.

Monthly
- Remove pulsators and clean them.
- Replace filters and/or clean vacuum controllers.
- Wash trap inside and out.

Every 6 months
- Monthly cleaning as usual.
- Replace all pulsators rubber parts.
- Replace all pulsators hoses, air tubes.
- Replace receiver jar gasket.
- Replace all milk hoses.
- Replace rubber hoses and rubber hose nozzles used to wash udder (rubber hoses harbour bacteria).
- Flush pulsator and vacuum lines.
- Check tension and quality of belts on vacuum pumps.

Yearly
- Do monthly and 6-monthly cleaning as usual.
- Replace all wash line hoses.
- Replace trap gasket.
- Replace wash manifold cups.
- Replace belts on vacuum pump.

Box 3.7. Working instruction for dairy farm FX with a problem in young stock rearing.

Farm FX: Working instruction on 'Colostrum feeding'

Company: Date of last revision:
Responsible person(s): Editor:
Aim of this working instruction:

Collection & storage of colostrum:

- Collect a minimum of 5.5 L within 2 hours after calving/birth aseptically.
- Feed the colostrum immediately after collection and freeze the remaining.
- Store the colostrum in a clean bucket in a cool dark place.
- If stored for more than 24 hrs colostrum must be frozen in volumes of 2 L at -21 °C for a maximum of 1 year.
- When freezing, put date of collection and cow identification on plastic bag.
- Prevent dirt, flies, animals from contaminating colostrum.
- Never add water or mastitic milk to colostrum.
- Check cow timely before calving for paratuberculosis; when positive, take actions according to Work Instruction 'paratuberculosis' (Johne's disease).

Colostrum feeding

- Never feed mastitic or antibiotic or blood containing milk to neonate calves.
- Measure colostrum quality (IgG) by colostrometer.
- Colostrum temperature must be > 23 °C.
- If too little colostrum is available from dam, use colostrum from other dams of high parity or from deepfreezer.
- Feed colostrum with a clean disinfected teat bucket.
- Do not leave the calf with the dam for more than 4-5 hrs.
- If calf does not drink voluntarily, use a clean stomach tube to feed colostrum.
- Calves must be fed a minimum of 100 gr IgG (2 L) immediately after birth and another 100 gr IgG (2 L) within 12 hrs after birth.
- Following colostrum feedings of 1.5 L at 6-8 hrs intervals.
- Feed colostrum for at least 3 days of life.
- Calf IgG levels can be checked with a refractometer on site (2-5 days of age).
- When thawing colostrum from freezer, do it 'au bain Marie', and not by microwave nor heating > 50 °C because of IgG breakdown.
- At feeding, colostrum temperature must be at 39 °C ± 2 °C.

Other colostrum management issues

- Keep record of calf when it receives colostrum from another dam.
- Apply the highest hygiene standards in the calving pen.
- Apply the highest hygiene standards in the single calf hutches.
- Provide optimal calf comfort in the single hutches (bedding; climate; feeding).
- Apply the highest personal hygiene standards (clean boots; clothes; hands).
- Clean all equipment after each feeding.

Annex 3A. Guidelines and working instructions on hygiene

A dairy farm produces 'raw materials' for food processing: milk and beef. The cleaning and maintenance of areas where such raw materials are being produced (cow houses; waiting area; milking parlour) and being stored (bulk milk tank) must, therefore, meet with the highest hygiene standards.

In this section we address the different elements which are relevant for cleaning and disinfection in order to achieve high hygiene levels. Most important are the working instructions and checklist for hygiene. They should contribute to a better awareness about hygiene among farm workers and improve compliance. Remember that the presented working instructions and checklists must be adapted to each specific farm.

About the procedure for cleaning & disinfection

In the procedure of cleaning there are 6steps to be followed:

- pre-treatment in order to eliminate loose dirt;
- cleaning to loosen dirt by applying certain products;
- rinsing to eliminate loosened dirt and neutralise cleaning product residues;
- disinfection to destroy bacteria that survived preceding cleaning steps;
- rinsing to eliminate residues of disinfectants;
- drying to eliminate the last rinsing water.

These 6 steps are integrated into *3 different working methods*, depending on the areas where more or less contact does exist with the raw material (milk) being produced. These 3 are:

- Cleaning and drying
  For areas where no direct contact exists between surfaces to be cleaned and milk.
- Cleaning, rinsing and drying
  For areas, materials and equipment where or on-which contact of residues of cleaning products with milk must be avoided.
- Cleaning, rinsing, disinfection, rinsing and drying
  For surfaces of equipment and materials which are in direct contact with milk being produced and which are not subjected to heat-treatment.

Hygiene rules to be followed

Next to applying one or more of the three methods named above, the farm workers responsible for executing hygiene measures should follow themselves some strict rules. These rules form part of *Good Dairy Farming* codes of practice. Examples are:

- instructions developed and applied must be strictly followed;

- personal hygiene of people involved is a prerequisite (hands; nails; clothes; boots);
- equipment that can be taken apart should be regularly subjected to cleaning & disinfection methods (e.g. milking machine);
- in cases of purchase or in situations of reconstruction, the surveillance of hygienically working remains paramount;
- in cases of replacing certain parts the mounting instructions must be followed strictly;
- the working instructions on hygiene must be executed and complied with….
  - at the right moment;
  - at the proper frequency;
  - by using adequate dosage of products;
  - while using clean materials and equipment;
  - without neglecting rinsing after the cleaning & disinfection steps.

Checkpoints in the cleaning & disinfection procedure

In order to provide the farmer with the certainty that the effects of cleaning & disinfection procedures are being achieved, it is worthwhile to insert a few checkpoints in the whole procedure. These checkpoints too form part of the *Good Dairy Farming* codes of practice.

Examples of checkpoints are:

- *timing of the cleaning & disinfection* → should not be conducted during moments that the milk is being produced (= not during milk harvesting);
- *proper dosage of cleaning/disinfection products* → a too low dosage will negatively impact the effect; a too high dosage is too expensive and environmentally unfriendly;
- *use of clean working materials* → to prevent re-contamination;
- *duration of the different steps* → disinfection should at least take 5 min to be effective;
- *rinsing after disinfection of surfaces in contact with milk* → to avoid contamination of milk by product residues;
- *separation of dirty and clean parts of equipment, materials and surfaces* → to avoid recontamination and insufficient cleaning;
- *temperature of refrigerator, of milking machine rinsing water and bulk milk tank* → checking at each milking to avoid deviations and milk losses;
- *storage places of chemical products* → not too close to the bulk milk tank;
- *checking expiration date of cleaning & disinfection products regularly* → to avoid loss of efficacy.

Other issues of concern
To be sure that products meant for hygienic purposes which are delivered to the farm are in good order, they must be checked upon delivery. Checkpoints in this case are:
- expiration date;
- damaged packing material;
- correctness of packaging label;
- recording in the 'Chemicals Log' and the bill put in the archive;
- if cool storage is needed, check on this;
- delivered products must never be stored directly on the floor.

Annex 3B. Herd Treatment Advisory Plan (HTAP) for young stock up to 4 months age

A working instruction

Farm code:

Veterinarian:
Practice address:
Telephone number:
Date of update:

Disorder/ Disease	Treatment/Advice	Withdrawal period milk	Withdrawal period beef	Follow-up
Diarrhoea	Replace all milk by electrolytes for the next 48 hours	NA	NA	If no improvement after 48 hrs or if case worsens, call vet for advice
Pneumonia: calf severely ill	Call the vet	NA	NA	
Pneumonia: calf slightly ill	Antibiotics P intra-muscularly (IM) 1x/day for 5 consecutive days (dosage xxx)	NA	NA	If no improvement after 48 hrs or case worsens, call the vet
Omphalitis	Antibiotics D IM 1x/day for at least 10days (dosage yyy)	NA	NA	If no improvement after 48 hrs, or case worsens, call the vet

Another example of a HTAP. The xxx and yyy refer to a dosage of the antibiotics which needs to be specified in mg/kg body weight or ml/kg body weight.

Annex 3C. Herd Treatment Advisory Plan (HTAP) for clinical mastitis cases

A working instruction

Farm code:

Veterinarian:
Practice:
Telephone number:
Date of update:

Disease type	Treatment / Advice	Withdrawal period milk	Withdrawal period beef	Follow-up
Acute severe mastitis	Take milk sample			If no improvement after 3 days or worsening, call the veterinarian
	Milk frequently			
	Antibiotic L IM 2x/day for 2 days (xx)	60 hrs	16 days	
	Injector A in udder 1x/day	48 hrs	7 days	
Subacute mild mastitis	Take milk sample			If no improvement after 3 days or worsening, then call the veterinarian
	Antibiotic L IM; 1st day double dosage,2nd day single dosage (xx)	72 hrs	10 days	
	Injector S in udder 1x/day for 3 days	72 hrs	12 days	
	Milk frequently during the day			
Mastitis in dry period	Take milk sample			If no improvement after 3 days or worsening, then call the veterinarian
	Antibiotic L IM; 1st days double dosage; 2nd day single dosage (xx)	72 hrs	10 days	
	Injector A in udder 2x/day for 3 days	48 hrs	7 days	

Another example of a HTAP. The xx refer to the dosage in mg/kg or ml/kg body weight to be specified in the HTAP (IM= intramuscularly).

Annex 3D. Herd Treatment Advisory Plan (HTAP) for claw and leg lesions

Disorder	Treatment / Advice	Withdrawal period milk	Withdrawal period beef	Follow-up
Peri-arthritis	Antibiotic N 1 ml/20 kg IM for 3 days	2 days	5 days	If no improvement, call the vet
Peri-arthritis + Arthritis				Call the vet, prognosis poor
Mortellaro disease or Digital dermatitis	CTC spray locally 2-3 times after each milking after cleaning and drying claws; Locally hoof gel; Antibiotic C IM 2 ml/50 kg for 3-5 days	0 1 day	0 5 days	When endemic situation, design a full programme separately
Interdigital dermatitis	CTC spray locally after cleaning and drying claw Formalin footbath 3-4% every 4 weeks for 3 days	0 0	0 0	Design a separate programme when prevalence is high (> 30%) Check calves!
Interdigital Phlegmon (footrot)	OTC 10% IM 1 ml/25 kg for 3 days Antibiotic E 1 ml/50 kg subcutaneously (SC) for 3 days	3 days 0	28 days 8 days	Check calves too!
Sole ulcer	Corrective claw trimming + hoof block under healthy claw	0	0	
Laminitis (haemorrhages)	Functional trimming	0	0	Design separate programme when prevalence is high (> 20%) Check calves!

Another example of a HTAP. (IM= intramuscularly).

Chapter 4. The HACCP-concept, the 7 principles and 12 steps (general issues)

4.1. Introduction

The HACCP-concept has originally been developed in the food industry to control food safety and the risks of food-borne diseases in the USA NASA space programme (Pierson, 1995). Originally, the Pillsbury Company started with the development of the concept in 1959 and evaluated and subsequently adopted in this primary HACCP-concept the US Army concept of 'Modes of Failures'. The latter was being used to both predict what could go wrong and select key points in the process for monitoring (as preliminary stages of critical control points in HACCP). In 1971 the principles of HACCP and their application were first published and presented at the US Conference on Food Protection (Pierson, 1995). The history and a conceptual overview have been presented by Hulebak and Schlűsser (2002).

The starting point for the development of a Quality Risk Management programme on the basis of the HACCP-concept is either a complaint from the farmer about the performance of his herd, a deviation in herd performance as detected by the veterinarian during his Herd Health & Production Management programme visits, or the wish of the dairy farmer to be supported routinely in his quality control activities. An assessment of the strengths-and-weaknesses (SWA) on a dairy farm with regard to the animals and their environment, and the management (Chapter 2) is a primary step toward the development of a HACCP-like programme for dairy farms. For developing Quality Risk Management (QRM) programmes, it represents the first analysis of hazards and associated risks (see further).

In dairy production, contrary to industrial branches, we speak about HACCP-*like* applications because our 'raw material' regards living animals, cows and calves. These cows show biological variation, which can be illustrated by sero-prevalence data of a certain infectious disease in the herd. It is only by arbitrary decision that we handle cut-off points to call a proportion of the herd 'sero-positive' and another proportion 'sero-negative'. At the same time we know that false-positive and false-negative test results occur simply because our diagnostic tests will hardly ever show 100% sensitivity and 100% specificity at the same time (Noordhuizen *et al.*, 2001). This is a phenomenon of continuous dynamics, different from diagnosing physical entities like temperature or metal fragments present or not. In the latter situations, we can set absolute target values and a certain tolerance level to consider an item positive or negative; it is the difference between black-white and grey zones on the one hand, and black-and-white only on the other hand. This will have consequences for the design and application of the HACCP-concept to the dairy farm as we soon will see.

At the start of designing a HACCP-like programme for a dairy farm on request of the farmer or the owner, it is highly indicated to form a '*Farm Quality Management Team*' (this is the Step 1 from the implementation procedure). This *Team* commonly comprises the dairy farmer (or on large dairy enterprises the farm manager or maybe even a special farm quality manager), the veterinary practitioner and an independent animal nutritionist. When needed, the *Team* can always be expanded with other specialists but should never exceed the number of 7 persons to keep discussions manageable. The type of specialist will also depend of the type of hazard(s) under hands (e.g. zoonoses, highly contagious diseases, welfare disorders). If more professional advice would be needed, these persons can be consulted on a specific basis and moment in time. *Team* members should be well aware of the fact that both the design and the implementation of the HACCP-like programme must be conducted in terms of discussion, coaching, and advice. One cannot just leave the farmer with a bundle of work sheets or action plans. In many cases farm workers need additional and continuous training on-site before programme implementation can be carried out; coaching of the farm-workers and the farm-technicians by the veterinarian is paramount. Discussion and subsequent adoption is highly relevant, and farm advisors should invest in this issue. When farm workers understand the meaning of their actions, they tend to be more involved and interested in the work they carry out (A. Vieira, personal communication).

When deemed appropriate, the *Team* also answers the question about the *destiny of the product* delivered: is raw milk delivered to the dairy factory for processing into milk for consumption, or is it meant for cheese-making (raw milk cheese or cheese from pasteurised milk), or is it for extracting certain proteins for medical use? These three examples may have an impact on the hazards and risks to be dealt with (see at paragraph 2.2 in Chapter 2). On the other hand, farmers do sometimes not have any idea what happens to the milk they deliver, which phenomenon can be considered as a breakdown in the whole food chain.

It should always be kept in mind that a HACCP-like programme is farm-specific, because no farm is the same, management qualities differ, and husbandry conditions differ. However, for the design of such a programme we can still use the same basic blue prints.

Once the *Team* has been assembled, the general objectives of the farm and farmer are to be defined. At the same time it is to be established what the major demands of the customer (e.g. the milk processing factory, or the consumer of farm-made products) are. Thereafter, a time-table with defined development activities and deadlines needs to be established. In this time-table, first, the main hazards are to be identified.

Next step is the execution of a Strengths-and-Weaknesses assessment (SWA) to obtain the first major constraints and risks prevailing on the farm; this step, preparatory to the identification of risks, was addressed in Chapter 2. Then, the *Team* conducts a risk assessment given the hazards of concern. The next step is designing flow diagrams of the dairy farm operation and the geographical map of the farm in its surroundings (Chapter 5). These elements will be dealt with in subsequent chapters.

4.2. The 7 principles of the HACCP-concept

In Table 4.1, the seven principles of the HACCP-concept have been listed. It is paramount to stick as close as possible to these principles because they form the skeleton of the HACCP-like programme and these represent the linking with the other links in the food chain. Each of the principles will be elaborated into more detail in subsequent chapters when we start implementing the 12 steps for the design of our HACCP-like programme on a dairy farm. The seven principles are fully integrated into these twelve steps.

Table 4.1. The seven principles of the HACCP-concept (adapted after Cullor, 1995).

Principle 1	Identify the most relevant hazards and risks associated with the production process in all its stages until delivery, and analyse them. Hazards may be microbiological, chemical, physical or managerial in nature. Assess the likelihood of occurrence and impact of the risks, and identify preventive measures for control.
Principle 2	Determine the points/procedures/steps in the process that can be controlled to eliminate the hazards/risks or reduce their impact (critical control points, CCP; points of particular attention, POPA)
Principle 3	Establish target levels, or standards + tolerance levels which must be met to ensure that the CCP or POPA is under control
Principle 4	Establish a monitoring system to ensure a proper control of the CCP's and POPA's by scheduled testing and / or observations.
Principle 5	Establish corrective actions to be taken when monitoring indicates that a CCP or POPA is out of control; these actions must restore control
Principle 6	Establish procedures for verification which includes supplementary testing and procedures to confirm that the HACCP-programme is functioning effectively
Principle 7	Establish documentation concerning all procedures and records appropriate to these principles and their application

In Table 4.1 you can read the terms '*hazards and risks*' (Principle 1). These hazards and risks refer to the different diseases and disorders that we want to handle. Hazards are agents or noxae which may be microbiological, chemical, physical or managerial in nature, and which may cause a certain risk which is deemed unacceptable to animals, professionals, consumers or products. Risk refers to the probability of occurrence of a certain hazard and to the impact this occurrence may have. Hazards are different between countries, regions and farms because the prevalence of diseases differs largely between farms; risk conditions also differ largely between farms because husbandry methods and farm management qualities differ substantially. Therefore we need a farm-specific HACCP-like programme.

Examples of microbiological hazards and risks are zoonoses threatening public health: *Salmonella* spp., *Mycobacterium tuberculosis*, *Brucella abortus bang*, *Listeria monocytogenes*, Johne's disease, *Campylobacter* spp., *Leptospira hardjo*, and *E. coli* $O_{157} H_7$. But also mastitis and other bacterial, or viral and parasitological diseases (e.g. *Cryptosporidium parvum*) are involved (Hassan, 2001; Goodger *et al*., 1996; Tesh and O'Brien, 1991; Chauvin, 1994; Sanaa, 1994; Thorel, 1994; Heuvelink *et al*., 1998; Nydam *et al*., 2005; Oliver *et al*., 2005; Jayarao and Henning, 2001; ICMSF, 1988).

Examples of chemical hazards and risks are: residues of antimicrobial drugs, contamination of milk by milking machine cleaning detergents, mycotoxines, oil leaking on grass or corn from tractors used for silage-making (Niza-Ribeiro, 2003).

Examples of physical hazards/risks are poorly maintained equipment and their parts in the housing facility of cows leading to trauma. A poorly maintained slatted floor with too many unequal or broken slats or iron pins in the feed rack are a threat to cattle health and welfare.

Examples of managerial hazards and risks are poor identification of animals, poor colostrum management, poor feed harvesting, personal health status of people may sometimes represent a risk, and poor record keeping.

Risk factors can be general in nature (for example poor hygiene in the milking parlour) or very disease-specific (improper milking cluster washing greatly contributes to *Staphylococcus aureus* mastitis). They can be assessed in a qualitative sense, semi-quantitative or calculated through epidemiological techniques yielding odds ratios; subsequently the risk factors can be ranked in order of relevance (Table 4.2; Noordhuizen *et al*., 2001).

Table 4.2. Overview of risk factors for Mortellaro disease in dairy cows and their odds ratios, adapted after Frankena et al.*, 1992 in Noordhuizen* et al.*, 2001 (OR >1 means increased risk; OR <1 means reduced risk; OR= 1 means no association. HF= Holstein Frisian; FH= Dutch Frisian; MRY= Meuse Rhine IJssel).*

Variable	Specification	Odds ratio, OR
Parity of the cows	1	1.3
	2	1.1
	3	1.0 (reference)
Predominant breed of the cows in the herd	> 50% HF	1.2
	> 50% FH	1.02
	> 50% MRY	0.1
	HF * FH crossbreed	1.0 (reference)
Lactation stage	Dry	0.3
	Pre-top	0.8
	Top (50-70 days)	1.7
	Past-top	1.0 (reference)
Access to pasture	Limited	1.5
	Free	1.0 (reference)
Average walking distance to the pasture plots	> 200 m	5.4
	< 200 m	1.0 (reference)
Walking path quality	Metalled	2.6
	Non-metalled	1.0 (reference)

An example of semi-quantitative risk assessment is by using expert opinions on given subjects like particular diseases. A commercially available software programme using *adaptive conjoint analysis* can be used for ranking risk factors in order of importance (Sawtooth Software, USA, 2000; van Schaik *et al.*, 1998; Fels-Klerx *et al.*, 2000; Angus et al, 2005). Adaptive conjoint analysis has also succesfully been applied to the domain of cattle welfare (J.J. Lievaart, personal communication). Some further elaboration and clarification of adaptive conjoint analysis applications are given in Annex 4A at the end of this Chapter.

The qualitative assessment of risk factors should be conducted by the *Farm Quality Management Team* whenever the other methods are not available.

Series of different SWA sheets (strengths; weaknesses) for several farming areas can be downloaded from www.vacqa-international.com. These SWA sheets are simple and easy instruments to score the stronger and the weaker points on the dairy farm.

Moreover, they have been provided with instruction pictures and reference values. Examples have been given in Chapter 2. The hazards and risks are further addressed in Chapter 6.

In Principle 2 we speak about *critical control points*, *CCP*. These are points at different steps in the production process where risks should be controlled. CCP's can be single points in the process, series of points, observations, procedures or test sites. Formally speaking a CCP can only be considered as such when it meets several formal criteria. These criteria are:

- the CCP must be associated with the hazard or risk under study;
- it must be measurable or observable;
- it must have a target value or a standard with tolerance levels;
- it must be provided with corrective measures;
- corrective measures must guarantee the full restore of control after it was lost.

Obviously, when dealing with live animals, cows, the last criterion is very hard to meet. We have explained the phenomenon of biological variation in paragraph 4.1 of this chapter. Therefore, we introduce another term: '*point of particular attention*, *POPA*'. A POPA can be considered as a CCP not meeting all the criteria described before, hence full restoration of control cannot be achieved, in other words the risk can not be fully eliminated. At a POPA we strive for reduction of the impact of a risk. Note in this context that a zero-risk level does not exist in the real world. POPA's are distributed in the production process on the dairy farm just like CCP's. Failures in prevention programmes (e.g. biosecurity) and failures to reduce contamination to an acceptable level would also lead to a loss of control at a POPA or CCP (Griffin *et al.*, 1998; Bricher, 2004).

The named biological variation in animals is also the reason why absolute *standards and their tolerance values* sometimes are not available in dairy husbandry regarding issues like animal health, public health, and cattle welfare (Principle 3). In those cases when we deem the issue sufficiently relevant, we have to rely on *target values*, for example the target for clinical mastitis for a given year on a particular farm is set at 25%, a POPA. There is no guarantee that we can indeed reach that target, in spite of an udder health control programme or other activities. An example of a standard and tolerance is the initial temperature of the rinsing water used for cleaning the milking machine after milking: the standard is set at 80 °C; the tolerance is set at + or -2 °C. This can be considered as a true CCP.

On each individual farm, we assemble all CCP and POPA into an *on-farm monitoring system* (Principle 4). In that monitoring system we have defined what must be monitored, how it must be monitored (e.g. visual inspection, measuring, sampling for laboratory examination), in which frequency it must be monitored and by whom it must be monitored. A specific document of monitoring is necessary (see Chapters 7 and 10). When laboratory examinations form part of the programme, then this is a component of the monitoring system too. An example is the collection of milk samples from mastitis cases and their subsequent bacteriological culturing in order to obtain a bacteriological profile regarding udder health disorders. Another example is the routinely collection of blood samples in order to get information about the threat of fasciolasis in the herd. Or, the collection of colostrum samples for testing colostrum quality (IgG levels).

Under Principle 5 the corrective actions are defined and described for each CCP and most preferably for each POPA. In the example of the CCP regarding the temperature of the rinsing water for cleaning the milking machine after milking, the corrective actions in case of drops below the standard temperature are either to reset the water boiler on the right temperature, or to replace the old boiler with a new one. It is thinkable that an alarm device is installed to check this temperature automatically. In the example of udder health disorders, the corrective action may be the implementation or adaptation of an udder health control programme by the veterinarian, including *working instructions* like a *herd treatment advisory plan*, or a hygiene instruction for the milker(s).

Principles 6 and 7 are dealing with the evaluation of the functioning of the HACCP-like programme on a farm and the documentation that is needed to demonstrate to third parties that it is functioning effectively and correctly. The evaluation is first of all an internal evaluation, for example once yearly by the *Farm Quality Management Team*; next it should comprise an external validation by a certified auditing institution. The latter step is a matter of future development, but crucial for proper certification of the dairy farm regarding public health status, animal health status and animal welfare status.

These seven principles are fully integrated into the 12 developmental steps for designing an on-farm Quality Risk Management programme according to the HACCP-concept.

4.3. The 12 steps for designing a HACCP-like programme

Table 4.3 (adapted after Cullor, 1995), comprises the 12 steps as defined for the design of a HACCP-like programme for Quality Risk Management. Some issues have already been addressed in earlier paragraphs, some others are new.

Table 4.3. Overview of the 12 steps to design a farm-specific Quality Risk Management programme based on the HACCP-concept (the principles refer to the ones named in Table 4.2).

Step 1	Assemble a multidisciplinary, facility-based *Farm Quality Control Team*, including the farmer, the veterinarian, the nutritionist and economist; it can *ad-hoc* be extended with other specialists when deemed necessary
Step 2	Describe the final product, and the method of distribution if applicable (e.g. formulation; processing requirements)
Step 3	Identify the intended use of the (raw) product and the targeted purchaser (e.g. the milk factory)
Step 4	Develop a flow diagram which describes the production and distribution process. Work from whole farm level to the detailing of separate steps up to the detailing within steps
Step 5	Verify the flow diagram on-site on its correctness with the Team members and the farm workers; adjust when needed
Step 6	Prepare a list of steps in the production process at which targeted risks occur. Identify the hazards and prioritise them; identify the risks; conduct risk weighing (probability * impact) [Principle 1]
Step 7	Identify the critical control points, CCP, in the production process required to eliminate or to reduce the hazards and risks. Identify when needed the points of particular attention, POPA [Principle 2]
Step 8	Establish critical limits (tolerances) and standards, or specific targets for triggering the implementation of corrective and preventive measures associated with each CCP and POPA identified at step 7 [Principle 3]
Step 9	Establish an on-farm monitoring programme and its requirements regarding each CCP and POPA (laboratory examinations included). Use the results of monitoring to adjust the procedures and maintain control of the production process. Use monitoring also for herd performance assessment [Principle 4]
Step 10	Determine corrective measures, to take when monitoring results indicates that a value falls outside its target or tolerance level and hence control is lost [Principle 5]
Step 11	Establish effective record-keeping procedures that document that the HACCP-like programme has been implemented, is operational and effective [Principle 6]
Step 12	Establish procedures to verify that the HACCP-like programme is working correctly (e.g. internal reviews yearly; external verification and audits; periodic revalidation of the programme) [Principle 7]

Step 1 regarded the formation of a *Farm Quality Management Team*; in step 2 the farming goals and final product(s) as delivered by the farm are described; and step 3 regards the destiny of and requirements set for these products delivered by the dairy farm. First new items (step 4 and 5) refer to the development and verification of *flow diagrams* of the on-farm production process, including all the different steps and their interactions. In full text such a diagram is called the production process decomposition diagram. It is the basis for discussions in the *Farm Quality Management Team* and it assists in visualising to its members as well as to farm workers the different subsequent steps. This flow diagram is handled extensively in Chapter 5. The other steps 6-12, including the 7 Principles of HACCP, are dealt with in subsequent chapters. This Table 4.3 will be referred to in the subsequent chapters when we elaborate each subject in detail.

The axiom for designing a Quality Risk Management programme on dairy farms based on the HACCP-concept is the following: if a HACCP-like programme is to be adopted by the dairy farmer, it has to fulfil two basic requirements.

1. it should provide an individual farmer with clear procedures for the elimination or reduction of hazards and risks related to different kinds of disorders or mismanagement on the farm in the areas of public health, animal health, and animal welfare; and
2. it should make the execution of these procedures demonstrable to third parties, like authorities, consumer organisations and retailers, with regard to the certification of the public health, and animal health and welfare status, as well as to the measures taken to improve or retain that status.

Only if we bear this axiom in mind during all developmental stages of the programme, we will be successful.

When we put all results from the developmental stages together in a loose page classifier, we may call this the *Handbook of the HACCP-like Quality Risk Management programme*. Each page must be uniquely identified by a code referring to the area of concern, a date of last upgrade, author and a page number. The contents of such a handbook may look as presented in Table 4.4.

Table 4.4. A short overview of the contents of a handbook of a HACCP-like programme for Quality Risk Management on dairy farms.

Section 1	Identification of the farm (name, address, telephone numbers) List of farm co-workers with telephone numbers List of farm advisors (name, address, telephone numbers) List of people to call in case of emergency (doctor, veterinarian, city hall, feed mill, nutritionist) List comprising the members of the Farm Quality Control Team (names, addresses, telephone number) Statement paper expressing the mission of the farm and the product(s) to be delivered for a specific destiny Declarations of those professionals who are serving the farm operation, stating they will comply to the rules set within the programme Contracts as prevailing between farmer and milk processing factory, or veterinarian Animal Health certificates (e.g. IBR, BVD, leptospirosis, salmonellosis, Johne's disease) issued by the proper authorities
Section 2	SWA inventory on the farm (strong points; weak points) as preparatory for the analysis of hazards and risk conditions, but also functional for the design of work instructions
Section 3	Good Dairy Farming codes of practice or guidelines (e.g. good veterinary practice; good hygiene practice; good medicine application practice); also including work instructions and biosecurity assurance plans (Note that this section may very well be part of on-going herd health programmes!)
Section 4	Production process diagrams in different levels of detailing Geographical maps indicating the position of the farm and is land
Section 5	Selected hazards and risks lists. Defined CCP and POPA in the different process steps Target, and standards + tolerances list for each CCP and POPA Detailed lists of the monitoring procedures Lists with corrective measures to restore control or reduce the impact of a hazard or risk Lists with preventive measures The records comprised in the HACCP-like programme
Section 6	Support programmes with work instructions for operational management (e.g. dress & boot code; handling of hazardous materials; handling of waste materials; maintenance of vehicles and equipment; calibration of measuring devices; reparation of total mixed rations; harvesting & silage-making instructions)
Section 7	Training programmes in the framework of the Quality Risk Management programme (these are meant for farm workers)

Table 4.4. Continued.

Section 8	Internal review (effectiveness, feasibility, compliance) and External auditing procedures (correct functioning of the programme) and associated documents like checklists, or evaluation papers After an annual review, sections or items within sections have to be upgraded or adjusted; old pages have to be deleted and new ones added All programme documents should be stored for 2 years

4.4. Concluding remarks

In industrial branches which are applying the HACCP concept and principles, it is common use to develop and implement quantitative quality performance evaluation parameters. These parameters are usually physical in nature. Many examples of such quantitative parameters and related graphs are given in Evans and Lindsay (1996).

In the dairy sector such quantitative parameters are not abundantly available, not in the least because, next to physical parameters, most parameters are biological in nature, all with their natural, biological variation. Examples of measured variables in the dairy sector are: somatic cell counts and bacterial counts in bulk tank milk, kgs of milk produced per cow per day or lactation with milk fat and milk protein contents, temperature of milking machine cleaning water; these can be considered as 'hard' variables. On the contrary, parameters like mean yearly clinical mastitis rate, yearly lameness incidence, animal welfare status, mean sero-titer level in the herd for a given viral disease can be considered 'soft' data. In HHPM programmes, performance evaluation is conducted on the basis of these latter parameters, accepting a certain bias in data collection.

Nevertheless, attempts have been made to develop and introduce quantitative process performance evaluation parameters for certain farm areas. An example is the paper by Niza-Ribeiro *et al.* (2004) on *process capability indexes* for somatic cell counts in dairy herds. However, information as addressed in these papers is very scarce in literature, and the available information is far from being applied in the dairy sector.

In the current situation it should be accepted that, due to a lack of sufficient scientific data, process evaluation parameters like process capability indexes are not available in the dairy sector for common use. Therefore, we are forced now to rely on what we have available and can make available for our purposes. On the other hand, it would be desirable that research is undertaken to develop such quantitative parameters.

Annex 4A. An elaboration and clarification of adaptive conjoint analysis (ACA) applications

In Table 4A.1 the attributes (periods in an animal's life) and levels (hazards occurring in a period) of an example of the semi-quantitative ACA-assessment is shown. The aim of this computerised questionnaire is to find out in four series of different kinds of questions what the main hazards in the eyes of the farmer or veterinarian are. Examples of the different kinds of questions are displayed below: rating questions (Figure 4A.1), importance questions (Figure 4A.2), pairs questions (Figure 4A.3) and calibration questions (Figure 4A.4). At the end of the questionnaire, the ranking of answers can be calculated. Answers are statistically evaluated for consistency in answering. These components are derived from an internal report by Boersema (2006).

Table 4A.1. Attributes (respective rearing periods are in darker shade) and levels (lighter shade) used in an ACA survey on young stock rearing. In each rearing period, significant hazards are identified, where-after associated risk factors need to be determined.

Period I: Colostrum period until transition to milk
Birth problems & stillbirth
Diarrhoea in newborn calf
Aberrant umbilical cord
Insufficient feed intake
Pneumonia caused by choke
Johne's Disease infection
Wrong identification
Malformations at birth
Calf gets hurt (f.e. dung remover, pen etc.)
Period II: Milk period until weaning
Diarrhoea in older calf
Wrong teat removal
Overcrowding
Aberrant umbilical cord
Poorly growing calves
Couching
Johne's Disease infection
Pain during / after dehorning

Table 4A.1. Continued.

Period III: Weaning until insemination
Older calf not pregnant before 15 mo old
Lameness
Lungworm
Worm infection / suddenly losing weight
Fasciola hepatica infection
Trichophyton verrucosum infection
Fattening
Johne's Disease infection
Diarrhoea after weaning
Transfer of diseases from neighbouring cattle
Period IV: Pregnancy period until 4 weeks before calving
Abortion
Poorly growing pregnant heifers
Lameness
Lungworm
Worm infection / suddenly losing weight
Mastitis
Trichophyton verrucosum infection
Fasciola hepatica infection
Overcrowding
Fattening
Period V: Four weeks before calving until calving
Heifer has difficulties with calving
Mastitis
Abomasal displacement
Milk fever in heifers
Lameness
Fasciola hepatica infection
Lungworm
Udder oedema
Overcrowding
Feed intake deviations
Worm infection / suddenly losing weight

Table 4A.1. Continued.

Period VI: Heifer in first lactation
Long-lasting milk fever
Mastitis
Lameness
Abomasal displacement
Feed intake deviations
Udder oedema
Heifers with wrong udders / teats
Fasciola hepatica infection
Worm infection
Lungworm infection
Retained placenta

Please rate the following Period I: Colostrum periods in terms of how important they are.							
	Not ___ important		Somewhat ___ important		Very ___ important		Extremely important
Birth problems & stillbirth (I)	○	○	○	○	○	○	○
Diarrhoea in newborn calf (I)	○	○	○	○	○	○	○
Aberrant umbilical cord (I)	○	○	○	○	○	○	○
Insufficient feed intake (I)	○	○	○	○	○	○	○
Pneumonia caused by choke (I)	○	○	○	○	○	○	○
Johne's Disease infection (I)	○	○	○	○	○	○	○
Malformations at birth (I)	○	○	○	○	○	○	○
Calf gets hurt (f.e. alley scraper, pen, etc) (I)	○	○	○	○	○	○	○

Figure 4A.1. An example of 'rating' questions.

Under the same circumstances, how important would the difference be to you?

	Not ___ important	Somewhat ___ important	Very ___ important	Extremely important
Birth problems & stillbirth (I) ---instead of--- Calf gets hurt (f.e. alley scraper, pen, etc) (I)				

Figure 4A.2. An example of 'importance' questions.

If all circumstances were the same, which would be the most hazardous pair for you?

Wrong teat removal (II) Birth problems & stillbirth (I)	or	Overcrowding (II) Insufficient feed intake (I)

Strongly prefer left	___	Somewhat prefer left	___	Indifferent	___	Somewhat prefer right	___	Strongly prefer right

Figure 4A.3. An example of 'paired' questions.

Please type a number between 0 and 100 where 0 means 'not threatening for animal health & welfare' and 100 means 'definitely threatening'

How likely will the displayed hazards be threatening?

Calf gets hurt (f.e. alley scraper, pen, etc) (I)

Pain during/ after dehorning (II)

Figure 4A.4. An example of 'calibration' questions.

Chapter 5. Flow diagrams of the production process

5.1. Introduction

Step 4 in the developmental process for designing a HACCP-like programme for Quality Risk Management comprises the drawing of *flow diagrams* of the production process on the dairy farm (*production process decomposition diagrams*). Flow diagrams are structured and schematic representations of the production process on a particular dairy farm in all its relevant steps. They should be created on-site with the farmer and the farm-workers. All process steps should preferably fit on one page A_4 or A_3, or when desired on one readable computer screen in order to keep the overview and readability. They are meant to:

1. form the basis for the programme development by identifying and structuring the different steps in the production process;
2. facilitate discussions within the *Farm Quality Management Team* about hazards and risks, the CCP and POPA and their monitoring, as a communication tool;
3. assess the movements of animals, people and equipment, and their mutual contact points as related to transfer of infectious agents, as well as the destiny of the milk delivered;
4. design working instructions for particular areas;
5. show third parties the exact location of farm buildings, pasture plots, roads, fences, cow/calf groups.

The flow diagrams are best followed by *location maps* and a *geographical map of the farm and its surroundings* including the position of the land, and natural barriers like channels, rivers, ditches or mountains, and possibly villages and other activities. Besides the supportive information for on-site workers, these maps are also useful for external professionals who are to do a job on the farm, e.g. a contractor (FAO, 1997; CAC, 1999; Quinn, 2001; T. Mota, unpublished data, 2003).

5.2. Principles and procedure for designing flow diagrams

The basic blue print of a general flow diagram of a dairy farm is presented in Figure 5.1. This general picture can serve the further detailing – when needed – and specification for each individual farm, because the HACCP-concept requires a farm-specific approach.

In general we distinguish 2 types of flow diagrams:

1. The general farm flow diagrams (examples in Figures 5.1 and 5.2).
2. The detailed, more specific flow diagrams, commonly associated with the hazard of concern and the related process step (examples in Figures 5.3 and 5.4).

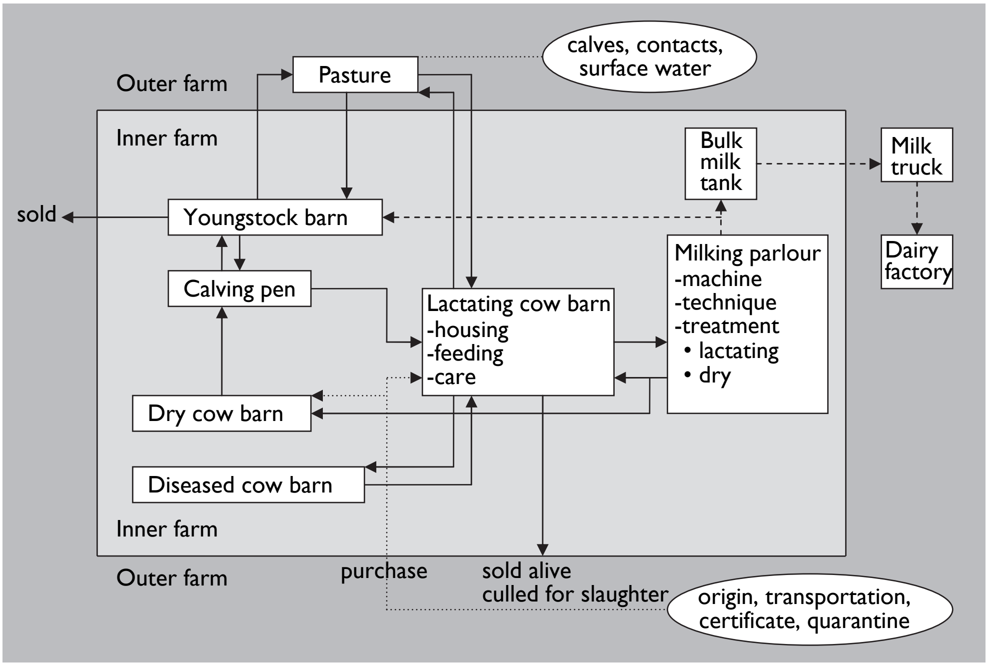


Figure 5.1. Example of a simplified General Flow Diagram of the production process on a dairy farm.

The general flow diagrams are a must for keeping the overview; they should be designed as an overall diagram and be kept as simple and practical as possible.

Next step in the field is to focus in more detail on the area of concern, that is: where the significant hazards have been defined, related to certain process steps (see also the examples for Farm FX in the boxes at the end of each chapter). For such areas, detailed flow charts are necessary for getting a proper insight.

It depends on the farming area and the step of concern to what extent the detailing needs to be done. The rule of thumb is two-fold: they should show enough detail to get sufficient insight in the process steps and details, while they should not comprise too much detail to keep items readable.

It is advisable to handle the 6 rules for defining standard operating procedures, SOP, to create the flow diagrams properly (Stup, 2001). This will allow people, like third parties, who are familiar with the SOP rules to easily look into the flow diagrams. Table 5.1 gives an example of these SOP rules and of the way they are handled to define a flow diagram content; in Table 5.1 the issue of cows being fetched for milking

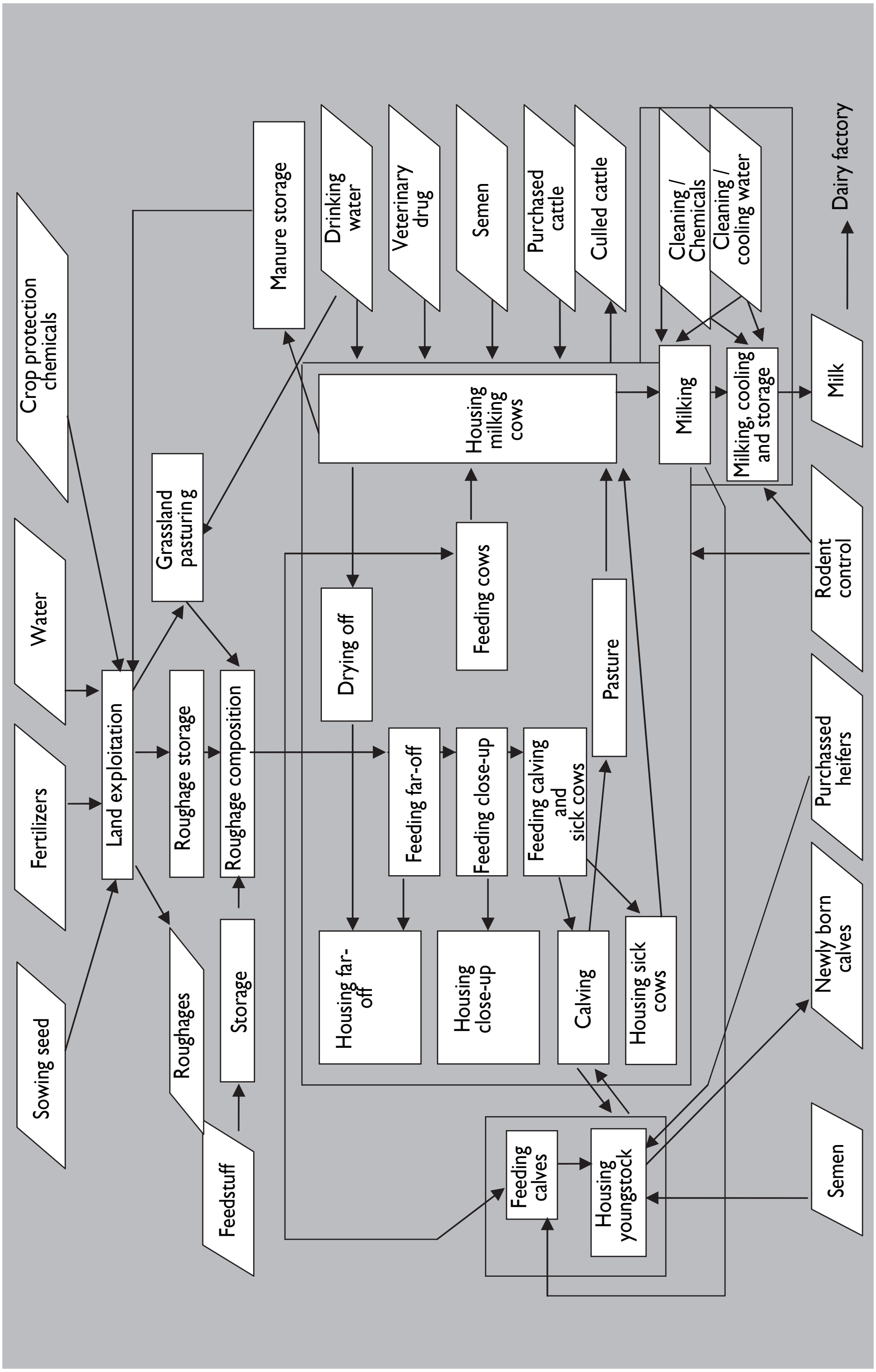


Figure 5.2. Another, more elaborated example of a General Flow Diagram of the production process on a dairy farm, with its process steps and interactions.

Table 5.1. Brief overview of the rules of thumb regarding the definition of SOPs in a process. Between brackets the applicability to dairy cows being fetched for milking (adapted after Stup, 2001).

Rule 1	Is the step essential for the fulfilment of the given activity?
	(*yes because cows are in pasture and need to be brought to the milking parlour*)
Rule 2	Are there safe and unsafe ways to complete the step?
	(*yes; cows could be moved in calmly or aggressively*)
Rule 3	If the step is executed in different ways, will that affect animal health or welfare?
	(*yes, cows are animals of routine; disturbing that causes stress; variation must be minimised as much as possible, hence minimising risks*)
Rule 4	If the step is executed in different ways, will that affect animal/herd performance?
	(*yes, variation leads to stress, possibly affecting health, milk yield and milk quality*)
Rule 5	Will variation in the way the step is executed, affect efficiency substantially?
	(*yes, for reasons previously mentioned*)
Rule 6	Is there another significant reason for the step to be executed in a certain way?
	(*yes, because stress can increase – next to previously named issues – the risk of injuries to the animals)*

is addressed (answers to the questions should be 'yes' in order to retain a particular step in the flow diagram).

Generally speaking, the procedure on the farm regarding the design of the flow diagrams is as follows:
1. Visual inspection of the farm, its buildings, lay-out, equipment, animal places, routing of animals, people, vehicles. This will result in a rough sketch
2. The sketch is taken to the *Farm Quality Management Team* members and discussed regarding certain specifications found during inspection.
3. The sketch is adapted and converted into a flow diagram.
4. The flow diagram is validated by the *Team* and the farm workers on-site.
5. When deemed necessary, the *Team* proceeds in designing the detailed flow charts according to the same principles.

5.3. Developing the flow diagrams

First stage is to distinguish the 'inner' and the 'outer' world of the farm. All issues outside the farm premises can be considered as 'external'.

Next stage, within the farm, the different locations, houses, for different cattle groups (e.g. calves, maiden heifers, pregnant heifers, dry cows, lactating cows) as well as specific activities (e.g. milking; calving; feed harvesting; calving pen; sick cow pen; quarantine facility, cull cow facility, dead animals facility) are identified.

In the third stage, we have to identify the routing of the animals from one site to another. In the 'outer world', we distinguish the pasturing –if applicable–, the different roads for cars, trucks, people, cattle (farm-raised and purchased), entering and leaving the farm, the location of the silage humps, the surface water routing, and the potential points of contacts with, for example, neighbouring farms or cattle. The level of detailing at this stage depends on the degree of fine-tuning deemed necessary by the *Farm Quality Management Team*. It can be advisable to leave the detailing to next stages of these flow diagrams (see further down).

The final, fourth stage in flow diagram development is to identify the external professionals visiting the farm; examples are: the veterinarian, AI technician, extension officers (nutritionist; economist), cattle traders, milk truck driver, feed truck driver, and other people servicing the farm or delivering products. This information is necessary for designing e.g. the distinction between 'dirty' and 'clean' roads, as part of a biosecurity assurance plan (BAMN, 2000) as is further detailed in Chapter 3.

With reference to the HACCP-like handbook of the Quality Risk Management programme (see Chapter 4), it is highly advisable to 'mark' the different major steps in the production process flow diagrams, for example with 'A' or 'AA', or 'I', etc. for the overall flow diagrams, and the detailing of those steps as 'A-1' or 'I.1' etc. in the detailed flow diagrams (see example of Farm FX). This will largely contribute to structuring right from the beginning and facilitate the later description of the items in the handbook, like hazards, risks, monitoring, GDF guidelines and working instructions.

The detailing in Figures 5.3 or 5.4 is depending on the step itself and the hazard of concern. The details in the step 'Veterinary Drug Treatment' (Figure 5.4) are less elaborated than those in the step 'Milking Cows' (Figure 5.3) simply because the latter has much more details to cover. In this stage 2 of designing specific farm flow diagrams, it is of utmost importance that appropriate awareness is created within the *Farm Quality Management Team* because the risk factors, the CCP's and the POPA's will commonly be assigned to the items in these stage 2 flow diagrams at a later stage (see Chapter 6).

When deemed necessary, some items in these stage 2 flow diagrams can even be further detailed, but we have to take care not to overload farm workers with highly sophisticated but unreadable flow diagrams.

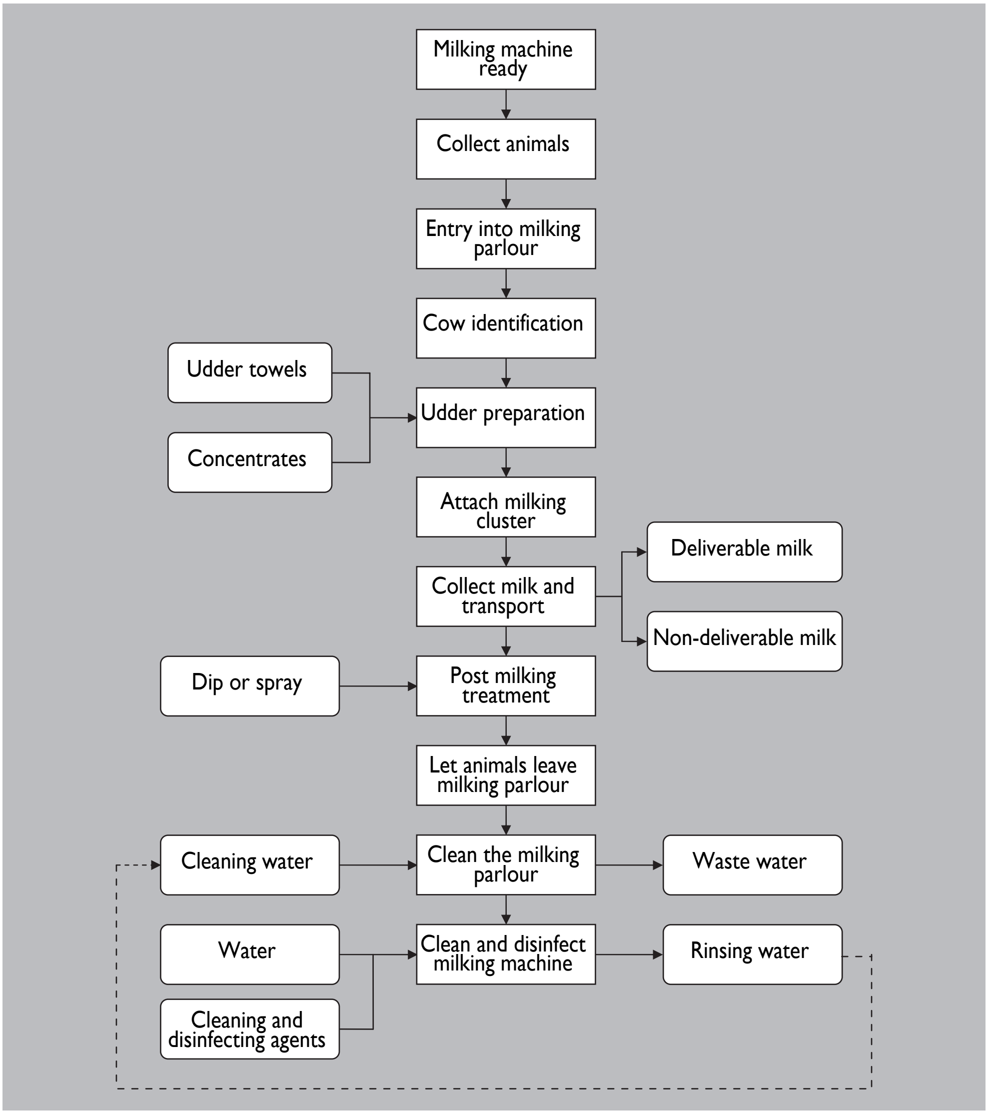


Figure 5.3. Example of a detailed flow diagram of one step (Milking Cows) as deduced from the general production process flow diagram in Figure 5.2.

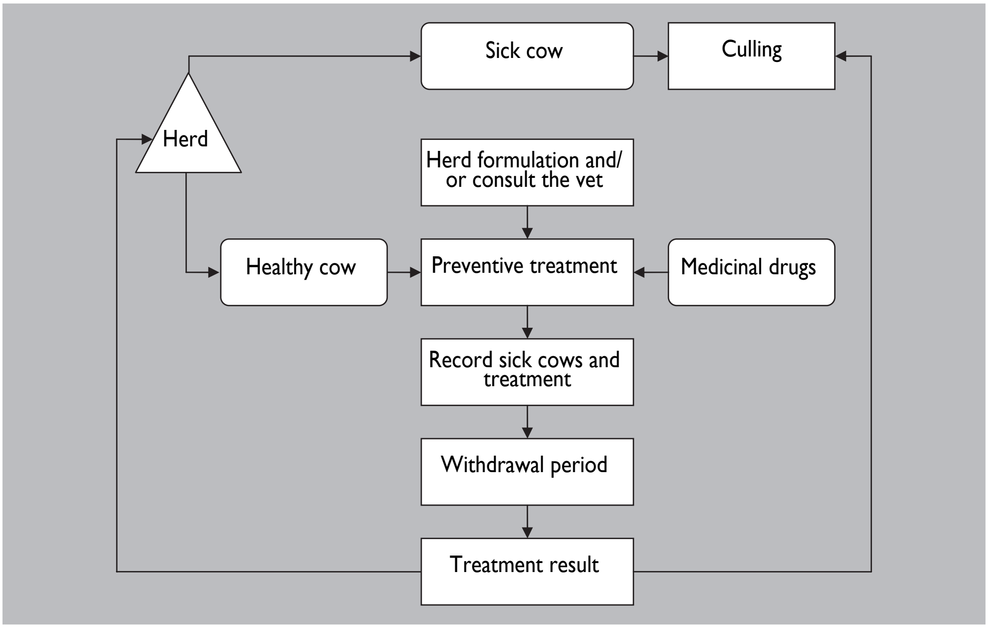


Figure 5.4. Another example of a detailed flow diagram, for the process step Veterinary Drug Treatment, as deduced from the General Flow Diagram in Figure 5.2.

5.4. Introducing the case farm FX

We now further introduce the *case Farm FX* (Box 5.1). This dairy farm will be followed up through subsequent chapters in order to illustrate the different designs and applications. Take notice of its code FX for further reference in the book. The cases where this example farm is addressed can be recognised by the boxes throughout the text. Two working instructions for farm FX were already presented at the end of chapter 3.

In Figure 5.5 we have presented the specified flow diagram of Farm FX with regard to the hazard of 'Udder Health & Milk Quality', and more specifically, the area of *Staphylococcus aureus* udder infections. Pre- and post-milking process steps are addressed, as well as milking itself. The SOP rules (Stup, 2001; see Table 5.1) have been used to draw the flow diagram. We can consider the earlier presented Figure 5.3 as a further detailing of one particular area of concern out of the Figure 5.5: the milking process; the same applies to Figure 5.4.

On Farm FX we were also confronted with another hazard area, namely 'diarrhoea in neonate calves' from the process of young stock rearing. Therefore, we also

Box 5.1. Farm FX

This dairy farm has 152 Holstein-Frisian crossbred cows, housed in a loose housing system with a common resting zone in cubicles. Cows are milked twice daily in a 2x8 herringbone parlour where automatic cluster detachment is conducted. The herd is divided into 2 groups: lactating and dry cows. The average age of the cows is 5 years. The average milk yield level is 8500 kg/cow/year, with 3.9% milk fat and 3.2% milk protein; the average level per cow per day is 27.6 kg. Female calves are reared on the farm as replacements. Sometimes, cattle are bought, but then their milk yield potential should be above 8500 kg. Milk collection is once every two days. The bulk tank has an automatic washing and refrigerating system.

The main problems are in the area of *Staphylococcus aureus* udder infections, and in calf rearing (diarrhoea in neonate calves).

developed flow diagrams for this process of young stock rearing (Figure 5.6) and, more specifically, for the period from Birth to Colostrum, because in this period the diarrhoea in neonatal calves does occur (Figure 5.7).

All flow diagrams of farm FX have been checked on-site on their reliability by the farmer and his co-workers, as well as by other members of the *Farm Quality Management Team*. Remark that there are differences in both set-up and lay-out of the different flow diagrams for this Farm FX, as well as the other flow diagrams presented in this chapter. Some of them use straightforward the SOP rules as listed in Table 5.1 (Stup, 2001); others are designed in a rather free-style manner.

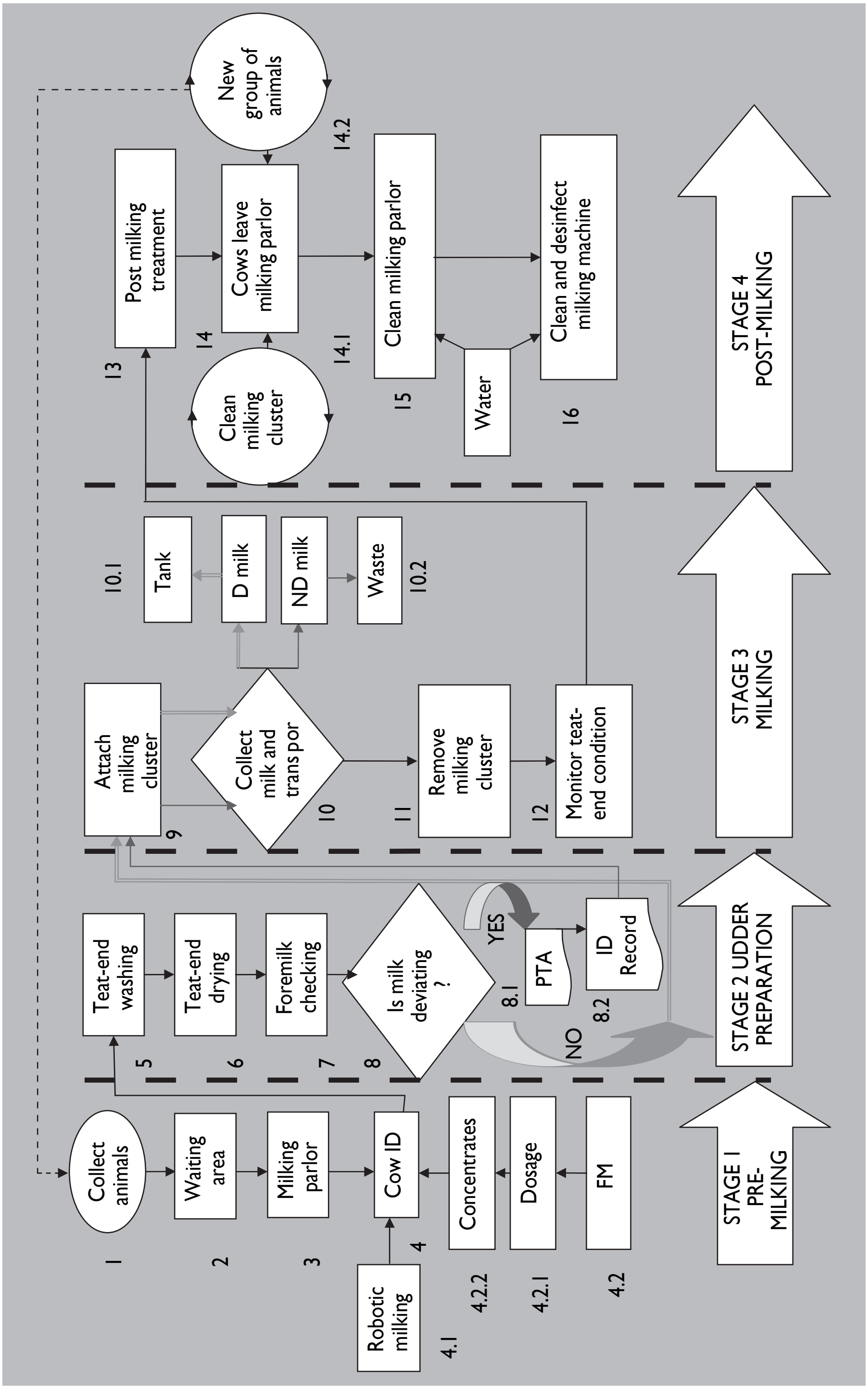


Figure 5.5. The flow diagram of the hazard area 'Udder Health & Milk Quality', where the specific hazard of Staphylococcus aureus udder infections are addressed on Farm FX.

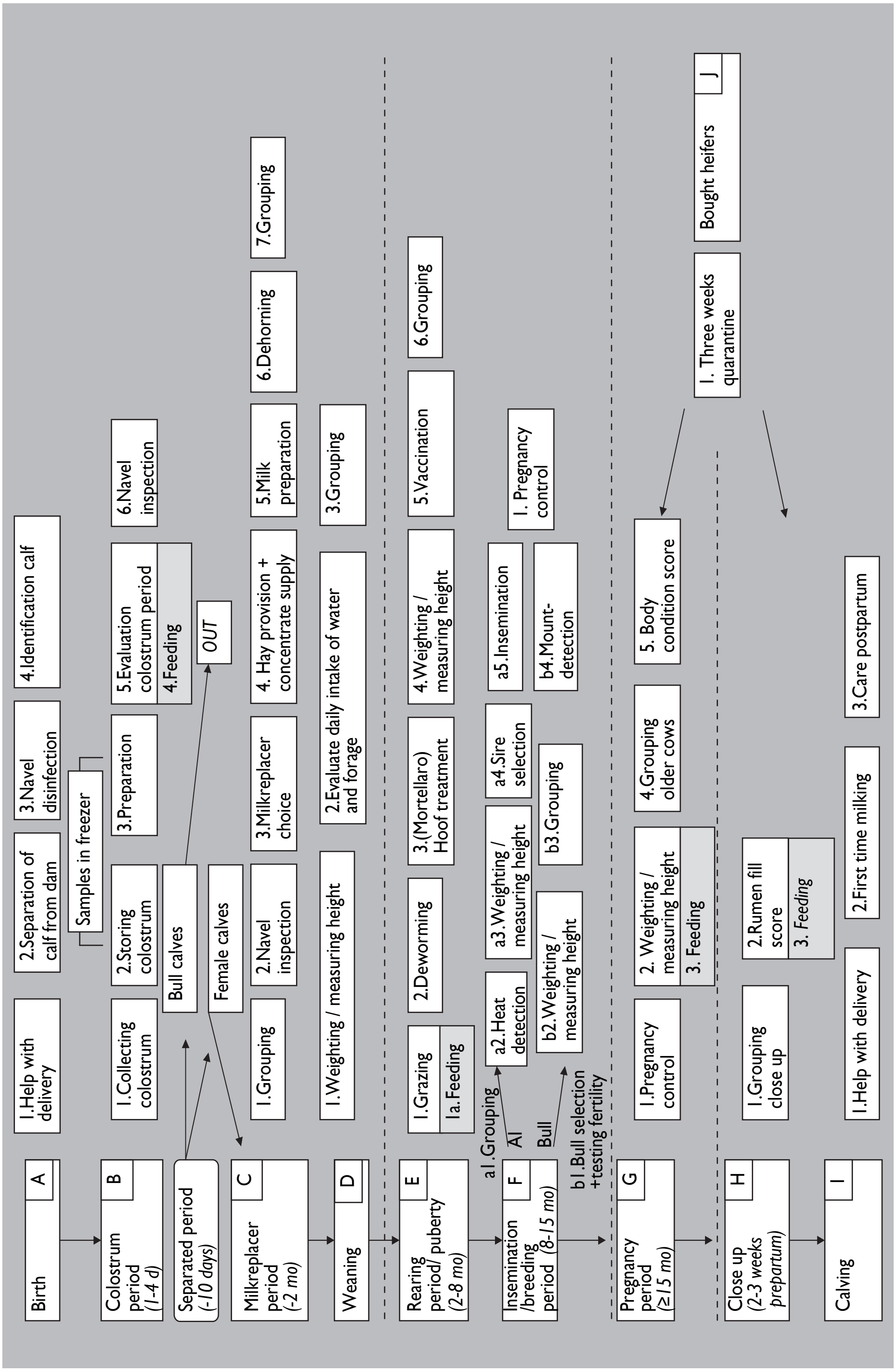


Figure 5.6. Flow diagram for Young Stock Rearing on Farm FX, where there exists a hazard area of diarrhoea in neonatal calves.

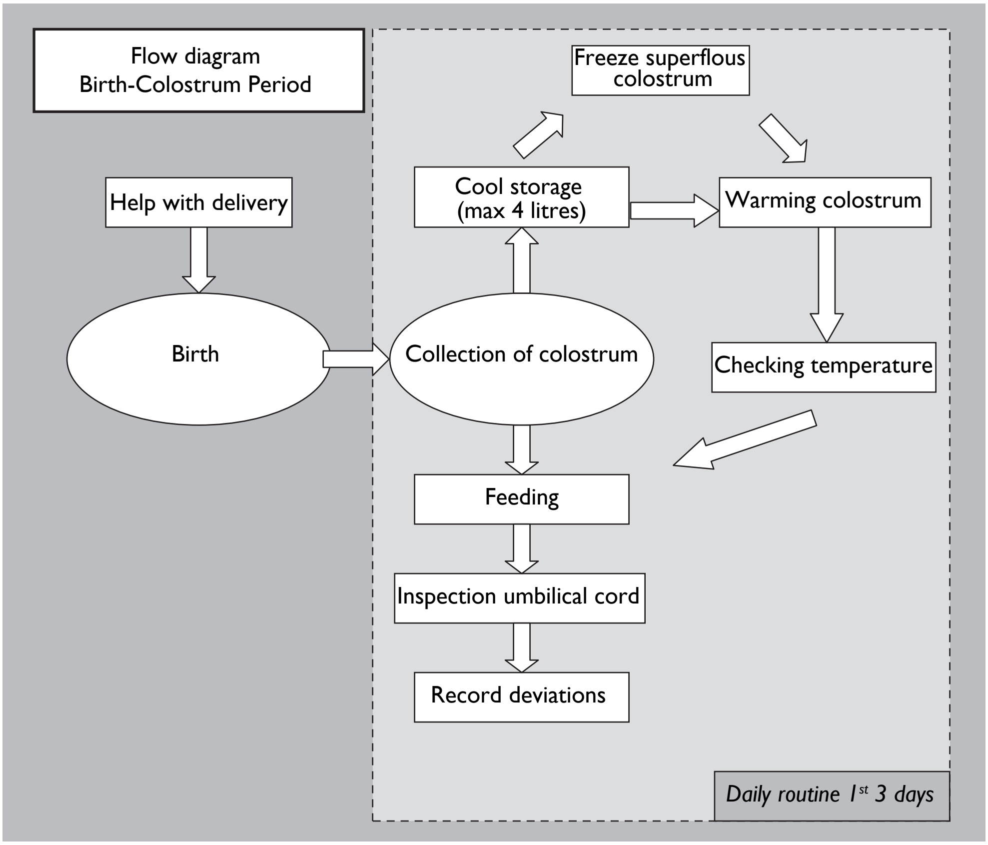


Figure 5.7. The more detailed flow diagram for the period from Birth to Colostrum, as deduced from the flow diagram on young stock rearing (Figure.5.6). This flow diagram relates to the second hazard area on Farm FX: diarrhoea in neonatal calves.

5.5. Concluding remarks

Flow diagrams can be manifold and differ largely in lay-out and contents. That is logic given the fact that dairy husbandry systems in the field differ largely too, but can also be due to the fact that at farm level we aim for simplicity and practicality. In some situations this requires a more free-style approach, while in other situations the SOP rules can be followed all the way through without loosing readability and practicality. After all, the flow diagrams are developed together with the farmer; moreover, the farm workers too should understand what is going on in flow diagrams. Some other examples of flow diagrams are listed in Annex 5A at the end of this chapter.

In multifunctional farms, where next to dairy farming other activities are undertaken (e.g. recreation, camping, care for mentally disabled persons, cheese making from raw milk, animal, cuddling) the complexity can be much higher (M. Barten, personal communication; see also in Chapter 11). But then again, it is a matter of introducing different levels of flow diagrams ('*slice the elephant*') to illustrate clearly what is going on where and how, and to get the proper and fully understandable flow diagrams on the table.

As long as the basic principles of creating flow diagrams are understood and we can use the SOP rules like instruments for the design and the templates from the example farms as our blue prints for this design, we are quite able to create these flow diagrams. Moreover, they must always be verified on the farm by visual inspection and in discussions with the farm workers before they are made operational.

Now that we have developed the respective flow diagrams, we can move to the next step in the developmental sequence of HACCP-like Quality Risk Management programmes: the identification of the priority hazards and their associated risks, and thereafter, the definition and selection of critical control points and points of particular attention.

Annex 5A. Examples of production process flow diagrams

In this Annex you will find other examples of production process flow diagrams. It may help you in designing the specific flow diagrams needed for each particular farm.

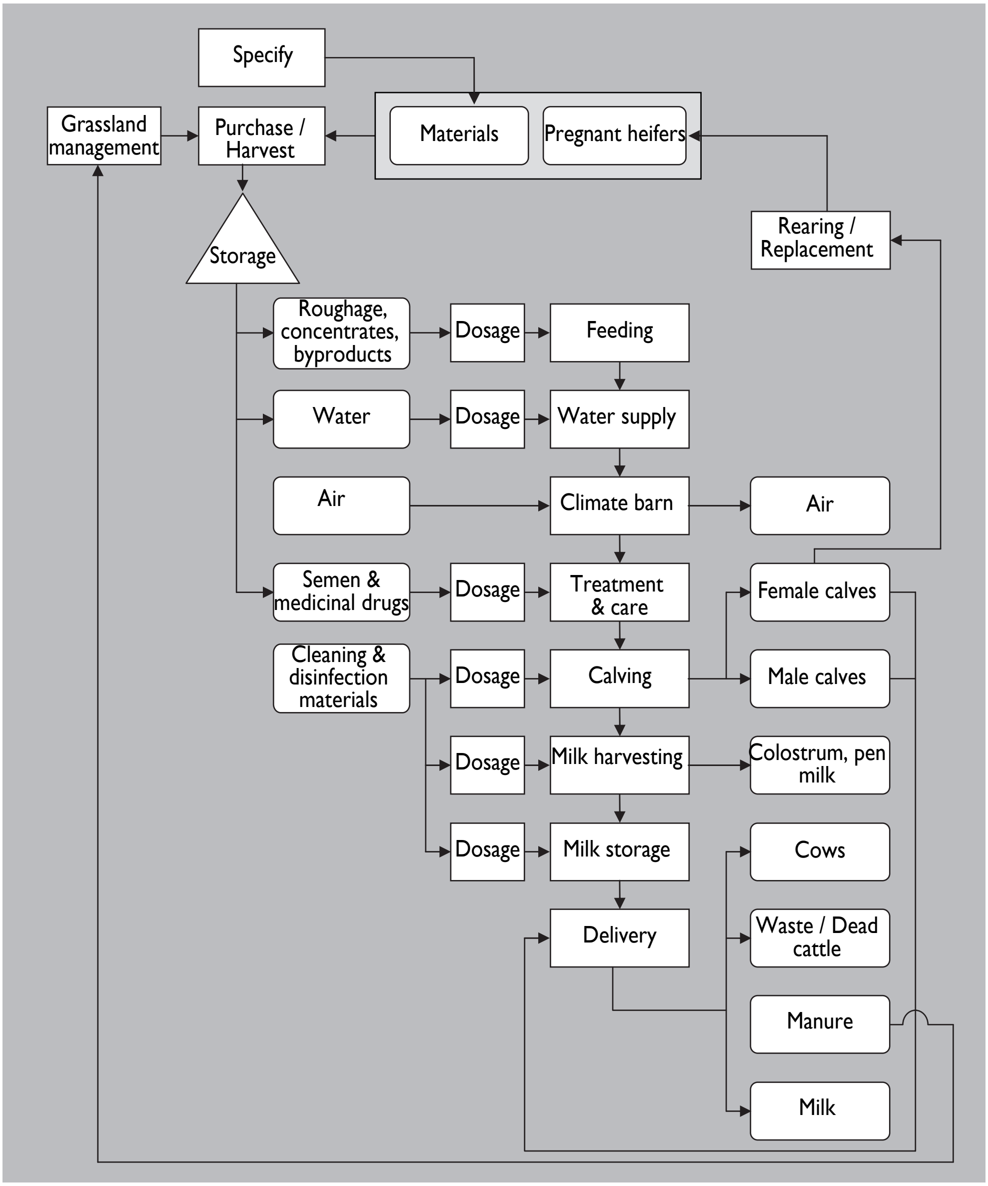


Figure 5A.1. Example of a flow diagram, focussing on feed and feeding management on a dairy farm.

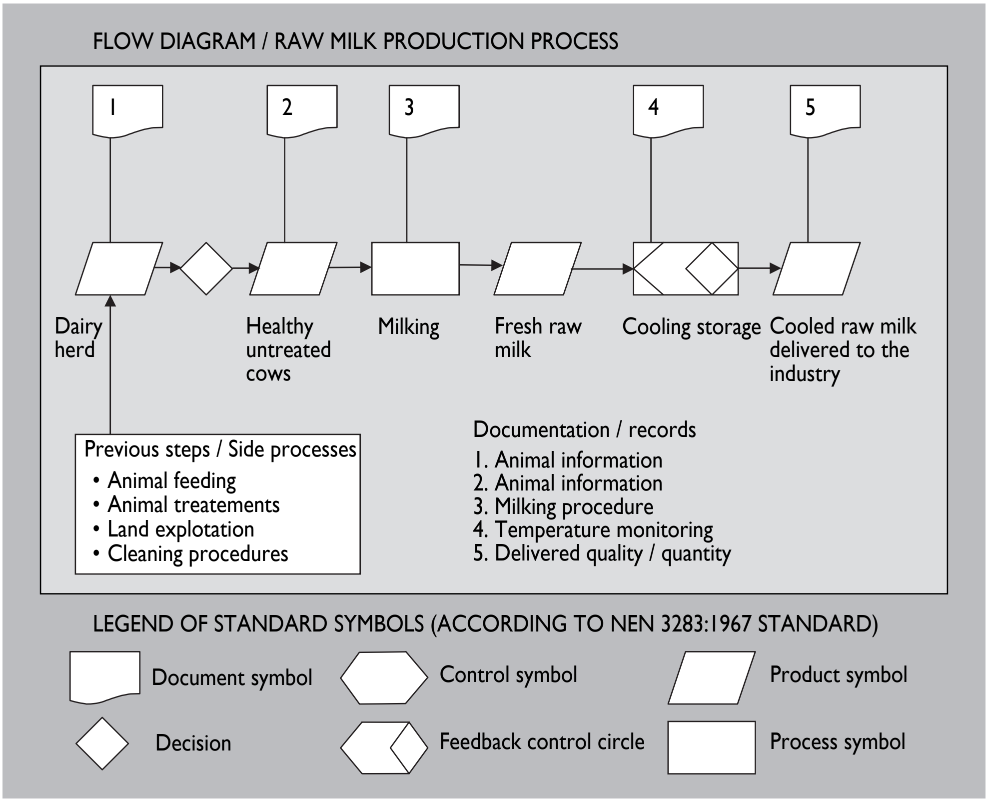


Figure 5A.2. Example of a general flow diagram of the production process steps on dairy farms, designed following standard operating procedures (NEN 3283-1967).

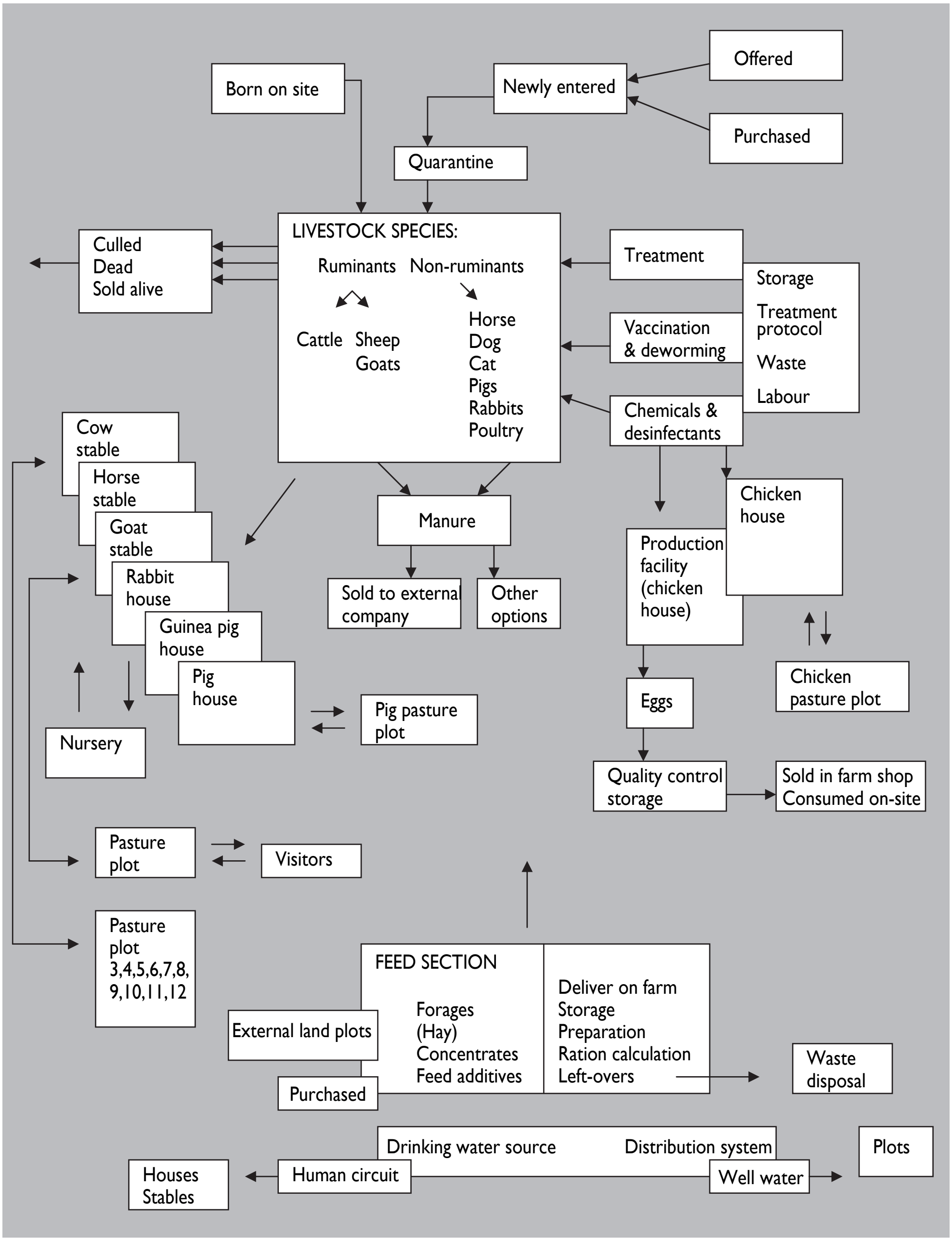


Figure 5A.3. Flow diagram of the children's farm in Zeist, The Netherlands.

Chapter 6. Identification of hazards and evaluation of risks

6.1. Introduction

By using the outcomes from the strengths-and-weaknesses assessment, SWA, from Chapter 2 and the flow diagrams presented and discussed in Chapter 5, it must be much easier to identify the hazards and risks. Once the latter has been done, we can position them in the flow diagrams to the sites where they occur or have their main impact. But first, the major hazards and risks have to be identified and weighted for relevance on the farm by the members of the *Farm Quality Management Team*. After that, it is highly advisable to have a double check on-site and discuss the findings with the people working on the farm. Finally, the *Team* makes an inventory of the *preventive measures* as already are being applied on the dairy farm.

6.2. Procedure for identifying hazards and risks

The *Farm Quality Management Team* has to define the hazards which are most relevant for that particular farm. The record keeping system on the farm can elucidate the hazards from the – recent – past; the veterinarian can use his own practice recording system to provide complementary information to this process. Moreover, regional animal health services or diagnostic laboratories can provide hazard information from the region of the farm. Finally, the dairy farmer can express his perceived but not (yet) actual hazards he wishes to deal with in a preventive manner.

The hazards are to be defined for the areas of public health (including food safety), animal health and animal welfare, respectively. The *Team* has to determine a ranking order of importance for these different hazards and to decide about the priorities of dealing with the most relevant ones.

The risk conditions which are associated with the defined hazards need to be specified for the particular farm. For that purpose one can use the lists of generic risk factors as present on the website www.vacqa-international.com for the different farming areas, and as introduced in Chapter 2. When for a certain farming area such generic lists are not available, the *Team* has to conduct a fact-finding in literature regarding the risk factors of a certain hazard, or assemble an expert team to detect through them the most relevant risk factors. The latter can be executed through a relatively simple conjoint analysis interview (Van Schaik *et al.*, 1998). It is of utmost importance that risk factors are weighted for their relevance, because in many disease situations there are far too many risk factors contributing somehow to disease occurrence to be handled practically; a selection has to be conducted for the most relevant ones. Risk factor weighting is in principle on the basis of Probability (prevalence) × Impact (disease effect). In all situations, the extracted risk factors have to be checked on the farm for their farm-specific relevance.

The Tables 6.1 and 6.2 show examples of risk factor profiles from various epidemiological studies: Table 6.1 in a more qualitative sense, Table 6.2 in a quantitative sense with odds ratios being calculated (Noordhuizen *et al.*, 2001).

Table 6.1. An example list of most important risk factors as determined for the introduction of M. paratuberculosis *on dairy farms (ranking in descending order of relevance as determined by veterinary specialists), adapted after Vos (1999).*

Description of the risk factor
Purchase of cattle from an unknown source or origin
Young stock with access to pasture plots (and having contact with faeces)
Supply of manure of unknown microbiological quality from an other farm used as fertiliser on pasture where young stock grazes
Cattle having contact with feral ruminants, and, hence, with their faeces
Cattle returning from a cattle market place, cattle show or (export) collection point
Young stock drinking from surface water which is known to have contacts with other farms
Own cattle being transported on a truck with cattle from other farms (health status unknown)
Visitors being allowed not to comply to certain hygiene rules on the farm and its entrance
Young stock drinking surface water not interconnected with other farms

6.3. Risk factor weighting

The next stage in the procedure is to assign a certain weight to the risk conditions found on the farm. After the identification of the hazards and risk factors, we need to weigh the risk factors in order to find out which one is truly relevant (*a true risk*) and which one is not. These weighted risk factors (true risks) are then assigned to the different sites in the flow diagrams (Chapter 5). In the '*hazards and risks lists*' in the HACCP handbook, these sites are commonly identified by a code which is most understandable by the farm manager and farm workers. Such codes are usually abbreviations of the particular step or site of concern. For example the step Milk Harvesting may become 'MH'; and the step Cattle Treatment may become 'CT'.

These weights can be used to prioritise the risks, and, hence, facilitate to address the most relevant ones, the ones that are considered '*true risks*'. Weighing can be done in three ways:

Table 6.2. An example of results from an epidemiological study into Mortellaro disease in dairy cows. The read-out parameter is the odds ratio (OR> 1 means risk increase; OR <1 means risk decrease; OR= 1 means no association between risk factor and disorder, or reference value). Adapted after Frankena et al.*, 1992 in Noordhuizen* et al.*, 2001. HF= Holstein Frisian; FH= Dutch Frisian; MRY= Meuse Rhine IJssel breed.*

Description of the risk factor	Specification	Odds ratio, OR
Parity of the cows	1	1.3
	2	1.1
	3	1.0 (reference)
Predominant breed of the cows in the herd	>50% HF	1.2
	>50% FH	1.02
	>50% MRY	0.1
	HF * FH crossbreed	1.0 (reference)
Lactation stage	Dry	0.3
	Pre-top	0.8
	Top (50-70 days)	1.7
	Past-top	1.0 (reference)
Access to pasture	Limited	1.5
	Free	1.0 (reference)
Average walking distance to the pasture plots	>200 m	5.4
	<200 m	1.0 (reference)
Walking path quality	Metalled	2.6
	Non-metalled	1.0 (reference)

1. Through quantitative epidemiological methods which result in a list of odds ratios in descending order of importance (Noordhuizen *et al.*, 2001). Sometimes such odds ratio lists are available in literature, but we have to take into account that those lists originate from different countries or regions with different husbandry systems and different local conditions. The results are therefore not to be generalised for other regions, nor other individual farms. To conduct an epidemiological observational-analytic survey your self in your region may be time-consuming and costly. Therefore estimation might be preferable.
2. Through application of adaptive conjoint analysis, ACA, which is a computerised questionnaire-like survey which is commonly used in product marketing to obtain and weigh people's preferences towards attributes of a certain product. Preferences are converted into quantitative scores, hence providing a ranking order. The same approach can be applied in a certain domain of animal production, like, for example, in animal health: udder infections. For further reading on ACA we

like to refer to other publications like for example van Van Schaik *et al.* (1998), Fels-Klerx *et al.* (2000), Angus *et al.*, (2005), Valeeva *et al.* (2005), Boersema *et al.* (2007). The outcome of an ACA exercise in an on-farm situation involving experts like the dairy farmers, veterinarians, nutritionists, or other extension specialists, is a close-to-reality ranking of risk factors in order of importance. The ACA results commonly do not differ largely in their ranking order from the risk factor lists obtained by epidemiological observational-analytic surveys.

3. When both preceding methods are no option, you may consider applying qualitative methods to obtain a certain weight, and hence, a ranking order of risks on the farm. The members of the *Farm Quality Management Team* should discuss the possibilities in details, and assign a weight to the potential hazards and risks list by applying the formula Probability of occurrence times Impact of the risk = $P \times I$. Next, they have to decide, using the results from $P \times I$, about the cut-off point above which to address a certain hazard or a risk on the farm; this is the phase of risk weighting to define *true risks*.

6.4. Designing the hazards and risks list

Table 6.3 gives an example of a hazard and risks list, including the reference in the HACCP-handbook, the type of risk (microbiological; chemical; physical; managerial), the coded process step (like MH or CT) as a reference to the HACCP handbook, the risk weight result. The risk factors in Table 6.3 can be used for determining CCP's and POPA's, which will be done in the Chapter 7.

Table 6.3. An example of a 'hazards and risks list' from the HACCP handbook developed so far, for the domain of physical and chemical contamination of milk on the dairy farm at the production process step Milk Harvesting and the process step Cattle Treatment (after Lievaart et al.*, 2005).*

Reference in the HACCP handbook	Type of hazard	Risk factor	Process step flow diagram	Risk weight	True risk?
CT_1	Chemical	Wrong drug used	Cattle Treatment, CT	4	No
CT_2	Chemical	Wrong drug dosage applied	Cattle Treatment, CT	4	No
CT_3	Chemical	Drug beyond shelf life	Cattle Treatment, CT	2	No
CT_4	Chemical	Cow's ID fails in withdrawal period	Cattle Treatment, CT	6	Yes
CT_5	Physical	Needle of syringe broken	Cattle Treatment, CT	1	No
MH_1	Chemical	Drug residues in milk	Milk Harvesting, MH	6	Yes

Another example of a hazards and risks list is presented in Table 6.4. This Table regards the microbiological contamination of milk during milk harvesting and cattle treatment. As can be noted, pathogens of zoonotic nature are concerned.

The great difference between Table 6.3 and Table 6.4 is that, with the zoonotic pathogens taken into account, in Table 6.4 the approach should be at the *whole herd level*, through *biosecurity measures* and *guidelines for Good Dairy Farming Practice* (like good milking hygiene practice; farm visitors protocol; working instruction for new cattle entering the farm), rather than at the *level of individual cows in process steps* as was used in Table 6.3. These guidelines, protocols, working instructions, and biosecurity measures have already been addressed in Chapter 3.

This whole farm approach at herd level is visible in Table 6.4 where process steps are addressed and not individual cows, and by the fact that the codes of the HACCP handbook refer to the same pages (MH_6 and CT_{11}).

The hazards and risk factors identified, and the risks weighted on the farm need further attention through the determination of control points (CCP and POPA), of monitoring including testing, and a set of corrective and preventive measures on the farm. These issues will be addressed in subsequent chapters.

Another example of a hazards-and-risks-list refers to the farming domain of 'Feed & Feeding Management'. These lists are short-listed in Table 6.5. For an extended list of

Table 6.4. An example of a 'hazards and risks list' regarding the microbiological and chemical contamination of milk on a dairy farm during the production process steps Milk Harvesting (MH) and Cattle Treatment (CT). M= microbiological; C= chemical (toxins). Risk factors have not been detailed for reasons of readability.

Reference in the HACCP handbook	Hazard detail	Type of hazard	Risk factors	Process step flow diagram	Risk weight	True risk?
MH_6 CT_{11}	*Brucella abortus*	M		MH; CT	2	No
MH_6 CT_{11}	*Mycobacterium bovis*	M		MH; CT	3	No
MH_6 CT_{11}	*Listeria monocytogenes*	M		MH; CT	8	Yes
MH_6 CT_{11}	*Salmonella dublin*	M		MH; CT	3	No
MH_6 CT_{11}	*Campylobacter jejuni*	M		MH; CT	4	Yes
MH_6 CT_{11}	*Staphylococcus aureus*	M; C		MH; CT	6	Yes
MH_6 CT_{11}	*E. coli* $O_{157}H_7$	M		MH; CT	6	Yes
MH_6 CT_{11}	*Yersinia enterocolitica*	M		MH; CT	2	No

Table 6.5. Short-list of some hazards in the domain of Feed & Feeding Management on a dairy farm. Possible areas of concern are veterinary public health (VPH), animal health (AH) and animal welfare (AW).

Hazards	Area of concern	Risk factors (examples)	Risk weighting results (probability x impact)
Pasturing & grazing			
Poor grass growth	AH	Poor botanic composition; poor seed selection; poor seeding process; too much water drainage; poor grassland management; weather conditions	1 * 2= 2 Low
Toxic plants in/around the grassland plots	VPH; AH; AW	Deficient grassland management	1 * 2= 2 Low
Heat stress	AH; AW	Pasturing without any shadow facilities	2 * 2= 4 Moderate
Infection transfer from cows to calves in pasture	AH; VPH	Too short interval between cattle grazing and young stock grazing; or after spread of slurry; contacts with different age groups or neighbouring cattle	2 * 3= 6 High
Fungi detected in grassland (mycotoxins)	VPH. (AH)	Deficient soil management; insects; seed selection and safety; poor grassland	1 * 3= 3 Moderate
Harvesting & silaging			
Oil leakage at silaging (tractors; wagons)	VPH	Poor maintenance of tractors and wagons; lack of check-ups	1 * 1= 1 Low
Agent transmission through dirty, hired equipment	VPH. AH	No cleaning/disinfection of equipment before entry to farm, neither when leaving the farm	1 * 3= 3 Moderate
Fungi formation in corn silage (mycotoxins)	VPH; (AH)	Poor harvesting and or conservation procedures	2 * 3= 6 High
Feeding management			
Agent transfer through manure/slurry contaminated feed	VPH; AH	Poor farm hygiene procedures; poor slurry handling practice; cross-over spots on farm where slurry and feed cross	1 * 2= 2 Low
Traumatic reticulitis due to foreign bodies in feedstuff	AH	Unknown origin of feedstuffs; no prior checks on purchased feedstuffs; no checks when feed is distributed	1 * 3= 3 Moderate
Chemically or microbiologically contaminated water	AH; AW	Unknown water sources or unknown quality; insufficient quality testing frequency; management failures with chemicals and or slurry or dead rodents/ birds	2 * 2= 4 Moderate

those hazards and risks we refer to the Annex of this chapter . The goal of the farming domain 'Feed and Feeding Management' is to provide cattle with fresh or silage feed, or purchased feedstuffs, which are optimal for the production performance of cows, without hampering their health and welfare status, and not provoking any hazards for public health including food safety.

The next stage in the developmental procedure of the Quality Risk Management programme is to define the critical control points, CCP, and the points where particular attention is needed, POPA. These issues are dealt with in Chapter 7.

Box 6.1. Further elaboration of the case Farm FX: hazard and risks in udder health.

The first major hazard identified by the Team is 'udder infections by *Staphylococcus aureus*', as could be determined on the basis of laboratory investigations of milk samples from mastitis cows at the start of the whole procedure.
The associated, and true risk factors now have to be identified. The first step to identify risk factors was by using the assessment of strong and weak points on the farm, a SWA (see text at paragraph 4.2.1). Next step is the weighing of the risk factors to find the most relevant ones, the 'true ones'. This second step is taken in Table 6.6.

Table 6.6. Example of a 'Hazards & Risks List' from the HACCP handbook. The area of concern is microbiological hazards, namely Staphylococcus aureus udder infections, during the process step of 'Milk Harvesting (MH)' on Farm FX. Risk is weighted on the basis of expected probability × impact.

Reference in the HACCP handbook	Type of hazard	Risk factor	Process step flow diagram	Risk weight	True risk?
MH_3	Microbiological	Contamination through the hands of the milker	Milk Harvesting, MH	3x2	Yes
MH_4	Microbiological	Improper washing	Milk Harvesting, MH	2x3	Yes
MH_5	Microbiological	Cleaning water	Milk Harvesting, MH	1x1	No
MH_6	Microbiological	Contaminated cloth	Milk Harvesting, MH	3x2	Yes
MH_7	Microbiological	Incorrect drying	Milk Harvesting, MH	2x2	Yes

»

Risk factors identified on the farm as potentially contributing to the hazard occurrence and with the highest weight and, hence, identified as 'true risks' are:

- contamination of the udder and teats by the hands of the milker;
- inappropriate washing and cleaning of the udder and teats when preparing for milking;
- lack of appropriate fore-milking;
- the microbiological quality of the washing water;
- the use of only 1 towel for cleaning the teats/udder of several cows;
- dirty conditions in cubicles, alleys and waiting area;
- deficient ventilation in the barn and milking parlour causing high humidity;
- too low temperature at end of washing/cleaning process of milking machine.

Box 6.2. Further elaboration of the case Farm FX: hazard and risks in calf rearing.

The second major hazard identified on farm FX regards the 'diarrhoea in neonate calves (from birth to 7 days old)'.

The associated risk factors potentially contributing to this problem, showing the highest risk levels after weighing (Table 6.7) and hence identified as true risks are:

- poor colostrum quality (too low IgG levels; mastitic dams);
- poor colostrum management (feedings too late; poor storage; old stock);
- poor hygiene practices (unhygienic collection; unhygienic feeding; birth problems);
- poor housing conditions of newborn calves (overcrowding; too few single boxes, calves born on slatted floor or in cow barn);
- absence of vaccination in pregnant heifers 3-4 weeks prior to calving (related with Rota/Corona virus and *E. coli* infections) and/or preventive antimicrobials.

»

Table 6.7. Example of a 'Hazards & Risks List' form the HACCP handbook. The area of concern is microbiological, namely infectious diarrhoea in neonatal calves, during the process step of young stock rearing on Farm FX. Risk is weighted on the basis of probability (prevalence) × impact. Risk factors have not further been defined for reasons of readability.

Process step Ref. HACCP-book	Hazard	Type of hazard	Risk factor(s)	Risk weight	True risk?
Birth-Weaning$_1$ (*BW$_1$*)	Birth problems	Biological		6	Yes
Birth-Weaning$_2$ (*BW$_2$*)	Wrong ID calf	Management (recording)		4	No
Birth-Weaning$_3$ (*BW$_3$*)	Diarrhoea in neonate	Biological		6	Yes
Birth-Weaning$_4$ (*BW$_4$*)	Navel disorders	Biological		4	No
Birth-Weaning$_5$ (*BW$_5$*)	Arthritis	Biological		6	Yes
Birth-Weaning$_6$ (*BW$_6$*)	Wrong extra teat removed	Physical		2	No
Birth-Weaning$_7$ (*BW$_7$*)	Poor weight gain	Management (feeding)		6	Yes
Birth-Weaning$_8$ (*BW$_8$*)	Diarrhoea in calf	Biological		4	No
Birth-Weaning$_9$ (*BW$_9$*)	Respiratory disorder	Biological		4	No
Birth-Weaning$_{10}$ (*BW$_{10}$*)	M. paraTBC infection	Biological		4	No
Birth-Weaning$_{11}$ (*BW$_{11}$*)	Wrong drug application	Chemical, Physical		2	No

6.5. Inventory of preventive measures

Following the identification of the priority hazards and their associated risks, we make an *inventory of preventive measures* which are already being taken on the farm. Preventive measures may be related to:

- vaccination programmes regarding viral, bacterial or parasitic diseases;
- operational veterinary Herd Health & Production Management programmes, including, for example, herd fertility schemes, udder health control programmes, parasite control programmes;
- risk management programmes including those to ascertain a targeted biosecurity level or the application of certain guidelines and working instructions.

Once, this inventory has been made, we can evaluate these measures on their efficacy and when needed adjust these measures. On the other hand it can be worthwhile to consider the application of other preventive measures, given the hazards that have been defined by the *Team* previously. This activity resorts under Chapter 7 when we speak about monitoring and corrective measures for critical control points and points of particular attention. It goes beyond the contents of this chapter to elaborate all possible preventive measures on a dairy farm. We refer to scientific literature and internet searches to find details on preventive measures from one or more of the three categories named. When applicable to farm FX we will present them. Table 6.8 comprises just a couple of *general measures of prevention* as an example; in Annex 6A this table is further elaborated.

6.6. Concluding remarks

As can be noted from the previous chapter, tables and figures, the hazards can be manifold. The three main categories (microbiological; physical and chemical hazards) are even expanded with a fourth one, which comprises more specifically the managerial hazards on a dairy farm. This complexity of different hazards and associated risk factors necessitates the design of clear and practical hazard-and-risks-lists as presented above. This is the only way to provide the farmer and his co-workers with a clear and concise overview. Such hazards-and-risks-lists are also highly comprehensive for external advisors like the veterinarian and nutritionist.

The hazards-and-risks-lists need to be updated at least once a year by the members of the *Team*, and when needed with support from additional specialists. Such an update is indicated as well because of the new knowledge that comes forward, e.g. from quantitative epidemiological studies about diseases and welfare disorders.

Table 6.8. An example of an inventory list for General Measures of Prevention in various areas of dairy farming. Dates refer to the frequency of executing the measures (dpp= days postpartum).

General measures of prevention	Planned yes/no?	Measures executed yes/no	Date 1	Date 2	Date 3	Date 4
Hygiene & Housing						
Barn climate checked						
Cubicles cleaned						
Bedding added						
Use of medicinal drugs						
Records are updated						
Drug storage cleaned						
HTAP upgraded						
Record keeping Health						
Sick cow records OK						
Lab results archive						
Vaccination programme						
See details separately						
Udder Health programme						
Udder hair is clipped						
Milkers are evaluated						
Milking machine checked twice yearly						
Mastitic cows < 60 dpp are sampled for culturing						
Cow treatments in HTAP						
Claw Health programme						
Herd claw trimming 2x/yr						
Cleaning of barn floor						
Formalin footbath used						

Annex 6A. General measures of prevention for hazards and risks

Below you will find an example of a list of General Measures of Prevention. The idea is that the veterinarian – together with the farmer or manager – sets up this list, following the different areas of dairy farming and farm management.

Under each paragraph different items have been named. Each item has been considered in this example as relevant to be monitored and checked on this particular farm. First of all it is discussed which item is relevant to consider, and whether the execution of such a measure is planned. Next, as can be seen on the list, this list is positioned on a site where it can be easily checked each day. The responsible person has to list whether or not the respective measure has been executed; moreover, the exact date of each execution of measures is listed under Date 1-4. In case that deviations are detected, one has the opportunity to take further actions.

This list assists in creating awareness in the farmer or manager, but also among those people who work on the farm. In such a way, it can be considered as a management - organisational instrument.

General measures of prevention	Planned yes/no?	Measures executed yes/no	Date 1	Date 2	Date 3	Date 4
Hygiene & housing						
Barn climate checked						
Cubicles cleaned						
Bedding added						
Housing hygiene checked						
Use of medicinal drugs						
Records are updated						
Drug storage cleaned/wk						
HTAP's upgraded						
Record keeping Health						
Sick cow records are OK						
Lab results archived						
Vaccination programme						
See details separately						
E.coli prophylaxis in the dry period						
Against BVD virus						
Official vaccinations						

General measures of prevention	Planned yes/no?	Measures executed yes/no	Date 1	Date 2	Date 3	Date 4
Udder health programme						
Udder hair is clipped						
Cows kept standing after milking						
Barn climate is correct						
Lying area clean + dry						
Milkers are evaluated						
Milking machine checked twice yearly						
Vacuum is checked						
Pulsator is checked						
Regulator is checked						
Teat cup liners replaced						
Rubber materials checked						
Teat End Callosity scored						
Mastitic cows < 60 dpp are sampled for culturing						
Teat disinfection checked						
Dry udder preparation						
First streaks checked						
Mastitis cows milked last						
Cow treatments in HTAP						
Claw health programme						
Herd claw trimming 2x/yr						
Cleaning of barn floor						
Formalin footbath used						
Floor checked for broken and unequal slats						
Locomotion is scored						
Claw lesions at trimming are recorded						
Young stock claws sprayed or formalin bathed						
HTAP is followed						
Pathways to pasture are checked for gravel						
Water troughs in barn and pasture are checked						

General measures of prevention	Planned yes/no?	Measures executed yes/no	Date 1	Date 2	Date 3	Date 4
Reproductive performance						
Dry cows are kept inside						
Dry cows in 2 groups						
Heat detection evaluated OK						
Body condition scoring is done and OK						
Detected/suspect heats are recorded						
Expected heat date list is used						
Light regime in barn OK						
Separate calving pen						
Cleaning/disinfection of calving pen is OK						
if DIYS-AI is used, is it evaluated regularly and OK						
Nutrition of cows & calves						
Rations are calculated at each change						
Mineral status is checked						
Feedstuff quality checked (mycoses and soil included)						
Body Condition Scored						
Rumen Fill scored						
Faeces Consistency scored						
Undigested Fraction in Faeces scored						
Concentrates increase after calving in > 3 weeks						
Young stock growth performance checked 2x/yr						
General management						
Biosecurity Plans in place and functioning						
Herd Health & Production Management programme in place						
Good Dairy Farming guidelines and working instructions in place						

OK= correct and in order.
HTAP= herd treatment advisory plan; DIYS-AI= do it your self artifical insemination.

Chapter 7. Critical Control Points (CCP) and Points of Particular Attention (POPA): their standards and tolerances or targets, their monitoring, and corrective measures

7.1. Introduction

The CCP's and POPA's are usually derived from the risk factors that have been identified during the strengths-and-weaknesses-assessment (Chapter 2) or in the step of analysing hazards and risks in more detail (Chapter 6). Moreover, a CCP has to meet several formal criteria before it can be considered as such. These criteria have been listed in Chapter 4, and are shortly presented under paragraph 7.2. At the same time it was determined that in living animals like cows and young stock there exists biological variation in many parameters while exact standards or absolute objective threshold values are not available (e.g. in the serum-titre distribution of antibodies against a certain viral disease agent in a herd) like there are in physical processes.

In those situations where one or more of the CCP criteria cannot be met, and while the control point still is considered of paramount importance, we can consider such a control point as a POPA. In dairy cattle farming there are much more POPA's than CCP's.

Furthermore, in addition to the definition of several formal standards, we add the definition of specific targets in various domains; this is highly comparable to the situation in veterinary Herd Health & Production Management, HHPM, programmes (Brand *et al.*, 1996).

All CCP's and POPA's together should be brought into an on-farm monitoring system. The monitoring is meant to trigger for corrective actions once control is lost, in other words when the risk that a hazard may occur (e.g. increase in mastitis cases) or has occurred (e.g. antibiotic residues in milk detected at the milk factory) increases. It would be best when corrective measures are designed and implemented only after a cost-benefit assessment has taken place.

It must be emphasised here that too many CCP and POPA will hamper a smoothly functioning monitoring process, and hence, impact the routine daily management practices on the dairy farm too much. The way to avoid such overload is addressed in the next section.

7.2. CCP and POPA

Shortly, the formal criteria to be met by a control point to be defined as critical (CCP) are that:
- it must be associated with the hazard/risks of concern potentially occurring within in or related to the process;
- it must have a standard value with tolerance limits;
- it must be measurable or observable;
- it must be crucial for process (step) control;
- corrective actions to restore control must be available;
- once control is lost, these corrective measures must be able to fully restore control.

As was indicated in Chapter 4, with live animals and their biological variation on dairy farms it is often very hard or not even feasible to obtain full restoration of control. Therefore, more often *target values* rather than absolute standards apply in animal production. Then we deal with POPA's.

There is a decision-tree approach to determine whether a certain control point, a step in the process, a procedure or a series of steps, is indeed critical or not. The sequence of 4 questions to be answered in this decision-tree is presented in Figure 7.1 (adapted after FAO, 1997; Griffin *et al.*, 1998; T. Mota, unpublished data, 2003).

For reasons of feasibility and practicality on the farm, the number of CCP's and POPA's on the farm should be restricted. This is particularly the case on farms with less than two persons working, for example the farmer and his son or wife part-time, or a co-worker.

Moreover, the CCP's and POPA's should form part of an on-farm monitoring system, through which observations, measurements, investigations, and tests have to be conducted; all these together also must remain within a feasible context. This is one of the reasons to integrate operational veterinary Herd Health & Production Management programmes with the HACCP-like Quality Risk Management programmes.

7.3. Standards & tolerances, and targets

As was stated above, the physical processes on a dairy farm will usually be accompanied by *standards and their tolerance limits*.
An example is the temperature of the warm cleaning water to wash the milking machine: at start it should be at 80 °C while at the end of the washing procedure, the temperature should still be at 60 °C, the tolerance being ±2 °C. Another example is the

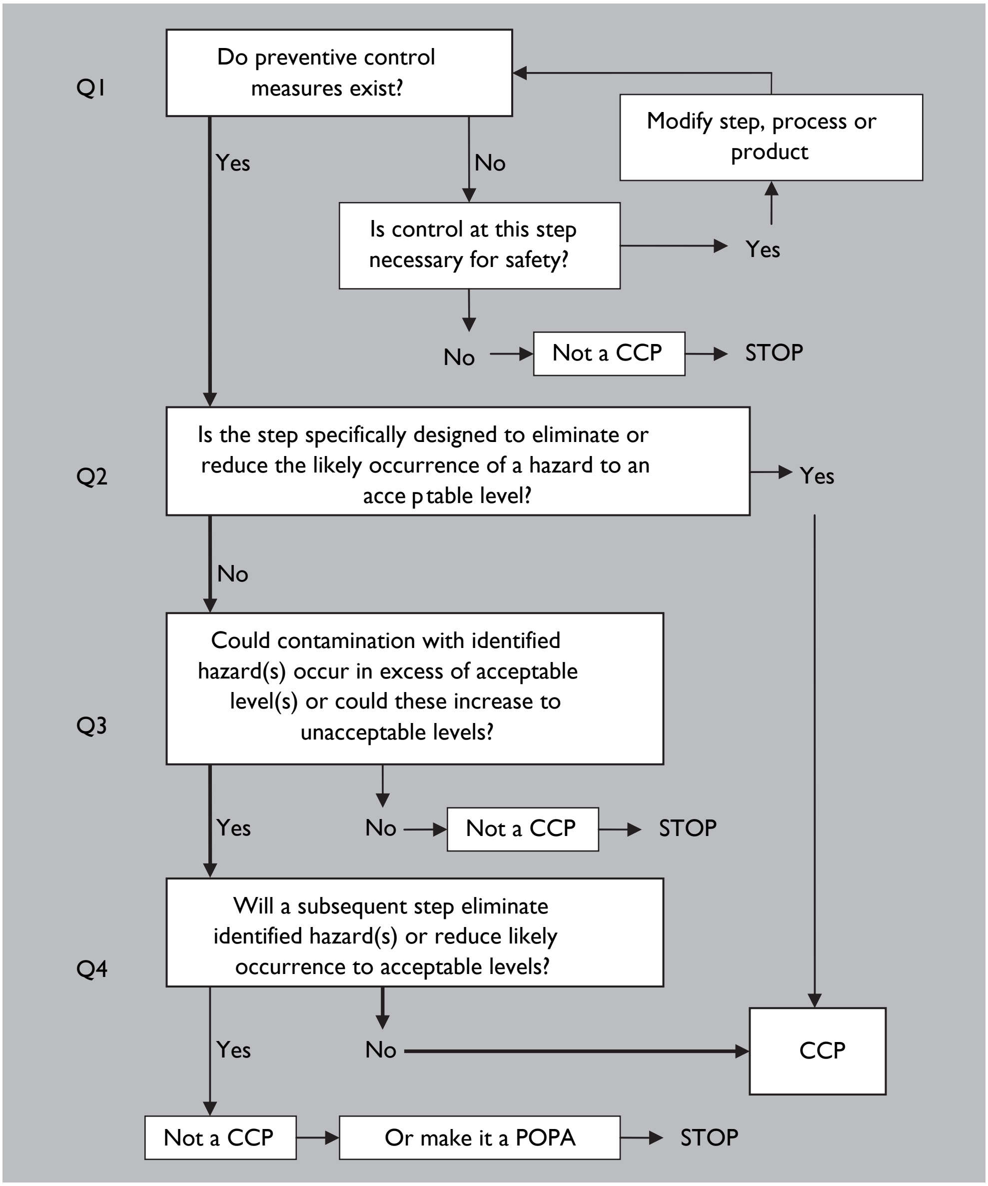


Figure 7.1. The decision-tree approach to determine whether a control point is critical (CCP) or not; in the latter case it might be defined as a point of particular attention (POPA).

vacuum level of the milking machine. It can be set at 48 kPa with ±2 kPa tolerance. Climate control in the cow barn or young stock barn has also several (physical) standards, regarding for example the ventilation capacity, the relative humidity, and speed of the air stream. When the cleaning water temperature or the vacuum level or the ventilation falls below the set standards and beyond the tolerance limits, then action is needed because otherwise certain hazards may occur. Low cleaning temperatures may induce higher bacteria counts in the milk at next milking, while a too low or too high vacuum level may induce poor milking and damage to the udder tissue, and may lead –through increased teat end callosity (TEC) possibly to mastitis (Neijenhuijs *et al.*, 2001), and, finally, poor ventilation may induce respiratory disorders and poor cow comfort, hence lowering productivity and welfare. These physical entities may be covered through electronic surveillance and bio-sensors, as is proposed in precision-dairy-farming (Berckmans, 2004).

In the situation where we deal with live animals, like cows and young stock, such standards and tolerance limits are hardly or not known. We have explained that by pointing to diagnostic tests where false-positive and false-negative test results most frequently occur. There we do not have a clear-cut break-off point; we usually set a more or less arbitrary limit by scientific agreement. Moreover, when dealing with health, welfare and other disorders, the population is our primary unit of concern, not the individual animal. In a population there is always room for a base level occurrence of disorders, even when the known risk factors do not play a substantial role. In those situations we better introduce '*targets*' instead of standards and their tolerances.

A farm-specific target for clinical mastitis cases per year could – realistically – be set at <25% while for another farm this figure would perhaps be <15% or <35%, depending on the situation that this farm has started from. A comparable target could be set for clinical lameness cases: <20% per year; or diarrhoea cases in neonate calves: <5% per year; or interval from calving to first service <70 days; etc.

It is clear that such targets have to be adjusted or updated at least once yearly, depending on the interval as defined by the *Team*. They have extensively been described in Brand *et al.* (1996). It appears highly valuable to conduct thorough inspection of the dairy farm, and to perform strengths-and-weaknesses (SWA) assessments to be able to define the farm-targets as best as possible. The SWA assessments presented in Chapter 2 will be very helpful.

The standards & tolerance limits, as well as the targets have to be defined within the HACCP-team, once the production process flow diagrams have been designed, the major hazards and risks determined, and the CCP's and POPA's identified.

Examples of CCP's and POPA's are presented in Table 7.2, and Table 7.3. The website www.vacqa-international.com comprises several standards & tolerance limits, as well as target levels for different elements in the strengths-and-weaknesses assessment

Table 7.2. Example of a part of a list of CCP and POPA, their target values, monitoring, corrective measures, and record keeping procedure for the production process step 'Cow Treatment' and the hazard of residues in milk and animal health hazard on a dairy farm. GMAP= good medicine application code of practice (as a guideline; see Chapter 3); HTAP= veterinary herd treatment advisory plan (as a working instruction; see Chapter 3).

Process step - element	CCP or POPA	Standard tolerance or target	Monitoring			Reference to Instruction	Corrective measures	Records
			how	frequency	who			
T_1	POPA	Use only proper drug	Check label properly	At each use	Farmer	GMAP HTAP	Use proper drugs; consult veterinarian	Drug record
T_2	POPA	No residues	Check the proper drug	At each delivery	Farmer	GMAP HTAP	Respect withdrawal period	Drug record
T_3	POPA	Proper dosage	Check the syringe	At each use	Farmer	GMAP HTAP	Adjust dosage	Drug record
T_4	CCP	Cow ID; no tolerance	Visual inspection	At each drug use	Farmer	GMAP HTAP	Mark the right cow	Drug record

Table 7.3. Example of a part of a list of CCP and POPA, their target values or standards, monitoring issues, reference to working instructions, corrective measures, and record keeping procedures for the process step 'Feed and Feeding Management' on a dairy farm, as related to the hazard of salmonellosis in lactating cows. PEP= pasture exploitation planning; GMP= codes of good manufacturing practice.

Process step -element	CCP or POPA	Standard or target	Monitoring			Reference to Instruction	Corrective measures	Records
			how	frequency	who			
F_4	POPA	Criteria set by lab	Check drinking water microbiological quality	> 2x yearly	Sampling by farmer; laboratory testing	Sampling Procedures	Adjust drinking water system	Lab record
F_5	POPA	Target 0	Check manure or slurry on pathogen	If suspect; otherwise 2x yearly	Sampling by farmer; laboratory testing	Sampling Procedures		Lab record
F_6	POPA	Target 0	Check cows on shedding of salmonella spp	On clinical indication; veterinary inspection	Sampling by vet + Laboratory testing	Sampling Procedures	Eradicate positive testing cows	Lab record; Health record
F_7	POPA	Target 0	Check pasture exploitation schemes to detect risk plots	2x yearly + on indication of suspect case	Farmer + vet or nutritionist	PEP		Pasture record
F_8	POPA	Target 0	Check feed harvested from pasture	On indication	Sampling by farmer; Laboratory testing	PEP		
F_9	POPA	Target 0	Check GMP and pathogen freedom for concentrates	At each delivery a GMP check	Farmer			Feed Mill record; Lab record
F_{10}	POPA	Target 0	Check purchased cattle for pathogens	At each herd entry	Farmer + vet and Laboratory	Biosecurity Plan; Sampling Procedures	Biosecurity Plan; Quarantine	Biosec record

parts for udder health, claw health, herd fertility, milk production & nutrition, and young stock rearing (see Chapter 2 for details). Such standards or targets may well be adapted to local situations due to differences in e.g. husbandry systems.

Box 7.1. Farm FX: Standards/Targets, CCP and POPA for *Staphylococcus aureus* udder infections.

The target for clinical udder infections on this farm have been set at a level of <30% cows per year; the target for *Staphylococcus aureus* clinical cow cases has been set at <25% of all clinical cases per year. As explained earlier, a formal standard with tolerance limits cannot be set for clinical mastitis. The target for average bulk milk somatic cell count was set at <250,000 per ml milk.

The major risk factors as identified in previous steps point to the application of CCP's and POPA's. The monitoring of these CCP's and POPA's is addressed in the next section on monitoring, as well as the related corrective measures.

Box 7.2. Farm FX: Standards/Targets, CCP and POPA for diarrhoea in neonate calves.

The target value for neonatal diarrhoea on this farm has been set at <5% per year calculated on the number of neonates per year. For diarrhoea as well no formal standards with tolerance limits can be set.

The hazard of neonatal diarrhoea on this farm was defined by laboratory testing as being associated with *E. coli* infections and the other identified risk factors.

It was further determined by the Farm Quality Management Team that various control measures could (strongly) reduce the incidence and prevalence of neonatal diarrhoea but not fully eliminate the risk. Hence, we deal with POPA's and not CCP's in this respect. See the previous chapter for the major risk factors identified on this farm where the POPA's should apply to. They are addressed in the next section on monitoring.

7.4. Monitoring

The CCP's and POPA's defined earlier in the design process of the HACCP-like programme are to be assembled within a unique on-farm monitoring system. Such a monitoring system comprises:

- the hazards/risks of concern;
- the step in the production process where monitoring should be conducted;
- the methods by which the monitoring is executed (e.g. observation; measuring; cow-side testing; laboratory testing; certain instruments like hearth girth measuring device for calves);
- the frequency of monitoring (e.g. twice daily; once daily; weekly; monthly);
- the person who is responsible for the monitoring (e.g. farmer; farm worker; veterinarian; nutritionist, etc); and
- the documents needed for this monitoring (e.g. hazards-and-risks-list; SWA).

Costs-benefits assessment of possible monitoring methods should determine the best choice for a given farm.

Results of monitoring are to be recorded in a special *Monitoring Results Sheet*: both the positive and the negative results. The latter are of interest because these can be handled to trigger further action, such as problem analysis or further laboratory testing. Moreover, they are handled by the persons who conduct the internal and external validation of the functioning of the HACCP-like programme.

Monitoring as described above strongly approaches the clinical monitoring as is conducted during programmes of veterinary Herd Health & Production Management (Brand *et al.*, 1996; Mulligan et al., 2007; Zaaijer and Noordhuizen, 2003). In such programmes focussed on operational management, issues regarding animal health, reproduction, productivity, welfare and cow comfort, and other management areas are frequently monitored for decision-making and action planning. Moreover, issues regarding housing and climate, or feeding and pasture exploitation, and hygiene are monitored as well because these often represent potential risk factors contributing to the occurrence of various disorders. It can, however, be stated that during these herd health programmes the monitoring approach is usually less structured, often rather qualitative in nature and less formal than in the HACCP-like programmes is demanded.

On the other hand, the integration of monitoring practices in veterinary Herd Health & Production Management programmes (HHPM) with the monitoring demands in HACCP-like programmes will assist in the adoption of the latter programme in routine management practice by the dairy farmers. HACCP approaches imbedded in HHPM can easily address operational management issues too, and, hence, reduce quality failure costs in their broadest sense. It makes the integrated approach quite efficient and cost-effective. In situations where the *Team* expects failures, one may consider the design and implementation of a specific training programme of short duration about the ways monitoring should be conducted on a given farm.

7.5. Corrective measures

Corrective measures may comprise a whole spectrum of measures for the different components, steps and CCP's or POPA's of the production process. Corrective measures must be defined as being focussed on one or more particular CCP's or POPA's and being complementary to codes of practice under the heading of *Good Dairy Farming,* as are presented in Chapter 3. However, these corrective measures are much more specific than those guidelines because they are associated with a particular CCP or POPA.

Based on the Good Dairy Farming guidelines, the *Farm Quality Management Team* can additionally design technical *working instructions* (sometimes named Operational Management Sheets) for specific farm operations like milking machine maintenance, walk-through claw bath use, working instructions within a biosecurity plan (e.g. cattle quarantine instructions; cleaning & disinfection instructions), or veterinary herd treatment advisory plans. Working instructions are highly specific for the hazard or risks of concern and must be made as farm-specific as possible too. Table 7.4 presents a shorthand comparison of HHPM and HACCP-like programme contents. Although the semantics may be the same, it must be clear that in a HACCP-like approach, key elements such as 'structure', 'formalisation', 'strict uniform procedures' and 'planning' are dictating the way that procedures must be followed. In a HHPM setting, the approach is rather qualitative and more free-style in nature.

The *Farm Quality Management Team* should take the feasibility of certain corrective measures on a particular farm into consideration. Corrective measures should not disturb the routine management procedures too much when ever possible; their execution should be feasible within the management practice on the farm. On the other hand, when alternative measures are not available, or will not result in the expected best effect, there remains little choice.

It would be optimal if corrective measures are eventually chosen following a cost-benefit assessment on the dairy farm in order to make the corrective measures chosen as cost-efficient as possible.

Table 7.4. A shorthand comparison of HHPM and HACCP-like programme contents.

HHPM programmes:	HACCP-like programmes	
Targets	Standards & Targets	
Herd inspection (cattle; environment)	Hazards identification	
Herd performance evaluation	Risk identification	
Problem Analysis	CCP's and POPA's	
Plan of Action	Monitoring scheme	
Corrective measures (advice/interventions)	Corrective measures for CCP/POPA	
Follow-up	Follow-up; recording	
Adjustment of plan of action	Adjustment of process steps	
	Internal validation	
Adjustment of managerial practices	Adjustment of managerial practices	
	External verification	
Optional: biosecurity plans	Biosecurity plans	a must
Optional: GDF guidelines	GDF guidelines	a must
Optional: working instructions	Working instructions	a must

Box 7.3 is an example of a formal Corrective Action sheet, in this case for the area of udder health & milk quality, and focussed on the aspect of 'incorrect udder preparation'.

Corrective Action Lists are designed following the same SOP rules as addressed earlier.

First, the area of concern is mentioned (teat-end preparation in the forenamed example). Next, every relevant item is mentioned on the list to avoid misinterpretation about the meaning. Third, with regard to the monitoring it must be stressed that the relevant issues should be listed (see example) also comprising the person made responsible to execute the activity. The rationale behind this set-up is that (1) there should not be any misunderstanding among the farm workers what should be done, by whom and how, (2) this corrective action list forms part of the HACCP handbook. The former puts the responsibility to at least one person in particular who can be evaluated on his performance. The latter means that it must be shown to third parties inspecting the farm for internal validation of the proper HACCP functioning, as well as to those who perform an external audit. The relevance of putting 'future measures' in this list is that these actions are preventive in nature, like the QRM programme requires.

Box 7.3. Example of a formal Corrective Action sheet for udder and milk quality.

Sheet of Corrective Action
- INCORRECT UDDER PREPARATION -

RESPONSIBLE: ....
DESCRIPTION OF THE ACTION TO IMPLEMENT:

Repeat teat-end preparation - Steps 5 and 6

MEASURES TO IMPLEMENT IN THE FUTURE:
In the 5th step - do the washing of the teats in the proper way, never washing the udder without drying
In the 6th step - only use one cloth per cow/teat and verify if they are in the best hygienic conditions

REGISTRATION:

Date and milking (Morning/ Afternoon)	Action executed	Motive presented	Person responsible

7.6. Concluding remarks

The number of critical control points and points of particular attention can be high. At all times we have to watch for overloading the farmer and his co-workers with too many CCP's and POPA's. The monitoring of these must fit into daily management routines and must be practical. A cost-benefit assessment to find the lowest costs methods for monitoring is warranted. Too costly or too much time-consuming monitoring activities will decrease the motivation of the people.

As was shown by the different Tables and Figures, the 'hazards-and-risks-list' mentioned in the previous chapter, can be expanded with the CCP's and POPA's. But also the monitoring activities, the corrective actions and the records involved can be added to that list to make it more comprehensible.

In the examples of Farm FX, as shown hereafter (Box 7.4, 7.5 and 7.6), reference can be made to specific working instructions and GDF guidelines when needed. From these last two Tables for Farm FX it can be concluded that there are –again- different formats for describing corrective actions. It will depend on the husbandry system and management features which format is to be applied.

The extended 'hazards-and-risks-list' including the CCP's, POPA's, monitoring activities, the corrective measures, and the record keeping can be considered the core component of the HACCP handbook in our Quality Risk Management programme.

Box 7.5. Farm FX: Monitoring and corrective measures for 'diarrhoea in neonate calves'.

Monitoring of birth management:
- Clean & disinfect calving pen; dry new straw bedding
- Navel disinfection immediately after birth
- Housing in individual clean disinfected box
  - visual inspection at each birth (farmer)
  - visual inspection by veterinarian each farm visit

Colostrum management:
- Immediately after birth aseptic collection of colostrum by the farmer;
  - check colostrum quality (IgG) by colostrometer in each dam (farmer)
- Supply 2 L good colostrum within 2 Hrs after birth
- Supply 5-6 L the first day, and subsequent 2-3 days too
  - check serum IgG level in calves in risk period (veterinarian by refractometer or at laboratory)
  - surplus colostrum of good quality can be stored in freezer with date, dam identification (farmer)
  - visual inspection on signs of clinical disease (diarrhoea) at least twice daily (farmer)

Additional measures can be found in the working instruction on 'Hygiene in the calving pen and around birth' and the code of practice on 'Good Medicine Application' (see in chapter 3)

Box 7.4. Farm FX: Monitoring and Corrective Measures for '*Staphylococcus aureus* udder infections'.

The monitoring of the respective CCP's and POPA's for Farm FX, as well as the corrective actions and records to be kept are developed for Farm FX.

Step of the process of production		Hazard identification	Probable occurrence	Preventive measures	CCP POPA	Critical Limits ´or Targets´	CCP'S Monitoring	Corrective Actions	Records
Stage 2	Step 4	MH3 contamination from the hands of the milker	Yes	Use of gloves or keep the hands in conditions of hygiene	CCP4 POPA4	Validation of the critical limits by taking samples from hands or gloves Score ≤ 1	Samples taken by the responsible of the milking process, 1xweek in the milking process	Clean the hands/gloves of the milker	See protocol of GDF and records of observation
		MH4 improper washing	Yes	Only wash the teat-end Minimal water should be used	POPA5	Minutes spent in the washing; temperature of the water	Monitoring of the time and temperature by the responsible of the milking process, 1xweek in the milking process	Repeat teat-end preparation	See protocol of GDF and records of observation
		MH5 poor quality of cleaning water	No	Guaranty of water quality	POPA6				

Box 7.6. Farm FX: Monitoring and corrective measures for some calf rearing problems.

Some risk areas, their target levels, CCP/POPA, and the monitoring scheme are presented, as well as intervention activities and prevention.

The terms GI, GMA, GH and GCFP in the last two columns refer to guidelines and working instructions (see also Chapter 3).

Proces-step	Hazard	Farm specific		CCP/ POPA	Monitoring				Intervention	Prevention
		Norm/ target & tolerance	Risk chance P*I		How to check	Where/ when to check	Check freq	Who checks		
A1	Birth problems	<5%		POPA	Manual/ History	Calving pen		Farmer/ advisor	Follow GI1	
A4	Wrong identification calf	Within 3days		CCP	Record keeping	Calf pen	Before day 3	Farmer/ advisor	Immediate tagging or before day 3	Follow worksheet ID
B5	Diarrhoea in neonate	<2%		POPA	Visual / clinical signs	During feeding	Daily (twice)	Farmer/ advisor	Follow GMA1	Follow GH1
B6/C2	Aberrant naval	<2%		POPA	Palpation	After feeding	Daily (twice) during first week of life	Farmer/ advisor	Follow GI1	
C6	Wrong extra-teat removed	0%		CCP	Visual	Before teat removal	Once after dehorning	Farmer/ advisor	Follow GI1	
D1/2	Poor weight gain	<10% calves beneath target-weight -70-80 kg at 2 mo (weaning)		POPA	Heart girth measurement	Before weaning	Once at 8 weeks (depending on length milk replacer period)	Farmer/ advisor	Inform advisor	Follow GCFP (GCF1+2)

Annex 7A. Examples of CCP and POPA, norms and tolerances, targets, monitoring and corrective measures

In this Annex you will find some more examples of CCP and POPA definition, standards & tolerances, target levels, monitoring and corrective measures in the area of Feed & Feeding Management of a particular dairy farm. These examples may further assist in designing the appropriate HACCP-like lists for the dairy farm.

Table 7A.1. Example of some of the hazards identified on a dairy farm as related to feed and feeding management, associated weighted risk factors, and definition of CCP or POPA.

Hazard type	X	Associated risk & weighing Probability x Impact = Risk level[1]	CCP or POPA	Standard & tolerance; target
Pasturing & Grazing:				
Poor grass growth	A	1 x 2 = 2	POPA	Optimise
Toxic plants in/around grassland	V,A,W	1 x 2 = 2	POPA	Zero
Heat stress	A, W	2 x 2 = 4	POPA	Optimise
Infection transfer at pasturing from cattle to young stock	V, A	2 x 3 = 6	POPA	Zero
Fungi on grass (mycotoxins)	V (A)	1 x 3 = 3	POPA	Optimise
Harvesting & Silaging:				
Oil leakage at silaging (dioxins)	V	1 x 1 = 1	POPA	Optimise
Agent transmission through dirty hired equipment	V, A	1 x 3 = 3	POPA	Optimize
Fungi formation in corn silage (mycotoxins)	V, (A)	2 x 3 = 6	POPA	Optimise
Agent transfer through manure contaminated feed	V, A	1 x 2 = 2	POPA	Zero
Traumatic reticulitis due to feed	A	1 x 3 = 3	POPA	Zero
Chemically or microbiologically contaminated drinking water	A, W	2 x 2 = 4	POPA	Optimise

X = main area of concern; V = veterinary public health/food safety; A = animal health/productivity; W = animal welfare

[1]three levels are identified: high risk; moderate risk and low risk. Note that the outcome applies to this particular farm and not to all farms.

Table 7A.2. Examples of monitoring elements in the area of feed and feeding management, methodology, frequency and person responsible (see also Table 7A.2).

Hazard	Monitoring item	Methodology	Frequency	Responsible person
Poor grass growth	Check botanic composition; seed selection and seeding process; water drains; grassland management	Visual Information check Visual; calendar	At start + during season Before start + during season From 2 to 4 times per year	Farmer
Toxic plants in pasture	Check for toxic plants in season	Visual	Once every 2 weeks	Farmer
Heat stress in pasture	Check for shadow facilities	Visual	Once a year	Farmer
Infection transfer at pasturing from cows to young stock	Check interval between grazing cows and young stock; check grazing plan	Visual Calendar	Each grazing plot change From 2 to 4 times per year	Farmer
	Serology or culturing	Laboratory		Veterinarian
Mycotoxins in pasture	Check soil management; insects; harvesting season; seed selection and safety; grassland improvement plans	Visual Calendar	From 2 to 4 times per year Season related In season: 2 times	Farmer

Table 7A.3. Examples of corrective and preventive measures to respectively restore lost control, eliminate risk factors or reduce their impact (see also Tables 7A.1 and 7A.2).

Hazard type	Monitoring Results	Corrective Measures & Prevention
Poor grass growth	Botanic composition is poor	Check water drainage and correct when needed Check grassland management practice: adjust stocking density; adjust timing of cows in/out pasture plots (use calendar & planning); adjust application of fertilizer Check seed selection and seeding practice; adjust choices or practices
Toxic plants in pasture	Toxic plants detected	Eliminate these plants; apply proper chemicals in right dosage and at the right time If the neighbour is involved, contact him about joint action, otherwise apply double fencing
Heat stress in pasture	Heat stress occurs; no shadow	Keep cows in barn during day-time, pasture them at night Provide extra drinking water and ample ventilation Consider planting trees or shadow facilities
Infection transfer from cows to calves in pasture	Infection transferred	Cure diseased animals; check veterinarian Prevent next transmission by separating calves from cows grazing
Mycoses in pastures	Fungi found	Adjust time of harvesting grass and maize; do not damage the plants Apply proper soil management practice: plough back stubbles Check plant seed quality and seed disinfection Apply weeds control; apply plot-oriented fertilising Use fungicides when deemed necessary

Chapter 8. Support programmes in a HACCP-based Quality Risk Management programme

8.1. Introduction

Developing and implementing a Quality Risk Management, QRM, programme which is based on the concept and principles of HACCP requires *preparatory activities, as well as supportive activities*. The former have been highlighted in Chapter 2 on the inventory of strong-and-weak points on a dairy farm and in Chapter 3 on Good Dairy Farming guidelines. Moreover, it has been pointed out that an operational veterinary Herd Health & Production Management, HHPM, programme on the dairy farm (Brand *et al.*, 1996; Mulligan et al., 2007) will, when executed in a professional way, facilitate the development and implementation of a HACCP-based QRM programme, and as such it could be considered as a preparatory activity. This is caused by the fact that record-keeping, monitoring of animals and their environment, interventions, actions for the short and the longer term, and reporting already form part of these HHPM programmes (Radostits, 2000).

In addition to these preparatory activities, a HACCP-based QRM programme will require *support programmes* in order to facilitate the smoothly running of this QRM programme, once it is implemented.

Among these *support programmes* the following components can be distinguished:

- Yearly strategic planning issues of the dairy farm business (8.2).
- Economics (8.3).
- Herd Health & Production Management programmes, HHPM (8.4).
- Cattle welfare & Cow Comfort (8.5).
- Technical training programmes for farmer and farm workers (8.6).
- Human resource management & working conditions for employees (8.7).

The different support programme components are separately addressed hereafter.

8.2. Yearly strategic planning of the dairy farm business

In the yearly strategic planning are comprised elements like objectives for the next year for the different farming areas, and an evaluation of the performance of the past year (see also the various paragraphs in Chapter 12). Moreover, other domains can be addressed in strategic planning, such as farm economics related to disease occurrence, aspects of udder health control, fertility management, claw health and dairy replacement rearing (Esslemont *et al.*, 1985; Waltner-Toews *et al.*, 1986; Heinrichs, 1993; Mulligan *et al*.,2007). Brand *et al.* (1996) have described the 'management planning circle' comprising the setting of targets for various farming areas (e.g. udder health, claw health, calf rearing, herd fertility, production), the determination of materials and methods necessary to achieve the targets, the evaluation of performance figures in the respective farming areas, and the adjustment of targets, management practices or methods when targets have not been achieved.

Planning also comprises the definition of contracts with suppliers and buyers, and with contractors. The latter are for example those who execute particular jobs on the farm like grass or corn harvesting and silage making, ploughing and renovation of grassland, manure collection and spreading over the pasture plots. This usually refers to seasonal work, meaning that many other farmers would require such contractors to execute these tasks. It is highly indicated to design contracts with those people to be sure that the planned work is carried out indeed and in periods the farmer likes them to.

In daily management procedures several aspects return seasonally. Sometimes these aspects are detected through performance problems encountered on the dairy farm, some other times they are seasonally bound to certain months in the year, and again other times they are to be addressed from a prevention point of view.

For those situations, a *yearly farm management action planning chart* can be very helpful for daily farm management. A general example for a particular dairy farm is given in Figure 8.1. Another example for the area of feed and feeding management to be filled in by the farmer is given in Figure 8.2. The *Farm Quality Control Team* is the body to discuss about and compose such wall charts and revise it each year. Charts like those presented in Figures 8.1 and 8.2 are visualising periodical and planned activities; they will help the farmer and farm-workers to remind the planned actions and execute them in time. The charts may also serve the evaluation the following year (see also Chapter 9 on internal validation).

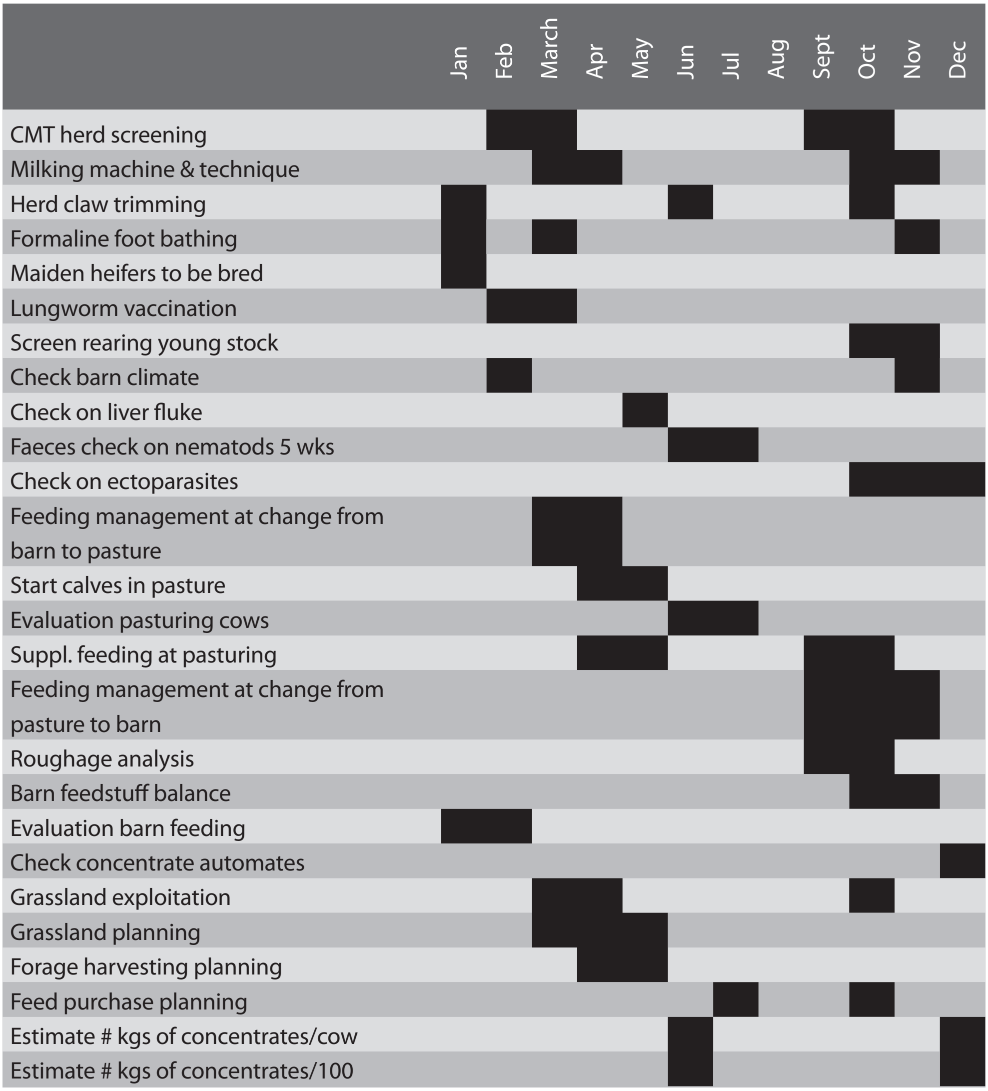


Figure 8.1. Example of a Farm Management Planning Calendar for general health and nutrition.

Action	Handbook item #	Frequency	JAN	FEB	MRCH	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Grassland management		2x/yr												
Grazing system evaluation		1x/yr												
Harvesting procedures		1x/yr												
Harvesting equipment		1x/mo												
Silage making procedure		1x/2 mo												
Silage sampling		1x/yr												
TMR weighing calibration		1x/mo												
Silage contamination		1x/mo												
Feeding automates calibration		1x/3 mo												
Feed rack maintenance		1x/6 mo												
Feed bunk maintenance		1x/6 mo												
Hygiene & maintenance equipment		1x/3 mo												
Test water for cattle		1x/yr												

Figure 8.2. Example of a Farm Management Action Planning wall chart for the area of Feed and Feeding Management (handbook item refers to a specific paragraph and item in the HACCP-based-QRM handbook on the farm).

8.3. Economic losses due to health and production disorders

A generally accepted definition of economics is: '*Economics is the science that is working on how individuals and society make choices to employ scarce resources over possible alternative uses*'. The three key elements in this definition are choices, scarcity and alternatives. Economics strives to support decision making (making choices) on e.g. a farm. Making decisions is necessary when resources are scarce, which in economic terminology means that resources are finite. Three types of resources are generally distinguished: natural and biological resources (land), human resources (farm labour) and manufactured resources (capital). These resources can be employed for different activities. Within a farm, capital can be used to expand the number of dairy cows, but can also be used to improve the hygiene in a barn. Since capital is 'scarce', choices have to be made where to employ it. Economic analysis aims at supporting those decisions (H. Hogeveen and A.G.J. Velthuis, 2007, personal communication).

The *assessment of economic losses* due to health-, welfare- and production disorders in cows and or young stock, or due to milk quality failures, is another component of farm planning. Because of the chronic nature of production disorders, economic loss is spread over the year, and the economic loss of certain factors, such as milk production decreases, cannot directly be seen. Farm accounting reports give all kinds of detail about the costs of production but these are in terms of feeding costs, machinery costs, costs for animal improvement, etc. The factor health costs only comprise costs for drugs and the veterinarian, which is only a small proportion of the total economic loss of a production disorder as will be shown later. The total costs of disease can be large. For instance, for the Dutch dairy situation, it was estimated that the costs of health and fertility problems account for 10% of the gross production value (Dijkhuizen, 1990).

A proper understanding of the costs of a disease is important to support decisions of farmers with regard to e.g. animal health. It is important that this understanding goes beyond the knowledge of costs of a disease as it is given by calculations of others. All calculations of costs of disease and cost-effectiveness of preventive and curative measures can be regarded as averages for a certain situation. Costs of disease vary from farm to farm. This is not only dependent on the incidence of disease but also on the level of cost factors (Huijps *et al.*, 2007). In order to support decisions of farmers, the advisor must be able to interpret such published data to translate them to the specific situation of an individual farm. Therefore, insight in the theories behind economic calculations in the field of animal diseases is necessary. For that purpose we refer to publications by Dijkhuizen and Morris (1996), McInerney (1996), Mourits et al. (1997), Huirne *et al.* (2002) and Tozer and Heinrichs (2001).

Under practical circumstances it is very difficult to make an estimation of the costs of disease, because production functions differ between farms; moreover, many farmers do not optimise production. In this paragraph, we will therefore be pragmatic and consider the factors that determine the cost of disease as they are described by Halasa *et al.* (2007). In their paper, economic consequences of (clinical or subclinical) mastitis were described. Their framework is applicable to production diseases in general. They distinguish factors (Table 8.1). Although the relative cost of the factors might differ between countries and between regions, the economic principles behind them are the same and will be explained below.

8.3.1. Production losses

Milk production losses are the most important part of this factor. Most diseases give a more or less substantial loss in milk production and affect the output of a farm, given a certain level of input, directly. The economic damage of a lower milk production per cow depends on the structure of the farming business. Milk payment systems may differ (payment based on kilograms of milk or kilograms of milk components such as fat and protein, or milk quality features such somatic cell count level and bacteria counts). Moreover, the calculations of the economic damage due to decreased milk

Table 8.1. An overview of the factors relevant in calculating disease losses (after Halasa et al.*, 2007).*

Production losses	Labour
Veterinary services	Product quality
Diagnosis setting	Other diseases
Veterinary medicinal products	Culling
Discarded milk	Investments in prevention

production differ between a quota system (as applied in the EU countries) and a non-quota system. Diseases might also lead to weight decrease of animals and that would give a decrease in meat production, which is a side product of the dairy production. Moreover, reproductive problems many times have an effect on the calving interval and thus on the production of calves. The associated damage of a loss in meat and calf production is relatively easy to calculate using the price of meat and calves.

8.3.2. Veterinary service

Besides delivering drugs (in many countries still an important veterinary practice service), the veterinarian spends time on setting a diagnosis of a disease. Veterinary service may be mandatory for each treatment, if required by national legislation, or is only provided upon request by the farmer.

8.3.3. Diagnosis setting

Costs for diagnostics can be made in some circumstances by either the veterinarian or the farmer himself. An example of often applied diagnosis is the use of bacterial culturing to get more insight in the cause of mastitis.

8.3.4. Veterinary medicinal products

Drugs necessary to treat infected or affected animals are a direct cause of economic damage, owing to their direct cost, and indirectly through increased treatment labour costs. The cost of drugs varies between countries, depending on the legislation and the infrastructure of the country.

8.3.5. Discarded milk

Economic damage due to discarded milk is comparable with that from decreased milk production. However, there is one difference: the discarded milk is actually produced by the cows, which means that feeding costs for that amount of milk have to be taken into account in the calculations, as well as in the calculations for milk production loss. The economic damage of 100 kg of discarded milk is therefore larger than for 100 kg of decreased production.

8.3.6. Labour

Cost of labour is difficult to interpret. Opportunity costs of labour may differ from farm to farm. If the labour is external, then the cost of labour for the time that has been used to prevent mastitis is quite easy to calculate (hours x hourly wage). If the labour comes from the farmer's free time, the opportunity costs are zero. However, if because of disease the farmer spends less time on other management tasks, the opportunity costs are the decrease in income due to skipping these tasks. Although hard to estimate correctly, the loss of labour joy represents a major loss on dairy farms affected by diseases.

8.3.7. Product quality

This factor includes meat and milk quality. Some diseases (especially mastitis) have an effect on the quality of milk. The associated economic damage is difficult to calculate and the direct effect of this economic damage for the individual dairy farmer is even more difficult to estimate. The only changes in milk quality that have a direct effect and can be estimated, are the factors that are part of the milk payment system, for instance, bacterial count and somatic cell count. Bacterial count and/or somatic cell count do change with the mastitis status of a cow and therefore, in most countries, there is a regulatory limit (payment schemes or *bonus/malus* type of systems) for bulk milk bacterial count and bulk tank somatic cell count. Another milk quality factor that can be affected by diseases is antimicrobial growth inhibition in milk due to antibiotic residues. The costs for decreased milk quality depend on the milk quality payment scheme that is used, but these costs can be considerable.

8.3.8. Other diseases

The factors described above (milk production losses, drugs, discarded milk, veterinary service, labour, product quality, diagnostics) can be regarded as direct costs of diseases. Besides these direct costs, cows with a certain disease may be a risk factor for other animals. In the case of infectious diseases, this is due to the shedding of bacteria or viruses, which can spread a disease. Within an animal there might also be an association between specific diseases and other cattle diseases. Ketosis is for instance a risk factor for mastitis (Swinkels *et al.*, 2005). The proportion of disease, which is caused by one animal that was diseased, can be regarded as indirect costs of that disease.

8.3.9. Culling

Culling is a difficult factor to estimate since it is a result of other effects (except in the case of death from causes other than culling). Culling is a decision of the dairy farmer. A cow is culled when replacement is the optimal decision. Cows with diseases have a higher risk of being culled. The cost of premature replacement of animals due to mastitis is probably one of the largest areas of economic loss. However, it is very difficult to calculate precisely (Lehenbauer and Oltjen, 1998). When a cow is culled, there are direct costs that are the costs of rearing or buying a replacement animal (mostly heifers). Indirect costs are e.g. a decreased efficiency of milk production by the replacement animal, since the milk yield of multiparous cows is higher than that of primiparous cows (although the genetic milk production potential may be higher in lactating heifers than in multiparous cows). Moreover, the milk production of a lactating heifer might be disappointing (lactating heifers have a relatively high culling rate). On the other hand, there are returns of culling a cow like the price of meat, and – indirectly – a better herd production efficiency and an improved labour joy after a cow was culled which needed much attention and care. The costs of involuntary culling differ over time, depending on milk production, parity, lactation stage and reproductive status.

8.3.10. Investments for prevention

Disease management includes the use of materials and commodities that cost money. These materials can be either renewable (for instance disinfectants and drugs could be seen as a specific type of renewable materials) or non-renewable (for instance a new milking parlour). The purchase of renewable materials has short term economic consequences and the costs can be easily calculated. The purchase of non-renewable materials has long-term consequences. Purchase costs have to be divided over various years by depreciation. Moreover, because capital is tied up by such purchases, interest rates have to be calculated as well. Finally most non-renewable materials require maintenance and this also generates costs. Although the benefits in terms of reduced disease incidence may outweigh the costs of these materials and investments, this cost factor is part of the costs of disease.

8.3.11. Cost calculations for some diseases

There is a wide range of methods available to calculate the costs of disease and the economic efficiency of disease control measures (Dijkhuizen *et al.*, 1991). In this paragraph these methods will not further be explained. Moreover, in the scientific literature numerous papers have been published on the economic effects of disease and the cost-effectiveness of disease prevention. It goes too far to give a complete review of the costs associated with all diseases in dairy production. We will just give a few examples of recent calculations on animal diseases:

- the cost of mastitis on a dairy farm;
- the cost-effectiveness to treat subclinical mastitis with antibiotics; and
- the cost of ketosis on a dairy farm.

The costs of mastitis: Several reports have addressed the economic losses as related to mastitis and udder health management (Hogeveen and Osteras, 2005; Swinkels *et al.*, 2005). In a recent study (Huips *et al.*, 2007), costs of mastitis were calculated for average Dutch circumstances (Hogeveen and Osteras, 2005). The average costs for a case of clinical mastitis were estimated to be € 210, varying from € 235 for clinical mastitis in the first month post partum to € 164 for clinical mastitis in the last part of lactation. The costs for subclinical mastitis were dependent on the number of cows with an increased somatic cell count and were due to milk production losses. For a farm with an average production of 8,500 kg per 305 days, these costs varied from € 53 per cow per year when the bulk milk somatic cell count was lower than 100,000 cells/ml to € 120 per cow per year when the bulk milk somatic cell count was higher than 400,000 cells/ml. Using an average incidence for clinical mastitis (30%) the total costs of mastitis for a Dutch dairy farm with 65 cows were calculated to differ from €7,453 (bulk milk somatic cell count lower than 100,000 cells/ml) to €11,808 (bulk milk somatic cell count larger than 400,000 cells/ml). Costs for production losses are the largest proportion (53%) of these costs. Some of the assumptions made for this basic calculation can be found in Table 8.2.

As stated before, the economic consequences of disease may differ between farms. Moreover, the incidence and severity of disease may also differ. To illustrate this, data have been collected on 64 dairy farms. The incidence of clinical mastitis differed largely between farms (see Table 8.2). The bulk milk somatic cell count and thus the number of cows with an increased somatic cell count, also differed largely between farms. From an economic point of view the variation in costs of, for instance, milk production losses, labour and culling is much more interesting. The costs associated

Table 8.2. Costs of mastitis calculated for the average Dutch situation (Basic) and according to data collected on 64 Dutch dairy farms. The mean, minimum and maximum values are presented (after Huijps et al.*, 2007).*

		Farmers data		
	Basic	Min	Mean	Max
Farm size (number of cows)	65	28	83	160
Farm size (kg quota)	650,000	195,000	702,621	1,500,000
Yearly mastitis incidence (%)	30	6	29	100
Bulk milk somatic cell count (cells/ml)	200,000	60,000	178,484	300,000
Costs milk production losses (€/kg)	0.12	0	7.47	12
Costs per visit of veterinarian (€/visit)	20	0	23.50	100
Costs of drugs (€/treatment)	20	5	33.18	110
Value of farmer's labour (€/hour)	18	0	18.83	200
Costs of culling (€/culled cow)	480	0	382.50	750
Total costs for mastitis (€/cow present)	80-185	17	78	198

with a decreased milk production due to disease differed from 0 to 12 cents per kg (under quota circumstances). Also the costs for labour differed largely between farms (0–200 € per hour). In these costs for labour, some farmers did not look at opportunity costs per se, but took also the willingness to pay to prevent the labour associated with clinical mastitis into account. A large variation could be seen in costs for culling. Under practical circumstances, the costs for mastitis per cow present on a farm varied between € 17 and € 198.

Costs of treatment of subclinical mastitis cases due to Streptococcus uberis*:* Traditionally, subclinical mastitis cases are not treated with antibiotics except during the dry period. However, recently this practice seems to be changing. By some veterinarians, treatment of some types of subclinical mastitis is regarded to be effective. Various factors play a role on the cost-effectiveness of treatment, amongst others probability of spontaneous cure, probability of the cow becoming clinically diseased, spread of infection to other cows, cure rate under treatment and physiological effects of the infection. Since the decision on antibiotic treatment of subclinical mastitis involves much uncertainty and variability, the economic calculations were carried out with a stochastic Monte Carlo model (Steeneveld *et al.*, 2007). This model simulates the dynamics of an infection for a cow known to have subclinical mastitis caused by *Streptococcus uberis*. Besides the effect of treatment on the infection status and economic damage of the cow, possible infections in other cows are also taken into account. The average economic damage (with basic input parameters) when a cow with chronic subclinical *Streptococcus uberis* mastitis (diagnosed after 2 subsequent cow somatic cell count measures above 250,000 cells/ml) is not treated is € 110 (Table 8.3). With treatment, the average damage was higher, € 122, with a long (8 days) treatment, the average damage was even more higher. For the average cow, treatment is not economically efficient. The reduced costs for milk production losses, clinical flare-ups and culling did not outweigh the additional costs of drugs and discarded milk. However, the spread of economic damage indicates that the risk of high damage is much higher when a cow with chronic subclinical mastitis caused by *Streptococcus uberis* is not treated. This indicates that, although for the (Dutch) situation on average treating a subclinically *Streptococcus uberis* infected cow is not cost-efficient, the economic risks are higher when a cow is not treated.

Costs of ketosis: An interesting aspect of ketosis is that ketosis does increase the risk of clinical mastitis and left displaced abomasum. In a recent Dutch study, costs of (clinical and subclinical) ketosis were calculated using a Monte-Carlo simulation model to simulate a herd with 65 dairy cows (Shrestha *et al.*, 2007). Costs for ketosis were calculated for a situation with and without a milk quota (Table 8.4). Incidence of clinical ketosis was 3.5%, while the incidence of subclinical ketosis was 6.7%. The resulting yearly costs due to ketosis were estimated to be respectively € 1,778 and €

Table 8.3. Economic consequences (in euros per case) of chronic subclincal mastitis caused by Streptococcus uberis after the day of diagnosis as calculated under default circumstances (after Steeneveld et al.*, 2007).*

	No treatment[2]	Treatment[2]
Costs of drugs	0	27
Costs of discarded milk	0	21.42 (8.45, 37.57)
Costs of milk losses during subclinical infection	6.59 (0.65, 19.07)	3.33 (0, 15.11)
Costs milk losses after infection	20.74 (0, 51.42)	25.85 (0, 58.81)
Costs of clinical flare-up	9.75 (0, 58.20)	4.51 (0, 48.95)
Costs of culling	41.03 (0, 377.55)	22.73 (0, 220.08)
Costs of newly infected cows[1]	31.81 (0, 124.54)	16.69 (0, 76.75)
Total costs	109.92 (4.41, 473.09)	121.53 (39.85, 394.26)

[1]Including costs for milk production losses, clinical mastitis and culling.
[2]Average and (between brackets) 5% and 95% percentiles are presented for when treatment as well as no treatment is given respectively.

2,353 for a situation with and without a milk quota. As can be noticed from Table 8.4**,** natural occurring variation did give a large difference in costs per year. The largest proportion of costs is caused by milk production losses. However, culling give the highest risk of high costs. The costs due to increased risk of other diseases as mastitis, left displaced abomasums and decreased fertility are substantial, but in relation to the costs due to milk production losses and culling relatively low. Under a non-quota situation, costs for milk production losses are higher than under a quota situation (see Table 8.4)**.**

On a dairy farm, production diseases are responsible for a large part of the cost price of milk. To support the decisions concerning health and disease, an understanding of the economics of diseases is important. It is not enough to use an average cost calculation per case of disease and multiply the number of cases with that average cost figure. It is paramount to understand the principles behind the farm economics, so that farm-specific calculations can be made. Knowledge about basic economic principles, such as the production function, is therefore relevant. At this moment, economics are only 30-40% of the motivation of dairy farmers to change mastitis management (Valeeva *et al.*, 2007). This might also be the case for other disorders. However, in European dairy farming, the forces of the free market are going to play an increasingly important role in the income of the dairy farmer. Therefore, the costs of production and thus the animal disease status will become more and more important.

Table 8.4. Dynamics of ketosis and other disease events caused by ketosis and the resulting economic effects for a Dutch dairy farm with 65 cows under quota and non-quota circumstances. The mean, 5 % percentile and 95 % percentile are presented (after Shrestha et al.*, 2007).*

	Quota			Non quota		
	5%	Mean	95%	5%	Mean	95%
Dynamics						
Probability of clinical ketosis	1	3.5	7	1	3.4	7
Probability of subclinical ketosis	3	6.6	11	3	6.8	11
Probability of culling (%)	0	2.0	6	0	2.0	6
Probability of mastitis (%)	0	0.6	4	0	0.6	4
Probability of LDA (%)	0	0.13	0	0	0.15	0
Probability of Cystic Ovary (%)	0	0.16	0	0	0.15	1
Costs						
Costs of milk losses (€)	405	807	1,267	678	1,366	2,149
Costs of culling (€)	0	751	2405	0	1,172	3,902
Costs of mastitis (€)	0	120	840	0	115	840
Costs of treatment (€)	0	78	300	0	73	250
Costs of left displaced abomasum, LDA (€)	0	16	0	0	18	0
Costs of prolonged calving interval (€)	0	6	26	0	6	25
Costs of feed (€)	-	-	-	-624	-396	-197
Total costs (€)	1,588	1,778	3,506	702	2,353	5,170

In this respect the goal with regard to animal health should not be a maximum level of animal health, but an economically optimal level of animal health.

8.4. Herd Health & Production Management programmes (HHPM)

8.4.1. General elements regarding HHPM

Programmes of HHPM have been extensively described by Brand *et al.* (1996) and De Kruif *et al.* (2007). In the following section we, therefore, only highlight some aspects of direct interest because they are related to the implementation of HACCP-based Quality Risk Management programmes.

HHPM comprises 3 main components:

1. an elementary programme of *routine monitoring* of animals, farm conditions & management, and available data;

2. an advanced programme for *problem analysis and solving* on the farm (e.g. udder health; claw health; metabolism & nutrition related disorders)
3. preventive actions regarding disorders in different farming areas.

The following activities are envisaged during the implementation of HHPM programmes:

1a. Activities at the start:

- Conduct a *strengths-weaknesses assessment* in the different farming areas, like milk production, nutrition, milk quality, udder health, lameness, reproduction, calf rearing. The VACQA-International website provides means for such actions (see Chapter 2).
- Discuss with the farmer the *different priorities* among detected weaknesses to approach. Some should have higher, others lower priority (see also Chapter 2). Set targets for each area.
- *Explain* to the farmer the way this programme is set up and conducted by the veterinarian during and after planned *farm visits*. Settle the fees for visits and follow-up activities (e.g. hourly fees).
- Start at the first farm visit the *monitoring component* of the programme.

1.b. The monitoring component of the programme

Irrespective whether there is a herd problem or not, the routine monitoring of animals, farm conditions & management, and available data should be done during each farm visit (see also Chapter 2 on the VACQA website elements of monitoring). This activity should be well-planned in time and properly executed.

The *ultimate objective* of this monitoring is to obtain *signals* that certain areas of farming are either performing as desired, or show room for improvement, or even deserve immediate attention. It refers to a rather qualitative approach of pending herd problems in trying to detect such in an early stage. Monitoring should also be used to *evaluate* the outcome of advice given earlier, for example to see whether body condition has been restored again, or whether nutrition efficiency has been improved over the past period. Monitoring provides means to have a continuous insight into the production process in its various features and to support control of the production process, like the early warning in a HACCP-based QRM.

Examples of monitoring in the three different areas are:

Animals:

- Body condition scoring, BCS
  - Rumen fill scoring, RF
  - Faeces consistency scoring, FC
  - Scoring undigested fraction in faeces, UFF

- Teat end callosity scoring, TEC
- Growth rate checks on young stock (by weight scale or heart girth measurements)
- Reproductive examinations (and findings like cystic ovarian disease)
- Clinical disease cases as indicator (e.g. ketosis & acidosis for nutritional disorders; negative energy balance as related to reproductive disorders)
- Locomotion scoring
- Cow hygiene scoring (udder and hind legs)

Farming conditions & management:

- General hygiene practices at farm entrance, on farm premises, and in barn, at feed bunk, cubicles, alleys
- Housing conditions (including maintenance)
- Barn microclimate (ventilation; temp; relative humidity)
- Hygiene in milking parlour
- Milking hygiene and practice of milkers
- Ration composition and feeding management
- Grassland management
- Feed storage (grass and corn silage quality)
- Colostrum feeding management

Data inspection:

- AI information on sires
- Milk recording data (kgs; milk fat; milk protein)
- Milk quality data (cell counts; bacteria counts; other)
- Analysis of different feedstuffs (roughages and concentrates)
- Result sheets from laboratories (including autopsy results)

After conducting the monitoring, one has to carry out an interpretation of all findings (synthesis). When deemed necessary, sampling for additional laboratory examination is done (e.g. blood, milk, faeces, urine) and a herd probability diagnosis is set. On the basis of this herd probability diagnosis a Plan of Action is designed with advice and intervention for the short and the longer term. This plan of action is discussed with the farmer on feasibility and practicality before it is finalised. In some cases it is beneficial that the veterinarian makes cost-benefit calculations to show the foreseen outcome of certain actions After the start of the intervention or advice activities, a date for follow-up farm visits is fixed. In cases where monitoring points to a current problem, it is indicated that a more in-depth analysis of the particular farming area is started (see below at 2).

Monitoring activities appear to make a farmer more aware of issues that take place on his farm and contribute to reduce 'farm blindness'. This is the socio-psychological part of its use.

2. Advanced programmes for problem analysis and solving
Once the routine monitoring programme part has been established, it is time to move onwards to problem (if any) analysis, based on the strengths-weaknesses assessment and the subsequent discussion on priorities in problem approach with the farmer.

The following steps are distinguished (see also the schematic overview in Figure 8.3):
Step 1: what is the complaint of the farmer exactly? (*drop in milk production*).
Step 2: specify this complaint into more detail: what problem exactly affects which cows since when, where, in what signs expressed, and which changes have occurred before the signs became manifest, and is this complaint cyclic over the years or seasons?? *(drop in milk production kg since cows were turned into pasture, it mainly affects the older cows in late lactation)* Check the available data sources on the farm for validating the complaint.
Step 3: conduct a thorough inspection of the animals: the herd in general + the specific problem group. Check also farm conditions and managerial issues as indicated by the problem definition under step [2]. Farm conditions and management often regard risk factors contributing to the disorder. The strengths-and-weaknesses assessment, carried out in the beginning of HHPM could be used as basis for further in-depth analysis!
Step 4: classify the obtained information according to animal-related issues; management-issues; farm conditions related issues.
Step 5: design a differential diagnoses list in order of relevance from 1 to 5.
Step 6: exclude diagnoses from the list of step [5] or confirm them, e.g. by sampling animals and subsequent laboratory investigations. If needed call third parties for additional advice, e.g. nutritionist or milking machine engineer.
Step 7: design a probability diagnosis for each particular component of the complaint *(e.g. reproduction problem like suboestrus could be caused by lameness and/or negative energy balance).*
Step 8: set up a draft-action plan for the shorter and the longer term including interventions when indicated.
Step 9: discuss this action plan with the farmer, and check feasibility and acceptance level. Adjust the plan when needed, put the date and the names of those who agreed.
Step 10: indicate a time window for the follow-up, and describe what the farmer is expected to do and what not; the same for the vet or other advisors. Indicate prognosis and expectancies; tell which animals can serve as improvement indicators and which cannot. Check improvement or other performance yourself during each follow-up visit to the farm. The follow-up window may comprise weeks or months; at least one visit should be made (and can easily be coupled to a routine programme of monitoring as presented under step [1] where farm visits are made once every 2 or 4 wks. Work on the planning

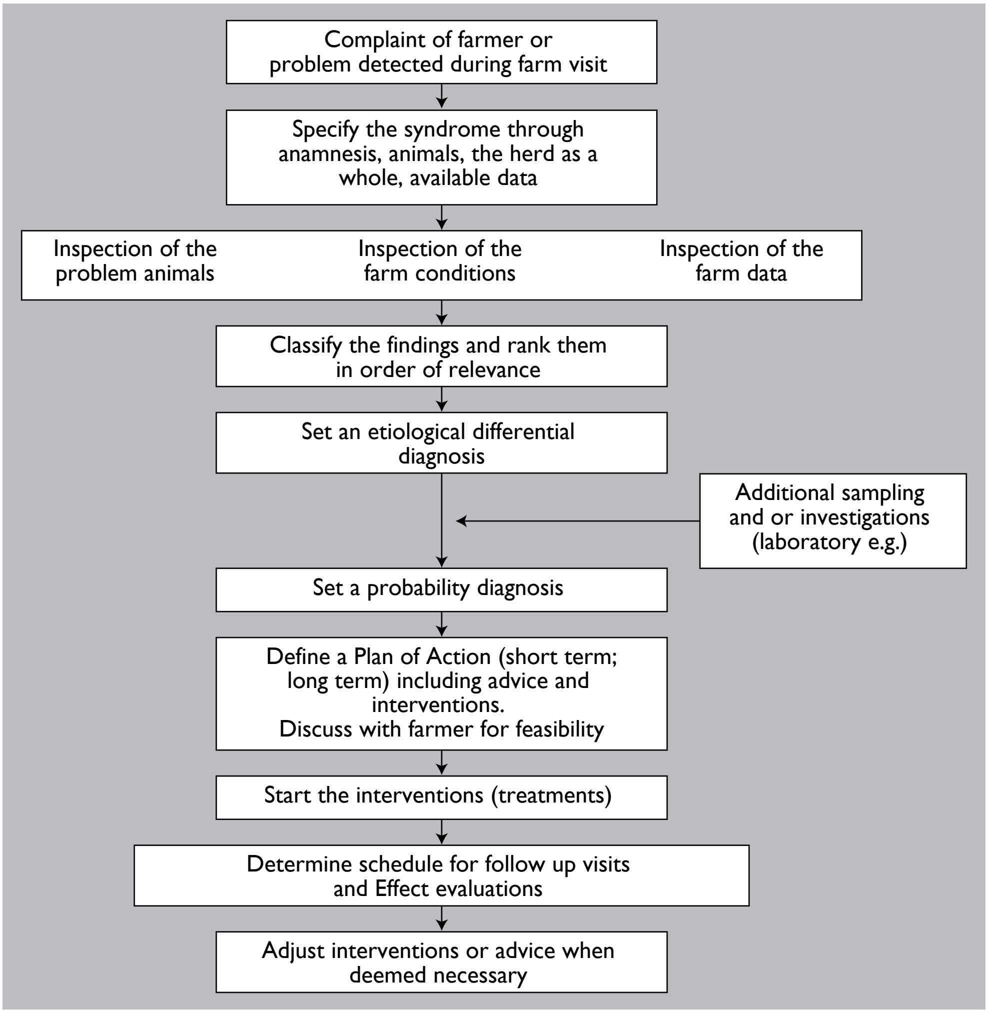


Figure 8.3. Overview of the different steps in the problem analysis procedure in HHPM.

of prevention by using the records of the farm and the results of monitoring and analysis. An example could be the elaboration of working instructions (see Chapter 3).

3. Preventive actions

Preventive actions on dairy farms can be manifold. Different vaccination strategies can be developed for farm-specific (health) situations. Furthermore, several guidelines and working instructions can be applied like those addressed in Chapter 3 (e.g. biosecurity assurance plans; good medicine application guideline; herd treatment advisory plan).

And finally, risk identification and risk management schemes can be developed in HHPM.

It is beyond the scope of this book to elaborate further on these issues and we refer to the respective text books. It should be clear, however, that there are many similarities between HHPM and HACCP-based Quality Risk Management programmes.

8.4.2. The HHPM protocol, agreements, and farm visits

Dairy Herd Health & Production Management programmes should be executed according to a preset protocol. First, because the veterinarian should have a *standardised method* to work. Second, because the farmer should be (made) aware of the activities that are undertaken and of the purpose of those activities; farmers do not like surprises in this respect. Protocols have been developed for different farming areas (Brand *et al.*, 1996).

A protocol starts with the defined *objectives* for a certain area (e.g. udder health, or claw health). Farming objectives, e.g. more milk per cow per year, should be translated into *technical targets*. Examples of such targets are: shortening of the calving interval by 15 days, optimise disease control and prevention, reduction of the clinical lameness incidence with 10%, reduction of the clinical mastitis incidence with 15%, reduction of the diarrhoea incidence with 20%.

It should be clear on beforehand what the *weak and the strong points* on a dairy farm are, and what priorities the farmer sets for improving health status or farm productivity (see VACQA website and Chapter 2).

When the objectives and herd health targets have been set, and the weak and strong points of the farm are known, the veterinarian discusses with the farmer about his *priorities*. For example, one farmer may have a priority in solving suboptimal milk production, while an other is more interested in controlling clinical mastitis, and yet another in optimising calf rearing. Once those priorities have been established, the following step in the protocol is to define the *methodologies* for approaching the priority area. In that way it is made clear to the farmer what he can expect during the execution of a HHPM programme. The final element in the protocol is always the *evaluation* of herd performance.

Subsequently agreements about the execution of the herd health programme have to be made. These *agreements* comprise the following issues:

- farming areas which will form part of the programme (e.g. udder health; productivity & nutrition; claw health; young stock rearing; control of highly contagious diseases, etc);

- animal identification and recording system that is needed at the farm and records needed for veterinary advisory work (usually the minimum basis for recording is a farm logbook and a wall chart with all events at herd level);
- frequency of farm visits (commonly for a 80-100 cow head herd this will be once every 4 weeks; for larger herds more frequently);
- activities at the farm: monitoring elements (see below); farm visit advisory report; status evaluation;
- planning of activities over the coming 6 or 12 months, and structure of the farm visits. The farmer should know by and large what activities he can expect the next visit(s);
- development of e.g. Udder Health Treatment Advisory Plan, based on clinical mastitis, subclinical mastitis, bulk milk cell count patterns, bacteriological findings, milking machine function and milking technique; development of a Claw Health Advisory Plan, a Young Stock Disease Prevention Plan, etc.

Farm visit evaluation reports are used for the follow up visits to the farm in order to keep up motivation of the farmer, to keep track of management changes based on vet advice given and to check which issues have not been addressed by the farmer and why not. They commonly comprise 1 page A4.

In conclusion, a veterinary herd health programme for dairy farms has to be executed following preset protocols for both routine monitoring activities, analysis and prevention activities. Only then, such programmes become recognisable in structure and execution for farmers. Farmers are strongly focussed on planning and expectations regarding such programmes. The 'product' of herd health should therefore be sharply defined and described.

Monitoring of animals, farm environment and management, as well as data is an easy method which can generate quite useful information for decision-making. Monitoring does not cost much time and therefore can be very cost-effective. It should, however, not be restricted to one area, say fertility. Dairy farming and dairy production are multidisciplinary activities which are integrated by the farmer and co-workers in a rather holistic type of approach. The aim of monitoring is hence to provide signals of farm-broad performance.

See further Chapter 2, where the VACQA-International website has been presented, with examples of field scoring sheets for monitoring strong and weak points on a dairy farm in different farming areas. When comparing the HHPM approach with the different chapters on HACCP-based Quality Risk Management, it must be clear that there are many similarities. However, the four key words of the HACCP-like programmes are: *Organisation, Planning, Structure, Formalisation.* These four features are most frequently lacking in current HHPM programmes.

8.4.3. Handling Staphylococcus aureus udder infections in HHPM (adapted after Zadoks **et al.***, 2002)*

Staphylococcus aureus problems can maybe be controlled, but commonly not eradicated. The most important source of infection for other cows is the infected cow. However, the pathogen is also prevalent on the udder-skin, in bedding material, in flies, in forages. The number (rate) of new infections depends on the number of existing infections; however, new infections do occur independent of whether infections exist or not. Infections in heifers and in cows during the dry period have been reported. Especially in the case of *Staphylococcus aureus* one can say that 'once a weak quarter, always a weak quarter' where (re-)infection is involved. Other bacteria do not play a 'protective' or 'competitive' role; nor do they increase the risk of (repeated-) infection. Teat end callosity increases the risk of infection (Neijenhuijs *et al.*, 2001, 2005). The transmission occurs primarily in the milking parlour from one milking cluster to another, or from the hands of milkers. Therefore, hygiene at milking and milking practices, as well as milking machine maintenance are paramount issues in this context.

Newly emerging are coagulase-negative staphylococci (CNS) and also *Mycoplasma* spp. with regard to udder infections. It is beyond the scope of this book to address all possible situations on a dairy farm. One has always to bear in mind that the udder health dynamics in time, associated with shifts in pathogen profiles, necessitates the consequent adjustment of management practices regarding udder health. In this section we will stick to the handling of *Staphylococcus aureus* on the dairy farm, just as an example.

Management Practice regarding *Staphylococcus aureus* problems in three steps:

Step 1: A mastitis problem caused by *Staphylococcus aureus* is identified by:

- its prevalence/incidence within the herd (clinical & subclinical, new and or repeated infections);
- the pattern of varying bulk milk somatic cell counts;
- the number of cows with increased somatic cell count;
- the number of cows with infection but without increase of SCC;
- the culling of (chronically) infected cows.

Step 2: Once the problem has been identified, the '*Five Point Schedule*' for mastitis control applies: milking machine function; milking technique evaluation; teat dip/spray before and or after milking; drying off therapy for all cows; adequate treatment of clinical cases -see further; culling of chronically infected cows (Brand *et al.*, 1996). *Additional measures* refer to:

- separation of 'clean' and infected cows;

- – introduction of a sequence in cows to be milked: low somatic cell count cows first; high somatic cell count (mastitis) cows last;
- – disinfection of milking clusters between cows; good milking hygiene;
- – fly control;
- – provision of cow comfort and hygiene (see above in this chapter);
- – biosecurity assurance plans (see also Chapter 3).

Step 3: Determine whether to treat (and when) or to cull an infected cow. Weighing factors in this decision making are:

- – duration of the infection;
- – time of occurrence in the lactation;
- – severity of the infection;
- – value of the cow;
- – parity of the cow;
- – (sub)types of *Staphylococcus aureus*;
- – timing of treatment (in lactation or at drying off, or both);
- – duration of the treatment if any;
- – type(s) of antibiotics to be applied and available;
- – route(s) of administration of the antibiotics (see Chapter 3).

Different criteria can be followed to make a decision, the 'rules of thumb' are:

a. *Probabilities of recovery* of a *Staphylococcus aureus* infected cow (after treatment in lactation or at drying off) are *reduced* when:
   - – somatic cell counts are high (> 1 or 2 million/ml);
   - – more quarters are affected;
   - – affected quarters are hind-quarters;
   - – subsequent milk samples for bacteriological culturing were positive;
   - – old parities are involved;
   - – problems occur in early lactation;
   - – treatment is of short duration (< 3 days) and poor (injectors only);
   - – the bacteria are not sensitive to penicillin or other tested antibiotics.

b. *Probabilities of recovery* of a *Staphylococcus aureus* infected cow (after treatment in lactation or at drying off) are *increased* when:
   - – young parities are involved (e.g. parity 1);
   - – the bacteria are penicillin sensitive;
   - – only 1 quarter is involved;
   - – cow is close to drying off;
   - – somatic cell counts are not too high (< 1 million/ml);
   - – treatment duration is prolonged (3 days injectors + injections).

Further reading on this subject can be found at: htpp://www.nmconline.org/ and in Journal of Dairy Science (1994) volume 77: 75-79, (1997) volume 80: 2803-2808, (2000) volume 83: 278-284.

8.4.4. Example of an Udder Health Treatment Decision scheme (work instruction)

The scheme presented in Figure 8.4 can be considered as a part of a HHPM programme; it could be a component of a Herd Treatment Advisory Plan (see also Chapter 3). But it can also be handled in the context of HACCP-based QRM programmes. Figure 8.4 is an example of how a work instruction may look like when it is not in a text format. Some farmers appear to prefer this format above text formats, because they are easier to follow and it visualises the different steps in a sequence to be followed. Some previous explanation and training on this subject, however, seems warranted in order to be sure that farm workers will comply with the procedure.

8.4.5. Critical issues for dairy farm residue prevention

In this paragraph are listed the 10 major issues for preventing residue problems on dairy farms as described by and adapted after the American Veterinary Medical Association and the National Milk Producers Federation in the USA in 1991.

1. Practice a sound and healthy herd management:
   a. apply a proper mastitis control programme;
   b. keep the cattle in a clean, fresh and healthy environment;
   c. employ a proper nutrition and reproduction programme;
   d. make sure that a sound vaccination programme and an appropriate parasite control programme are in place;
   e. make sure the herd is protected against introduction of diseases by developing and implementing a biosecurity assurance plan;
   f. develop and apply a proper surveillance programme for newborn calves and replacement heifers.
2. Establish a valid working relationship between veterinarian - client - patients:
   a. the veterinarian and the client have established a good working relationship and a proper understanding for making clinical judgements regarding the health of cattle and the need for medical treatment;
   b. take into account all variables to assure the absence of violative drug residues.
3. Use only (FDA and or EC) approved drugs and follow the guidelines provided by the veterinarian, e.g. through his HTAP (herd treatment advisory plan, Chapter 3):
   a. understand the difference between the different drugs and regulations;
   b. understand exemptions to the rule;
   c. create a list of approved medicinal products;
   d. keep records of products used (see also Chapter 3: Good Medicine Application code of practice).
4. Make sure that all drugs have labels that comply with official labelling requirements.
5. Store all medicinal products correctly (see Chapter 3: Good Medicine Application code of practice).

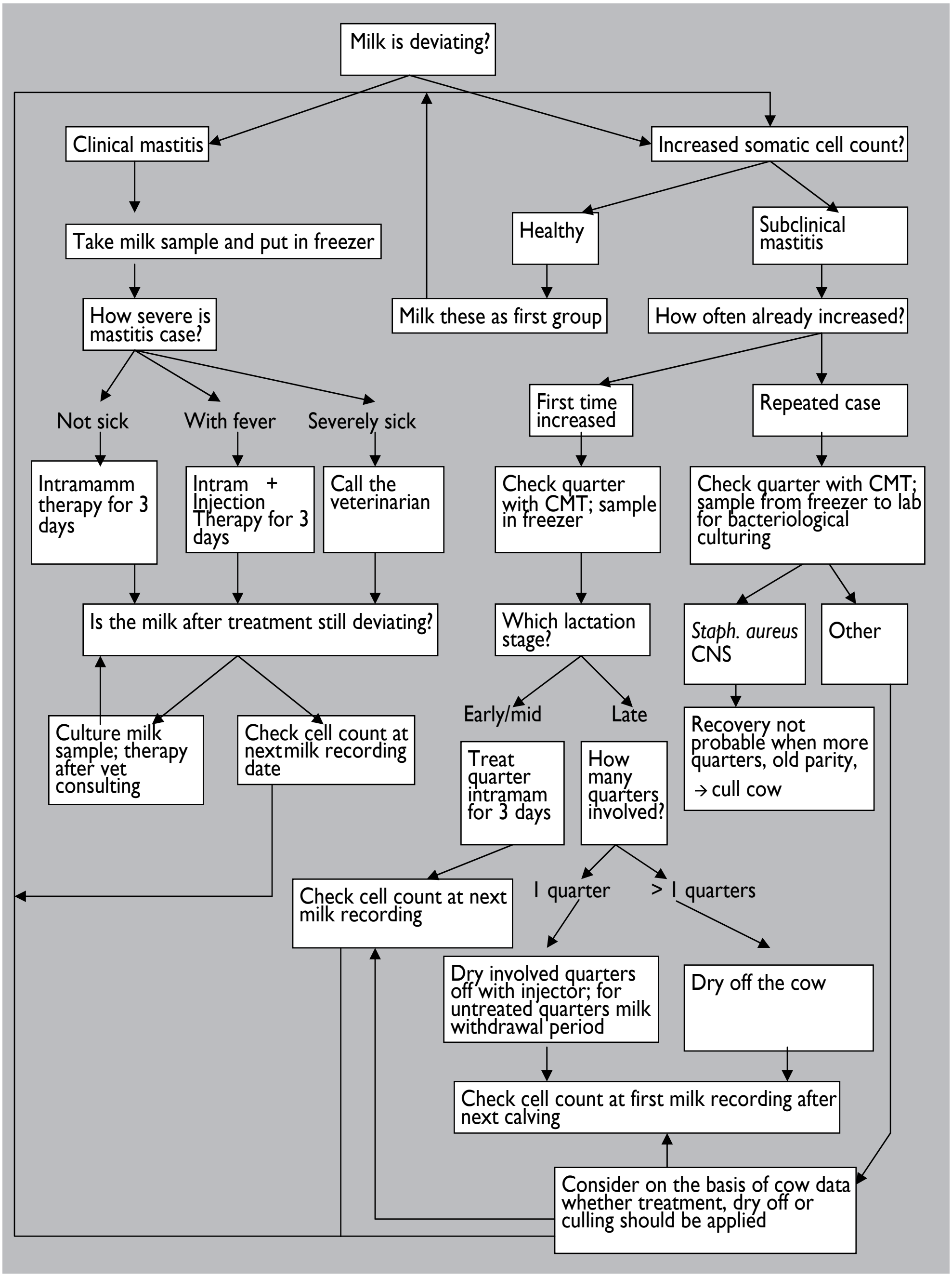


Figure 8.4. An example of an Udder Health Treatment Decision scheme for a particular farm A. CMT= California Mastitis Test; intramam= intramammary infection; CNS= coagulase-negative staphylococci.

6. Administer all medicinal products correctly and identify treated animals (see chapter 3: Good Medicine Application code of practice).
7. Maintain and use proper treatment records on all animals treated.
8. Use drug residue screening tests on the farm. Test milk or urine by appropriate tests before the milk leaves the dairy farm.
9. Implement employee and family awareness of the proper use of medicinal products to avoid the marketing of adulterated milk, and to avoid public health threats (occupational disorders).
10. Complete the residue prevention programme every year.

8.5. Cattle welfare & cow comfort (tactical considerations)

It has been described elsewhere that appropriate cattle welfare, or, in other practical terms, an adequate cow comfort largely contributes to optimal health and performance of cows on the dairy farm (Noordhuizen and Lievaart, 2005). The *Five Freedoms* as described by FAWC (1992) and Webster (2001) are commonly considered as the basis to assess cattle welfare, and are as follows; freedom from
1. hunger, inappropriate feed and thirst;
2. physical and physiological discomfort;
3. fear, distress and chronic stress;
4. pain, injury and diseases;
5. physical limitations to express normal species-bound behaviour.

However, these five freedoms are not easy to handle in the daily field practice (Noordhuizen and Metz, 2005). Bracke *et al.* (2001) have converted these five freedoms into 12 so-called primary and secondary *biological needs*. Table 8.5 presents an overview of these biological needs. The biological needs are much easier to convert into clinical-observational and zootechnical parameters under field conditions than the five freedoms. The VACQA-International website www.vacqa-international.com will provide field assessment scoring sheets for cattle welfare & cow comfort on the dairy farm.

Another concept, currently addressed in literature and practice, concerns the *Cow Comfort* concept (Noordhuizen and Lievaart, 2005). This concept is based on the philosophy that cows experience better welfare and better health, and even produce better, when their comfort needs are being met. Moreover, cow comfort represents a practical approach to cattle welfare. Good Cow Comfort comprises 4 domains:
1. Optimal feed & feeding management, and drinking water.
2. Optimal housing & climatic conditions.
3. Optimal animal health.
4. Species-bound specific behaviour.

Table 8.5. Overview of biological needs for cattle welfare and cow comfort scoring (adapted after Bracke et al.*, 2001).*

Primary needs	
1.	Feed and feed related behaviour
2.	Water and drinking related behaviour
3.	Resting, laying and sleeping
4.	Movement (locomotion)
5.	Social comfort (rank; interactions; agonistic & antagonistic behaviour)
6.	Animal health
7.	Security (fear, flight behaviour and aggression)
Secondary needs	
8.	Excretion (manure and urine)
9.	Thermoregulation
10.	Exploration and orientation
11.	Body care (grooming: comfort behaviour)
12.	Reproduction

Cow Comfort regards the practical and clinically observable aspects of dairy cattle welfare associated with the cattle and their environment. The 4 domains are interrelated. For example, a certain housing situation will more or less provoke agonistic and antagonistic behaviour in cattle; the management of different lactation groups will be different from managing all lactating cows in only one group; poor climatic conditions may induce other behaviour of cows (e.g. in hyperthermic stress). The strengths-and-weaknesses assessment sheets regarding disorders on the VACQA website comprise already many elements of Cow Comfort; a specific scoring sheet cattle welfare & cow comfort exists in a short and a longer version.

The 4 domains of Cow Comfort show close relationships with the primary biological needs defined by Bracke *et al.* (2001) either directly or indirectly. For further details we refer to Noordhuizen and Lievaart (2005). The dairy processing industry will – under the pressure of consumer groups and retailers- increasingly pay attention to cattle welfare & cow comfort as a quality issue, and set target levels for cattle welfare & cow comfort.

The advantage of these cattle welfare & cow comfort scoring sheets is that next to certain farming areas needing improvement, other farming areas are shown where farm management is performing well. Especially for the dairy farmer, this positive approach is very motivating (Noordhuizen and Metz, 2005). The methodology of scoring from 1 to 5 is more often reported as a proper means to assess animal related issues such as animal welfare (Candiani *et al.*, 2007).

This is elaborated below as an example, where the welfare issues on 100 dairy farms in two different regions were scored (Table 8.6). Scores were given on a scale, varying from 1 (poor-bad) to 3 (moderate) or to 5 (good). At the end of the scoring exercise, an end-score is obtained for the farm as a whole. Also end-scores for each cluster (biological need = farming area) are obtained, as well as end-scores for individual items within each cluster. In this way, one has 3 levels of assessing cattle welfare & cow comfort: (1) the farm as a whole, (2) each cluster, (3) each item.

Poorest scoring results were obtained for the farming areas 'Housing', 'Health management' and 'Pasturing'. Commonly poor housing results were found in the older farms, which had not (yet) adapted their housing system and equipment to new demands; poor health management refers to deficient disease control programmes, lack of veterinary herd health programmes, or poor vaccination schemes; pasturing was often lacking.

Disadvantage of this rather qualitative and subjective scoring method is that not all elements which determine cattle welfare status, e.g. emotion, perception, or

Table 8.6. Results of cattle welfare and cow comfort scoring in the field on 100 dairy farms (adapted after Noordhuizen and Metz, 2005).

Areas with highest scores (score 5 = good)	Areas with lowest score (score 1 = poor)
Light regime during the day	Poor maintenance of slatted floor
Light regime during the night	Poor cubicle design and sizes
Feed is freely available	Poor/absent bedding material
Easy access to concentrate feeders	No regular herd claw inspection/trimming
Absence of draught in barns	No regular body condition scoring
Pasturing of cows is applied	Poor mastitis detection procedures
Easy rising and laying down	Poor mastitis prevention measures
Participation in HHPM	Pasture plots not available
Sufficient space/cow in barns	Too long distance to pasture plots
Easy entering/exiting feed rack	Pathways to pastures of poor quality (gravel)
Good quality foot path to pastures	Too long time spent in waiting area
Herd body conditions scores fine	Poor provision of shade, water, additional feed in pasture season
Behaviour of cows is normal; no aggression	

ethics are taken into account. Even with formal methods of *Risk Assessment* (CAC, 1999; OIE, 2004; EFSA, 2005) this objective can not be achieved (M.B.M. Bracke, personal communication). Risk Assessment in the animal production sector is often more qualitative than quantitative in nature, due to lacking scientific information. Sometimes such qualitative risk assessment yields rather low Kendall's coefficients of concordance (SPSS, 2001) for different groups of experts (ethologists; veterinarians) interviewed (Bracke, personal communication).

Therefore, new methodologies, such as *Semantic Modelling*, are being developed to overcome these problems; the results are very promising (Bracke *et al.*, 2001, 2004). Semantic Modelling, for example for the domain of animal welfare, handles descriptive and normative attributes in the area of physiology and animal behaviour, and ethical attributes, as associated with the biological needs of animals, separately and convert these to a weighted welfare index. Semantic Modelling aims at a quantified assessment of animal welfare, based on a systematic, formalised review and analysis of all available scientific information, and using relational database processing in its modelling. Scientific information from different disciplines is converted into a weighted welfare score (Bracke *et al.*, 2001, 2004). Differences between risk assessment and semantic modelling have been tabulated by Bracke (personal communication).

Another option refers to the application of *Adaptive Conjoint Analysis* (ACA) methods to welfare assessment, where expert opinion is investigated in order to obtain an overview of the most important factors and conditions contributing to or hampering welfare (J.J. Lievaart, personal communication). In the latter method it all depends on the extent to which interviewed experts appear to be true experts. Expert answers to the computerised questions are for that purpose weighted and statistically tested on consistency in their answering (Bouma *et al.*, 2004). See Chapter 4 and Annex 4A for further explications.

Cattle welfare is an issue of concern, not only for dairy processing industries, but equally to authorities (EU) and retailers (see website of www.EUREP-GAP.org); moreover, an increasing number of dairy farmers is well aware of the relevance of emphasising cattle welfare in their farm business. To a large extent the terms of reference of named retailers platform are quite similar to the kind of good dairy farming codes of practice we have addressed in Chapter 3.

8.6. Training programmes for farmers and farm workers

Any veterinary advisory programme focussing on improving animal health and welfare, as well as public health including food safety, such as Herd Health & Production Management programmes and Quality Risk Management programmes, should comprise a component of *on-site training*. 'Training' has been identified by the OIE and FAO (OIE, 2006) as elementary to the application of good farming practices associated with, for example, food safety in animal production. Next to training one should pay attention to the proper 'conduct' of farm workers, involved in the execution of Quality Risk Management programmes on a HACCP-basis. 'Conduct' relates to attitude and mentality building among farm workers, which requires a certain training as well. Good dairy farming guidelines and working instructions (Chapter 3) contribute to the achievement of proper conduct.

The on-site training may comprise (a wide variety of) professional short courses, tailor-made to the needs of a particular dairy farm and the quality of the farm workers on that farm. Farming areas which regularly appear to be in need for such courses are:
- udder health;
- nutrition;
- claw health (including preventive and corrective claw trimming practice);
- animal treatment procedures (see also chapter 3 at GMA guidelines);
- awareness of prevalent risk factors regarding animal health, public health, animal welfare and product quality disorders;
- awareness of potential public health threats originating from handling and administering medicinal products to animals (occupational disorders);
- biosecurity assurance plans;
- general and specific hygiene plans on the farm.

The courses are most often associated with the introduction and implementation of Good Dairy Farming guidelines and the working instructions on the dairy farm in particular farming areas. Moreover, introducing and implementing the QRM programme will undoubtedly also need the assistance of tailor-made support-training-programmes for particular areas.

For example, the implementation of biosecurity assurance plans on a dairy farm requires the full commitment of all farm workers. These plans are not easy to understand for people who have worked with the principles involved: risk identification and risk management. Training of farm workers in those principles and using the farm itself as the example will help the adoption of these. The same may apply to hygiene principles and procedures. If one or more of these principles are neglected, the whole application will fail.

Such courses should be highly practical, of short duration (1 to 2 hours maximum per session), highly subject-focussed, executed on-site, participation of all farm-workers. They should allow an ample discussion when the farm workers ask for it. If deemed necessary, the training courses are repeated every year, for example as a refresher course comprising new developments or techniques.

Preferably the farm workers receive a *certificate of attendance* of such a course, signed by the *Farm Quality Management Team* members; hence illustrating that farm management appreciates their attendance and participation for improvement of the farm performance. It could be considered to take a kind of exam at the end of the course, for example through simple and practical multiple choice questions.

Finally, it is worthwhile to ask the course attendants for suggestions, because in that way they will feel involved, and at the same time this will reinforce mutual trust and confidence.

8.7. Human resource management, including employee working conditions

As a farm expands, management responsibilities tend to concentrate in one or just a few managers, and additional people are hired to carry out the majority of the daily production labour (Hadley *et al.*, 2002). When more employees are added, managers must find other, better ways to ensure that they are performing high quality work. Human resource management includes the set of practices (including 'attracting', 'developing' and 'maintaining' a quality workforce) that managers use to ensure this quality (Desler, 2003; Schermerhorn, 2005).

Whenever more structure and organisation is applied in the on-farm management, for example by implementing a HACCP-like Quality Risk Management programme, the role a veterinarian will play in human resource management will increase as well. It is, however, questionable whether a veterinarian should play a role in the attraction-process of on-farm workforces. On the other hand, farm managers, who attract workforces, should have a clear understanding of the job or task description and the required qualities or skills of such people. Veterinarians advising farmers in the framework of a HACCP-like QRM-programme, give farmers more insight in their on-farm production system. This insight gives farmers a clear idea what jobs or tasks exactly need be done and what kind of person is needed.

An appropriate insight in the production system also reveals where the threats for human health are sited. This could help adapting working routines in such a way, that the highest level of health care for the workers will be met. Veterinarians play a more important role in 'developing and maintaining quality workforces', since this includes training and enlarging knowledge and skills. In QRM-programmes, in which every target of every step (with tolerances) and corrective actions are written down, everybody is supposed to know what target should be met and what to do in case something goes wrong. In this way it is easier for employees to perform high quality work, hence they will be more motivated and experience a proper working environment. Other human resource management issues integrated in QRM programmes are e.g. Standard Operating Procedures (SOP= written instructions to eliminate variations introduced in the production process when individuals perform tasks in different ways), other working instructions and continuous training in veterinary or zootechnical issues. These forenamed issues will increase the (quality of) knowledge of workers and should ensure stability in the production process in which risks of deviations remain at acceptable levels. Moreover, the HACCP-like programme provides an internal (and external) evaluation and validation of the production system as a whole, including e.g. performance reviews and evaluation of work conditions of employees. During these evaluations, auditors take a close look at what workers actually do, providing the HACCP-*Team* with information which enables them to optimise the efficiency of workers. (see also the validation and verification steps in Chapter 9 and 10; Desler, 2003; Schermerhorn, 2005).

8.8. Concluding remarks

As has been stated before, a Quality Risk Management programme is a dynamic and flexible kind of activity. This means that it could change over time, always adapting to new situations or developments. Just because of this dynamics, there will always be a need for designing new support programmes as dictated by the new situations, and new training programmes, as dictated by new developments. Every time it is the individual farm and its specific needs that will be the basis for developing tailor-made support and training programmes. Visualised, this phenomenon in time may look as is illustrated in Figure 8.5.

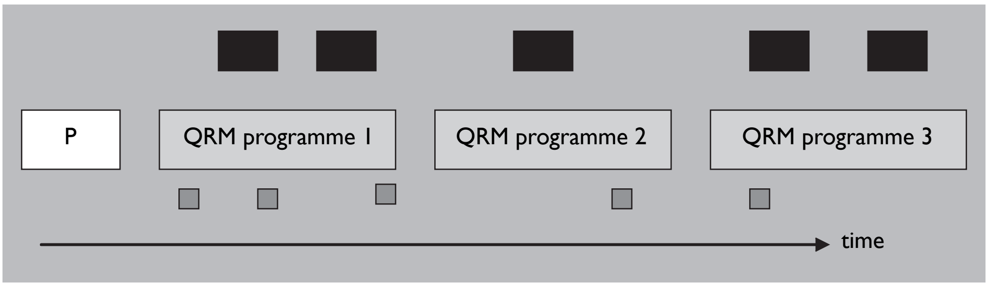


Figure 8.5. Visualisation of the development of a HACCP-based QRM, with support and training programmes. P = preparatory programmes (like Herd Health & Production Management programmes); dark grey boxes are training modules, specifically defined for this particular farm; light grey boxes are respectively QRM programme version 1, version 2 and version 3; black boxes are respective support programmes running with the QRM programme.

The effect of on-site training programmes for various farming areas and subjects should not be underestimated. They not only contribute to a proper attitude and mentality, training programmes also contribute to a better technical functioning of people working on the farm, as well as to their well-feeling and pleasure in work. They also increase involvement and responsibility of farm workers. It has even been suggested that farm workers are regularly monitored for the detection of healthy carriers of bacterial or parasitic agents which could be transmitted to animals, and, hence, jeopardising animal and public health (OIE, 2006). It will depend on national or regional acceptance and traditions whether this monitoring would be applied or not. At least it should be part of the consideration, especially when problems of such kind appear on the farm in the animals or among people.

Veterinarians who desire to implement HACCP-like QRM programmes should not only have an adequate knowledge bout the HACCP-concept and principles. They also should take into consideration the most relevant issues of human resource management, farm economics, behavioural economics, communication, business environment and benchmarking, as well as the development and impact of EU regulations. Several of these subjects are also addressed in the following chapters.

Chapter 9. Documentation in HACCP-like Quality Risk Management programmes

9.1. Introduction

In the previous chapters many different documents related to the implementation and functioning of a HACCP-like programme of Quality Risk Management have been introduced and illustrated.

In this chapter we will summarise these different documents and assign them to respective categories, featuring in the handbook of the HACCP-like QRM programme. When needed, more documents will be presented and their use explained. Documents are necessary, not only for the on-farm operational managerial matters, but also for the purpose of conducting, evaluating and adjusting the HACCP-like Quality Risk Management programme. Ultimately, they may assist in requiring a farm certification if warranted.

9.2. Summary of documents of the HACCP-like programme

The documents in the preceding chapters can be categorised under different headings. Table 9.1 provides an overview of these categories and documents within categories. The steps in the developmental procedure for a HACCP-like Quality Risk Management programme, related to these documents, are given as well. The 12 steps Table has been presented in Chapter 4.

Most of the documents – but not all – named in Table 9.1 can be downloaded from the website www.vacqa-international.com. This website comprises many different documents in various formats, which are not all dealt with in this book.

In addition to the type of documents which are short-listed in Table 9.1, there are other documents which can be of interest when developing and implementing Quality Risk Management programmes following the HACCP-principles and concept. The options for that purpose are nearly infinite. We will just present a few examples.

Among these is the *General Preventive Measures planning list (GPM)*, an overview Table which can be developed on the dairy farm once the QRM programme has been installed and running. It is created on the basis of the results of the first 6 or 12 months. This GPM is presented in the Annex 6A of this book, given its volume. The planning list is meant to timely focus the attention of the farmer and or manager to issues which have, for example, shown before to represent (season-related) problems

Table 9.1. Short overview of types of documents handled within the HACCP-like programme of Quality Risk Management (see chapter 4 for the 12 steps of the HACCP-like plan for programme development).

Type of documents	Step in the HACCP development procedure	Chapter reference
The 12 developmental steps for a HACCP-like programme and the HACCP handbook contents	A reference chart for the a preparatory phase	Chapter 4
Strengths-and-weaknesses assessment sheets from the VACQA-International website	Preparatory stages as basis for identifying hazards and risk factors (Step 6)	Chapter 2; Chapter 6
Strengths-and-weaknesses assessment results (spider grams & histograms) from the VACQA-International website	Preparatory stages as basis for identifying hazards and risk factors (Step 6)	Chapter 2; Chapter 6
Good Dairy Farming guidelines & Working Instructions	Preparatory stages; Step 10	Chapter 3
Flow diagrams of the production process	Step 4, 5	Chapter 5
Hazards & Risks Tables	Step 6	Chapter 6
General Measures of Prevention	Step 6	Chapter 6
CCP and POPA listings (including standards + tolerances, or target figures)	Step 7, 8	Chapter 7
Monitoring schemes	Step 9	Chapter 7
Events Log	Step 9	Chapter 7
Corrective Measures Log or Improvement Logs	Step 10	Chapter 7
Support programme documents	Support (Step 11)	Chapter 8
Documents related to on-site training	Support (Step 11)	Chapter 8
Documents for internal validation	Step 11, 12	Chapter 9
Documents for external verification of the HACCP functioning (including auditing)	Step 12	Chapter 9

in the herd, or which could be considered relevant from the point of view of general prevention.

Other additional documents regard the *inventory logs* on *Forage Feeds & Grassland Improvement* (Table 9.2) and on *Chemicals' Storage & Stock* (Table 9.3).

The list in Table 9.2 is not comparable to a *Grassland Planning & Exploitation Calendar* which can be used under operational conditions on a dairy farm for planning of

Table 9.2. Example of headings of an inventory log on Feed Forages & Grassland Improvement, taking notice of undesired plants in pasture and the treatment to eliminate them.

Farm code:				
Date:	Plant identified:	Identified by:	Actions taken:	Remarks:
Chemical used:	Date of pasture treatment:	Withholding period:	Date of pasture back in use:	Remarks:

Table 9.3. Example of headings on an inventory log of Chemicals' Storage and Stock.

Farm code:					
Date of purchase:	Type of chemical:	Targeted use:	Quantity used… Date… Remainders…	Quantity used… Date… Remainders…	Quantity used … Date… Remainders…

pasturing and or mowing, harvesting, and management activities for all pasture plots which are prevailing on a farm each season.

Adjacent to this Table 9.3 is the following Table 9.4 on *waste management* on the dairy farm. This list could comprise expired antibiotics and chemotherapeutics, milking machine cleaning and disinfection products, other chemicals, and even the footbath contents after treating claws on the farm (e.g. formalin solution). This represents an

Table 9.4. Document for handling remainders of chemicals, expired antibiotics, packaging materials in the context of waste management on the dairy farm.

Product name	Expiration date	Place of storage	Targeted use	Quantity remaining	Empty bottles or containers and packaging materials sent to …	Date and Signature

environmental issue and the owner (or farmer) has the responsibility to society to send the meant products to a company which is certified to deal with those waste materials. This forms part of the *environmental hazards* control on the farm. One could add a column on the destination of used syringes and needles as well.

9.3. Concluding remarks

It is obvious that many different documents could be developed in the course of a HACCP-based QRM programme. However, it must be kept in mind that these documents must serve an appropriate goal on the farm when implementing them, must fit the practical and daily management on the dairy farm, and should not become a burden to farmer, manager, or farm workers. On the other hand, farmers and farm-workers should be stimulated and motivated to keep records in good order and up-to-date.

The documents named in the Tables can be considered the core components of the *HACCP-like handbook* (see Chapter 4). This handbook has the same names of chapters on all dairy farms, but the contents of these chapters and the specific documents within each chapter will differ largely from farm to farm, due to the specifications of each individual farm. The handbook contents can also be used at internal validation, as well as for external verification activities (see Chapter 10). In that way a farmer can prove to the 'outside world' (authorities, retailers, consumers) what the status on his farm is regarding public health & food safety issues, as well as animal health & welfare issues. Because preventive and corrective measures are to be described beforehand, these too can be used to the purpose of internal validation and external verification. The dairy farming production has, hence, become more transparent to the outside world.

The handbook (and hence its documents) must be updated and upgraded at least once a year, for example after each external audit. The dates of updating and upgrading must appear on each document. The documents can also be scanned and stored on CD ROM, for example as PDF-files.

Older documents are to be stored in the archives for 5 years, either as paper documents or as CD ROM. In those archives the farmer also keeps the other documentation, such as laboratory results, reports of farm visits by the veterinarian, reports of problem analysis by the veterinarian or other farm advisors, and those documents which are associated with e.g. on-going veterinary Herd Health & Production Management programmes. Several analysis procedures and examples of analyses regarding herd health or production problems on the dairy farm have been extensively described by Brand *et al.* (1996). The methods – including their frequency for calculation – as presented by these authors, can be useful for internal validation purposes in a HACCP-like Quality Risk Management programme.

Chapter 10. Validation & verification of the HACCP-based Quality Risk Management programme

10.1. Introduction

An integral component of any HACCP-like programme is the validation and verification (see also Chapter 4). Validation refers to the internal monitoring and scrutinising that the HACCP-based QRM programme is functioning as desired and expected. Validation may result in an adjustment of the QRM programme, its procedures or components. Internal validation can and must be carried out by (a member of) the *Farm Quality Management Team*, for example the veterinarian. It should be done at least once every year. On the other hand, it must be emphasised that internal validation is also a responsibility of the farmer or farm manager to be addressed in the daily farming routine.

Verification refers to the external assessment whether the QRM programme is in fact HACCP-like, and meets the formal criteria for HACCP programmes as have been pointed out by authors like Pierson (1995), Noordhuizen and Welpelo (1996), Quinn (2001) and by Van der Meulen and Van der Velde (2004). Commonly this verification is conducted through auditing by (certified) external parties.

10.2. Validation

Validation is most commonly an action oriented towards the functioning of the QRM programme, that means to be carried out on the farm itself. Validation regards an on-going, continuous process of checking, whilst the QRM programme is introduced and running. All tools and flow charts developed, and documents introduced and all changes made are continuously monitored and checked on proper functioning. For this so-called internal validation several options prevail. Among these are:

- Herd performance figures, as known from HHPM programmes (Radostits and Blood, 1985; Brand *et al.*, 1996).
- Evaluating laboratory testing results indicating freedom of certain (viral, bacterial and other) diseases, as well as associated with certain CCP/POPA monitoring activities.
- Animal Health certificates, as component of formal (regional) disease control programmes. Examples are: BVD, BHV-1, leptospirosis, salmonellosis, tuberculosis, brucellosis, Q-fever, neosporosis, blue tongue.
- The SWA sheets as addressed in chapter 2 (VACAQ-International website).
- Evaluating on-farm working instructions, and corrective measures; evaluate the need to adjust production process diagrams, after consultation of employees.

To facilitate the internal validation, the auditor may use the following documents:
- Specific internal auditing logs (see Table 10.1).
- Specific internal auditing checklists (see Table 10.2).

Because the SWA sheets are focussing on both the stronger and the weaker points on certain farming domains, they may be used for the internal validation. A strategic plan of action, based on the results of the SWA scoring and focussing on the year(s) to come, can form a part of the internal validation process.

During the whole process of developing, introducing and implementing the different components of the HACCP-like Quality Risk Management programme as addressed in previous chapters, each component and tool has to be checked on site for appropriateness and functionality. Their (internal) validation must be a routine daily practice of the farmer or farm manager. Validation is not a task for 'outsiders' of the farm only!

When deemed necessary, other internal validation documents can be developed and specified for a particular farm with a specific additional service or product (see also Chapter 11). The headings of an *Internal Auditing Log* may look as are presented in Table 10.1.

Table 10.1. An example of headings in an Internal Auditing Log for validation of the proper functioning of the HACCP-based QRM on the dairy farm.

Farm code:			Auditing person:	
Date:	Farming area audited:	Findings at auditing:	Actions required:	Person responsible for action taking:

Table 10.2. An example of an internal auditing checklist. This checklist has to be signed by farmer and auditor(s), and dated upon its completion.

Farm code:	Date:	Internal auditor:		
	Are controls & procedures still the same as in QRM handbook?	Are all records up-to-date & completed in time?	Actions required & by whom executed?	Date & signature of auditor
Front section of handbook				
Phone/address /name facts		Yes/no		
Milk cooling				
Tank cooling time is correct	Yes/no	Yes/no		
Tank thermometer	Yes/no	Yes/no		
Refrigerating service	Yes/no	Yes/no		
Plate cooler is correct	Yes/no	Yes/no		
Calibration of thermometer	Yes/no	Yes/no		
Cooling tower maintenance	Yes/no	Yes/no		
Cleaning & Sanitising				
Wash up procedure displayed	Yes/no	Yes/no		
Temperature of detergent is OK	Yes/no	Yes/no		
Machine checked	Yes/no	Yes/no		
Rubber ware replaced	Ye/no	Yes/no		
Medicinal drug use				
ID of treated cows is correct	Yes/no	Yes/no		
Treated cows are recorded	Yes/no	Yes/no		
GMA guideline followed	Yes/no	Yes/no		
HTAP updated in time	Yes/no	Yes/no		
Udder hygiene				
Udder sanitation is correct	Yes/no	Yes/no		
Water quality				
Quality tests conducted twice yearly and are in order	Yes/no	Yes/no		
Cattle houses & environment				
Cleaning procedures correct	Yes/no	Yes/no		
Manure scrapers present/correct	Yes/no	Yes/no		
Maintenance is correct	Yes/no	Yes/no		

Table 10.2. Continued.

Farm code:	Date:	Internal auditor:		
	Are controls & procedures still the same as in QRM handbook?	Are all records up-to-date & completed in time?	Actions required & by whom executed?	Date & signature of auditor
Cattle houses & environment (continued)				
Exits to pasture have no gravel	Yes/no	Yes/no		
Barn climate is correct	Yes/no	Yes/no		
Herd health status				
Participates in HHPM	Yes/no	Yes/no		
Cattle Health certificates	Yes/no	Yes/no		
Johne's disease control programme in place and in order	Yes/no	Yes/no		
Milking machine function				
Regular services done and correct	Yes/no	Yes/no		
Milk filtration is correct	Yes/no	Yes/no		
Waste management				
Effluents management is correct	Yes/no	Yes/no		
Human health precautions OK	Yes/no	Yes/no		
Forage feeds				
Mycoses detected	Yes/no	Yes/no		
Weeds detected & eliminated	Yes/no	Yes/no		
Chemicals stock/use recorded	Yes/no	Yes/no		
Treated plots identified	Yes/no	Yes/no		
Concentrate feeds				
GMP produced feeds purchased	Yes/no	Yes/no		
By-products are safe	Yes/no	Yes/no		
Trainings conducted	Yes/no	Yes/no		

10.3. Verification

Verification refers to another component regarding the functioning of an applied Quality Risk Management programme based on HACCP principles and concept. Verification regards the assessment of the functioning of the programme by external auditing institutions.

When the HACCP-based Quality Risk Management programme on the dairy farm will form part of a whole dairy chain quality assurance programme, there will be a need for certification of the farm. Such certification should be done by these external, officially approved institutions. That is why one often speaks about 'external verification'.

Commonly, the auditing team is a multidisciplinary team with adequate knowledge about and experience in HACCP procedures; at least one member of the *Farm Quality Management Team* will accompany the auditor(s) during their audit. They will start with verifying the internal validation records (see preceding paragraph) and the HACCP documentation. Note that in the case of external verification, the auditor will also address other internal validity issues of the HACCP-like Quality Risk Management programme. He/she will discuss with owner/farmer and employees about how communication proceeds and how it is effective (see also Chapter 14), about how working instructions are carried out and complied with, what needs to be adjusted in working instructions and why, about the way they respond or react in case of emerging problems. Most of the times, a member of the *Team* will join the external auditor, e.g. the farmer or manager, and sometimes maybe the veterinarian.

An external audit is finished with a written report, highlighting the deficiencies which need attention and improvement. Ideally, the external audits, with positive results, will ultimately lead to a certification of the particular farm. It would be best when such HACCP-like certification would be comparable to HACCP certification in other, more industry-like branches.

Chapter 11. Application of the HACCP principles to multifunctional farms open to the general public

11.1. Introduction

Multifunctional farms are those farms which have different functions at the same time. They may comprise commercial dairy farms which produce milk and sometimes also cheese, but which also provide one or more additional services to the lay public like camping, or receiving groups of children or mentally disabled people. They may also refer to institutions which are fully focussed on specific services such as city or children's farms comprising several species in cities and often under local governmental auspices. Children's farms are present all over Europe. They are represented by, for example, Kinderboerderijen (The Netherlands), City farms (UK), Fermes d'enfants and Fermes d'animation (France), Jugendfarmen and Aktivspielplatze, (Germany), Pedagogic farms (Quintas pedagogicas, Portugal), Kinderzoo (Austria), Fattorie Aperte and Fattorie Didattiche (Italy) or others.

In The Netherlands there are, for example, 400 of such institutions ('Children's farms') receiving a total of between 15 and 20 million registered visitors per year. These farms offer practical activities, training, information, a social meeting place, recreational facilities, animal 'therapy', tasting fresh animal products, and – to children – the service of 'animal cuddling'. The latter service is the main issue on Children's farms.

Multifunctional farms actively promote the equal access and involvement of children, young people and adults through practical experience through a wide range of educational, recreational, social and economic activities. These activities are focussed on farming, hence empowering people to improve their own life and environment (EFCF, 2005). The need for such farms has increased over the past decades, not in the least because the knowledge gap between professional farming and urban populations has increased dramatically.

Veterinarians are involved in these farms through the need for curative interventions and to conduct a surveillance of animal health and animal welfare. The management of these farms is sometimes complex due to the great variety of animal species, and to the potential hazards related to public health. Especially, microbiological, chemical and physical hazards may occur on these farms when lay people (including young children), not familiar with animal handling, get access to these farms.

From a public health safety point of view it is worthwhile to consider the application of HACCP concept and principles to these types of farms. It would make such farms much safer to the general public and will safeguard visitors from the forenamed hazards.

In some countries there exists a particular 'hygiene code for city farms'. This initiative was taken after outbreaks of certain zoonoses, like with *E. coli* strains (STEC), campylobacteriosis, salmonellosis, cryptosporidiosis, affecting lay people. Up to 10% of Dutch city farms may harbour zoonotic pathogens (Heuvelink *et al.*, 1998, 2002), which emphasises the need for strict adherence by visitors and farm workers to hygiene rules on these farms. By applying HACCP principles and concept such hazards and risks may be better controlled (ICMSF, 1988). Moreover, HACCP application may contribute to freedom of financial liability claims related to, for example, injuries or illnesses attracted on these farms. Because HACCP-based programmes to control food safety will become compulsory for dairy farms probably within a few years according to the suggestion in EC Hygiene directive 853-2004, it seems logical to control safety risks for visitors to dairy farms, also using a HACCP-based approach. Finally, such farms under a HACCP-like regime can be certified which assists in getting people's confidence.

11.2. Potential activities and services of city (or commercial dairy) farms

The activities and services of city farms or commercial dairy farms open to the general public can be manifold. It mainly depends on the needs and cultures of the host communities which activities and services are exactly provided. Table 11.1 presents a short-list of such activities and services.

Farms with animals have to safeguard their visitors and animals from hazards in the area of public health, animal health and animal welfare respectively. This includes physical hazards (trauma) due to aggressive or unexpected behaviour of animals. In that respect they too have to comply to the *General Food Law* (EC regulation 178–2002). When these farms provide visitors with facilities to produce food products on-site, they also have to comply to the new *Hygiene directives* (EU 852/853/854–2004).

11.3. HACCP applications

When applying the HACCP concept and principles to city farms and other (dairy) farms providing activities and services to lay people, the same axioms apply as named in Chapter 4, namely that the blue print of the HACCP approach may be the same, but the farm-specific elaboration will be totally different between farms. Therefore, two examples will be presented in this chapter. Example 1 refers to a commercial dairy farm

Table 11.1. Short overview of activities and services which can be provided by city farms and commercial dairy farms.

Food growing and food production in community gardens, with instructions
Animal handling, animal husbandry and animal welfare related activities
Conservation and nature preservation related activities (farm camping)
Young children activities, including animal cuddling
Young children city farm clubs (play schemes; excursions)
Senior citizen city farm clubs (including grandparents with grandchildren)
Visits and programmes for particular groups (e.g. mentally disabled persons)
Venues for arts and crafts workshops (classes; demonstrations; practicals)
Visits of school classes; activities for instructing school children
Summer holiday camp for children
A social meeting place in the format of a 'farm café'
Venue for seasonal festivals, special events, or celebrations
Evening recreation, conservation projects, training programmes
Venue and support for local self-support groups
Basis for volunteering and for learning new skills
Production of (raw) food products of animal origin

where additionally activities for lay people are provided: 'animal cuddling'. Example 2 refers to city farm 'The Bank', where no commercial dairy activities take place.

11.4. Application of HACCP-principles to control public health threats on dairy farms open to the general public (Example 1)[1].

11.4.1. Introduction

In many European countries the number of dairy farms has diminished strongly and will probably decrease further in the coming years for reasons described below. The Centre for Statistics in the Netherlands calculated that the number of holdings with cows in milk and cows in calf diminished from 46,977 in 1990 to 23,527 in 2005 (LEI-CBS, 2006).

Urbanisation and decreased economic margins between farm income and production costs lie often at the bottom of the decision to stop farming. Furthermore, many young people are no longer motivated to take over the farm. Remaining farmers often increase herd size and implement new technologies to increase herd productivity per man and per hectare. Sometimes threats are turned into opportunities by applying

[1] Adapted after an original paper published in *Tijdschrift voor Diergeneeskunde* 2007/2008 by M. Barten, J.P.T.M. Noordhuizen and L.J.A. Lipman (by courtesy of the Journal editors).

services or products aimed to citizens as a strategy to make a (better) living in the future. Excluding farms with an extra branch in relation to conservation plans of landscape and nature, 81.830 Dutch agricultural farms added an extra branch in extended agriculture in 2005 (LEI-CBS, 2006).

Besides economic benefits, the development of opening farms to citizens is often beneficial for a more positive public image of the agricultural sector. The general public nowadays has little knowledge about agro-production. Strict hygiene rules and up-scaling of farms contributed to the fact that only a minority of people has an origin, connections or an affinity with farming, farmers or the origin of the food products they buy. Consequently, the perception of the public is largely determined by animal health and food safety calamities that occur and the image built by the media (Noordhuizen, 2004a). Negative publicity by animal welfare organisations around bio-industry and modern management on farms, for example dairy farms with robotic milking or farms where cows are kept indoors all year round, can damage a good public image. The sympathy and understanding of citizens is, however, indispensable for the agricultural sector, and even more in densely populated countries, to maintain its right of existence. Farms open to the public can make a contribution to this by giving people the opportunity to get more acquainted with the sector.

In the wide variety of products and services that have been developed, e.g. bed and breakfast, traditional or biological production of food, camping, games and sports, the direct contact with animals comprises a service offered on many farms open to the public. This service can be aimed at different groups of people, like children, mentally- or physically disabled people or people who want to reenter employment. Besides advantages of opening farms to the general public, potential threats have to be taken into account. Outbreaks of zoonoses (King, 2004; Lejeune and Davis, 2004; Desachy, 2005), for example due to contacts between humans and sick or latent carrier animals, or due to consumption of non pasteurised milk (Prater, 2003) can render people ill, which could result in insurance claims (Jayarao and Henning, 2001; Hensel and Neubauer, 2001). People can also get injured due to contact with animals (Hendricks and Adekoya, 1998) or by dangerous machinery on the farm (Cogbill *et al.*, 1985; Elkington, 2002; Franklin *et al.*, 2000; Meijers and Baerg, 2001). Besides direct financial consequences, negative publicity can cause indirect financial losses. This can harm an individual farm but also the whole branch. Laws aimed to protect human health like the Dutch Occupational Health and Safety act can render farmers liable when no adequate measures were taken to prevent people from getting injured or ill.

In this paragraph, the on-farm service of ‘animal cuddling’ is taken as an example to describe how the principles of HACCP (Cullor, 1995; Pierson, 1995) can be applied to control public health issues on dairy farms open to the public. The application of HACCP can help in providing clients with more certainty about the quality of products and services (Noordhuizen and Welpelo, 1996; FAO, 1997; Codex Alimentarius Comm., 1991/website). The ultimate objective of such application is to safeguard visitors from the various hazards. Furthermore, the potential (advisory) role of veterinarians to assist farmers in their application of HACCP will be illustrated and discussed.

11.4.2. The HACCP team (step 1 of the 12 developmental steps in HACCP)

Before HACCP principles are applied, the multidisciplinary HACCP team has to be assembled as has been mentioned in Chapter 4 (Pierson, 1995; Codex Alimentarius Comm., 1991/website). When only one or two people are running the farm business, which is a common situation on most dairy farms, the HACCP team will be relatively small. Because different skills, specific knowledge and expertise appropriate to the product or process are needed for the development of a HACCP plan, it is likely that in a small HACCP team not all expertise is immediately available. In such situations it is recommended to involve external support for specific areas. Veterinarians trained in the field of Quality Risk Management and in veterinary public health can make an important contribution in fields as hygiene, public health (zoonoses), animal health and animal welfare, or animal handling practice. The HACCP team hence can comprise the farmer, an employee and a veterinarian. Specialists can be added to the HACCP team when needed to advise in certain areas like for taking care of certain target groups of visitors, or for designing suitable housing systems for animals to be cuddled.

11.4.3. Description of the provided service and the target group (step 2 and 3 of the 12 developmental steps in HACCP)

After the HACCP team has been assembled, a clear description of the targeted service and the target group itself is needed. 'Animal cuddling', which is taken as an example in this chapter, can be offered in different appearances. Contact with animals can be provided directly or through a fence. Furthermore, the service can be aimed at different groups of people with different objectives. Besides giving pleasure to children, contact with animals can also be beneficial for diseased people, people with a drug or alcohol addiction, and overworked and disabled people by giving them a sense of responsibility, self-esteem or positive feelings. Depending on the mental and physical condition of the target group, additional safety demands on the service may be necessary (Brison *et al.*, 2006; Franklin and Crosby, 2002; Pickett *et al.*, 2005).

The service has to be clearly defined before animals are selected for animal cuddling. Dependant on the goal of the service and the target group, some animal species or individuals will be more suitable for animal cuddling than others. Animal characteristics, like age, body size, natural behaviour have to be considered, but also unpredictable animal and possibly human behaviour are an inevitable part of the selection and Quality Risk Management programme design process.

11.4.4. Development of flow diagrams of the production process (step 4 and 5 of the 12 developmental steps of HACCP)

A flow diagram describes the different steps of a production process in their logical and chronological order, with interactions when applicable. Before the target product 'raw milk' is delivered to the industry, different production steps are passed. These steps can be illustrated in the general flow diagram representing an overall description of process steps as was illustrated in Chapter 5. Secondary, detail processes like feeding different groups of animals, land exploitation, animal feeding treatments, can be worked out in detailed diagrams or charts. Several elaborated examples of flow diagrams for dairy farms can be found in Lievaart *et al.* (2005), as well as in Annex 5A.

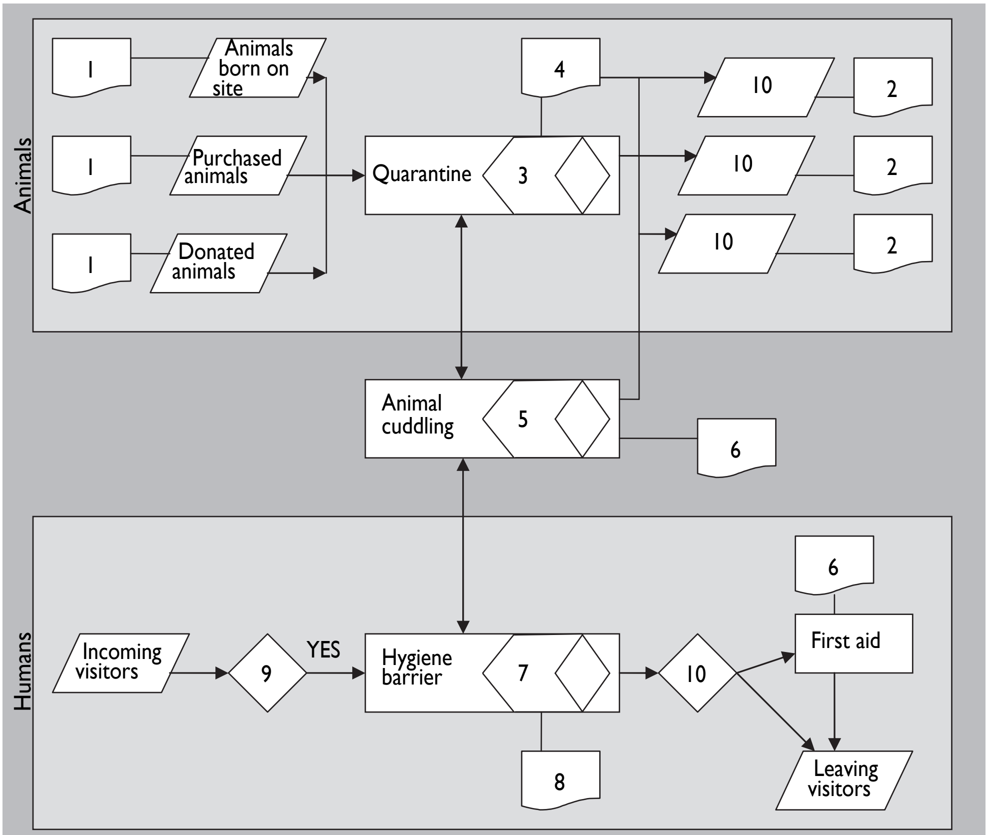
To apply HACCP principles on dairy farms open to the public, flow diagrams for services aimed at visitors have to be developed, in addition to the forenamed general flow diagrams for the raw milk production process. An example of a specific flow diagram of the animal cuddling process is presented in Figure 11.1. Complexity can arise when the processes of dairy farming and animal cuddling are interfering.

Depending on the farming areas, where the service of 'animal cuddling' is provided, a (detailed) specification of the flow diagram has to be made in order to visualise interactions and contact points of humans with animals. Animal cuddling can, for example, be offered at cow feeding, at calving, at cuddling dry cows, feeding calves, regrouping of calves.

The described general flow diagrams have to be adapted to the specific situation of an individual farm before the HACCP team can inspect the process to verify that each step in the diagram is an accurate representation of the actual situation. The flow diagrams will further support the discussion within the HACCP team about hazards and risks, and create awareness among team members and other people on the farm (see previous chapters).

11.4.5. Hazard analysis (step 6 – principle 1 in the 12 developmental steps of HACCP)

The hazards on a dairy farm open to the public can be divided into those influencing the quality and quantity standard of the targeted product of animal origin and those influencing the safety of activities offered to the public (zoönoses and injuries). Besides an influence on the quality and quantity of raw milk for example, animal health and production system related hazards as animal welfare, can influence the acceptance of products by consumers and services by the general public. Depending on the product or service, different hazards and risks are relevant to be considered.



1. Records on newly entered animals on the farm. For example; species age, origin, health state.
2. Records on animals removed from the farm, i.e. reason for and date of removal, species, age, destination.
3. Screening of animal health and character traits
4. Records on test results regarding animal health
5. Screening of animal and human behaviour
6. Records on the number and description of incidents
7. Check on the functioning of hygiene barrier (functioning of hand and boot washing facilities, availability of clean clothes)
8. Protocols for cleaning and checking the functioning
9. Decision whether visitors are allowed to enter the room for animal cuddling. Situation-dependianimal cuddling. Situation-depending: admittance can be refused to very young children, mental and physical disabled people.
10. Decision whether visitors need first aid on-site.

Figure 11.1. Overview of process steps involved in the part-process of 'animal cuddling'.

Commonly three categories of hazards are distinguished: microbiological, chemical and physical hazards and risks. Sometimes specific managerial hazards and risks are defined on dairy farms (OIE, 2006; Boersema *et al.*, 2007).

Focusing on the service 'animal cuddling', microbial hazards, like zoonotic bacteria, viruses and parasites, can be present on animal skin and in an environment contaminated with animal waste (e.g. manure). The exact outcome of the (microbial) hazard analysis will be different on each farm, dependant on the animals selected for cuddling, the health state of these animals and the regional / national differences in prevalence of zoonotic pathogens (Hugh-Jones *et al.*, 1995; Schlundt *et al.*, 2004).

For the Dutch and further European situation, pathogenic *Enterobacteriaceae*, like *Salmonella* spp., *Campylobacter jejuni*, *E. coli* O_{157} and *Yersinia enterocolitica,* are zoonotic bacteria that can be prevalent without signs. Furthermore, dermatophytosis, zoonotic scabies, contagious ecthyma, giardiasis and cryptosporidiosis are zoonoses to be taken into account, especially for immune-compromised and elder or youngest people. We should not neglect the fact that in some countries brucellosis or tuberculosis have not been eradicated and still may pose a risk to humans.

On several farms open the public, people can also get into contact with chemical hazards, like cleaning products, pesticides, herbicides, and veterinary medicines, when these products are e.g. left straying around on that farm. Furthermore, chemicals can be found on the hair-coat of animals when they are treated with e.g. pour-on applications of veterinary antiparasitic medicines.

The category of physical hazards is strongly related to animal and human behaviour. People can get injured, for example, due to biting, kicking or scratching of animals, but also as a consequence of poor maintenance of houses, fences or equipment.

11.4.6. Risk Assessment (step 6 of the 12 developmental steps of HACCP)

During risk assessment, the HACCP team will discuss the hazards and conclude which risk conditions are prevailing on the farm. In the process, the team has to make a decision about the relevance and priority of each hazard to be addressed. Risk weighing can be conducted on the basis of locally existing veterinary epidemiological evidence (Thrusfield, 2005; Noordhuizen *et al.*, 2001) or through the approach of adaptive conjoint analysis (Van Schaik *et al.*, 1998) by which expert opinions on a given subject (e.g. the relevance of certain risk factors for disease) are collected, validated and ranked. The third option to give risks a certain weight is by qualitatively assessing the probability of occurrence of that risk and the impact it may have once it is occurring. Examples can be found in Lievaart *et al.* (2005). The HACCP team members conduct this weighing to the best of their knowledge and experience.

Focusing on the hazards of 'animal cuddling' listed in Table 11.2, different risk factors can be defined. Important risk factors in relation to the hazard 'animals carrying zoonotic pathogens' are visitors having direct contact with animals and presence in

Table 11.2. Hazards related to public health and food safety on dairy farms open to the public.

Service or product provided on the farm	Microbiological hazards	Chemical hazards	Physical hazards
Animal cuddling (possibly different species involved)	Animals carrying or shedding zoonotic pathogens	Pour-on applications of veterinary medicines	Trauma as result of being hit or kicked, scratched or bitten
Sport, games in the farm yard or on premises	Zoonotic pathogens in the environment. Toxic herbs or plants. Contaminated water.	Pesticides, herbicides, cleaning & disinfection products	Dangerous machinery (parts), protrusions, unequal grounds, electric fencing, open water. Poor health condition of participants.
Food production (raw milk, dairy products) & Food consumption	Food-borne zoonotic pathogens	Residues of chemicals and veterinary medicines	Foreign objects

an environment contaminated with animal waste (e.g. manure; Lejeune and Davis, 2004). Furthermore, many visitors who come to farms open to the public, like young children and pregnant women, generally have a more fragile state of health which put them together with people having skin lesions, more at risk than others (Table 11.3).

Besides infections with zoonotic pathogens, injuries due to hitting by the head of an animals, biting, scratching or kicking by animals are important hazards. Unpredictable behaviour of animals is a risk factor related to these hazards, as can be the behaviour of target groups of visitors (Table 11.4.). Moreover, limited knowledge about natural and abnormal animal behaviour and little experience in animal handling will put people more at risk than well trained animal keepers for example.

Table 11.3. An example of some risk factors associated with a certain hazard.

Risk factors associated with the hazard 'Animals carrying zoonotic pathogens'
Direct contact of humans with animals
A stay in an environment which is contaminated with animal waste (manure; scabs)
Lesions of the human skin
Fragile state of health of visitors (young, old, pregnant, immuno-deficient people)

Table 11.4. An example of risk factors associated with a given hazard.

Risk factors associated with the hazard 'trauma as a results of being hit, kicked, bitten or scratched by an animal'
Direct contact of humans with animals
Contact with animals through a fence
Unpredictable behaviour of animals (e.g. mother behaviour; male behaviour)
Unpredictable/undesirable behaviour of visitors due to e.g. ignorance, health or mental state
Limited knowledge of visitors about animal behaviour

11.4.7. Critical Control Points, CCP, and Points of Particular Attention, POPA (step 7 – principle 2 – of the 12 developmental steps of HACCP

A *critical control point* (CCP) was defined as a step, series of steps, or a procedure in the production process, which can be inspected or measured, which is associated with the hazard of concern, at which process control can be applied; where control is essential to prevent or eliminate a safety hazard/risk; and where related corrective measures must guarantee the full restoration of control once it was lost (see Chapter 4). When an envisaged control point does not meet the criteria named for CCP's, but still is considered highly relevant, that control point is named a Point of Particular Attention, POPA.

11.4.8. CCP's and POPA's in relation to the hazard: 'animals carrying zoonotic pathogens'

An adequate measure to prevent people from getting ill due to an infection with zoonotic pathogens or getting injured by animals is to prohibit people to have direct contact with animals and to prohibit access to cowsheds or pastures (CCP). The implementation of this control point will not be desirable, when direct contact with animals is defined as the main goal of the service 'animal cuddling'. Nevertheless, an implementation of such a control point for selected groups of people, like very young children or immune-deficient people, can be advisable in situations where infections are known to be prevalent. Furthermore, this control point has to be implemented when animals are defined as carriers of zoonotic pathogens. Adequate fences and supervision can provide control of this CCP. When people are allowed to have direct contact with animals, additional control points (POPA) are necessary.

Animals exposed to visitors are *a priori* tested negative of selected zoonotic pathogens, ideally. Critical control points can only be defined for zoonotic pathogens that can be tested easily and reliably, for example by visual inspection on clinical signs or with on-site and laboratory tests. Unfortunately, for many zoonotic pathogens quick, reliable and affordable test methods are not available (often the test sensitivity and specificity are too low; Fletcher *et al.*, 1984). Besides this problem, reintroduction of zoonotic pathogens can not be excluded on many farms where animals and visitors are entering and leaving. Nevertheless optimising the health state of the herd is important in these open systems to reduce public health risks. A strict policy (good farming practice codes) on the purchase and introduction of new animals in the herd will be of value. Furthermore, exposure of visitors to animal waste must be reduced (as much as achievable) to diminish risks for people getting infected with zoonotic pathogens. This point of particular attention can be targeted on different levels of hygiene. For example by removing animal droppings from the animal cuddling area at least every two hours or by removing dirt and faeces from hair coats before animals are exposed to visitors.

11.4.9. CCP's and POPA's in relation to the hazard: 'trauma as a result of being hit, kicked, bitten or scratched by an animal'

Depending on the specific farm situation, target service and target group, certain animal species and individual animals can be defined as being dangerous in nature. Commonly male individuals like bulls, stallions and rams are not suitable to be used for animal cuddling and, hence, must be excluded. But also other animals can be defined as dangerous. For example, animals in estrus can behave less desirably due to more assertive or unpredictable behaviour. Furthermore horned goats or sheep can easily cause injuries when exposed to children. But also a free ranging calf of two or four months can be defined as dangerous due to relatively large body size and assertive (curious) behaviour when this animal is exposed to little children. Prohibition of exposure of visitors to dangerous animals can be defined as CCP. Animals reliable in nature can behave dangerously in different situations, for example when they feel intimidated. To prevent situations that provoke dangerous behaviour of animals, supervision, and a suitable environment (i.e. housing) is necessary (POPA). Besides this, employees and voluntary workers must have or gain sufficient knowledge of natural animal behaviour to prevent dangerous situations. Instruction posters could be placed on the premises to inform visitors what is expected from them to prevent dangerous situations. This point of particular attention could be changed into a critical control point when an exam has to be taken by the visitors to test their knowledge. In such adjusted control programmes, targets could be set for sufficient knowledge.

11.4.10. Targets associated to CCP's and POPA's (step 8 – principle 3 – of the 12 developmental steps of HACCP)

For each CCP standards/tolerances and for each POPA the targets must be defined to make control possible. Targets have to be defined dependent on the circumstances and goals of the individual dairy farm. For most CCP's and POPA's named in Tables 11.5 and 11.6, named targets can be set on a zero-tolerance, for example not allowing

Table 11.5. CCP and POPA associated with the microbiological hazard of 'animals carrying zoonotic pathogens'.

No contact between visitors and animals is allowed	CCP
Animals are free from selected zoonotic pathogens	CCP or POPA[1]
Exposure of visitors to animal waste materials is as low as possible	POPA
Isolation of sick animals	CCP[2]

[1]Depending on diagnostic test characteristics (sensitivity & specificity) and the disease specifications (e.g. intermittent shedder or not).
[2]Depending on the micro-organism involved.

Table 11.6. CCP and POPA associated with the physical hazard 'trauma as a result from being hit, kicked, bitten or scratched by an animal'.

No contact between humans and animals is allowed	CCP
No direct contact of humans with 'dangerous' animals is allowed	CCP
Avoiding situations which provoke dangerous behaviour of animals	POPA
Sufficient information for visitors about natural and abnormal animal behaviour	POPA

visitors in specific areas on the farm premises. For the POPA 'Exposure of visitors to animal waste is as low as achievable' targets can be set in relation to bacterial plate agar counts as is used in the food industry. For example not allowing more than a certain number of colony forming units per cm^2 for aerobic grow and a zero-tolerance for enterobacteriaceae on the plate agar taken from a dining-table. It also implies that a sanitation plan must be put into place.

11.4.11. Establishment of a monitoring system for CCP's and POPA's (step 9 – principle 4 – of the 12 steps of HACCP)

For all CCP or POPA together a specific monitoring system has to be developed. To optimise and maintain the health state of a herd for example, it will be necessary to perform regular checks on e.g. the presence of zoonotic pathogens. Depending on the pathogen, this can be done by visual inspection on clinical signs or through laboratory examination after sampling faeces, urine or blood to detect pathogen carriers or shedders.

Most hygiene measures to make the exposure of visitors to animal waste as low as achievable (POPA) and the prevention of dangerous situations (POPA) can be monitored by visual inspection. For example, visitors should be supervised on wearing suitable clothing and footwear, washing hands and behaving as prescribed. Cleanliness of the environment can practically be checked by visual inspection. Ideally cleaning procedures are regularly checked with agar bacterial count or contact plates. For the CCP and POPA examples described in Tables 11.5 and 11.6, *monitoring lists* can be developed. On these lists will appear: the CCP /POPA of concern; their standard/tolerance or target values; the site in the production process where it must be monitored; the frequency of the monitoring; the method of monitoring (e.g. visual; testing after sampling); the responsible person to do it; the action to be followed once monitoring has shown loss of control. An example of a monitoring list for supervision of human behaviour is presented in Table 11.7.

Table 11.7. An example of a monitoring list for supervision of human behaviour on dairy farms which are open to the public and which provide a service of animal cuddling.

Monitoring sheet		
Supervision of the behaviour of visitors for 'cuddling animals'		
Date: March 15th, 2007	**Supervisor responsible**: Mariska	
Previous checks on hygiene (presence and functionality):		
Environment= OK	Clothing = 1 overall worn out	
Footwear = OK	Washing facility = clean and functioning	
Time:	13.00 – 15.00 hrs	
Visitors group:	mentally disabled children, 6 to 8 years old from institute X	
Number of persons involved:	2 adults; 15 children	
Animals:		
Goats: Mike and Robin	Shetland pony: 1	Sheep: Brownie
Rabbits: 5	Calves: 3020–3022–3025–3026	
Report: quiet afternoon; 1 child scratched by another child; another child fell while playing with calves – no first aid necessary; One rabbit injured (probably broken leg after cuddling) and killed afterwards		
Notice: when abnormalities do occur, please call <name> at <telephone number>		

11.4.12. Establishment of intervention methods & corrective action plans (step 10 – principle 5 – of the 12 developmental steps of HACCP)

Monitoring data can be used to notice that a process step has deviated from the critical limit or target. Corrective action must be taken to ensure that the CCP or POPA has been brought under control again, or at least the impact has been reduced.

11.4.13. Corrective actions in relation to the microbiological hazard: 'animals carrying zoonotic pathogens'

When monitoring data of the daily visual health inspection or regular sampling reveals signs of zoonotic diseases, exposure of visitors to animals suspected of carrying zoonotic diseases must be prohibited immediately. When visual inspection reveals an insufficient level of hygiene, entrance must be denied temporarily. Adaptations in cleaning method / frequency or a more hygienic design of cowsheds and stables can help in up-scaling the level of hygiene.

When visitors do not behave according to the farm prescription rules, correcting actions must be taken by drawing attention to these rules, warnings or ultimately refusal of entrance. Examples of prescription rules are not allowing visitors to eat or drink in the cuddling area and an obligation to wear suitable clothes during and wash hands after contact with animals. Dependant on the animal species present, extra behaviour prescription rules for visitors can be added.

11.4.14. Corrective actions in relation to the physical hazard: 'trauma as a result of being hit, kicked, bitten or scratched by an animal'

As mentioned in the previous example, corrective actions must follow when people behave irresponsible, for example when possibly dangerous behaviour of animals is not taken into account. People getting injured by animals have to be provided with first aid or professional medical care immediately. Farm employees have to be instructed and trained regularly in first aid to be prepared to this job. Animals causing troubles or exhibiting undesired behaviour on repeated occasions have to be excluded from cuddling or even replaced by other animals or – if applicable – by other animal species.

11.4.15. Establishment of verification procedures and record keeping (step 10 and 12 – principles 6 and 7 – of the 12 developmental steps of HACCP)

Verification procedures: To determine whether the HACCP-like programme is working correctly, verification procedures must be designed. Verification procedures are preferably not carried out by the person who is responsible for performing the monitoring and corrective actions. This task can be performed by a local veterinarian skilled in this area or by qualified external parties.

A verification procedure must include a review of the HACCP-like programme and its records, deviations and product dispositions and a confirmation that CCP's and POPA's are kept under control. When possible, validation activities should include actions to confirm the efficacy of all elements of the HACCP-like programme. In addition to these internal validity screenings, it can be expected that in the near future external verification through auditing needs to be implemented. The latter could eventually lead to certification of these kinds of dairy farms.

Documentation and recording: Results of the hazard identification and risk analyses, and determination of CCP's, POPA's and their critical limits or targets have to be documented when a HACCP-like programme is applied. Furthermore, written procedures and recording of the CCP and POPA monitoring activities (frequency; methods; results; responsible person) as well as the associated corrective measures for improvement (CCP or POPA; date; area; type of measures taken; effects) are indispensable to assist the farmer to validate that the HACCP-like programme is working according to the targets. The stored documents can, moreover, be used to perform short and long-term evaluations.

Another domain of documentation in such Quality Risk Management programmes refers to guidelines under the heading of Good Dairy Farming codes of practice (FAO, 2004; see also at Chapter 3), as well as their specific working instructions on the farm. An example of such a working instruction is given in Table 11.8. Obviously such working instructions may refer to other, already existing guidelines and protocols, as is the case in Table 11.8.

Table 11.8. Example of a technical 'working instruction for the cuddling area with calves'. Actions to be taken prior to the visitors' entry to the facilities.

Move calves for cuddling from their pasture plot to their housing facilities, and feed them concentrates according to the 'Feed Instruction Protocol'
Remove the litter, straw, waste, and the feed left-overs before each feeding and prior to visitors' entry
Clean the sitting area for people, the equipment and the floors according to the 'Cleaning & Disinfection Protocol' and do it prior to visitors' entry
Dry the benches with clean towels after washing, prior to visitors' entry
Check the working of hand- & boot-washing facilities and the presence of soap and tissues prior to visitors' entry
Remove the used overalls and dirty towels; put them in the washing basket; replace them by other, clean ones prior to visitors' entry

11.4.16. Concluding remarks

In addition to hazards related to the production of milk, dairy farms open to the public have to deal with particular hazards related to the activities undertaken by lay people entering the farm. Controlling safety risks for visitors entering the farm can be performed by the application of a HACCP-like risk management programme. The HACCP concept regards the identification of hazards and the analysis and handling of risks. It can, therefore, be highly suitable for that purpose (Noordhuizen and Welpelo, 1996).

In this section is demonstrated that it is feasible to develop and implement a HACCP-like programme for dairy farms open to the public, in order to control microbiological, chemical and physical hazards regarding public health. Besides prevention of calamities, the HACCP-like programme can be used in case of complaints to prove to third parties that safety risks of farm products and on-farm services are kept under control as much as possible. Furthermore, it can be used as a marketing tool (including eventual, formal certification) as well. For further detailing on the programme development we refer to the previous chapters in this book.

11.5. The HACCP-like approach to City farm 'The Bank' (Example 2)[2]

This city farm (children's farm) is situated since nine years in the centre of a small town of 50,000 inhabitants, adjacent to a residential area. The yearly number of visitors is about 100,000 people. Visitors appear to stay for a two-hour visit in average. This farm comprises 1.5 hectares of grassland. The geographical lay-out of the buildings, pasture plots, manure storage and feed storage facilities is presented in Figure 11.2. A short-list of routine practices on the farm is presented in Table 11.9.

From this point onwards, we will follow the 12 steps for developing a HACCP-based Quality Risk Management programme (see Chapter 4). Previous chapters can be helpful in explaining and clarifying the issues addressed.

11.5.2. The Farm Quality Management Team (step 1 of the12 developmental steps of HACCP)

Before the start of developing a HACCP-based Quality Risk Management programme (QRM) a *Farm Quality Management Team*, the *Team*, was formed. This *Team* comprised the farm manager and the veterinary QRM expert. When deemed necessary the *Team* was extended by another specialist, like a myco-toxicologist or veterinary public health specialist. Once the *Team* was formed, an in-depth discussion and training took place in order to bring the *Team* members at the same level of understanding concepts and principles of hazard and risk identification, risk management and HACCP concept and principles.

[2] Extracted from and adapted after the internal report 'HACCP-like approaches on multifunctional farms' by J. Raposo, J.P.T.M. Noordhuizen and L. Lipman, Faculty of Veterinary Medicine, Utrecht University, The Netherlands, May 2006.

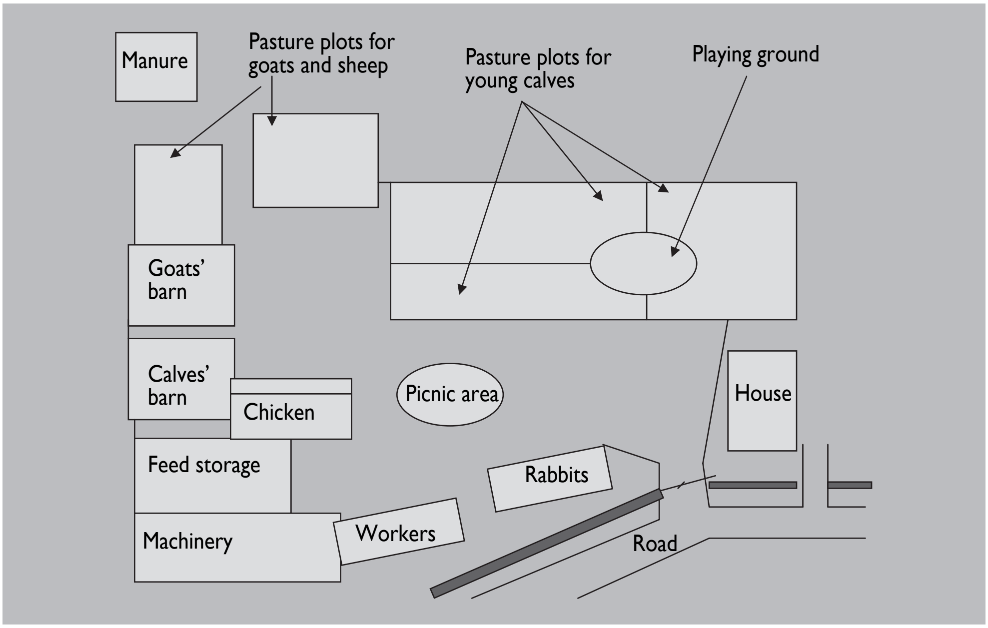


Figure 11.2. General outlines of the city farm 'The Bank', with animal houses, pasture plots, picnic and playground areas, storage for feed, machinery and manure, house of the manager and canteen for workers, public road and canal alongside.

Training assumes an important function because it provides the technical skills required for the development, introduction and implementation of the QRM; at the same time it assists in changing the attitude of the people involved, when needed.

11.5.3. Products (or services) and their destination (step 2 and 3 of the 12 developmental steps of HACCP)

The following 'products' are delivered by the farm:

- Information and training about animals present and the way they live on the farm.
- The service of 'cuddling' (direct contacts) involving cats, dogs, rabbits, sheep, goat; this service represents about 75% of all activities on these farms; about 20% of the visitors are younger than 5 years of age.
- Products produced on-site (e.g. eggs on this city farm; or cheese, not applicable here).
- Excretion products (e.g. manure; urine).

These are part of the social, environmental and agricultural projects within the framework of sustainable development in agriculture (EFCF, 2005).

Table 11.9. Short-listing of routine practices executed on this city farm.

Domain	Specification
Water	Human drinking water is supplied to all animal houses; well water is used in pasture plots. All drinking water is quality checked twice yearly (chemical; microbiological quality monitoring). Water distribution systems are separated.
Waste disposal	Manure is collected in a large container on the premises (see Figure 11.2) and is transported by a private company every 8 weeks to be used as soil fertiliser. All other garbage is handled as household garbage, collected every 2 days.
Personnel	The farm manager has been trained in agricultural management. There are 6 permanent workers, 8 handicapped workers and some volunteers. All people working on the farm receive basic training at the start and regularly after that.
Equipment	All installations on the farm are subjected to annual maintenance checks (monitoring) and repairs by the farm workers.
Animals	There are 2 cows, 4 horses, 12 sheep, 8 goats, 1 pig, chickens, 2 cats, 2 dogs, rodents (guinea-pigs; rabbits) on the farm.
Parasite & Pathogen control	The faeces of all animals are routinely collected and screened for gastro-intestinal parasites and pathogenic bacteria (e.g. *Salmonella* spp; *Campylobacter* spp.; *E. coli* O_{157}) four times a year in a regional diagnostic laboratory; records must be kept on the farm (monitoring).
Deworming & Vaccination	Animals are preventively dewormed every 8 months by the farm manager, except for the guinea-pigs dewormed every 12 weeks. Vaccination is carried out by a veterinarian in horses, sheep and goats, pigs, dogs.
Pest control	Rodenticides are distributed all over the farm premises after closing hours (when animals are inside houses) and re-collected before opening hours
Cleaning & Disinfection	A strict cleaning & disinfection scheme, as well as a hygiene protocol for bathrooms, houses, plots and storage facilities are applied. Doors, fences and equipment in contact with visitors are cleaned and disinfected once a week. Between different areas, hygiene barriers are needed to avoid contamination
Supplier control	The concentrates are delivered by commercial animal feed suppliers; the feed is produced under Good Manufacturing Practice codes. Roughages are harvested in a Nature Preservation Park nearby and transported by own farm workers.

11.5.4. Flow diagrams of the farm (step 4 and 5 of the 12 developmental steps of HACCP)

The flow diagram of the 'production process' on this farm is rather complex to construct, because several different species are involved, each with their species-related specifications, for example for feed or housing. The general model of the farm is depicted in the flow diagram in Figure 11.3, adapted after Lievaart *et al.* (2005).

For the example of 'cuddling' as a main service of this farm, we developed another (secondary) flow diagram, only focussing on the species involved: sheep, goat, cats, dogs, rabbits. This secondary flow diagram is presented in Figure 11.4. Both flow diagrams were validated during an inspection tour on the farm and after discussion with the farm manager and farm workers.

11.5.6. Hazards and associated risks (step 6 of the 12 developmental steps of HACCP)

The hazards which could be involved in these kinds of farms refer to microbiological, chemical, physical and managerial properties which can cause an adverse health effect through illnesses or injuries. The microbiological hazards of greatest importance on these farms are the zoonotic pathogens, being viruses, bacteria, endo/ectoparasites, protozoa, or indirectly through their respective toxins.

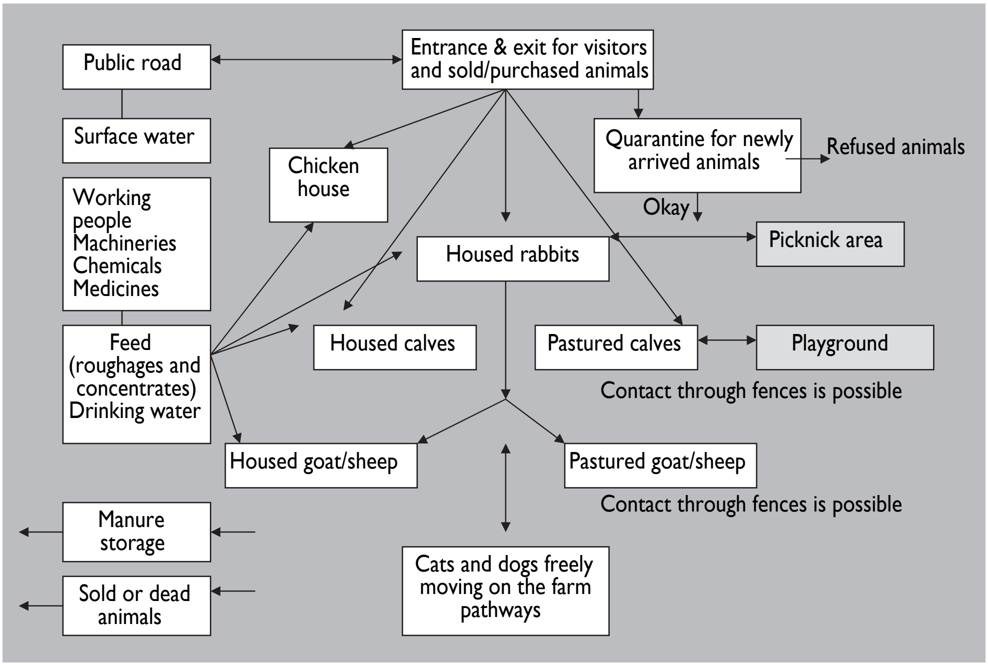


Figure 11.3. General flow diagram of city farm 'The Bank'.

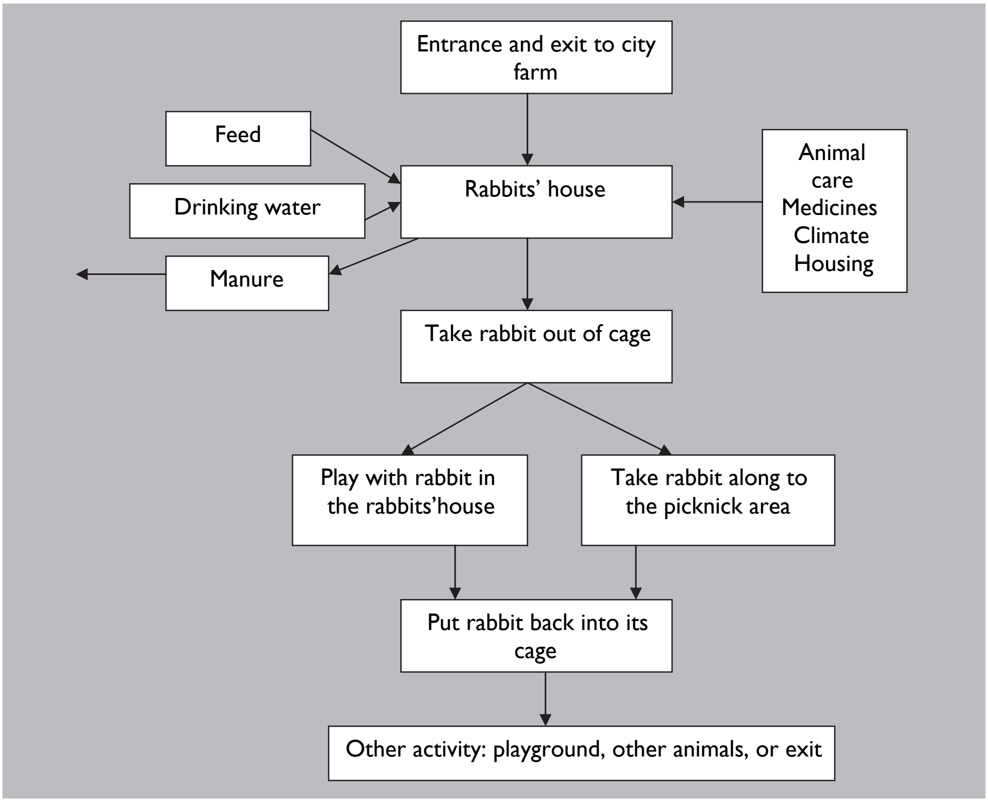


Figure 11.4. Secondary flow diagram of city farm 'The Bank', associated with the service of animal cuddling: rabbits. The respective contact points between humans and animals can be distinguished.

Because this farm comprises several different animal species, the spectrum of micro-organisms potentially involved in such diseases is far much larger than on mono-species farms like dairy cattle farms. Moreover, even when visitors have no direct contact with some animal species (e.g. cattle), it is still possible that micro-organisms may affect the visitors (e.g. VTEC through faeces) in an indirect way. The responsibility of the farm and farm manager, hence, is high.

Table 11.10 presents a short overview of zoonotic micro-organisms of several species on this farm. More information about such pathogens can be found in Savey (1994), Hugh-Jones et al. (1995) and Schlundt et al.(2004).

Table 11.10. Short overview of some relevant zoonotic micro-organisms potentially occurring in some animal species prevalent on this farm.

Cattle, sheep, goats	Chickens, birds	Rabbits	Other rodents	Cats, dogs
Campylobacter spp.	*Campylobacter* spp.	*Campylobacter* spp.	*Campylobacter* spp.	*Campylobacter* spp.
Corynebacterium pseudo-tuberculosis	*Staphylococcus aureus*	*Staphylococcus aureus*	*Staphylococcus aureus*	
E. coli O_{157}. VTEC-STEC	*E. coli*			
Cryptosporidium parvum	Swans? (water!)			
Ecthyma (parapox virus)	Avian Influenza H_5N_1		*Leptospira canicola* & *icterohaemorrhagica*	*Leptospira canicola* & *icterohaemorrhagica*
Listeria monocytogenes		*Pasteurella multocida*	*Pasteurella multocida*	*Pasteurella multocida*
Chlamydia psitacci	*Chlamydia psitacci*			*Capnocytophaga canimorsus*
Mycobacterium paratuberculosis				
Coxiella burnettii				*Bartonella* spp.
Salmonella spp.	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
Trichophyton verrucosum		*Trichophyton verrucosum*	*Trichophyton verrucosum*	*Toxoplasma gondii*
Mycobacterium avium	*Mycobacterium avium*		*Mycobacterium avium*	*Toxocara canis/cati*
Yersinia enterocolitica	*Yersinia enterocolitica*			

Among the *chemical hazards* which may potentially occur on this farm and following exposure of visitors (through ingestion and absorption, or skin contact) can be distinguished:

- detergents and other products for cleaning and disinfection; residues of such products may be present on equipment or animals; storage facilities may be open to visitors;
- pesticides (insecticides; herbicides; fungicides; wood preservatives; rodenticides) which are not properly stored;

- anti-parasitic products applied through pour-on; product or residue may remain on the hair-coat or skin of animals;
- other veterinary drugs like antimicrobial drugs and hormones for the treatment of animals, and which are not properly stored;
- mycotoxins in animal feed (grass and corn, silages, concentrates, or other feedstuffs).

Physical hazards refer to a wide variety of items which can function as a hazard on this farm, particularly for visitors not familiar with farming and handling animals or their facilities. The main hazards are in the areas of direct contact between visitors and animals or their surroundings: i.e. fences, equipment, contact points, animal houses with sharp items. These hazards may occur:
- when visitors are handling animals inappropriately;
- when visitors are handling animals which appear to be (too) aggressive for the group of people dealing with them (elder people, young children) or which appear to be too big for them to handle;
- when there are sharp (iron, wooden, plastic) parts and other things straying around on the farm or in the houses and potentially causing injuries;
- when items stray around on the farm which may be ingested by people (young children!) and may cause choking through blocking of the respiratory track.

Finally, we may distinguish *managerial hazards* on the farm, directly or indirectly causing or contributing to disease or hampered welfare, or public health disorders. The main hazards in this category are:
- housing: maintenance; lay-out;
- feed storage and feeding management (moulds in silage);
- poor animal identification (presenting the wrong animal to visitors);
- non-isolation of sick animals, hence exposing visitors to sick animals;
- other, miscellaneous hazards, related to e.g. poor maintenance of equipment (e.g. metal protrusions; oil leaking).

From the hazards, potentially occurring on this farm, the *Team* had chosen to deal with four particular main hazards. These are:
- microbiological: *E. coli* O_{157} H_7;
- chemical: rodenticide ingestion by children (difenacum is the active substance);
- physical: animals are poorly handled;
- managerial: wrong identification of sick animals.

Further *hazard identification* was conducted using literature search for risk factors (Prescott *et al.*, 2002**;** Davis *et al.*, 2005; Heuvelink *et al.*, 2002; Schouten *et al.*, 2005) and specific features regarding transmission; shedding and survival, as well as exposure characteristics for humans. See also Chapter 3 regarding the section on *Biosecurity Plans*.

An average visit to a city farm like this takes two hours, and the main occupation of young children visiting is 'cuddling', meaning that there is direct contact of humans with the animals and their potential micro-organisms (see Table 11.10).

Regarding the *microbiological hazards*, at the level of the large region where this city farm is located, prevalence figures of between 10 and 20% (average = 14%) of dairy and veal farms being positive on *E. coli* $O_{157}H_7$ culturing (De Rijcke and Oswald, 1994; Bouwknegt *et al.*, 2004) have been found, animal prevalence figures within farms ranging from 4 to 60%. Due to the routine screening 4 times per year with always negative test results, the *true risk* of *E. coli* $O_{157}H_7$ infection transmission to humans seems rather limited. The true risk was determined as being Probability (0-25%= score 1) times Impact (high, 3) = score 3; serious enough to pay attention to controlling this hazard. Probability and Impact scoring figures are derived from Table 11.11.

Nevertheless, applying the precautionary principle, this farm should apply the highest hygiene standards feasible to prevent visitors from attracting this hazard.

The hazard associated with the rodenticide regards the fact that it is a cumarin-derived product, preventing the production of blood coagulants through inhibiting pro-thrombin and blocking reductase in the blood coagulation process. The acute oral toxicity in experimental animals is high, it can lead to death within one day. The hazard on this farm may occur when children consume rodent-bites.

On this farm the product is distributed in dishes after closing hour and re-collected the next day before opening hours. The risk remains that cats and dogs take the bites to other places, or that dishes are forgotten to be picked up. The *true risk* of this

Table 11.11. Scoring probability and impact of certain risks to determine true risks on city farm.

Score	Probability	Impact	Interpretation of impact (examples)
1 (very low)	0-25%	Very low	No or little effect or minor discomfort
2 (low)	25-50%	Low	Fever, diarrhoea, minor sequela, minor trauma, little clinical distress
3 (high)	50-75%	High	Major sequela, septicaemia, major trauma, [long term] clinical distress
4 (very high)	75-100%	Very high	Permanent lesions, high morbidity or mortality, more dramatic clinical signs

hazard occurring is assessed as Probability (2) times Impact (4) = 8, serious enough to address this particular hazard.

Regarding the *physical hazard* of 'improperly handling animals', it can be determined that the animals on this farm do not show or have shown any aggressive behaviour in the past years. But it must be kept in mind that aggressive animal behaviour can be triggered by inappropriate human behaviour. This hazard is about hitting, kicking, biting, pushing, scratching, jumping by the animals or crushing of hands or feet, or being stuck between an animal and the wall or fence, causing injuries, particularly to young children. This risk is always present; the true risk weighted as Probability (3) times Impact (3) = 9, a serious, true risk to be addressed.

The last hazard, being a *managerial hazard* of 'wrong or too late identification of sick animals' is an important one because especially sick animals may shed micro-organisms in their faeces or other excretions. These animals should at all times be kept away from visitors, but also farm workers should apply special hygiene rules to avoid becoming affected too (*occupational disease*). The guinea pigs and the one pig are always in isolation from other species, but several species are kept in plots one after the other. The *true risk* regarding the other animals is assessed as Probability (2) times Impact (3) = 6. This hazard will hence be addressed in more detail.

11.5.7. Critical control points and points of particular attention (step 7 and 8 of the 12 developmental steps of HACCP)

Once the hazards and risk have been established, we have to look for those sites in the flow diagrams in Figures 15.2 and 15.3 (i.e. those sites in the production process on the farm) where these risks do occur. Next, we have to define control points (CCP or POPA) for which we can define *targets*. When defining CCP and POPA, we use the decision-tree scheme with questions addressed in Chapter 7. These actions have been combined in Table 11.12.

The *targets* for each CCP or POPA can be presented as follows:

- For (a): accept only animals with health certificates, and from reliable sources, tested free from *E. coli* infection.
- For (b): only mix animals from quarantine with others when they test negative on *E. coli* and other selected zoonotic pathogens.
- For (c): do not allow eating and drinking, nor hand-contacts on contact points.
- For (d): always wash hands after contacts according to instructions present.
- For (e): do not leave products in the open after opening hours.
- For (f): no physical injuries.
- For (g): all sick animals properly identified and isolated.

Table 11.12. The main hazards on this farm and the responses to questions for determining a CCP or a POPA.

Process step[2]	Hazard of concern[1]	Q 1	Q 2	Q 3	Q 4	Q 5	Outcome
Animals newly entering farm (a)	*E. coli* on animals	Y	Y	N	Y	Y	POPA
Quarantine (b)	*E. coli* on animals	Y	Y	Y			POPA
Points of direct contacts (c)	*E. coli* on visitors	Y	Y	N	Y	N	POPA
When leaving contact points (d)	*E. coli* on visitors	Y	Y	Y			POPA
Distribution & collection of rodenticides (e)	Chemical contamination of visitors	Y	Y	N	Y	Y	CCP
Physical contact points (f)	Poor animal handling (injuries)	Y	Y	N	Y	Y	POPA
Animal houses & pasture plots (g)	Wrong identification of sick animals (possible infection of people)						POPA

[1]*E. coli* is *E. coli* $O_{157}H_{7}$.
[2]GDF points to the fact that these issues can be put into guidelines and/or work instructions; the (a) to (g) refer to the targets given in the text. Other, managerial issues can be put into GDF guidelines too.

As can be noticed from Table 11.12, there is only one CCP for these hazards on this farm. This is because it is the only point where full control can really be exerted, when e.g. an appropriate working instruction for all farm workers dealing with these chemicals is applied and strictly followed. The other control points do not necessarily meet all CCP criteria and, hence, are POPA. GDF guidelines or working instructions apply there too.

11.5.8. Monitoring CCP and POPA (step 9 of the 12 developmental steps of HACCP)

The monitoring of these CCP and POPA should be defined by the Team. It is one of the most important elements in the QRM programme, because a proper monitoring can point to deficiencies or drawbacks. The chosen monitoring method should allow the assessment of the loss of control at a CCP, or POPA, at an early stage, so that corrective decisions and actions can be taken. An intrinsic element of such monitoring is the recording of monitoring results. For the previously named hazards, the monitoring procedure, including also the persons responsible for its proper execution can be defined as given in Table 11.13.

Table 11.13. Part of a CCP & POPA list of a QRM programme, with monitoring methods, monitoring frequency and person responsible for the respective monitoring.

Process step	CCP or POPA	Monitoring procedure	Monitoring frequency	Person responsible
New animals entering farm	POPA	Health certificate *E. coli* tested free (possibly other agents)	Before each new entrance	Farm manager
Quarantine	POPA	Faeces sample cultured for *E. coli* at 1 week after entry (also samples for brucellosis, tuberculosis)	For each new animal	Farm manager
Contact points for transmission	POPA	Worker assigned task to watch visitor behaviour	Each time visitor enters contact point	Designated worker
When leaving contact points	POPA	Worker watches visitor behaviour; instruct visitor to wash hands	Each time a visitor leaves contact point	Designated worker
Distribution & Collection of rodenticides	CCP	Worker checks that all numbered dished are collected	Each day before opening hours	Designated worker
Physical contact points (injuries)	POPA	Worker watches physical behaviour of visitors	Each time visitors enter contact points	Designated worker
Animal houses & Pasture plots	POPA	Worker watches animals carefully	At each feeding (> twice daily)	Designated worker

The farm workers designated as being responsible for a certain monitoring procedure should be identified specifically. Therefore, an organisational scheme can be handled and discussed each day. Obviously, it is a matter of organisation to assign specific tasks to specific people. A side-effect advantage is that these farm workers will eventually feel responsible for the tasks they have been given, which improves their involvement and performance. Monitoring results need to be recorded on a *Monitoring Results Sheet*.

11.5.9. Corrective measures (step 10 of the 12 developmental steps of HACCP)

Corrective measures have to be established, preferably beforehand, for each CCP and POPA. These measures are triggered by the results of the monitoring. A downward trend to loss of control or a full loss of control as indicated by monitoring the CCP and POPA must be sufficient to rapidly take the necessary corrective actions before more problems (the hazard) occur. The corrective measures must be described as part of the HACCP-based handbook, and be immediately accessible to farm workers.

When we follow the same hazard sequence as mentioned in Tables 11.12 and 11.13, the following corrective measures can be defined:

- For (a): if new animals tested positively before entry to the farm à refuse access; If new animals do not have a recent Health certificate indicating their freedom of *E. coli*, leptospirosis, tuberculosis or brucellosis à refuse access; the farm manager takes the decision.
- For (b): if animal is testing positive for *E. coli* during quarantine à deny animal entry to the farm; provide a fully separated house for positive testing animals; do not allow any contact with visitors; the farm manager takes the decision.
- For (c): any visitors starting eating, drinking or smoking must be stopped immediately; they must refrain from eating, drinking and smoking at all times; at their refusal to do so, they have to be expelled from the premises; the designated farm worker is responsible.
- For (d): any visitor not passing by the washing facility after animal contact must be guided to that place; refusal to comply to this rule must be followed by expulsion from the premises; the designated farm worker is responsible.
- For (e): any chemical product left after opening hours must be withdrawn; chemical products must be stored in a closed, cool, dark place; the designated farm worker is responsible.
- For (f): any wrong behaviour of visitors towards animals must be corrected immediately; repeated poor behaviour must result in expulsion of that person from the premises; the designated farm worker is responsible.
- For (g): Animals showing any signs of disease or disorder must be housed, away from visitors. According to the veterinary Farm Advisory Plan either the animal(s) are taken into observation by the farm manager, or the veterinarian is called for consultation; the farm manager takes the decision.

As component of the QRM programme, GDF guidelines and work instructions can be developed for specific on-farm functions (see also Chapter 3). Examples of such work instructions are: Washing Procedure at contact points; Visitors Instructions when entering the farm; Visitor Instructions for Handling Animals; work instruction for Handling Chemical Products (including the storage, application and disposal of such products as well as antibiotics or anti-parasitics). For defining these work instructions in detail, one can use the work instructions as provided in Chapter 3 as an example.

11.5.10. Internal validation and external verification (step 11 of the 12 developmental steps of HACCP)

The HACCP-based QRM programme must be maintained and internally verified in a dynamic way in order to retain its effectiveness and efficacy. Adjustments by the *Team* need to be carried out regularly and when deemed necessary.

As part of the internal verification one can conduct a strengths-and-weaknesses assessment every 3 or 6 months. Furthermore, one can evaluate the different records, like incidents reports (based on monitoring results sheets) and their associated *Improvement Logs* (based on the corrective measures taken). Non-announced visits by the external member of the *Team* (for example the veterinarian) for evaluating the daily routines deduced from the QRM programme as being complied with can help in this verification procedure.

Verification must imply methods, procedures, diagnostic tests, and other evaluations in addition to monitoring, corrective measures and control, to determine the compliance with the HACCP-like QRM. On this farm, the faeces and blood sampling for testing on presence of *E. coli* $O_{157}H_7$ (as part of a monitoring scheme), and the monthly farm visits by the veterinarian also form part of the internal verification procedure.

External verification once a year is (not yet) in place, although in some countries regular inspections of these farms, for example with regard to hygiene practices, by officers from the Ministry of Agriculture are the starting point for external accreditation and certification. This implies all issues forenamed under internal verification.

11.5.11. Documentation (step 12 of the 12 developmental steps of HACCP)

In the QRM on this city farm the following documents have been installed:

- animal health certificates, specifically for e.g. *E. coli* $O_{157}H_7$, leptospirosis and salmonellosis obtained through accredited laboratories;
- laboratory results from the regularly taken faeces and blood samples;
- dated hazards and risks inventory sheets (the *Team*);
- the monitoring list for CCP and POPA, responsibilities, corrective measures;
- the daily monitoring report from the designated farm worker(s) for particular items;
- the daily checklists for properly handling rodenticides;
- daily animal health checklists;
- the HACCP-based QRM handbook for reference use by farm workers;
- GDF guidelines and work instructions for both farm workers and visitors;
- Events Logs and Improvement Logs;
- farm visit reports from the veterinarian;
- training documents for farm workers;
- verification records.

The records should be kept in archives for 5 years. Hence, they may assist in detecting trends and events over time. In Figure 11.5 an example is given of a work instruction, on 'Visitor's Hygiene at Contact Points'.

Visitor's Hygiene & Behaviour at Contact Points and in Contact Areas
1. Always wash hands thoroughly with soap for at least 20 sec after leaving a contact point. Disinfectants must be available at all times. Adults should closely supervise the hand-washing of the children. 
2. Do not eat or drink at contact points or in areas where animals are located. Hand-to-mouth handlings like smoking, carrying toys and pacifiers that might be put in the mouth should not be taken into the contact areas.
3. Children less than 5 years old, pregnant women, and persons with a decreased immune-function (e.g. elderly people), should be particularly careful in following the forenamed rules.
4. At contact points, always remain calm and with a defensive attitude towards the animals. Remember that animals can get easily frightened when you make sudden (hand-) movements close to them.

Figure 11.5. An example of a work instruction for visitors (hygiene and behaviour).

The work instruction presented in Figure 11.5 must be clearly visible and readable at each contact point and in each contact area. A contact point or area must be identified as such by a special sign (see Figure 11.6).

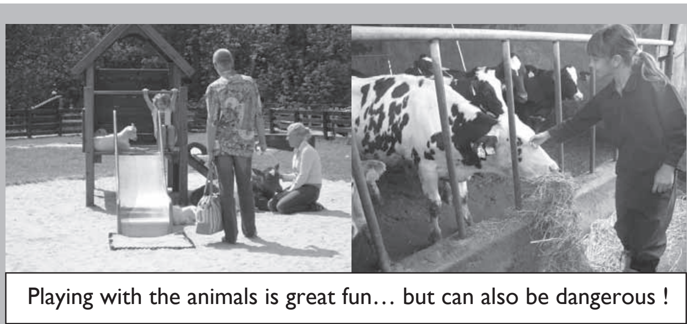


Figure 11.6. Example of a sign warning for unexpected (dangerous) animal behaviour.

Chapter 12. Applications of the HACCP principles to milking goat farms in France[3]

12.1. Introduction

Lactating goats represent an important segment of the animal production sector in France. With regard to its production, it is ranking first in Europe with an annual production of about 563 million litres (Institut d'Elevage, 2006a). There are two distinguished routes for milk processing: either the milk is collected by an industry, or milk (24%) is processed on-site for cheese (Institut d'Elevage, 2005b). In the west of France, the goat farms are rather intensified and reaching high production levels (788 kg/goat/lactation; Institut d'Elevage, 2006b). In order to achieve high production levels, farmers aim for high yield in the first lactation, rather than for longevity. That is a major reason why the replacement rate reaches levels up to 40% per year. Parallel to this phenomenon, rearing additional young animals contributes to an investment in the up-scaling of the farm size and to improving genetic make-up for milk production. Thirdly, rearing young animals is needed for replacing culled or dead animals.

The main disease categories in milking goats in this western region, deduced from expenditures for treatment, are listed in Table 12.1. The average expenditure for health control amount about 7 € per present goat (composed of 0.99 €, 0.46 €, 5.56 € respectively for kids from birth to weaning, goat kids after weaning, adult goats) and 0.84 €/100kg milk (Malher and Vasseur, 1999).

The three most relevant disease categories in goats after weaning are, hence, respiratory, parasitic and digestive disorders. Deduced hazards in the latter cases would be an insufficient growth rate during rearing and mortality of the kids. Most of these disease categories, if not all, regard multifactorial disease entities, where risk factors from different farming areas contribute to the incidence and prevalence of named disease categories.

In order to improve the technical performance and, hence, the economic results of these intensive milking goat operations, it is of strategic relevance to pay attention to the management of goat kid rearing and to the most important diseases that occur during the rearing period and also may affect future productive life.

[3] This chapter has been derived from a paper by Malher and Noordhuizen, published in Revue de Médicine Vétérinaire (2007) htpp://revmedvet.envt.fr (reproduced by courtesy of the Journal).

Table 12.1. Distribution of cost elements related to disease treatment in milking goats (goat kids before and after weaning, and adults) in western France (Malher and Vasseur, 1999).

Disease expenditure category	Percentage of expenditures for health control		
	Kids until weaning	Goat kids after weaning	Adult goats
Digestive and metabolic disorders	32%	11%	27%
Parasitism control	22%	22%	7%
Respiratory disorders	14%	37%	4%
Others	14%	15%	4%
Several miscellaneous indications	7%	6%	5%
General hygiene measures	6%	4%	10%
Nervous disorders	5%	5%	-
Reproductive disorders	x	x	17%
Udder health	x	x	14%
Regulatory prophylaxis	x	x	12%

The 'x'means: 'not applicable'.

There are two ways of approach:
1. developing and implementing a veterinary Herd Health & Production Management – HHPM – programme focussing on operational management (Brand *et al.*, 1996); and
2. developing and implementing a risk management programme based on the HACCP (hazard analysis critical control points) concept and principles(Codex Alimentarius Committee, 1991; Cullor, 1995, 1997; Noordhuizen and Welpelo, 1996).

Given the General Food Law (EC regulation 178-2002) and the new Hygiene directives (EC 852/853/854-2004) with consumer protection as core element (see Chapter 1), it may be worthwhile to consider the development and implementation of HACCP-like programmes on milking goat farms. Moreover, the EU hygiene directive 853-2004 suggests that primary producers install a HACCP-like Quality Risk Management programme for the elimination or reduction to an acceptable level of public and animal health or welfare hazards and their associated risks. Small ruminants are an important production sector in many countries throughout the world, including the U.K. and the Mediterranean area, Africa, Middle East, Asia, and Australia.

Quality in milking goat farms can be described as '*the whole set of veterinary and zootechnical features of a farm which determine its ability to satisfy the needs of the farmer and – indirectly and ultimately – the clients*'(after Heuchel *et al*., 1999). This definition comprises not only the farm performance in a technical sense, but also its ability to safeguard clients from hazards and risks in the area of public health & food safety, animal health & welfare.

Therefore, the main objective in this chapter is to describe the development of a HACCP-like Quality Risk Management programme for operational management on milking goat farms, and show its feasibility, namely in the area of goat kid rearing using an example Farm ZZ. It is discussed furthermore, how veterinary practitioners can play a paramount role as a coach-consultant for such programmes and support the farmer in his Quality Risk Management activities.

12.2. The HACCP concept and principles

The HACCP concept has 7 principles. These principles form part of the 12 developmental steps regarding a HACCP-like programme (Cullor, 1995; Lievaart *et al*., 2005) which have been introduced in Chapter 4. These 12 steps are the guideline for developing a Quality Risk Management programme for goat kid rearing on an example milking goat farm ZZ in western France in the following paragraphs. HACCP can be described as a programme '*which has a prevention focus and which is rigid and flexible at the same time, dynamic in its application, and which contributes largely to the safety and quality of products produced in the context of a quality driven market*' (Heuchel *et al*., 1999).

12.3. Characteristics of the example milking goat farm ZZ

Farm ZZ comprises 230 adult – predominantly Saanen – milking goats which are group-housed in straw yards as a loose housing system all year around. Milking is conducted in a 2 x 8 milking-unit herringbone parlour twice daily. Feeding comprises roughage such as grass (hay), alfalfa (hay, dehydrated) and concentrates. There is a separate parturition area for 25 goats at a time. After birth, the kids receive colostrum for 2 consecutive days; thereafter, they are fed milk replacer *ad libitum* through an automatic milk feeding system untill weaning age. During the suckling period, the first 60 goat kids are kept for replacement, whereas other goat-kids and males are sold at 7-10 days age to a fattening unit in an other farm.

After weaning, a goat-kid receives a daily ration of hay and 500 g of pelleted concentrates, allowing a normal growth rate. Thereafter, they are fed with hay and concentrates according to the nutritionist's prescriptions (Mohrand-Fehr *et al.*1996).

General features, events and targets of the goat kid rearing process are schematically presented in Figure 12.1 (adapted after Ricard, 2001).

The farmer's objective is to provide a sufficient number of young, healthy replacement goats given the yearly culling rate of 30%. These replacements should have their first parturition at about 12-14 months in order to timely replace the culled ones. This means that kids must be ready for AI on time (preferably at 7 and ultimately at 9 month age), at an appropriate body weight (50-54% of adult weight), and a body condition score of 2.75-3.0 (Mohrand-Fehr *et al.*, 1996). The previous goals can only be reached if growth rate is in order, if no health disorders occur hampering this growth rate, and if reproductive processes are dealt with properly (e.g. synchronisation at 7 month age by intra-vaginal sponges followed by PMSG injection to induce ovulation [e.g. Cronogest by Intervet®], and by AI or successful mating by approved bucks). The farmer irregularly conducts pregnancy testing after AI to detect non- or pseudo-pregnancy.

Growth rate target in the first month of age is 250-300 g/day, and up to weaning 160-220 g/day. Problems around weaning occur more often when the kid's body weight is lower, the milk replacer level is higher, non-liquid feed is not used, and when they have been affected by diseases (Petrau-Gay, 1986). Growth rate target from month 4 to AI period is 50-110 g/day; from month 7 to parturition 40-50 g/day.

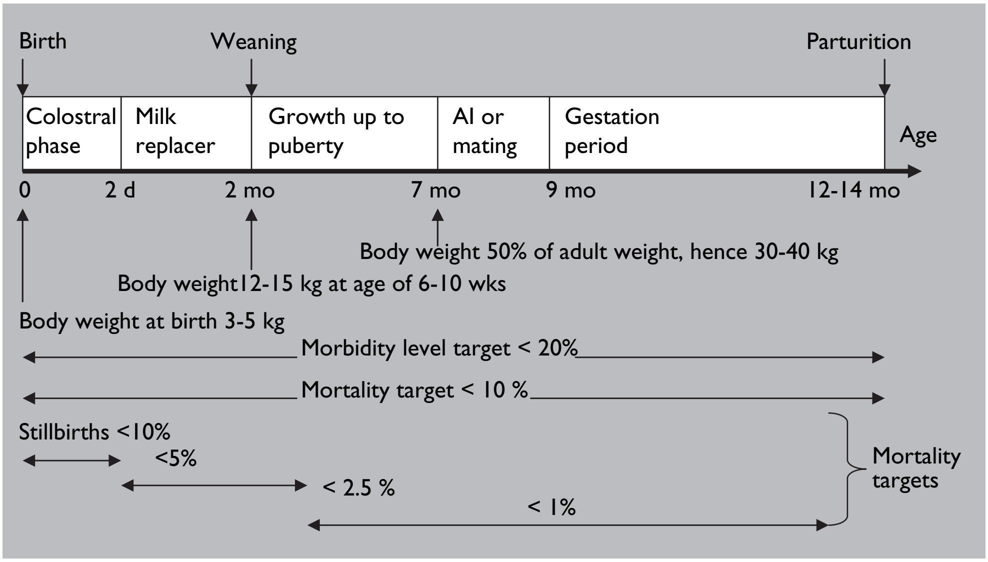


Figure 12.1. General schematic overview of the goat kid rearing period with major events and targets (adapted after Ricard, 2001).

General risk periods are around birth (birth history; weight at birth), after weaning, around the age for AI and around first parturition. Disorders (hazards) occur in periods as indicated in Table 12.2. It is noticeable that this farmer has not the objective to market goat-kids. Therefore, we will not take into account the hazards of early contamination for different, specified diseases such as CAEV, paratuberculosis, MAEDI-VISNA, mycoplasmosis, or blue tongue which might impair the quality of these goat-kids to be marketed.

Table 12.2. General overview of hazard areas, disease categories, some disease diagnoses and details of the rearing risk periods of goat kids.

Hazard type	Category of disorders/ diseases	Diagnosis of disorders/diseases	Rearing period details (age period) of highest risk
Microbiological	Respiratory disease	Enzootic pneumonia (*Pasteurella* & *Mycoplasma* spp.)	After weaning
	Digestive disorders	*E. coli* diarrhoea	First week of age
		Cryptosporidium diarrhoea	Second and third weeks of age
		Ecthyma	Up to 2 month age
		Coccidiosis	From 1 to 5 month of age
Physical	Presence of horns	Causing lesions in other goats	After mating
	Dehorning failure	Poor dehorning procedure	Second week of life
Managerial	Deficient growth rate	Milk replacer diet management	Before weaning
		Poor quality roughage	Before and after weaning
	Digestive disorders	Weaning shock Low level of food intake	Days/weeks after weaning
		Acidosis – Fattening due to excess of concentrates	Post-weaning period
	Reproductive performance	AI at too young age	6-7 month age
		AI at too old age	7-9 month age
	Poor dehorning practice	Horns or horn remainders are present	Second week of life

12.4. Developing the HACCP-based Quality Risk Management programme

In order to develop a HACCP-based Quality Risk Management programme, we follow the 12 developmental steps as listed in Chapter 4, Table 4.3 (adapted after Cullor, 1995) as the guideline.

12.4.1. Assemble a HACCP team, define the farm products and objectives (Step 1, Step 2 & Step 3)

The on-farm HACCP-*Team* would comprise the farmer, his veterinarian and possibly one or more specialists in a particular area where specific hazards do occur. The latter may refer to e.g. zoonoses, or chemical hazards, or an independent nutritionist when growth rate is a problem on the farm. This *Team* decides about the path to follow, the hazards to be addressed, the flow diagrams to be developed, and other actions to be taken.

The *Team* also discusses about the products of the farm: is it milk for the milk processing industry or milk for cheese-making at either that industry or on-farm? Are goat kids being reared for the market or for selling to other goat farms? Is there a specific service provided by the farm such as on-farm holiday accommodations, possibly contributing to public health hazards? The identification of these products and services contributes to the definition of the hazards and associated risks of concern in a later stage (see Step 6), as well as the standards and targets, and the monitoring.

It is highly recommendable to design a geographical site-map of the farm with e.g. all buildings for animals (age groups), milk harvesting, cheese-making, cheese selling-point, feed storage, machineries, waterways if any, roads, natural fences. Such a map will facilitate discussions within the *Team* when developing the HACCP-like programme and with third parties visiting the farm (e.g. animal feed truck drivers, dealers of chemicals, accountants, welfare inspectors). If consumers enter the farm for buying cheese, possibly additional hazards have to be identified and precautions taken regarding hygiene and/or infection transfer.

12.4.2. Designing flow diagrams of the production process (Step 4 and Step 5)

Under Step 4 there are flow diagrams being developed regarding the production process on the goat farm. A general flow diagram comprising all steps of the production process on that farm can be designed on the basis of the site-map of the farm (see previous steps). The outlines are, however, different as is shown in Figure 12.2.

Once the most relevant hazards have been identified (Step 6), it is very well possible that a more detailed flow diagram of a particular farm area is needed. This detailed flow diagram will assist in understanding better where hazards and risks do occur and

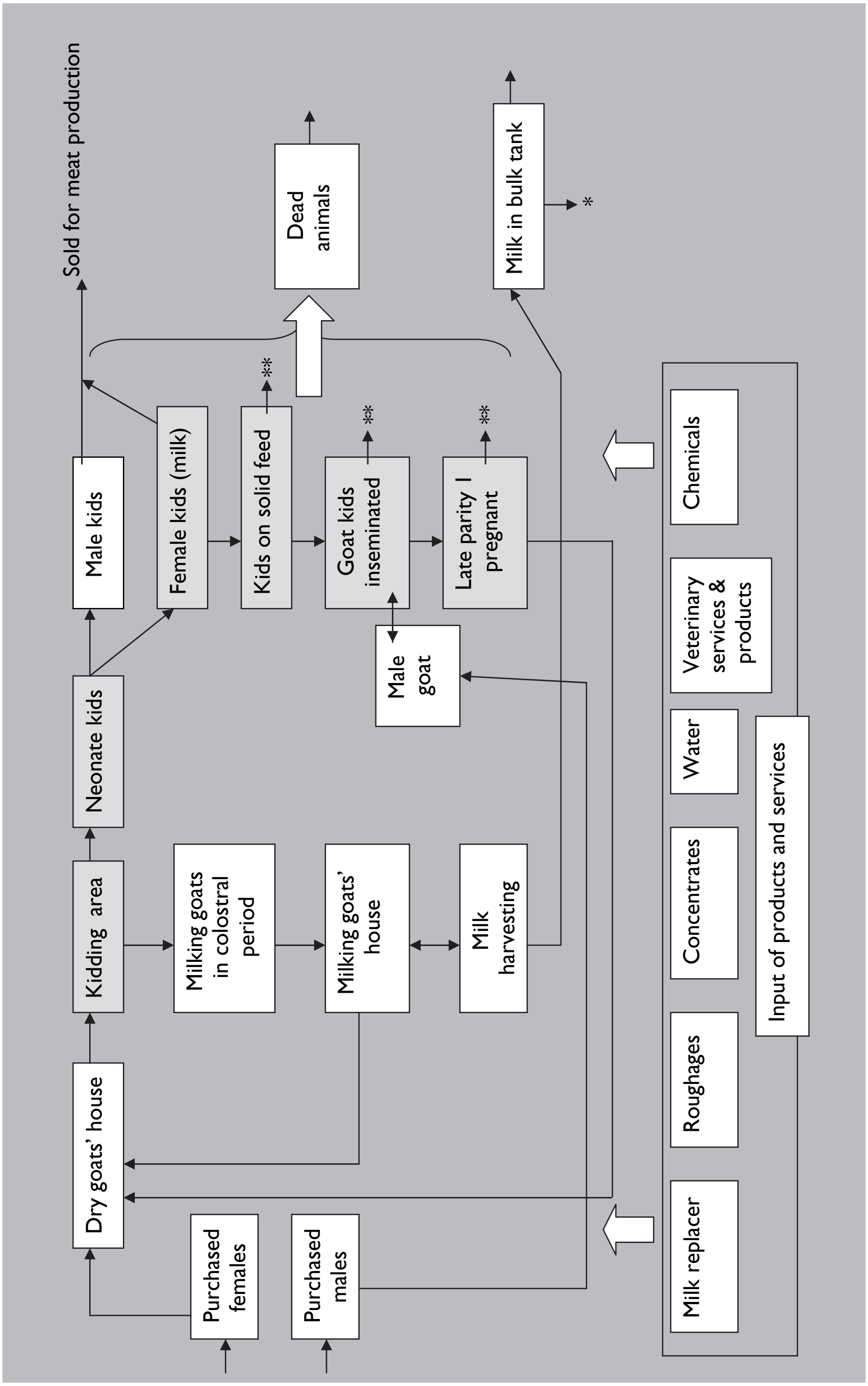


*Figure 12.2. General Flow Diagram of Milking Goat Farm ZZ (the grey areas re-appear in Figure 12.3 focussing on goat kid rearing). * = some farms make raw milk cheese on their farm; ** = on several farms goat kids are being sold for rearing or replacement elsewhere.*

where corrective or preventive measures can be taken. It helps the *Team* members but also other people either working on the farm or visiting the farm. Figure 12.3. shows a detailed flow diagram for the area of goat-kid rearing on Farm ZZ, the area where the hazards of concern are.

Flow diagrams have to be verified by *Team* members on-site and together with the farm workers for completeness and accuracy.

12.4.3. Identification of hazards, prevailing preventive measures and risk analysis (Step 6)

Next, the *Team* on Farm ZZ has (1) to define in more diagnostic detail what diseases (hazards) we are talking about, and (2) which diseases are the most relevant to this particular farm, on the basis of either their prevalence, or the wish of the farmer to prevent these diseases from entering the farm.

Deduced from the previous objectives of the farmer in this farm, hazards are mainly those which may result in:

- a too small number of goat-kids at mating;
- goat kids having an heterogeneous growth;
- goat kids having a too low body weight at 7 months of age;
- goat kids being too fat (over-conditioned) at mating;
- goat kids failing to get pregnant at mating;
- goat kids bearing and transmitting certain infections (e.g. *E. coli*, coccidiosis, infectious pneumonia), impairing herd health and productivity.

Hazards can be distinguished into four main classes: microbiological, chemical, physical and managerial in nature. The most important microbiological hazards in kids are – next to compulsory epidemic diseases for which official control programmes may exist (e.g. foot-and-mouth-disease; brucellosis; tuberculosis) – endemic diseases like respiratory disease (Ricard, 2001; Malher and Vesseur, 1999). The highly contagious epidemic diseases are not dealt with in this chapter.

Important chemical hazards are not identified in the present case of Farm ZZ, but one may consider residues from or contamination by machinery oil, detergents and disinfectants. Relevant physical hazards could be represented by the horns of the animals, potentially causing trauma in other goats.

Managerial hazards are, for example, those related to digestive disorders like acidosis and a too small or a too high growth rate of the kids, and those related to reproductive performance (Malher *et al.*, 1999). It should be born in mind that during the early rearing period a relatively low growth rate may well be caused by forenamed diseases

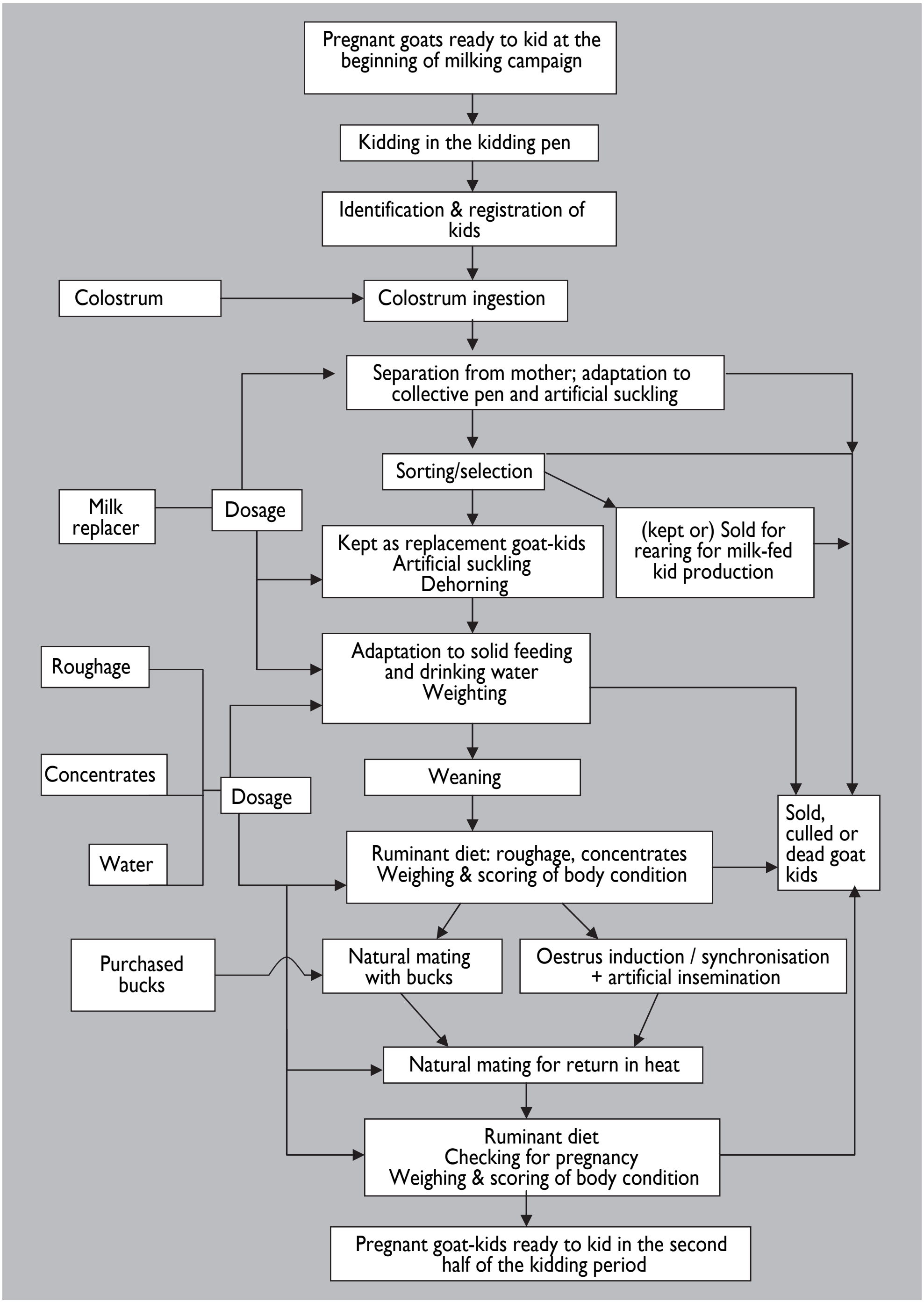


Figure 12.3. Detailed flow diagram regarding the specific part of goat kid rearing on the milking goat Farm ZZ.

and not by nutritional failures alone. Improper dehorning practices may be considered a managerial hazard too.

An overview of most highly important diseases or disorders in goat-kids has been presented by Chartier *et al.* (2006) and Chambre d'Agriculture des Deux-Sèvres (2004) and is summarised in Table 12.2. For Farm ZZ, the most relevant diseases resorting under the forenamed hazards have been identified by the *Team* (Table 12.3).

According to the 12 steps in HACCP, the preventive measures which are currently prevailing on Farm ZZ have to be identified as well. These preventive measures have been short-listed in Table 12.4.

With this information in hand, the next phase in Step 6 is to start an analysis of putative risk factors which are associated with the respective hazards on Farm ZZ named in Table 12.4. The risk factors originate from literature reviewed by Ricard (2001) and from regionally collected data (Institut d´Elevage, 2005a) and, hence, are population-based. They have to be screened on Farm ZZ for applicability and only those which are prevailing on this particular farm are retained. The selected risk factors on Farm ZZ associated with the named hazards are also presented in Table 12.4.

Now that relevant risk factors for selected hazards have been identified (Table 12.4), the next phase is to weigh these risk factors in order to find the most relevant, true risks on Farm ZZ. Risk weighing can be conducted in roughly three ways:
1. Qualitatively, by members of the *Farm Quality Management Team*; especially when the two other methods are not available and is based on their knowledge, experience and expertise.
2. Semi-quantitatively, by applying adaptive conjoint analysis procedures and search expert opinions regarding a certain farming area of concern such as veterinary specialists in respiratory diseases in goats (Van Schaik *et al.*, 1998).

Table 12.3. The major hazards (disorders) on Farm ZZ as identified by the Farm Quality Management Team.

Hazard type	Disorders of high priority on Farm ZZ
Microbiological	*E. coli* diarrhoea in the first week of age
	Enzootic pneumonia
Chemical	None identified by the *Team*
Physical	Stress at dehorning
Managerial	Poor growth rate

Table 12.4. Short-list of hazards, disorders on Farm ZZ, preventive measures, risk factors and risk weighting results as related to major hazards named in Table 12.3. (Note that the threshold value for 'weighted true risk' is set at >45, see text).

Hazard type	Disorders of high priority on Farm ZZ	Preventive measures currently prevailing on Farm ZZ	Associated risk factors	Result of risk weighing (PxIxD) on Farm FX
Microbiological	*E. coli* diarrhoea in the first week of age	Anti-coccidial products applied routinely Vaccination against *Clostridium* enterotoxemia yearly Separation of replacement goat kids from kids to be sold Separation of goat-kids from adults until kidding	Colostrum management is poor	3 x 5 x 3 = 45 true risk
			Hygiene of kidding barn (density, condition of bedding, contact with adults at birth, quality of umbilical disinfection) is deficient	3 x 4 x 4 = 48 true risk
			Automatic milk feeder adjustment is conducted infrequently	3 x 4 x 3 = 36
			Nursery hygiene (density, condition of bedding) is poor	3 x 4 x 4 = 48 true risk
	Enzootic pneumonia		Animal density in yard/house too high	2 x 2 x 4 = 16
			Housing hygiene (barn climate/ventilation, humidity percentage, quality/conditions of bedding) needs improvement	4 x 3 x 3 = 36
Physical	Stress at dehorning	Dehorning conducted by cauterisation	Poor dehorning method	1 x 3 x 3= 9
			Wrong age at dehorning	3 x 3 x 5= 45 true risk
			Poor health status at dehorning	3 x 4 x 4= 48 true risk
Managerial	Poor growth rate	Equipment for weighing animals and feed are present and being used	Low weight at birth	2 x 3 x 5 = 30
			Quality of diet / feed intake until weaning is poor	3 x 3 x 4 = 36
			Too early anti-coccidial treatment	2 x 2 x 4 = 8
			Too young and/or low weight at weaning	3 x 3 x 4 = 32
			Quantity/quality of hay (low level of refusal) after weaning is poor	3 x 4 x 4 = 48 true risk

3. Quantitatively, by conducting observational-analytic epidemiological field surveys (Noordhuizen *et al.*, 2001; Thrusfield, 2005).

When the methodologies under (2) and (3) are not available, which is very often the case in animal production, the only option for the *Team* is to give balanced weights to risk factors following the principle as described by Poncelet (1995):

Probability of occurrence × Impact of occurrence × Detection possibility (P×I×D)

Prevalence figures can be used to assess probabilities, while disease effect data (e.g. economic losses, loss of growth rate, mortality data, impaired welfare) can be used to assess the impact of a certain disease risk, either on a morbidity/mortality scale, or an economic impact. Note that 'detectability' can alter a weighted risk; commonly one could apply the value '1' for 'hardly detectable' and '2' for 'normally detectable'. Especially in cases where disease detection is not possible in live animals, the scoring value for D may be high e.g. '3' or '5', as long as the other two parameters show relevant values. On a scoring scale from 1 (negligible) via 3 (intermediate) to 5 (high level) the different aspects of certain disease risks can be weighted. A decision level for the outcome of this formula has to be established (e.g. 40), above which a risk is considered to be a true, non-acceptable risk. Weighted risk levels between 25 and 40 can be considered 'fit for future surveillance'.

Step 6 is concluded with the identification and weighting of most relevant risk factors for the selected hazards on Farm ZZ. The outcome is listed as well in Table 12.4; there have been 6 true risks defined through the process of weighing on Farm ZZ.

12.4.4. Critical control points & points of particular attention (Step 7)

In this step we have to define the critical control points and points of particular attention, CCP (Critical Control Points) and POPA (Points of Particular Attention) respectively. A CCP is a point, area, or series of points in a production process where control is critical to eliminate hazards and risks (Lievaart *et al.*, 2005).

A CCP meets certain formal HACCP criteria, while a POPA fails to meet one or more of these criteria. These criteria are: the point must be associated with the hazard of concern; it must be measurable or observable; standard value and tolerance limits must be set; corrective actions must be available; and once process control is lost at this point, the corrective measures must be able to fully restore process control. Most often, a POPA fails to meet the third and fifth criterion, but is still considered crucial for risk reduction in the production process. Most frequently, these POPA's form part of managerial practices.

For the 'true risks' the CCP respectively POPA have been defined (Table 12.5) as related to the hazards determined. As can be noticed from Table 12.5, the critical points on Farm ZZ are POPA and not CCP. The main reasons have been given before. Other reason is that most of the disease-related issues in animals show a biological variation. This phenomenon can, for example, be seen in the frequency distribution of serological titres. Somewhere on this distribution we have agreed on a cut-off point, above which we call animals test-positive, and below which we call animals negative. In biological test systems we have to deal with false-positives and false-negatives. This also hampers the definition of strict standards and tolerance limits for e.g. serological titres; we rather speak about targets. CCP should have standards with tolerance limits, while a POPA most commonly will have a target value set at a particular farm. An example is the target value for peri-natal mortality rate, or the percentage of goat-kids with diarrhoea in the first week of life.

12.4.5. Establish critical limits, standards or targets for CCP and POPA (Step 8)

In this step of development the *Team* has to define the standards and tolerance limits (CCP) or the target values (POPA) for this particular Farm ZZ. Therefore, we handle the major hazards as defined in Step 6 and their associated risks, and presented in Table 12.5. These hazards were:

- *E. coli* diarrhoea;
- enzootic pneumonia (caused by *Pasteurella threalosi, Manheimia haemolytica* and or *Mycoplasma* spp.);
- poor growth rate in the suckling period and around weaning;
- poor growth rate in the post-weaning period.

The associated risk factors on Farm ZZ were also identified (Table 12.4; 12.5). We have found that there are 6 POPA and no CCP (see Table12.5) distinguished on Farm ZZ. Targets can now be described. Table 12.5 comprises the respective target values (POPA) for the various hazards and associated risks. Note that the target values are close to those handled in regular veterinary Herd Health & Production Management programmes, HHPM (Brand *et al.*, 1996).

12.4.6. Designing the on-farm monitoring scheme and the corrective measures (Step 9 and Step 10)

The monitoring of all defined CCP and POPA should be part of a practical monitoring scheme on the farm. This monitoring scheme must include the following items: CCP or POPA of concern, the way that monitoring at that point takes place (observation, measuring, testing methodologies), the frequency of monitoring (daily, weekly, monthly), the person responsible for this monitoring, the recording of monitoring findings. Commonly there will be a link between the issues addressed in Table 12.5 (including corrective measures) and the monitoring items.

Table 12.5. Overview of identified priority disorders on Farm ZZ, control points, weighted risk factors, CCP or POPA identification, Standard & tolerance values or Target values, and corrective measures.

Disorders of high priority on Farm ZZ	Control point	True risks defined	CCP or POPA	Standard & tolerance, or target values	Corrective measures and reference
E. coli diarrhoea in the first week of age	Hygiene around kidding	Poor hygiene in kidding barn (density, condition of bedding, contact with adults, quality of umbilical disinfection)	POPA	New clean litter in a newly disinfected barn with >1.5 m^2/ pregnant goat 100% records of identification at birth and disinfected umbilical cord	Preparation of kidding barn: cleaning, disinfection and new bedding between kidding batches, goat density, presence of an infirmary for aborted goats Kidding surveillance and recording: identification, birth weight, umbilical cord disinfection Separation of goat kid at 12 hours after birth
	Colostrum quality & intake	Colostrum deprivation and/or poor colostrum quality	POPA	100% suckling actively or colostrum supplemented (recording of the kids which are supplemented) >95% of kids with adequate blood IgG	Kidding surveillance: checking for repletion of belly and suckling every 4 hours If not satisfying: colostrum collection and storage after checking for colostrum quality (colostrometer), distribution of 100 ml colostrum /kg to be distributed in 3 to 4 meals each 3-4 hours within the 12 first hours Follow working instruction on 'Colostrum Management'
	Hygiene of nursery	Poor nursery hygiene (density, condition of bedding, automatic feeder use)	POPA	>0.3 m^2/kid until 1 month then >0.5 m^2 Temperature: 18-25 °C No draught, Dry litter Frequent cleaning & disinfection 1x/day 1 teat of Automatic milk feeder for 15 kids 1 checking of feeder/week: concentration, temperature of milk 45 °C, temperature of the teat: 40 °C	New pens, cleaning, disinfection, new bedding, warming by IR lights Cleaning of suckling cups once daily Adjustment of concentration and temperature in milk feeder

Table 12.5. Continued.

Disorders of high priority on Farm ZZ	Control point	True risks defined	CCP or POPA	Standard & tolerance, or target values	Corrective measures and reference
Stress at dehorning	Dehorning	Wrong age at dehorning	POPA	90% between 8 and 12 days of age	Adjustment of dehorning age
		Poor health status at dehorning	POPA	10% of weakest and sick animals dehorned in the third week	Clinical examination of kids (Body temperature, absence of diarrhoea) before dehorning Delay of dehorning when suspected of disease Follow working instruction 'Good dehorning practice'
Poor growth rate	Post-weaning growth	Poor quantity/quality of hay after weaning	POPA	Body weight of 12–14 kg at weaning (2 months), >30 kg at 6 months Hay of best quality: >1200 kcal of net energy/kg dry matter (>0.7 UFL/kg) Feed intake of 480 g/d of hay +350 g/d concentrates at weaning to 670 g/d of hay and 520 g/d of concentrates at 6 months 1 meter of manger / goat	Check goat-kid weight (and age) at weaning Assess hay quality regularly (at least each new batch) Record concentrates (type, quality, quantity) before weaning Record hay intake (quality, quantity) before weaning Assess hay intake after weaning (initial weight and % of refusals per day) Record concentrates distributed (type, quality, quantity) after weaning Check goat-kid weight every 6 weeks Follow working instruction 'Feeding Scheme Kids'

Checking on colostrum quality by a colostrometer should – most certainly in case of problems – be conducted by the farmer at 90% of the goat-kids births. The same applies to checking on serum IgG levels in neonate goat-kids: at least 90% should be checked by the veterinarian in case of problems. In routine monitoring situations without problems, 20% of kids born should be checked each defined birth period (with a minimum of 5 kids).

Body weight estimations must be made by the farmer according to the schedule presented in Figure 12.1. The findings from the monitoring activities must be recorded in a so-called *Monitoring Log*. Results of monitoring are used for adjusting managerial activities or other production process related issues.

As already presented in Table 12.5, there are various corrective measures to be described for each CCP and POPA. Once that monitoring indicates a loss of control at a certain point, these corrective measures must be put into place.

Table 12.5 also comprises references to several *working instructions*: on Cleaning & Disinfection, on Colostrum Management, and Feeding Scheme for Kids. These are *operational management instruments* to assist the farmer in conducting the respective activities in the best possible way. Usually they comprise just one page A_4 to keep readability and simplicity. Examples can be found at www.vacqa-international.com. The working instructions form part of Good Farming codes of Practice, GFP, as proposed by OIE and FAO (FAO, 2003; OIE, 2006). GFP are guidelines and working instructions meant to improve attitude and mentality of farm workers with regard to 'best practice' approaches on the farm. An example of a working instruction is presented in Table 12.6.

12.4.7. Record keeping and system verification procedures (Step 11 and 12)

Like in every programme, records must be kept in programmes of Quality Risk Management according to the HACCP concept (OIE, 2006). Some of these records have already been addressed in the Figures and Tables presented in this chapter. Additional to these are: a *Medicine Log* to record – according to regulations – the treatments given; a *Herd Treatment Advisory Plan* (with indications, medicinal drugs, dosage and route of administration for adequate on-farm treatments by the farmer), laboratory results sheets (test results, autopsies). These records are all needed to validate that the HACCP-based programme is functioning appropriately. Such validation is conducted each 6 months, at least once yearly.

External verification should be done by external institutions through auditing procedures executed by multidisciplinary trained person. Only when farm certification, as part of a whole Food Chain Quality Assurance system, is warranted by e.g. retailers

Table 12.6. Working instruction for Climate Control in Neonatal Goat-kid barns, and frequency of checking, X refers to general lay-out and barn design principles.

Farm code:	Date of last revision:	Author:
Responsible person(s) for execution:		
Area of concern	Activity details	When
Prevent newly born kids from cooling down	Dry the newborn kids	Each birth
	Prevent drought and damp	Daily
	Provide fresh air all day-night	Daily
	Install separate climate control units/barn	X
	If needed, provide a lamp	
Climate control parameters	Relative Humidity <85%	Daily
	Wind speed <0.3 m/sec	Daily
	Temperature: from 25 °C at birth to 18 °C at 5 days old (IR lamp may be provided). From 16 °C to 10 °C after 5 days	Daily
General management issues	Prevent rain from falling inside	X
	Provide clean dry bedding	Daily
	Provide good drainage in bedding	X
	Provide light >100 lux	X
	Check feed intake	Daily
	Check signs of health disorders	Daily

or milk processing industry, such a farm-status certification, and hence, external verification, is necessary.

12.5. Discussion and conclusions

This chapter has been conceived to show that the application of the HACCP concept and principles is feasible – next to dairy cattle and children's farm – at milking goat farm level too. The most important issue is that what is known already should be better structured, organised and formalised under the heading and application of a HACCP-based Quality Risk Management programme. While in Herd Health & Production Management (HHPM) programmes the approach is (too) often rather qualitative in nature and conducted in a more free-style format, the forenamed three characteristics of the HACCP-like approach puts emphasis on the fact that under a HACCP approach most issues have to be described beforehand. The corrective measures, for example, will commonly be weighted and discussed once a problem has arisen during a HHPM programme, while in Quality Risk Management programmes they must have been described already. Cost-benefit assessment of such measures must have already taken place beforehand; HACCP development requires time investment and, hence, can be costly.

Farmers have indicated during field surveys that the benefit of HACCP-like programmes is indeed the fact that they are well-structured and well-organised. Moreover, they indicate that by using the risk factor tables, as well as the working instructions and guidelines, they have become much more aware of the issues at stake. A good example in this context is the working instruction on 'Good Dehorning Practice' (Institut d´Elevage, 2005a). They feel better prepared to deal with problems once they are pending (Boersema *et al.*, 2007). In this way, the HACCP-based approach is much more preventive in nature because it is focussed on risk management rather than on disease control.

As expected, there were only POPA's; the main reason is that animal production concerns living animals rather than physical entities such as in branches of the food processing industry. Living animals show biological variation, hence, full restoration of process control once it was lost can not be guaranteed through risk management measures on farms. These measures, however, do contribute to risk reduction. Both preventive and corrective measures do contribute to either risk elimination or risk reduction.

One other advantage of applying the HACCP-like programme in the way we have presented here is that operational management can be very well coupled to the more tactical Quality Risk Management. This facilitates greatly the adoption of the programme by the farmers.

The Quality Risk Management programme presented in this chapter, closely relates to the initiative that has been taken by ANICAP (2006) to create a best practice type of approach to goat farms. The latter shows many similarities with the Good Farming codes of Practice, addressed by the OIE (2006) and FAO (2003). Quality risk management points to the three domains where the EU is striving for improvement in primary animal production: public health & food safety, animal health and animal welfare (EU directives 852/853/854-2004 and EC regulation 178-2002). The EU has done the suggestion to implement HACCP-like programmes on primary production farms for safeguarding these domains. The ultimate goal is the protection of the consumers.

When veterinarians desire to play a substantial role in this area, they have to acquire additional knowledge and skills. The latter are mainly associated with the understanding and application of the HACCP concept and principles, communicative skills, marketing and business administration, farm management, entrepreneurship, and farm economics (Cannas da Silva *et al.*, 2006; Noordhuizen *et al.*, 2006). Then, they would be able to function as coach-consultant for Quality Risk Management on the EU indicated domains on these milking goat farms: public health, food safety, animal health, and animal welfare.

Chapter 13. Veterinary advice to entrepreneur-like dairy farmers regarding Quality Risk Management[4]

13.1. Introduction

In this chapter miscellaneous issues are presented which can be considered as complementary to the implementation of Quality Risk Management programmes. The first paragraph addresses the characteristics of entrepreneur/like dairy farmers, as opposed to some general features of bovine practitioners that hamper the proper introduction of Quality Risk Management programmes.

13.2. Veterinary advice to entrepreneur-like dairy farmers

Various recent scenario studies showed that the dairy farmers who will last in this sector will comprise family run dairy herds with 4 to 8 tons of milk per year on the one hand, and herds with over 8 tons of milk per year on the other hand. The latter herds will, undoubtedly, be the larger herds with more than 150 cows. On these farms we will find *entrepreneur*-like farmers who show a different attitude, mentality and farming style. Farming goals, strategies, characteristics, and management style differ from the smaller family run dairy operations.

The current veterinary curriculum will, if at all, primarily focus on the smaller family-run dairy farms with regard to veterinary herd advisory programmes, while little or no attention is paid to the forenamed *entrepreneur*-like larger dairy farms and the larger family-run dairy farms. The future trend in the dairy sector is towards larger dairy herds. Hence, the question can be raised whether the veterinary curriculum as well as the veterinary practitioners are well prepared to provide these larger farms with the proper veterinary services. The authors consider this issue a 'blanc spot' in the students' curricula and in continuing professional education. In some areas, entrepreneur-like dairy farmers have left their veterinary practice because the latter does not meet with the demands of these farmers.

The *objective* of this paragraph is to address the different features of *entrepreneur*-like dairy farmers as well as the stronger and weaker points of current practitioners, in order to come up with a plan of action for veterinarians for preparing them to the task of providing advisory services tailor-made for and requested by *entrepreneur*-like dairy farmers. In the following sections first the major features of entrepreneur-like farmers are given (1), followed by the strengths-and-weaknesses assessment results

[4] Adapted after the text by Van Egmond *et al.* (2006) and Noordhuizen *et al.* (2006) originally issued by Pfizer Animal Health BV, The Netherlands, on CD ROM.

regarding veterinary practitioners (2). Subsequently, the points of improvement and investment by practitioners are addressed in order to provide hands-on for the herd health practitioner of the future (3).

13.3. Major features of entrepreneur-like dairy farms and –farmers

13.3.1. Entrepreneurship[5]

'*An entrepreneur is someone who has got ideas and is full of action, who has the qualities to inspire other people and who does not accept the ordinary borders of structured situations. He is a katalisator of changes, instrumental to detect new opportunities, which makes the entrepreneur function an unique one*' (Schumpeter, 1949, in Bergevoet, 2005).

The 8 major features of an entrepreneur are:
- risk taking;
- capital providing (from own means or external sources);
- innovative;
- finds opportunities to make profits;
- is responsible for the process to create new values;
- enhances changes;
- decision-making based on multiple judgements;
- a planner.

For those who advise an entrepreneur it is absolutely necessary to get acquainted with the goals, attitude, social values and observable behaviour of these farmers before moving to action. In Figure 13.1, the characteristics are combined in one ideal entrepreneur:

Psychological factors are, for example, innovative behaviour and risk attitude. Risk attitude should in this context be considered as based on positively evaluating behaviour; therefore, entrepreneurs are often considered as risk-takers. An other aspect regards the 'locus of control'. This means that the results of a decision process are determined by the person himself or externally, as influenced by knowledge and experience. Entrepreneurs usually are convinced that the results of decisions are determined by themselves on the basis of efficiency and self-efficacy under consideration of their own risk-perception. They often observe the right opportunities and select them. They understand the art and science to take decisions which lead to the achievement of their goals. They understand complex information. They are able to create situations of cooperation and trust, for example through their connections and contact with peers. They show conviction and social-communicative skills.

[5] Adapted after Bergevoet, 2005.

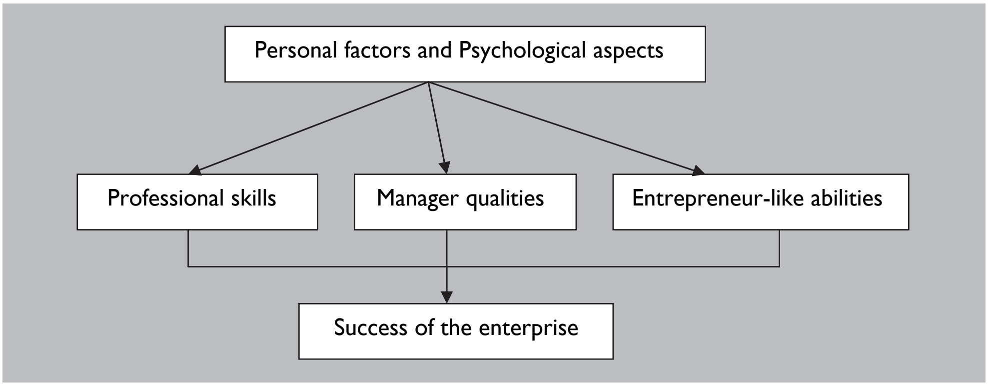


Figure 13.1. The characteristics of the ideal entrepreneur.

The *entrepreneur*-success manifests itself in the achievement of multiple goals. These farmers are highly interested in pleasure in their work (showed by public image; working with animals; food safety as primary feature of their enterprise; in the fact that challenges are opportunities instead of threats) and that they do not necessarily cling to economic goals, but rather to intrinsic aspects of a dairy farm. See also the paragraph about behavioural economics.

The following clusters of characteristics have been determined for *entrepreneur*-like dairy farms:
1. professional skills;
2. commercial and market-oriented focus;
3. high degree of organisation;
4. skilled in communication, discussion and negotiation;
5. farm economic orientation;
6. aware of own abilities and skills; aware of what others should provide;
7. behavioural economics.

Each of these clusters can be further elaborated in detail. A short sketch of such elaboration will be dealt with below.

13.3.2. Brinkmanship and further
(a professional farmer has the proper knowledge and skills in the farm-technical areas, has the proper sense for animals and farm, and aims at optimal technical results; he uses performance figures to frequently evaluate performance)

These farmers have a broad view on their farm business and know very well what is going on in their farm. They show a strong drive in their farming activities, are looking for stability without too much changes occurring. They aim at this stability by optimising the number of personnel versus costs (reflected for example by the weighing between purchasing a tractor or an automatic milking system) and by trying to eliminate farm-blindness. They know about developments in the sector as well as within the EU policy. These farmers try to gain new and more knowledge and look for trustful, sustainable knowledge-intensive advisors within their professional network on a national scale and – if indicated when for example the veterinary practice does not meet with their demands – abroad.

The technical and knowledge level of these farmers is high and further increases, leading to a critical attitude and strategic visions. They are planners on the shorter as well as the longer term, and try to make a prediction of the changes ahead. This enables them to adapt (elements of) their farm management in time. Such changes may refer to milk price, milk quota, subsidies, price of land, or incentives for disease control. These features distinguish the *entrepreneur*-like farmers from their manager-colleagues. These farmers hire people on the basis of their technical skills, or hire technical skills from outside. 'Passion' is an often heard feature among *entrepreneurs*.

Technical professionalism and strategic management are sometimes hard to combine in one person. Then it could be indicated to distribute these two tasks among different people, depending on competences present. A clear strategic vision (on paper) leads to peace on the farm and often to better results.

13.3.3. Commerce and market

Entrepreneurs show a strong market-orientation; they produce market-conform as put forward by e.g. quality demands. Such quality demands may originate from e.g. consumers/retailers, dairy industry and or the national or EU authorities. It should be stated at this place that the European Dairy Farmers, EDF, show activities in the area of developing HACCP-like programmes for application on their farms.

Entrepreneurs show a strong orientation towards society and towards opportunities. They are not defensive, but rather prospective in nature; they enter discussions with many stakeholders and actors from society, involving aspects such as agricultural politics, the environment, animal protection and nature conservation.

From areas like marketing sciences and business administration these farmers take the principles and *modus operandi* for further application within their farm and farm management (Cross and Smith, 1996; Griffin, 1995). A wide scope on developments of the sector, and their vision on (expected) developments creates awareness about opportunities and limitations that their production environment provides them with.

13.3.4. Organisation

One of the success factors on *entrepreneur*-farms [as well as on the larger family-run farms] refers to the level of organisation. This is partly caused by the fact that these farmers commonly hire external labour to execute all daily activities according to the farmer's strategy. Preferably, this external labour has got the proper knowledge and skills, as long as the costs involved are not too high. The latter means that often also unskilled labour is hired.

Many of the *entrepreneur*-like farmers have a 'farm business plan' in their head and not, for example, on paper. On truly large farms of, for example, more than 1000 cows and with several farm workers, it is indicated that a clear, general farm business plan is available on paper. This plan comprises the different business units, the goals per business unit, the routine activities per business unit to be conducted, as well as the points of evaluating performance in each business unit and the corrective actions in case of deviating performance. One of the advantages of such an approach is that the farmer can assign different responsibilities to different farm workers in a kind of task distribution over business units. An example of the latter is given in Annex 13B on young stock rearing.

Entrepreneurs are individualists who will see the advantages of team-work as long as the final results are achieved. A farm business plan is one of the necessities of such dairy farms; such a plan is regularly evaluated and adjusted when needed.

13.3.5. Communication

Entrepreneurs are highly interested in communication. They easily speak with other entrepreneurs and have social skills to easily move around in society. Sometimes, one may think they are arrogant or hard-headed, but that might well be the reflection of their position and their knowledge. They need through communication the stimuli from others in order to reflect on their vision and to innovate. They are commonly quite willing to put their data and (economic) information into the open for discussion, if there exists a mutual trust and respect.

They are quite critical persons who will not immediately accept or adopt the answers to their questions to e.g. advisors. An advisor needs to explain his way of analysing, inference and conclusions to them so they can assess whether they come to the same conclusions. If not, there needs to be ample room for discussion. *Entrepreneurs* need to weigh the arguments for conclusions and advice themselves. While communicating about an advice there should be 'chemistry of interaction' between farmer and advisor. When asked about it, it appears that *entrepreneurs* need specific products and services from advisors and specialists they select. The latter must, however, be able to provide 'added value' to them and will be tested on that issue.

The entrepreneur-like farmers pay attention to Public Relations; they are often willing to tell others about their farm and their strategies, their farming goals and the ways by which they try to achieve these goals. They may receive civilians, professionals, environmentalists, and school children on their farm for instruction purposes. See at Chapter 14 where communication is addressed in detail.

13.3.6. Farm economics

General issues: Economic decision-making is a daily process for *entrepreneur*-like farmers. They are very well aware of production costs and likes to save on (direct or variable) costs. They distinguish clearly between costs and investments. Cash-flow is a priority, like investments within the possibilities of the farm business; increase of scale in order to control the costs per unit of scale is another relevant issue to him (Griffin, 1995; McNealy, 1994).

Regarding costs and income, performance parameters are being used. Examples of such parameters can be found in an example from EDF (see Annex 13A). Feeding system (daily intakes of grass, corn and concentrates are compared to milk income from roughages and concentrates), productivity parameters (labour, capital, land), costs and income, management parameters and production figures, income per entrepreneur, family income, break-even points per 100 kg Fat Corrected Milk are just some of the EDF parameters. Efficiency as well as rentability are relevant issues to these farmers.

The costs related to hired labour all in are preferably kept around de 17 euro per hour. Advice from third parties is preferably obtained for free. They are willing to pay for such advice, if beforehand it is made sufficiently clear to them what the economic benefits will be for them or the enterprise. When the information transfer is completed, he will most probably stop the purchase of such service and change over to new information sources. Decision-making based on advice will most probably take place on economic grounds and opportunities provided (see also the section on economics).

Increase of scale: The following terms are handled in the sector regarding increase of scale:

- Increase of scale can be defined as increase of the *average* herd size over time.
- Increase of herd size is an increase of size of the *individual farm*.
- Scale effects: the differences between costs and income *per unit of herd size*, caused by the size of the farm (economies of size).

Causes of increase of scale: Increase of scale is a phenomenon that occurs in (nearly) all sectors. There are four main reasons for increase of scale:

- A more efficient use of fixed production factors. For example, a better use of production resources, a more economically efficient use of (labour saving) investments, a better balance between labour and production resource, a non-linear relationship between costs of a production resource and the capacity of that resource.
- Technological developments. New technological developments are not always applicable to all herd sizes. Hence, larger farms benefit more from new technologies than small farms.
- Differences in price. Larger farms have a better position for negotiating prices at the purchase side, and at the same time also at the selling side for price per volume and reductions.
- Effects of (EU and national) political decisions and policy could vary largely between countries.

For many reasons (such as farming goals, infra-structure, differences in costs advantages, agricultural policy etc) the agricultural sector shows less increase of scale than some other sectors.

Effects of scale: The analysis of effects of scale is usually conducted using graphs of average total costs (GTK), on both the short (GTK_k) as the long term (GTK_l), set against the average value of the output (see Figure 13.2). Economically seen, a farm has an optimal production size, when the average total costs per unit product (GTK) are minimal. On the short term, the optimal production size of a farm is determined by the short term costs graph. The available capacity of an enterprise is hence fixed, so only variable inputs can be helpful in defining optimal production levels. That is the point where the marginal costs are equal to the marginal income. The GTK_k lines represent the situation at different levels of fixed costs. According to the short term vision, a farm has the optimal herd size when it is positioned at the lowest point of the GTK_k graph (Figure 13.2). Hence, at situation one (GTK_{k1}) the Q×K is the optimal herd size.
On the long term, the production capacity is indeed variable. When we draw a line through all short term graphs at increasing herd sizes, then we can draw a long term costs graph, given a certain level of prices and state of the art of technology. The optimal herd size then can be found at that particular point, where at the lowest per unit product production takes place on the long term. In Figure 13.2 this point is in situation two, at an output of Q×L units.

The classical theory states that the GTK-graphs have a U-form shape like in Figure 13.2. This means that from O to Q×L scale advantages occur at an increasing herd size. However, further increasing herd sizes beyond the optimum lead to scale disadvantages, for example caused by increasing transport costs, greater complexity,

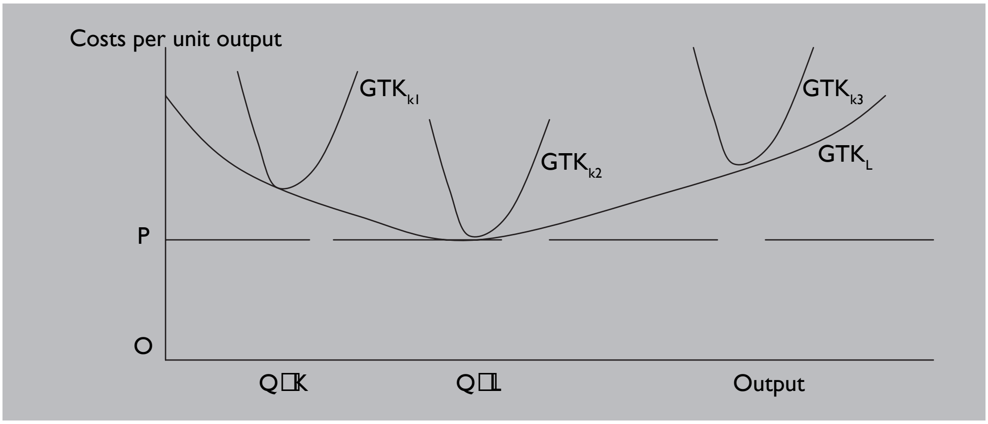


Figure 13.1. Optimal herd size on the short and long term (The output is given per time unit; K= short term, L= long term).

or increasing costs for communication and coordination. In the modern theory the vision prevails that at larger production volumes the scale advantages will compensate or will be larger than the scale disadvantages. Therefore, the GTK graphs will be more like a L-shape than a U-shape. The optimum scale can then not be defined because profits still increase at increasing herd sizes.

Farm economic results at different herd sizes in Dutch dairy farming: In the Dutch dairy sector, many farm economic data have been gathered. Some organisations present a yearly review of farm economic parameters and such parameters are being compared over the years. These data can be accessed through internet. There are, however, hardly any data on large farms available. The results presented in this paragraph are based on a simulation model especially developed for larger dairy farms (De Jong, 2006).

The model simulates four types of dairy farms, variable in herd size. The first farm is a large family run farm; the other three are other, larger farms. A reference farm is presented as well. The main difference between reference farm and other farms is in the fact that young stock rearing takes place elsewhere and that production is not associated with land on these larger farms. There are 6 main modules in the model (income; feed; cattle health & breeding; manure; sustainable production resources; labour). For each module, the costs and income are calculated based on inputs. For that purpose, standards and guidelines for prices and technical issues have been taken into account in each module. Details are given in Table 13.1.

Farm economic results of simulated dairy farms: Table 13.2 presents a summarising total review of farm economic results of the different farms. As can be noticed, the

Table 13.1. Farm situation for reference farm, family farm and 3 simulation farms.

			Simulation Dairy Farms		
	Reference	Family	Large 1	Large 2	Large 3
Milking cows (n)	112	112	500	1,000	2,000
Young stock (n)	66	0	0	0	0
Surface of land (ha)	66.5	1.5	4.5	8	14
Milk quota (kg)	909,540	889,328	4,264,544	8,673,300	17,710,000
Milk production (kg/cow)	8,150	8,150	9,095	9,315	9,625
Milk Fat %	4.37	4.40	4.22	4.19	4.14
Milk Protein %	3.48	3.50	3.46	3.61	3.37

Table 13.2. Results (in euros) per 100 kg milk, as derived from the simulation model.

Number of cows	Family farm 112	Large 1 500	Large 2 1,000	Large 3 2,000
Results per 100 kg milk (including milk quota costs)				
Net farm results	25.39-	17.69-	14.15-	12.63-
Income/costs ratio	57	65	71	73
Net cost price of milk	58.14	50.34	47.86	44.90
Labour income	17.93-	11.87-	9.23-	8.54-
Labour costs	7.47	5.82	4.92	4.09
Quota income	2.65-	4.13	7.52	8.77
Quota costs	22.75	21.82	21.66	21.40
Return on investment	20.51-	13.58-	10.17-	8.77-
Costs of interests	4.88	4.11	3.98	3.86
Results per 100 kg of milk (excluding milk quota costs)				
Net farm result	2.65-	4.13	7.52	8.77
Income/costs ratio	93	114	128	136
Net cost price of milk	35.39	28.52	26.20	23.50
Labour income	4.82	9.95	12.44	12.87
Return on investment	2.23	8.24	11.50	12.64

net farm income becomes better (= less negative) when herd size increases. Based on this Table 13.2 one can conclude that large scale dairy farming in The Netherlands yields advantages.

The costs per 100 kg milk on the three Large farms are substantially lower than on the family farm. Although the fixed costs and variable costs both decrease at increasing herd size, it are predominantly the fixed costs which represent the proportionally largest share in this scale advantage. In the total income per 100 kg milk there are no detectable scale effects.

Due to a lack of data about costs for veterinary services and animal health care, these have been set at a normative standard of 80 eurocents per 100 kg milk (= 8000 euro per 1 million kg milk). Hence, there are no scale advantages for animal health. In the real world, however, such advantages can be expected. Certainly when veterinary farm advisory programmes are in place such advantages can be expected, for example, because performance analysis can be performed through parameters independent of herd size.

Regarding veterinary advice mainly the variable costs are relevant. These are given in Table 13.3. Overall, scale effects are detectable within these variable costs too. Important areas within the variable costs for achieving advantages refer to feed costs and other costs. The decrease of feed costs at increasing herd size is caused by the higher milk production per cow. The fact that Large farm 2 shows higher feed costs is caused by the milk fat and milk protein figures on this farm.

Large farm 2 realises high milk protein figures as compared to the other large farms; this strongly increases the protein demands in the ration. Because feed protein is expensive, this Large farm 2 shows higher feed costs.

Table 13.3. Variable costs per 100 kg milk for the different simulation farms (in Euro).

	Family farm	Large 1	Large 2	Large 3
Number of cows	112	500	1,000	2,000
Variable costs per 100 kg milk				
Feed costs				
Roughage	6.50	6.08	6.03	5.88
Concentrates	5.23	4.98	5.01	4.91
Other feed costs	0.05-	0.07	0.26	0.07
Total feed costs	11.69	11.14	11.30	10.86
Animal health and breeding	1.70	1.53	1.51	1.49
Manure deliveries	1.94	1.95	1.96	1.96
Other costs	6.00	5.00	4.00	3.00
Total variable costs	21.33	19.62	18.77	17.31

13.3.7. Awareness and attitude

The *entrepreneur*-like dairy farmer is open for criticism and advises. Preferably such advises from reliable, trustful specialists are for free. This farmer visits congresses and seminars, uses internet, and has many informal contacts in his network and the latter are specifically useful to obtain the advice he is looking for. We should not underestimate the impact on these farmers of internet and globalisation of the dairy industry. A farm strategy is determined on the basis of, for example, contacts abroad and nationally, extension people, nutritionists, banking people, fiscalists, constructors, technological developments, field trials. Often these *entrepreneur*-like farmers have positions in the board of agricultural organisations, know many people from mechanisation companies, a feed mill, or are members of an association of people with equal vision or with comparable positions in society. Often they keep themselves a mirror: is this truly the right direction for my business? Is this truly the best solution for my farm problem or farm? Is this decision advantageous to my farm?

On the basis of selected, tailor-made solutions provided by specialists they pass the decision-making process which is largely based on economics. They determine themselves whether feasibility is guaranteed in such advice. If not, then your input as a farm advisor will be less impacting. They also determine whether an advice fits in the long term strategy of the farm. If they decide that the economic benefits from the advice are great, they tend to assign a lower priority to issues like practical feasibility and the long term strategy. If, for an acute problem, an instant solution cannot be found or given, then they will actively look for someone who could give the solution, from where-ever; they are prepared to pay for that. If such a person cannot be found or does not exist, then he will try something on his own.

Advises from the veterinarian (*variable costs*) are handled differently than advice related to e.g. purchasing a tractor. This difference is caused by perception of the farmer whether fixed costs or variable costs are involved. Too often the veterinarian is considered a costs factor, while purchasing a tractor is considered an investment. Costs of animal health care (comprising claw trimmer, animal identification people, veterinarian) are set at 1 to 1½ eurocent per kg milk. It is a pity that *curative veterinary costs (= variable costs)* are not separated from veterinary *advisory costs (= investment; fixed costs)* in farm accountants reports.

It is up to the farm advisor to demonstrate to the farmer that what is offered to the farmer is of interest to him and his enterprise. The expected benefit must be large so that the farmer includes this advisor in his team and pays for his activities. As stated before, there must be a positive 'chemistry of interaction' between farmer and advisor (van Dellen, 2004).

13.3.8. Behavioural economics

Low (outside) temperatures feel truly cold when you are used to warm (room) temperatures. But the same cold temperatures feel much less cold when you are used to them!

How much are you willing to pay to retain your voting right? And, how much money would you like to receive to refrain from voting? Usually, the amount for the first will be much lower than the amount for the second situation!

Why is a certain dairy farmer willing to pay his veterinarian for the treatment and advice to recover from a series of clinical mastitis cases, but is the same farmer quite reluctant to pay for a preventive udder health control programme that the veterinarian offers him afterwards?

This phenomenon refers to *choice behaviour*; with *decision-making under uncertainty*, and with preferences. During the decision-making process both rational and non-rational arguments come into the picture. The choice behaviour of people is namely influenced by:

- perceptions;
- impressions;
- emotions;
- attitude;
- motives;
- preferences.

People are more sensitive to how their current situation differs from a certain point of reference than to absolute features of that situation (see for example the mastitis problem versus the udder health control programme). People prefer a status quo rather than changes which possibly may lead to a loss of goods or money, even when those losses might be compensated for on the longer term (see again the mastitis problem versus the udder health control programme; the latter would decrease mastitis occurrence but would also increase milk yield).

This all refers to the Behavioural Decision Theory by Tversky and Kahnemann (1971, 1974) and Rabin (1998). We have to deal with the elements presented above when we want to 'sell' one or more components of our veterinary advisory programme to farmers. Knowledge about these forenamed 6 features and utilising them in our discussions with the farmer will help us in better marketing of our advisory programme.

13.4. The cattle veterinarian: a strengths and weaknesses assessment

In this chapter we give a telegram-style summary of the strong and the weak points regarding cattle veterinarians like could be collected in the field. The following *strong points* for cattle veterinarians were considered:

- his relationship with farmers is based on trust;
- such a relationship is hard to break down;
- he has knowledge about health and disease;
- he has actual knowledge about reproductive affairs;
- he prevents a large proportion of disease losses;
- one can always reach him; he is always available;
- the veterinary training is highly esteemed;
- it is a protected, professional association, no loose persons.

The following *weak points* for cattle veterinarians were listed:

- his attitude is much too dominant in general, professionally in particular;
- he talks too much and listens too little (poor communication);
- he does not work according to structured protocols; his advice is not structured; he does not provide clear working instructions;
- he has limited knowledge about cattle nutrition and related issues;
- he has limited knowledge about managerial affairs;
- he has limited knowledge about dairy farm economics;
- he has little to no knowledge about entrepreneurship and organisational matters on the dairy farm;
- he has the public image of being too expensive (i.e. related to medicines);
- he tells his clients insufficiently about his fields of expertise or knowledge (no marketing knowledge);
- he does not indicate what he could contribute to the dairy farm;
- he is little pro-active and hence too much in waiting (next to the telephone);
- he does not offer on-site training to farm workers;
- there are too many personnel changes in the veterinary practice which may hamper the establishment of trustworthy relationships;
- he is (maybe) not willing to invest in discussions with the farmer; he shows little empathy.

With the forenamed information from other paragraphs and the current information in this section we are now able to consider what needs to be changed or improved in cattle veterinarians in order to become a full discussion partner (and from thereon an advisory partner) to the *entrepreneur*-like dairy farmer. Subsequently, we will try to indicate how this can be achieved.

13.5. Points of improvement for the cattle veterinarian

The trend in the dairy sector is towards scale increase (see also above). The question is whether the veterinary service should be adapted to this development. How can a cattle veterinarian market his technical knowledge and skills at herd level to the larger dairy farms, to the entrepreneur-like farmers? It is important to retain the strong points and improve the weak points (section 13.4).

The design of a *general veterinary practice business plan* for the short term (1 year) and the longer term (3 to 5 years) is a first must. It provides all practice workers with clarity about direction and strategy of the veterinary practice. An advantage of a written business plan is that emotions are shifted to backstage and therefore the plan becomes more rational. Moreover, a written business plan is easier to discuss with third parties, like advisors. What are exact targets; what is the methodology to achieve these targets; when should it all take place; who is responsible for what actions; which tactics would be best; is every veterinarian in the practice committed to the plan? These are all questions to discuss and to consider among the veterinarians and other workers in the practice; agreement should be reached. Several organisations can assist the veterinary practices by providing tools and support for designing practice business plans.

Maximising the rate of success of this business plan can be stimulated by activating and acting along the following 7 steps:

1. Optimise the internal communication in the practice. This step is paramount before other steps to avoid problems down the line. External coaching can be sought to tackle this problem.
2. Conduct a market analysis among clients asking for their wishes and needs (SWOT, segmentation of clients, empathy, analysis of existing needs and needs to be created). Formulation of specific (tailor-made) products or services for specific client groups (Eelkman-Rooda, 2006).
3. Design of a Plan of Action for the shorter and the longer term (what to do, how to do it, who is responsible for execution, what should when be delivered, how to evaluate?). Such a Plan should be designed in a SMART way (= specific-measurable-acceptable-realistic-time-related). Be aware of the fact that for new products and services there must be a demand developed, which takes several farm visits and discussion rounds! It could be a good investment to – after initial talks – perform a SWA assessment of the farm performance together with the farmer for free! Discuss the outcome of this SWA together with the farmer: is there agreement; where are priorities and why; does the farmer like to take action?
4. Internal and mutual practice training regarding the methodology to raise the proper questions (= not yes/no answer questions), to listen actively, to summarise discussions, to control the progress of discussion. Veterinarians commonly deliver

solutions for a problem which the farmer does not see (yet) or has not adopted. This issue is highly crucial in veterinary practices!
5. Suppressing the (expression of available) technical knowledge of the veterinarian towards others.
6. Investment in developing social communicative skills and marketing qualities, for example through trainings and courses, often outside the veterinary sector (Eelkman-Rhooda, 2006).
7. Optimise external communication through analysis of demands of client groups; development and PR of new demands. Invest in adequate oral and written communication. Increase the number of contact moments with the farmers and put regularity in it (study groups, seminars, farm visits, telephone calls, e-mails, etc.). Raising guided questions to make the farmer detect for himself that something might be or become a problem for him is most probably a greater art than providing solutions!

In order to realise this, there are several *pre-conditions* to consider:
- Operational matters, like dehorning of young calves or claw trimming, must be separated from the advisory visits; make new appointments to deal with those curative or clinical handlings.
- Be clear to the farmer about the activities you are dealing with: when are you busy with advisory work and when with curative work.
- Switch your mobile phone off as soon as you start making your farm visit. It is quite denigrating for a farmer to find out that obviously the person at the other end of the telephone line is more important than he is!

It appears that a new structure must be developed for the declaration of costs and fees for veterinary advisory activities. This would open the opportunity to distinguish between curative costs (e.g. sick cows) and advisory costs. Moreover, it can then be made clear how advisory costs are built up per product or service, or groups of products and services, with or without price reduction, with or without declaration of hours spent on a certain problem analysis or consultation of other specialists at the practice office.

To shift the perception of veterinary costs from variable costs into investment costs (fixed costs) we may think about subscriptions for veterinary products and services. This product may comprise several components, depending on the needs, wishes and perceptions of the dairy farmer (see also the section above on behavioural economics).

13.6. Options to define and to market advisory products

13.6.1. General issues

The veterinarian who wants to function as a farm advisor or coach should be able to understand entrepreneurship, be a full discussion partner, be able to conduct proper analyses, be an authority at the same time, be skilled to make people do something, and be commercially educated. He should adopt the principles of marketing (Walker, 1990).

Marketing by the veterinarian comprises the following elements:
- improvement of social communicative skills through methodology of raising the right questions in the proper way, discussion techniques;
- acquire insight in obtaining qualities in non-veterinary areas;
- address marketing in a more technical way (marketing plan);
- application of the forenamed in daily practice and field;
- increase creativity of the veterinarian;
- conduct a regular analysis of needs and wishes of client (groups);
- develop new demands in clients.

The results of these action points should be that at the same time the position of the veterinarian and the pleasure in his work improves. More opportunities become visible and are being dealt with.

Know where you stand in the sector as a veterinarian and veterinary practice! The dairy chain is a complex one, more complex than other chains; there are many links. From the producer of the raw product up to the consumer there are many players in the field. For an optimal service to the *entrepreneur*-like dairy farmer, it is of utmost importance that the veterinarian has knowledge of and working contacts with these players to market his products and services. The power of such cooperation in the sector will provide a better result for every player.

13.6.2. Choices of veterinary practices regarding their products and services

Veterinary practices usually have various products and services. Each practice should ask itself regularly whether the current products and services still meet the demands of their clients, and whether these still fit in the business plan of the practice. Next to profits and margins, there are also other considerations, like emotions, investments, strategy, long term expectations etc which play a role in decision-making about continuing a service or product or stop it.

Figure 13.3 schematically represents the position of the services of an example veterinary practice or veterinarian. For each veterinary practice the considerations in

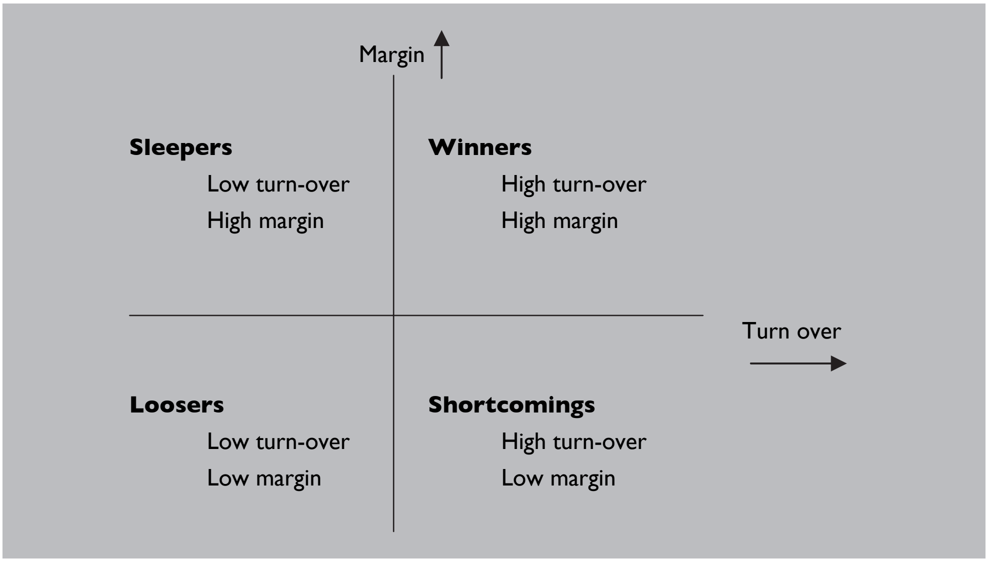


Figure 13.3. Positioning quadrant for veterinary products and services.

each quadrant will be different and unique! What could be a 'winner product' could be a 'looser' in another practice which should be stopped. For example, a companion animal urgency clinic. The reason of existence for this clinic is the number of acute patients with urgency. In comparison, there are several other companion animal clinics in this city which have considered the treatment of acute urgency cases as loosing on the job and have deleted this service from their clinic.

Other examples of considerations about sleepers, winners, loosers and shortcomings could be:
- Sleepers: the treatment of subclinical mastitis in full lactation.
- Winners: veterinary advice on reproductive performance.
- Loosers: treatment of urgent acute cases like milk fever.
- Shortcomings: general veterinary medicines.

Suggestion: Take Figure 13.3 and list for yourself or your practice in which quadrant the different products and services could be positioned.

In addition to the forenamed 'classical' examples there are other, more modern products and services in a bovine veterinary practice, for example:

- Design and delivery of a farm-specific Hygiene-protocol.
- Design and delivery of farm-specific protocols in the area of infectious diseases (Biosecurity Plans, BAMN 2001), udder health, claw health, replacement rearing. These commonly comply with rules set for Good Agricultural codes of Practice as laid down by the FAO (2003).
- Design, implementation and support of Quality Risk Management programmes on a dairy farm (SWOT assessments; HACCP-like programmes, Noordhuizen and Welpelo, 1996; Lievaart *et al.*, 2005; www.vacqa-international.com).
- Design and execution of certain on-site training programmes for farm-workers.

For practice management it is important to realise that products and services have a certain *level of elasticity*. An example of an elastic product is a flight: the more the price decrease, the more demand there will be. An example of an inelastic product is open heart surgery: irrespective of the price, the supply and demand will be same. The products and services that you want to offer as a veterinarian can be distinguished in the same manner; price policy could be adapted to this picture.

Using *segmentation* of products and services which the veterinary practice is marketing you can design a practice business plan, in which the accompanying strategy and tactics are comprised. In this way we can plan and execute the activities and profits, and are we directing our own business.

We have to realise that several forces are active in and around our practice. Among these forces are forces from society (e.g. public aversion against bio-industry; public demands for better animal welfare), technological factors (automatic milking systems) and regulatory issues (e.g. laws; EU directives and regulations; quality assurance demands). The veterinarian cannot influence such factors, but he is confronted with them and should develop an opinion about them. In time anticipation on such issues and changes is a good strategy in general.

An *analysis of environmental conditions* such as named above is crucial to a veterinary practice: know where you stand and stand for. But also: know what you can perform and what not; show that also to your clients. Keep a close eye on developments in the market in the broadest sense, and weigh whether or not you have to follow such developments, and what consequences of such a choice would be for the veterinary practice in the shorter and longer term. Such an analysis is useful too for defining management activities in the practice appropriately. The latter will be addressed in the following paragraphs.

13.6.3. The veterinary practice as an enterprise

The veterinary practice is a commercial business due to the fact that the veterinarians function as independent people in a certain branch or sector, for own account and own risk = *entrepreneur*)

Next to veterinary technical aspects, the current veterinary practice can be characterised by many managerial issues. Practice management here means the conducting and governing of the practice. Preconditions for such management are that:

- there must be strategic insight into the practice (possibly hired from outside);
- there is a good network of contacts with the outside world;
- coaching of all co-workers can be done;
- feed back can be given to co-workers in the proper way;
- there is knowledge and experience regarding conflict handling;
- communication takes place at a high quality level.

Furthermore, for a proper execution of management tasks the veterinary practice must formulate answers to the following questions:

- What tasks and activities must be assigned to the management?
- What would be the benefits of these to the practice?
- Which knowledge, skills and attitude are needed for the execution of these tasks and activities?
- What is the time-consumption of these and is this considered worthwhile?
- Who wants and will perform what tasks in this context?
- How can you create the right teamwork? (TEAM= Together Each Achieves More)

Management of a veterinary practice regards 4 main areas, which are interrelated (see Figure 13.4). One element of personnel management regards, for example, the question how the continuing education plan for veterinarians must be organised for the coming 3 to 5 years, taking into account the gaps in the current organisation regarding:

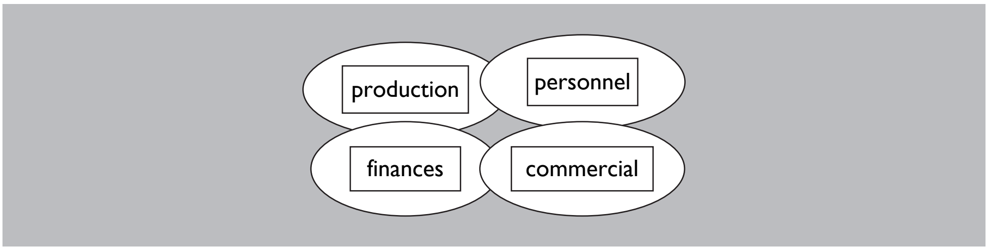


Figure 13.4. The four interrelated areas of a veterinary practice.

- personnel selection and hiring;
- personal development plans;
- planning of careers;
- needs for continuing education → who needs to go to what course when and why; and how are these needs and courses to be made complementary!

It is useless when all veterinarians in the practice would follow the same courses (unless these are compulsory). It is much more cost-effective to make a whole practice planning meeting the needs and demands of the practice, and – if possible – preferably but not necessarily meeting the interests of the individuals. This implies that a certain differentiation must be planned: one will focus more on udder health and milk harvesting, while the other will focus more on infectious diseases, and again an other on communication and marketing. Such a differentiation will be beneficial to the clients but also to the practice and the individual veterinarians.

13.6.4. Marketing in more detail

Marketing should focus on both *internal practice* and *external affairs*. Internal marketing addresses efficient team-work; in the previous paragraph this has been discussed. External marketing should only be started once the internal marketing process was passed successfully. If not, then the results of external marketing will in general be poor and very de-motivating for those who took the initiative. In external marketing the following components are considered:

- Identify the different client target groups.
- Define the composition of the package of instruments by which clients are approached (products/services; distribution means; communication; process).
- Determination of the marketing goals (turn-over; profits; market-share).
- Definition of the services to be delivered (nature; customers; tailor-made packages; modus operandi).
- Conduct of a SWA analysis of clients' farms.

Target groups can be characterised on the basis of socio-economic factors (age, income level, education level, profession, status, professional objectives), geographic features (region, climate, land), psychological aspects (spontaneity, creativity, feel of honour, social status) and of features related to purchasing behaviour (brands, sensitive to prices and service, motivations for demanding products and services). These issues can be put into *profiles*.

Marketing of services is determined by the nature of such services (e.g. veterinary advisory programmes for supporting herd health management on dairy farms or for supporting Quality Risk Management on dairy farms), the fact that this should be based on a continuity in the relationship with the clients, and that these services must be tailor-made to client needs or needs to be developed. In other words, such services must have *added value* for the client. Participation of the client in such services is not always decided on rational grounds (see the section on behavioural economics). A dairy farmer will in general be more and earlier motivated to participate in such a service when he is encountering problems; and then he is willing to pay for such services; often we have seen that these farmers are less willing to pay for services to prevent such problems. On the other hand, we observe more and more that dairy farmers are willing to pay for screening services, that is, when there are no overt problems on the farm and farmers want to have a continuous programme of second opinion and monitoring of animals and farm conditions to execute this second opinion (Noordhuizen, 2006).

Through full empathy of the veterinarian in the true problem of the farmer, the veterinarian is able to change his public image from the (variable) cost component to the investment component (*problem solver; advisor/coach*), once the spontaneous contact moments have been passed. Through intensification of contact moments with the *entrepreneur*-like farmers and showing empathy, the relationship and interactions with these farmers will improve; price of the veterinarian's service or products then comes no longer on the first place!!

It is very sensible to design a *marketing plan* using the forenamed points of attention. Below the goals of such a marketing plan are presented, and we will address several components from the so-called *marketing mix*. There are many websites, books and courses available on the issue of marketing; therefore, we will not elaborate in full detail on these issues.

The goals of a marketing plan are to define:
- The overall strategy (what to be done?) for the next year and 5 years.
- The tactics (how should it be done?) should accompany this strategy.
- Task distributions (who should do what?).
- Evaluation and adjustment each quarter of the year.
- Evaluation of the goals (have goals been achieved?).

The marketing mix (= the 4 P) refers to the tactics:
- Position
  - where in the market do we stand as a veterinary practice;
  - where are we heading for in the coming 1 to 5 years;
  - how do we want that the clients consider us.
- Promotion
  - sum of the planned activities in the coming year.
- Personnel
  - who is performing which task and when.

- Price
  - the benefits for performances conducted (product/service) adapted to the internal and external conditions.

The design of the marketing plan for the shorter (1 year) and the longer (5 years) term provides all co-workers in the practice with clarity about direction and strategy which will be followed. It also comprises who will do what and when and how.

13.6.5. Communicative skills

This is not the easy talking, but rather comprises elements related to internal and external communication like:

- acquiring skills in techniques to raise the proper questions (not questions leading to yes/no answers);
- discussion and meeting techniques;
- skills to handle conflicts;
- the ability to listen carefully to others;
- coaching of co-workers;
- appropriate non-verbal communication and attitude.

We are encountering these elements when we talk business with the dairy farmer in order to detect what he is expecting from the practice and what our added value could be for him (*analysis of demands*). When we could detect that, we would be able to define a product/service which suits him because it meets his demands, goals and expectations. In that case we are able to charge him for all costs regarding our activities. The message must, however, first be communicated internally on the practice (internal communication) before we communicate it with him (external communication). Communication is further elaborated in Chapter 14.

Each human being is sensitive to one or more particular needs. The American psychologist Maslow has clustered the needs of human beings to 8 *primary needs of people*:

- Looking for security — *Not looking for risks*
- Togetherness — *Following trends*
- Ease and comfort — *Handy and clever*
- Progress — *Technological improvements*
- Innovation — *Trend-setting*
- Delight — *Joy of labour*
- Exclusiveness — *Seeking prestige*
- Gaining advantage — *Profits/money*

When you like to proceed with the communication message as effectively as possible, then it can be advised to investigate for which primary needs your communication-partner or customer is sensitive. Most clients in a veterinary practice are treated similarly, independent of their individual needs. If you want to achieve a maximum number of satisfied clients in your practice, then you should investigate the individual needs of each individual client.

13.6.6. Communication with the client

What happens in the subconscious mind of your client during the communication process? By using the *AIDA formula* you are able to measure where the client is positioned in the communication process. The AIDA formula:

A = attention ⇒ develop the client's attention for the product/service.
I = interest ⇒ develop interest so the client wants to know more about it.
D = desire ⇒ there is a strong desire to choose the product/service.
A = action ⇒ the client indeed takes the product or service.

Depending on the nature of a product or service, we can distinguish simple and complex communication. In more complex communication it often happens that the application of the AIDA formula needs several contact moments. Then it becomes paramount to realise where in AIDA you have left the communication the last visit; only then the proceeding in the process is guaranteed. An example of a complex communication regards the marketing of veterinary advisory programmes. It usually does not yield results in one discussion; more preparatory visits are needed. And when you want to expand such programmes in the field, you will need a thoroughly prepared plan and a good monitoring of the proceeding in the communication process in order to achieve the goals set. The too early offering of a solution (e.g. the advisory programme) during the communication process leads to a poor result and poor feeling at both sides.

> Leading a meeting; meeting techniques; presentations before groups; handling conflicts; analysis of needs among farmers; advisory & coaching; approaching market demands...
>
> All these topics are addressed in many [short duration] courses which are given by professional organisations yearly. Therefore, they will not be further elaborated in this context.

13.7. Conclusions and recommendations

In the previous paragraphs we have first given an overview of characteristics, demands, wishes and expectations of *entrepreneur*-like dairy farmers. Then we have looked to the current strong and weak points of cattle veterinarians (section 13.4). Finally, we have addressed the question how both sides could be *matched* properly, and where the veterinarian – if applicable – should fill the gaps in his knowledge, skills and abilities needed for such matching.

In the following Figure 13.5 we have – as a summary – created two schematic listings of characteristics of both the *entrepreneur*-like farmer and the veterinarian respectively. In between there are some examples of course and training elements which could help bridging the gap between the *entrepreneur*-like farmers and the veterinarians.

Each individual cattle veterinarian should consider for himself, what his current position is in the dairy sector and which position he likes to take, what he must invest, with what priority and in which manner, in order to be sufficiently able to create this named bridging. It cannot be done here for all veterinarians at the same time; the differences between veterinarians in that respect are much too large. Therefore, we are forced to present a more general approach. In Box 13.1 is a *Plan of Action* with 5 elementary steps to convert the classical curative or herd health practitioner to a veterinary advisor/coach.

The advising/coaching veterinarian must realise that he enters a *demand-market* and no longer deals with a supply-market, as far as entrepreneur-like dairy farmers and farmers from large (family-run) dairy farms are concerned. A proper price-quality ratio of the services and products provided by the veterinarian on request by the farmer is a contributory factor to the overall success.

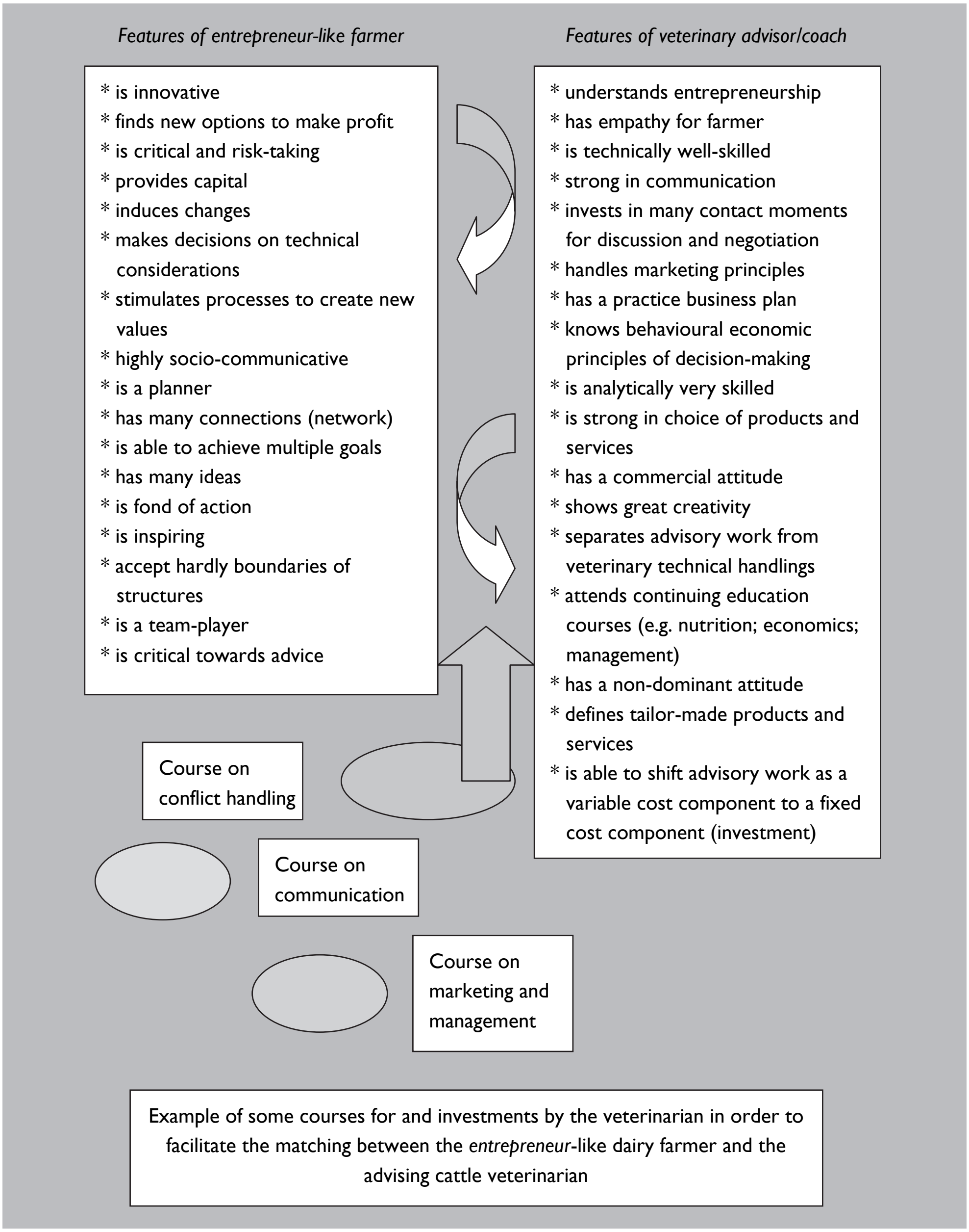


Figure 13.5. Schematic representation of characteristics of both entrepreneur-like dairy farmers and veterinarians, as well as means to bridge the gap between them.

Box 13.1. Plan of Action (5 steps) to convert yourself from a curative or solely herd health veterinarian to a veterinary advisor/coach:

Step 1
You first conduct a self-evaluation using the SWA lists from section 13.2.3. What are your strong and what are your weak points?
Next, you make an inventory about the extent to which you are adequately familiar with the features of an entrepreneur-like dairy farmer.
Using these outcomes you can determine in which areas you need to follow continuing professional education courses (see also the Table at the end of the document). It seems quite obvious that the first, general courses will be in the areas of communication; conflict handling; marketing, organisation & management.
Step 2
Start with following the courses as determined under [1]. Subsequently, try to practice the issues learned from these courses as much as possible on a – previously selected – dairy farm of which the farmer has earlier stated that he is willing to cooperate in your new strategy and to serve as your sparring-partner.
Step 3
Select a dairy farm where you could start with questioning the farmer about his enterprise-strategy, goals, methods to achieve his goals, and furthermore, about his farming goals, strong and weak points on the farm, and his needs and wishes regarding farm advice. Train yourself in properly applying the AIDA technique on this selected farm (sparring partner).
Step 4
Again conduct a self-evaluation using the features named under 'Features of a veterinary advisor/coach' in Figure 12.5 at the end of this chapter.
As long as there are too much elements lacking from your 'profile', you will be forced to invest further in the development of your skills and knowledge. A too rapid and too early start with implementation of advisory activities will only yield negative results.
Step 5
When the previously named steps have been passed with good result (that is, when deficiencies have been tackled sufficiently), only then you can make a start with the implementation of your advisory/coaching work in practice. This means that you have to search for farmers who are suitable for marketing your advisory products. After this selection you can start with the advisory/coaching track which is addressed in the document. When you have succeeded to bind a few farmers to you as a client of your advisory practice in a sustainable way, only then the track is successful. If not, then you have to make one or a few steps backward in the plan of action named above, and restart from there.

Annex 13A. An example of parameters on farm economics as handled by EDF

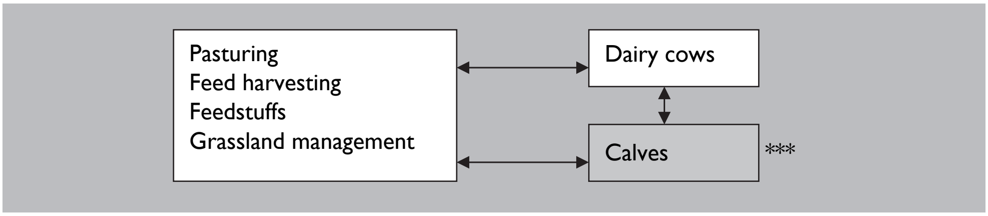
Reasons for differences in Costs and Returns – EDF Analysis 2003
(Values in euros without VAT)

	Dairy Farm X	EDF average (158 farms)
Farm data		
No. cows	139	133
Milk output (FCM/year)	1,151	1,013
Returns from dairy	93%	92%
Growth of own quota	68%	67%
Percentage of quota rented	0	5
Feeding system		
Forage area (ha)	93	99
Grassland (% of forage area)	50	60
Land rented (% of forage area)	62	43
Grazing or 100% indoor	G	-
Grass intake (kg/day)	40.6	34.1
Corn silage intake (kg/day)	25.0	19.5
Concentrate intake (kg/day)	5.6	6.0
Concentrate intake (tons/cow/year)	1.55	2.30
Milk out of non-concentrate feed (kg FCM/year)	5,162	3,231
Prices		
Milk price (per kg FCM)	33.1	31.7
Cull cow price (per kg)	0.5	0.7
Male calf price (per animal)	84	119
Land rents (per ha)	440	311
Quota purchase price (per kg)	17.0	13.9
Quota rent price (per kg)	-	0.08
Concentrate price (per ton)	160	190
Productivity		
Labour productivity (KG FCM/h)	218	162
Land productivity (tons FCM/ha)	12.4	19.9
Capital productivity (kg FCM/1000 euro)	1,760	1,976
Capital input (per cow)	4,701	4,617
Milk yield	8,271	7,832
Fat content %	4.5	4.1
Milk protein content %	3.5	3.3

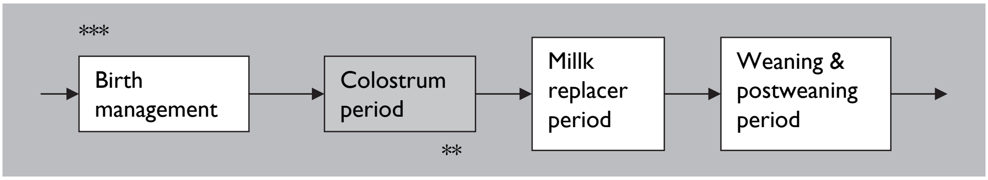
	Dairy Farm X	EDF average (158 farms)
Herd management		
First calving age (months)	24.0	26.3
Interval between calvings (days)	390	396
Average age of cows (years)	4.0	-
Culling rate dairy cows	31%	31%
Heifer production	105%	125%
Milking system (2 times; 3 times; robot)	2 times	-
Reproduced by courtesy of EDF.		

Annex 13B. Example of an elaboration of an organisational plan for calf rearing in 3 steps in order to develop operational working protocols

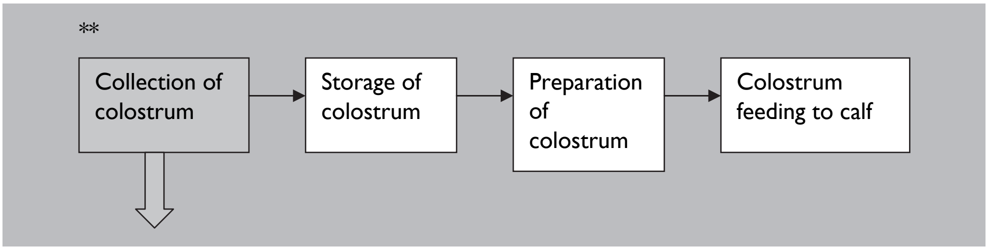
General farm organisation with 3 major, mutually interactive, business units.



Young stock rearing can be further developed from here; for example, for the first few months of life:



Subsequently, the colostrum period can be further defined:



Define the operational management activities for each component of the series above:

1. define the goals for colostrums collection (quality; quantity; hygiene);
2. determine which activities must take place (what; how; with what; who);
3. set the critical management points for [2];
4. define how evaluation of [2] and [3] take place (technical parameters);
5. define what to do if adjustments are needed (other methodology).

Chapter 14. Communication in the veterinary advisory practice: practical application of behavioural economics and communication skills[6]

14.1. Introduction

In veterinary advisory practice, everyone knows what he/she is talking about – at least that is what we like to think. Both the veterinarian and farmer are dealing with a problem, they are discussing options, come to a solution and finally into action. Throughout the process we are result-driven, stick to the facts and focus on the problem – so we like to think.

While talking about the veterinary advice like this, one soon realises that dealing with a veterinary management problem is not as rational, technical and result-driven as it may sound.

When it comes to consultation in herd health programmes and in Quality Risk Management, the process is inevitably influenced by the experiences of all persons involved, their perception, their preferences and, not the least, their attitudes towards each other. Therefore, one should realise that the actual problem of a consultation, e.g. mastitis, a fertility or quality-related problem, is just one aspect the veterinarian has to deal with. He/she should be aware that talking about this issue, implies talking about other issues as well. Apart from the content, it is therefore paramount for the veterinarian to familiarise himself with some basic skills of the mechanism of the consultation process – with *communication*.

'*You cannot not communicate*' is probably one of the most famous statements on communication, made by the Austrian psychologist Paul Watzlawick. Every situation in which people act together inevitably involves communication; it may be consciously or, to an even larger extent, subconsciously.

As the farming industry gets more complex, and as farmers increasingly have to seek advice from experts, the veterinarian has to prepare himself to compete in this changing market. Communication is to be seen as a tool in this competition, and how to use this tool successfully is easy to understand. Everyone is always communicating. Communication is about using techniques and tricks, realising and making conscious what one is doing unconsciously all the time.

[6] This chapter is derived from the manuscript prepared by dr. Joachim Kleen, Glasgow Scotland, UK.

But communication is more than this. Acquiring communication skills will enable the veterinarian to work more efficiently and – hopefully – with more pleasure even in difficult situations. Once we understand what makes communication difficult or unproductive (e.g. the farmer does not adopt a proposed udder health & milk quality control programme), we may find ways and develop techniques to change this. Therefore, this chapter will not only deal with theoretical aspects of communication, but will stress the practical issues involved.

It is important to consider communication skills as a basic, necessary competence (Adams and Kurtz, 2006) rather than some psychological, theory-based witchcraft.

14.2. The meaning of communication

14.2.1. What does communication mean?

Communication is a widely used expression, derived from the Latin word *communicare* which means not only 'to communicate', but also 'to *share*': Information is shared between persons, and this information applies not only to the actual facts we talk about and the things we want to say, but also to our attitude towards the persons we talk to, the issues which are discussed and the circumstances of the specific situation. In addition to the spoken words, we share information about the way we feel and mutual body language. In turn we receive, if unconsciously, information from our communication partner. Hence, the expression '*a frisbee style of communication*' is currently often used.

Everyone has experiences, sometimes rather unpleasant ones, with misunderstandings. A question, casually asked without specific intention, may, for example, provoke an unexpected reaction. Or, the answer given to a question may be considered inadequate by the person asking. He or she may, in turn, react confused or even angry. We speak of misunderstandings, say we did not mean it and eventually wonder what has happened. We may even speak of an 'error in communication', trying to understand and explain what happened. If we regard misunderstandings as an error in communication, we ought to use our understanding of the communication process in order to interpret and consequently alter the underlying processes.

14.2.2. Verbal and nonverbal communication

Interpersonal communication is generally divided into verbal and nonverbal communication (Table 14.1). While the *verbal communication* is referred to as the actual spoken message, *nonverbal communication* is transmitted through many 'channels', and is sent and received partly consciously, to a larger extent, however, unconsciously. The mentioned channels of nonverbal communication consist of the

Table 14.1. Overview of relevant elements in communication.

Verbal communication	
	The actual technical contents of a written or spoken message
Non-verbal communication	
	Gestures and outer appearance
	Facial expression and gaze
	Body contact
	Posture: expressing superiority, equal or inferiority
	Paralinguistic signals: tone of voice, speed of speech, vocabulary

mechanisms often referred to as 'body language', these being gestures, facial expression, posture and body contact.

Other elements of the body language include gaze, outer appearance and paralinguistic signals. The term *paralinguistic* describes, broadly speaking, the manner in which words are said and relates to voice, speed of talking or vocabulary used. The effectiveness and importance of nonverbal signals could be demonstrated in an experiment. Here, different messages verbally indicating superiority, equality or inferiority of the sender were presented to test-persons using superior, equal or inferior nonverbal signals. In result, the perception by the audience was largely dominated by the nonverbal information. The audience would perceive any message as indicating superiority of the sender if his nonverbal signals, e.g. eye contact and posture, suggested this (Argyle *et al.*, 1970). This does not only show the dominance of nonverbal communication when it comes to perception of communication partners, but also the possibility of deliberately influencing our nonverbal communication channels.

Communication means therefore sharing information via a number of channels and in turn reacting to it. This process is inevitable and happens on different levels of our consciousness. The larger part of this process is of nonverbal nature and may to a certain extent be influenced and thus affect our communicational behaviour.

14.2.3. Communication in a medical environment

Some may ask whether it is indeed necessary to get involved with communication skills in the context of dealing with veterinary herd health and Quality Risk Management. As this chapter will show, the knowledge and use of these skills can help improve performance and quality of work. In the field of companion animal medicine, the advantage of learning and using communication skills has been widely recognised (Kurtz, 2006). It will help in providing better care, improve clinical outcomes and strengthen the clinician-client interaction. The mechanisms of improving service by consciously using communication skills, listed by Kurtz (2006), are:

- Ensuring interaction, not just transmission – The client gets involved in the process.
- Reducing unnecessary uncertainty – Good communication skills help in asking the right questions and giving the most useful answers.
- Requires planning and thinking in terms of outcomes.
- Demonstrates dynamism – useful as health is also a dynamic state.
- Follows a helical rather than a linear model – Clinician and client do interact.

Looking at these mechanisms, it is easily realised that learning and using communication skills is also useful for the advisor in herd health and quality management: it applies as well.

The Calgary Cambridge Guide for medical consultation provides a framework for the planning and conducting of a medical consultation which may be valuable for veterinary consultation too (Figure 14.1). While the structure of this consultation process is evolving, also the relationship between clinician and client is built. Therefore, while gathering information, the basis of clinician-client interaction is improved continuously and helps in further conducting the consultation. Using this framework in the course of a consultation in the herd health planning and Quality Risk Management requires only little adaptation. It shows very clearly that gathering information, planning and eventually taking action on a problem is not only dependant on the structure of the whole process, but, to similar extent, also of the relationship between vet and client. A function of this relationship is the communication between the partners in the process.

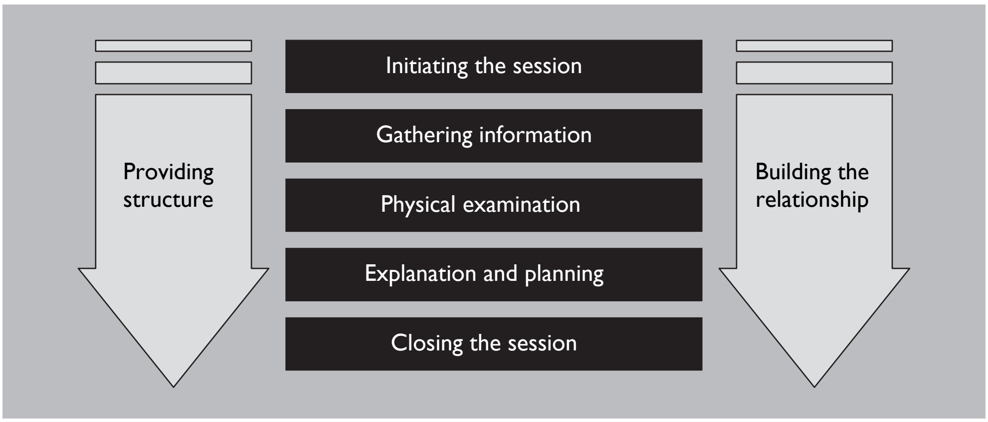


Figure 14.1. Framework for medical consultations and Calgary-Cambridge Guides (Kurtz, 2006).

14.3. Communication skills: an economic factor

The work of a veterinarian always includes working with people; they may be colleagues, technicians or clients. It is obvious that interpersonal communication plays an important role in the small animal sector, where the success of a practice may to a large extent be dependant on the communication skills of the veterinarian (Mills, 1998). Veterinarians with good communication skills tend to be more successful and less prone to stress (Brandt and Bateman, 2006).

The ability to communicate with a large animal client is, however, nevertheless of utmost importance for the success of a farm animal practitioner as well. Small animal practice involves decisions and communications relating to the emotions of the client; in farm animal practice, on the other hand, economic decisions have to be discussed and to be made, relating to resources and future of the farming enterprise.

In large animal practice the situation has dramatically changed over the last decades. Especially dairy farming has become more complex and is to a greater extent being dominated by economic considerations in a more and more competitive environment (Brand *et al.*, 1996). It has become increasingly difficult for farmers to be competent and aware of recent trends and developments in their industry. Therefore, dairy farmers are more likely to seek advice in areas like building, management, milking hygiene and –technology, feeding, health care, fertility and farm-economics.

As we will see, veterinary consultation is not only about passing on information, but also involves the decision making process of the farmer. This is not only driven by actual facts. Moreover, the relationship between veterinarian and his client, then dealing with each other, is not a consequence but rather the basis of a successful collaboration. Only a veterinarian competent in interpersonal communication will be able to advise successfully. Therefore, communication skills, having been recognised as a basic clinical skill (Adams and Kurtz, 2006), are an instrument for economic success, especially in a large animal practice. Acquiring and using communication skills have therefore been described as an element of Good Veterinary Practice (RCVS, 2007).

14.4. Getting involved in the consultation process

14.4.1. Reluctance to get involved

Giving advice in areas of cattle farming is sometimes regarded as being unrewarding and rather complex. It is important to understand that giving advice in the mentioned areas is indeed a complex and time-consuming process.

Given the complexity of herd health or quality control problems, every consultation requires a thorough history-taking process and analysis of the specific problem (see also Chapter 2). Continuing education and purchase of special computer programmes may be necessary in order to deliver best practice results. Decisions made will have a considerable impact on the processes on farm and, in addition, regularly involve costs for investments and other changes in management (see also Chapter 13). This process therefore gets the veterinarian involved into the on-farm management. Consequently, the veterinarian might feel he is taking over (at least partly) the responsibility for the economic success of the farm. Some veterinarians, however, might feel this engagement is not rewarded by the farmer and, moreover, may find it difficult to bill for this service. They are therefore reluctant to get engaged.

It can be stated that a certain hesitation to provide services in the area of veterinary consultation results from the reluctance to take over responsibility, the lack of recognition by the farmer and the difficulty to produce an income from this process.

14.4.2. The internal communication and decision making process

When it comes to advice in dairy farming, dairy herd health and quality management, the veterinarian is likely to be the first expert to be asked for advice. Here, the veterinarian should consciously make a decision whether he is going to get engaged or not and, consequently, leave the consultation to other competitors.

In order to be able to make this decision, the veterinarian should take his time to analyse the situation, that is, to ask and answer questions. A SWOT-assessment (assessment of Strengths, Weaknesses, Opportunities, Threats) of the practice gives information about the products and services that can be best offered to the client (Cannas da Silva *et al.*, 2006; see also Chapter 2). Secondly, analysis of the client's demands should lead to the conclusion what the veterinarian is able to offer him in order to meet his goals. Eventually it should be clear what added value to the farmer a consultation process in herd health management or quality control would have to offer.

At this stage, it becomes important to realise what impact the prospect process would have to the practice as a whole. Herd health management or quality control consultation is likely to be a time-consuming process, especially in the beginning. Therefore the internal communication within the veterinary practice has to deal with the offers to the client, the charging for these services and the time the consultation is likely to take. Only once these internal processes are completed (see also Chapter 13), the external communication with the client is to follow (Figure 14.2).

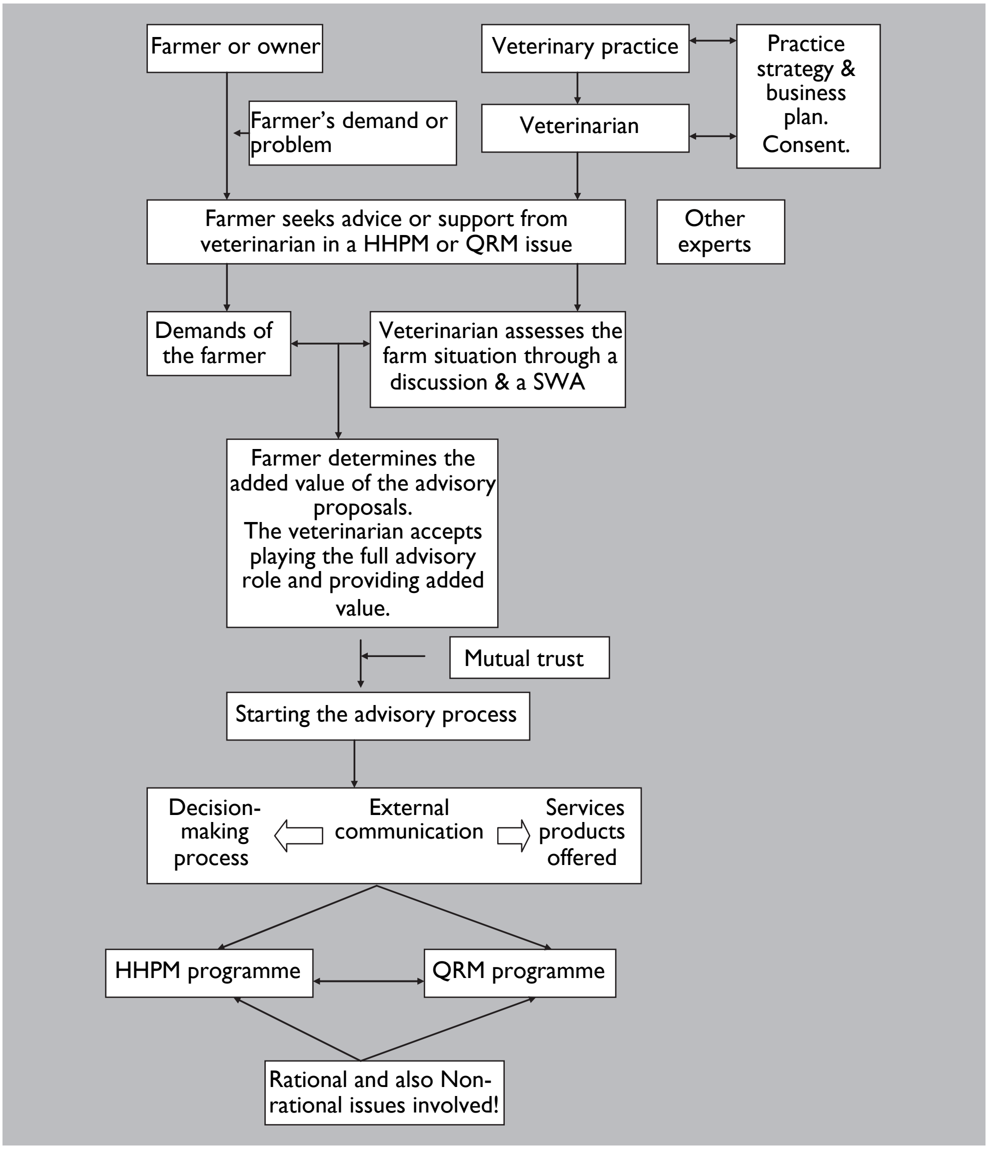


Figure 14.2. Schematic overview of subsequent steps in establishing an advisory plan, including aspects of internal and external communication.

14.4.3. The external communication

Once a decision is made to get an advisory process started, it has to be communicated to the farmer that a different stage of veterinary consultation is about to be entered. Here, communication becomes important in order to reach an agreement for both parties. Only a mutual understanding about the implications of this agreement (including the costs) will provide the foundation of every cooperation: *Trust*.

As the client is now being offered services and products, he also enters the process of decision making. In the following, we are going to take a closer look at the elements of this process and how the consulting veterinarian might influence this. Secondly, the mechanisms of communicating this to the client are to be reviewed.

14.4.4. The decision making process

For the veterinarian having decided to get involved in a consultation process, communication gets more important. The problem has to be identified, an action plan to be developed and, finally, action to be taken. Herd health planning or Quality Risk Management are likely to be thought of as being founded on *rational* and *objective considerations*. However, the decisions to be made by the client, as well as the actions to be proposed by the veterinarian are not solely based on rational judgements. Under similar circumstances, dealing with similar problems may in fact produce different outcomes and actions, for every decision is influenced by cognitive biases. Once it comes to decisions and, consequently, investments, *non-rational issues* will play a substantial role in the decision making process. These 6 issues are:

Perceptions	Impressions	Emotions	Attitude	Motives	Preferences

These do all influence the decision making process, and we are generally not consciously aware of the mechanisms. The consulting veterinarian should nevertheless be aware of these processes and adjust his communication towards it. These principles are known as 'behavioural economics' and form an area of research in current science, combining psychology and economics (Camerer, 1999).

We may try to picture the process of decision making by using the so-called '*AIDA-formula*'. AIDA as an acronym stands for:

- *Attention* – Is there something wrong? – Getting the farmer's attention.
- *Interest* – Can something be done about it? – Technical knowledge and skills veterinarian.
- *Desire* – I want to do it. – Expressed by the farmer.
- *Action* – We start doing it. – Farmer and veterinarian.

Using this formula, let us take a closer look at the behaviour of consultant and client during the decision-making process that precedes any action eventually to be taken.

Attention: Before it comes to active herd health or Quality Risk Management planning, the client has to be made aware of problems or, respectively, realise the extent of problems he may be aware of. He has to see the need to change his system actively. Whether taking action is felt as being necessary depends largely on the perception of what is being 'normal' or not. The own experience, often made in decades of successful farming, serves here as the most important reference to this client. Therefore, the view on the current situation may be biased by a long-term problem, e.g. *Staphylococcus aureus* mastitis which made SCC in the bulk milk creeping up rather slowly over a long period of time. This 'anchoring' implies a certain tendency to stick to a certain procedure or system which has been working for a long time.

An instrument for overcoming this may be the introduction of '*benchmark-groups*' as in the herd companion system of the British NMR (www.nmr.co.uk). Here, farmers can compare their own performance in certain parameters like milk production, milk quality or fertility with that of other farms. This comparison with other, similar farming enterprises turns the subjective view on one's own business into an objective assessment of the status quo. The attention is focused on an actual, not yet recognised problem and will help to interest the farmer in solutions offered. Another instrument which may be useful regards the *'farmers' study groups'*. Here, the veterinarian may provide an opportunity to provide education and information, whereas farmers can assess their status quo by exchanging experiences.

Interest: There are basically two options to draw a farmer's attention: either on the basis of a perceived farm problem, or on the basis of already existing veterinary work on the farm (e.g. a HHPM programme, to be extended to a QRM programme).

I have gained the client's attention to the problem. How do I interest him in my service? The above mentioned assessment of strengths and weaknesses (SWA) is a key in the planning of herd health management or Quality Risk Management, and may be used to interest the farmer in the services offered. As described in the 'attention' paragraph, overcoming the anchoring of a biased subjective view is the first step, done by analysis of the positive and negative aspects (see Chapter 2).

Overcoming the intrinsic reluctance to change a habit is the step to follow. Opportunities and threats must be presented by the veterinarian. When a specific problem is already recognised, possible negative consequences should be discussed e.g. losses due to reduced fertility due to a BVD infection. Once again, overcoming the anchoring by explaining the example of peers using a vaccination programme will create the interest and motivate the farmer 'to do the right thing'.

Desire: As herd health management or Quality Risk Management consultation aims for long-term planning and involvement, its benefit is felt differently than the investments which are to be made in the short-term. It has been stated that people tend to feel differently about 'losses' than about 'gains' (Bertrand *et al.*, 2007). Generally speaking, losses are perceived more severely than gains, leading to the tendency to take greater risks and invest more to prevent or minimise a loss than would be invested to realise gains. In the situation of herd health or Quality Risk Management, losses are often hidden and to a certain point felt being less threatening by the farmer. Although modern, risk-taking farmers nowadays tend to calculate on a 'money per litre' basis, problems in management are often just realised when it comes to penalties e.g. from the dairy industry or higher costs in treatment or replacement. Investments, on the other hand, are felt instantly and it depends largely on the education of the farmer and presentation (marketing) by the consultant, whether these investments are regarded as an instant loss or rather as a commitment made for the prevention of future losses (Bergevoet, 2005).

Communication should therefore aim to pointing out the current situation and current losses rather than illustrating hypothetical future gains. The latter will not motivate in the same way as the former. Tools for calculating the actual cost of disease are available and can be used to demonstrate herd health management problems (Sibley, 2006). Breaking the investment down to the mentioned 'money per litre' basis and comparing them to actual losses will help in creating the necessary desire to get involved in a herd health or Quality Risk Management process. Finally, the veterinarian has to present his services and himself in an assuring, confidence-building manner. A farmer will not participate in a HHPM or a QRM programme when he has doubts about the veterinarian as a person and his skills. Therefore, next to veterinary technical skills, also the appropriate use of non-verbal signals and the analysis of the relationship (see below) should lead to a motivating, encouraging communication.

Action: Taking action as the last step in the consultation chain can involve many different activities. This may be the purchase and use of a specific product, e.g. a vaccination. It can also imply changes in management, like feeding or milking routine. Starting to participate in a regular herd health or Quality Risk Management programme together with the veterinarian, or beginning to use computer based management programmes does also imply taking action.

Although it may seem the easiest part of the process, this step needs careful planning and effective communication once interest and desire were achieved. Opening a 'channel' for action can facilitate the desired and necessary measures to be taken (Bertrand *et al.*, 2007).

What does this mean? We may interpret the client's behaviour as a dualism. The preference of the status quo and the reluctance to change a well-known system on the one hand and the desire to try something new and unused on the other. A simple and uncomplicated plan and a clear schedule from the consulting veterinarian will open a channel for the action and aid the farmer in attempting to adopt a new management. Inversely, the client may not succeed in adopting the changes, if he is left alone in the early phase. Any problem arising here may block the channel for innovation and further action is not taken.

As we will see, different personalities and situations require different approaches depending on the relationship between veterinarian and farmer. A general rule is, however, that compliance to a certain option is usually better if it has been developed in a 'participative' discussion rather than being 'imposed' onto the client. Especially risk-taking, entrepreneur-like farmers will rather comply with an approach based on bilateral activity.

14.5. Different aspects of a message

Many theories dealing with and explaining communication are using a Sender – Receiver model (the '*Frisbee type*'), the most basic way to illustrate the mechanism. This model basically describes communication as a message being sent by a sender to a second person who receives it, and, in turn, reacts to the sender, himself sending a message now. Here it is important to remember that communication is a process of mutual interaction and never one-way only.

In the early 1980s the German psychologist Friedemann Schulz von Thun (1981) published a model on interpersonal communication called 'The communication square' which has since been widely adapted (Figure 14.3). Here, coming from the

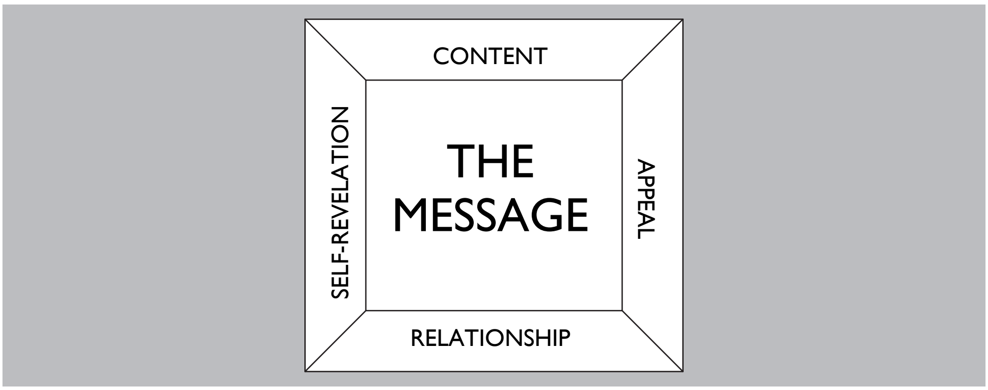


Figure 14.3. The Communication Square' according to Schulz von Thun (1981).

basic sender-receiver model, the message itself is more closely studied. The model describes 4 sites every message has, being content, appeal, self-revelation and relation between actors.

An example illustrates this: a veterinarian is trying to approach the problem of high SCC in a dairy herd. Analysing the hygiene on the farm, he may tell the farmer:

'*I suppose your cubicles are difficult to clean?*'

Apart from the fact-side of the message which is:

'*Your cubicles are difficult to clean*',

The farmer may interpret this sentence in different ways. The veterinarian reveals a part of his impression and opinion on the farm management. Having assessed the problems on the farm, he has defined the cubicles being a major problem. The farmer, who may or may not be aware of this problem, understands this self-revelation and interprets the remark as:

'*I don't like your cubicles. They look dirty to me*'

The farmer has called the veterinarian because he wants advice on his herd management. Being in this position, he is obviously expecting the veterinarian to offer him ways out of his cell count problem and is waiting for guidance. He may therefore interpret the remark as an appeal:

'*Change your cubicles or keep them cleaner*'

Depending on the farmer's experience and his awareness of the actual hygiene situation on his farm, and depending on the way veterinarian and farmer are usually dealing with each other, the interpretation of the sentence may be quite different from the ones above:

'*I am in the position to judge on your management*'

It becomes clear that each of the interpretations is clearly related to the situation and that they are relating to each other as well. The reaction of the farmer may vary, depending on the level he subconsciously prefers to understand. His answers on different levels could be:

Answer to 'Content': '*Yes, I'm struggling here*'

Answer to 'Self-Revelation': '*So you think they are dirty*?'
Answer to 'Appeal': '*It would cost me a lot of labour and money to change it*'
Answer to 'Relationship': '*Would you please help me with my problem, not arguing on my cowshed?*'

It is obvious that the farmer's reaction will be determined by how he sees the veterinarian, how he sees himself and their mutual relationship – the fact that the cubicles are indeed are suboptimal is of no higher relevance.

In a true partnership dominated by mutual trust, the answer to the sentence '*I suppose your cubicles are difficult to clean*' would probably be the first one, given on the 'level of fact'. It would lead to a discussion about how to improve a problem recognised by both parties, as probably would the answers on the side of self-revelation and appeal.

However, what about the relationship-issue? In our example, the message received and understood by the farmer – '*I am in the position to judge your management*' – has provoked an almost aggressive response. The farmer does not want to 'argue' with the veterinarian, and does not feel his problem is taken seriously, at least not to the extent he expects. Instead of going for the problem and thinking about a possible solution, the veterinarian in this scenario now would have to think about the misunderstanding and make it clear to the farmer that he in fact is determined to help him with his problem. We will shortly see what factors contribute to this error in communication.

It can be stated that the veterinarian did not pay enough attention to his relationship with his client, so that a rather overbearing message is sent. We could think of another possibility to interpret the sentence '*I suppose your cubicles are difficult to keep clean*': A message corresponding with the expectations of the client could be:

'*I care for your problem*'

This is probably what every farmer would expect his veterinarian to do: to care for his problem. No matter what the response to this message would be, the process of consulting on the problem can start.

14.6. The relationship between veterinarian and farmer

Having looked at the possible outcomes of a conversation, the question arises what factors determine the course of a conversation during the consulting process. As shown, the relationship between the persons involved may be the source of misunderstandings and largely conditions the result of the process. Difficulties arise from a situation that is incongruent between the communicating persons, thereby hindering the success of the advice process. Six main factors influencing interaction between partners have been identified and listed by Argyle (1994):

- amount of speech;
- emotional tone;
- dominance;
- role relations & definition of the situation;
- intimacy;
- tasks & topics.

Amount of speech: A veterinarian 'talking too much' has been identified as an obstacle in the veterinary consultation by Cannas da Silva *et al.* (2006); here 'and listens too little' could be added. In fact, any communication between equal partners is usually divided equally between the persons involved. It is common experience that situations in which only one party talks all the time are perceived as being uncomfortable and strange. A farmer may ask the veterinarian for advice: the veterinarian should in turn, however, *encourage the farmer to report* more on his actual problem and not exhaust the issue in a way that is discouraging for the farmer. A question asked may in fact be only the first point of an underlying complex of issues. If only the veterinarian as expert in a certain field is talking, the actual point of concern might be missed and the farmer may seek advice elsewhere. Nevertheless, a veterinarian may talk more than the farmer, he probably will in most situations when it comes to his advice and knowledge. This will be satisfactory to everyone involved as long as everyone agrees to the dominance shown by this. In (too) many instances, moreover, a veterinarian gives free advice to the farmer.

Dominance: As mentioned before, the *amount of speech* is a strong indicator of the dominance in a situation. A consultation may be dominated by the veterinarian, especially when he makes proposals and develops strategies for the farmer in his specific situation. However, a farmer may ask the consulting veterinarian for his opinion on certain ideas of his, thereby himself being the dominating part of the conversation. Generally speaking, *questions* are an instrument of leading a discussion, which may be used by either party engaged in the process. Therefore, either the veterinarian may lead the discussion by gathering information from the farmer by asking questions, or, vice versa, the farmer may be the dominating part as he is asking the veterinarian specific questions about his issues and plans. It is important to remember that there is no good or bad about being the *dominating* or *dominated* party in a conversation, as long as the aim is clear and agreed upon. The veterinarian should only be aware of the situation and accept the dominating part asking questions if he or she senses this being suitable. He or she should, on the other hand, not hesitate to take over the other part if the farmer is taking the dominating position.

Intimacy: It is considered being important to show certain empathy towards the client in small animal medicine. In a situation which the client may experience as uncomfortable and threatening, it may help that the veterinarian is showing sympathy towards him/her or – even more important – the pet. Although the circumstances are different when it comes to farm animal practice, it will help to deal with a problem if the veterinarian is considering ways of showing his own interest towards the client's problem by showing *intimacy*. This is done by an adequate use of *eye contact*, *emotional tone of voice* and *facial expression*. In the example above, the remark on the cleanliness of the cubicles would less likely cause a misunderstanding, as the relationship issue is appropriately supported by instruments of creating empathy, thereby showing the necessary interest for the a client's problem. Being aware of intimacy in a discussion is therefore rather supportive to send the message that the veterinarian is in fact interested in and determined to act as a support in the process. Inversely, neglecting this will eventually lead to the farmer thinking the veterinarian is cold and not willing to take his part in solving an actual problem.

Emotional tone: Given a situation in which a farmer is facing heavy losses due to animal health issues, and is deeply concerned about this, the veterinarian involved should ideally respond to this concern on the *same level of emotion*. So, instead of showing cold professionalism, it might be indicated to paraphrase the feeling of the client by saying 'This must concern you' or 'I understand this must be a rather difficult experience for you' (*see below: Active listening*). The congruency of emotion will under these circumstances build up the *necessary trust* and help building a fundament for further collaboration.

Role-relations and definition of the situation: Classical veterinary work – as it commonly used to be – does not require a definition of the role being played by the veterinarian: a cow was sick, and the veterinarian had to fix it. Still, largely depending on the geographical area, this is – like selling medicines – a substantial part of veterinary work and income. However, getting engaged in the more complex field of herd health and production management or Quality Risk Management, which implies consultation work, means a different approach to the role played by both veterinarian and client. How this role and situation definition is changing and requiring different has recently been described by Meens (2006). Here, the mentioned 'classical' veterinary fieldwork requires little input of the farmer, but strong and immediate action and advice from the veterinarian. The farmer is depending on the veterinarian, and the latter is in the position to give his advice. The input is one-way only. This can be called the stage of dependency and is dominated by the '*You*': You are the vet, you have to fix this problem for me.

When it comes to larger units and more complex problems, the farmer's attitude will change. In emerging, rapidly growing farms, the farmer may try to find solutions himself. He is seeing himself as a specialist with the highest competence to find specific solutions. The role of the veterinarian is that of another specialist from an adjacent field who is competent of rendering certain services. This may for example be the sale of medicines to the farmer. In this scenario, the farmer is acting in an autonomous way and will use the drugs in the way he believes to be the most effective one. This *stage of autonomy* is being pictured by the '*Me*' of the farmer. An advice by the veterinarian is desired and may be considered (especially when given for free), but the farmer relies on himself in the first place.

A different stage is reached when the roles are defined by the '*Us*' of *interdependence*. This probably reflects best most of the current situation in farming industry, where complex problems like multifactorial and production diseases require a bundle of interrelated solutions and, hence, associated disciplines. More than ever, the farmer is actually depending on the advises of a veterinarian and other specialists (nutritionist, economist, dairy extension specialist); the veterinarian like any other consulting specialist has to rely on the – written – information passed on to him by the farmer in order to be able to make the most appropriate decision what to say and to do. Success of this consulting process will be one which is achieved together.

Having shortly described these different stages of farmer-vet interaction, from the 'you' via the 'me' towards the 'us' of quality control or herd health and production management, we have to remember the *principle of congruency*: a farmer seeing himself in a stage of autonomy will not accept a veterinarian directing him. Vice versa, a client being in a stage of dependency is relying on the veterinarian to solve a problem for him. This client cannot cope with a veterinarian who is only giving advice and otherwise relies on the farmer's will and competence to use the tools provided by the veterinarian. In other words, a farmer in this picture won't be satisfied with a bottle of medicines. The veterinarian would have to inject and care for the patient as well. Lastly, the entrepreneur-like dairy farmer experiencing a certain problem or a complex of issues is not going to accept a veterinarian who is just dispatching medicines and otherwise avoids getting involved. He will eventually decide to obtain the input he wants and needs from specialists elsewhere, often leaving the veterinary practice aside.

Task, topic, and definition of the situation: This part of congruency in communication relates largely to the previous section. The veterinarian should therefore ask himself consciously, what the client in a specific situation wants and expects. This can be:

- Solving an actual problem; here the farmer relies on the veterinarian's knowledge and skills. The veterinarian is expected to manage the situation, not involving the farmer in the first place, or not involving the farmer in full (The '*You*'-Phase).
- Providing some advice or, maybe more important, medicines to deal with a problem. The veterinarian is expected to help the farmer and not primarily to act on his own (The '*Me*'-Phase).
- Start a consultation involving both; here, the client will probably expect the veterinarian to get involved and being asked questions to start with. His knowledge and experience are valuable and necessary. The client's actual problem may have been identified as being a symptom of an underlying problem (The '*Us*'-Phase).

It is important to note that these phases are not to be seen in isolation. A farmer may very well develop from the stage of dependency into a stage of autonomy, especially if he is developing his enterprise and acquires more knowledge and skills. The farmer preferring to act in interdependence with his veterinarian will, on the other hand, very likely choose to act autonomously if facing a situation he is capable of managing largely by himself.

14.7. Practical aspects

14.7.1. Applied communication skills

As mentioned earlier, the aim of the communication regarding a certain herd health problem is to *identify a problem and develop a solution*. The problem itself may not be evident *per se* and has to be identified in the first place. The initial complaint may, for example, be 'another mastitis' the veterinarian has been called to treat. The appeal to the veterinarian implied by the call may, however, be to take action on the herd health level or quality control level because the mastitis is perceived as a herd- and management problem by the farmer. The message on the relationship issue may, moreover, be to *take action together*. As the situation and the task is clear, taking a history and gathering information is the next step of the evolving consulting process (see also Chapter 2). Besides the necessary study of production data and on-farm management, careful communication with the client regarding the problem is the probably most important thing to do; a farmer wishing to act interdependently with his veterinarian expects to provide information. Whether the client wishes to take a dominating part or rather likes to see the conversation being dominated by the veterinarian is of lesser importance; the consulting veterinarian should in any case consider some basic rules of successfully gathering information, showing his willingness to collaborate and propose action. In comparison: in human medicine clients' recall and understanding may improve by 30% when they are asked to repeat relevant information. Moreover, compliance improved when clients were asked to give their own opinion about causes and explanations, or when the doctor asked the client whether he/she could agree with the proposed procedures (Kurtz, 2006).

14.7.2. Asking questions

As mentioned earlier, questions can generally be seen as an instrument of dominating a discussion. The character of the discussion itself as being rather one-way or being an exchange of information leading to a plan is, however, largely dependant on the kind of questions being asked. Commonly two types of questions are differentiated: closed questions and open questions.

Closed questions are of a directing, dominating nature and are by definition answered with either 'yes' or 'no'. Closed questions are advantageous in critical situations that require immediate action for they provide necessary information quickly and effectively. An example in the given example would be: *Do your cows predominately have mastitis after calving?* The answer would be 'yes' or 'no'. It would due to the directing nature fit in a situation of dependency ('*You*-phase').

Open questions are more dialogue-orientated and encourage the person being asked to share information. They are typical in an interdependent situation ('*Us*-phase') where the flow of information is in both directions. Open questions are an instrument of consultation and provide the necessary information to both parties involved. The asking part is receiving information, while, on the other hand, the person answering is consciously sorting and weighing the information by reflecting his response. Therefore the technique of open questioning is a mutual benefit within the consultation. An example of an open question would be: *When do you predominantly have mastitis in your herd?* The client here would recall the mastitis history of the herd, recognising the main incidence and thereby actively contributing to the consultation.

Depending on the dominance during the consultation process the direction of questions may of course be vice versa and the farmer may take a leading role by questions. The described stage of autonomy ('*Me*'-phase) clients might tend to use closed questions in order to acquire certain information they regard as being useful to them. Open questions are as well likely to get a specialist's opinion on a problem.

There is generally no good or bad about types of questions or the direction of enquiries. Every relationship will have a most effective way of asking, in a herd health management consulting process, however, the technique of open questions in a interdependent, cooperative environment will be the most effective and appropriate one. It is, however, highly indicated to ask questions in a *SMART* way (see below).

14.7.3. Active listening

In the section about the relationship, several aspects that contribute to the *congruency* of a communication process have been reviewed. *Empathy* and *mutual understanding* are necessary to reach an agreement regarding the situation. As it has been shown that messages can be quite complex in terms of their content, a useful tool of confirming having interpreted the message correctly is the so-called 'active listening'. By listening actively, persons involved in communication *reassure each other* of their mutual attention and understanding. Misunderstandings are prevented and corrected in an early stage, while the perception of the situation and the task of the consultation are defined.

Components of Active Listening are certain elements of body language and *rhetoric instruments*. While listening to the history of a current emerging problem, eye contact should be kept in an non-provocative manner (that means: no fixation), by this showing that the attention is kept to the reporting client. *Nodding*, indicating agreement, will also encourage communication.

The forenamed techniques of *verbalising* and *paraphrasing* serve in confirming the message understood by the recipient. Verbalising a message means to state the content of the underlying message received. A farmer may, for example, report on his problems in calf rearing, where he is currently experiencing major losses due to scour. By verbalising, the consulting veterinarian recognises the difficulties of his client by saying:

'*This must be quite frustrating for you: you invest a lot and you keep loosing calves.*'

Using the four side model, this message would mean:

- Content: This must be frustrating for you – you have heavy losses.
- Self revelation: I understand your situation – I would be frustrated as well.
- Appeal: Something has to be done - let's start!
- Relationship: I care for your problem – I will help you.

Paraphrasing means to repeat a statement in one's own words, confirming the understanding and indicating agreement to the sender. In our example, one statement of the farmer may be:

'This month alone, I've lost 6 calves despite feeding them colostrum early enough.'

It could be paraphrased by saying:

'So you have done the right thing and lost half of your calves nevertheless?!'

Again, this would assure the farmer that he is in fact experiencing a serious problem, that his efforts are right, and, above all, that the vet is caring for his problem. Next to paraphrasing, it is worthwhile to summarise from time to time what has been previously discussed.

These techniques are easy to use and will have an instant effect on the situation. It will be felt as being congruent and appropriate by all participants and be a good start for a consulting process.

14.8. SMART

Herd health and Quality Risk Management programmes have to be understood as dynamic and constantly evolving processes, always subject to changes and pressures (Sibley, 2006). It is therefore useful to give discussions in the planning process shape and direction. The SMART-scheme has proved to be useful in complex situations like these. The acronym stands for the way questions should be asked and plans be made:

- Specific: The communication should apply to the specific conditions and problems that is dealt with.
- Measurable: Introducing realistic and objective figures helps to focus on the actual problem and prevents disagreements (e.g. through benchmark or farmers' study groups, see above).
- Achievable: Instead of aiming for unrealistic targets, like completely eradicating a mastitis-problem in a herd, both the consultant and farmer should try to achieve a certain goal that is actually reachable and makes success measurable. In that way, disappointment is avoided and motivation kept high for the HHPM or QRM programmes.
- Relevant: The planning should focus on actual, costly and immediate problems rather than spending too much effort on less relevant targets.
- Time-based: In order to make success visible, thereby motivating both veterinarian and farmer, deadlines and fixed evaluations should be used. This will make achievements both visible and objective.

The SMART-scheme can aid in concentrating on the actual problems. It helps preventing waste of time and energy, and in avoiding disappointments. When we summarise the forenamed issues, we can design the schedule as listed in Figure 14.4, adapted from the forenamed framework (Kurtz, 2006, see above).

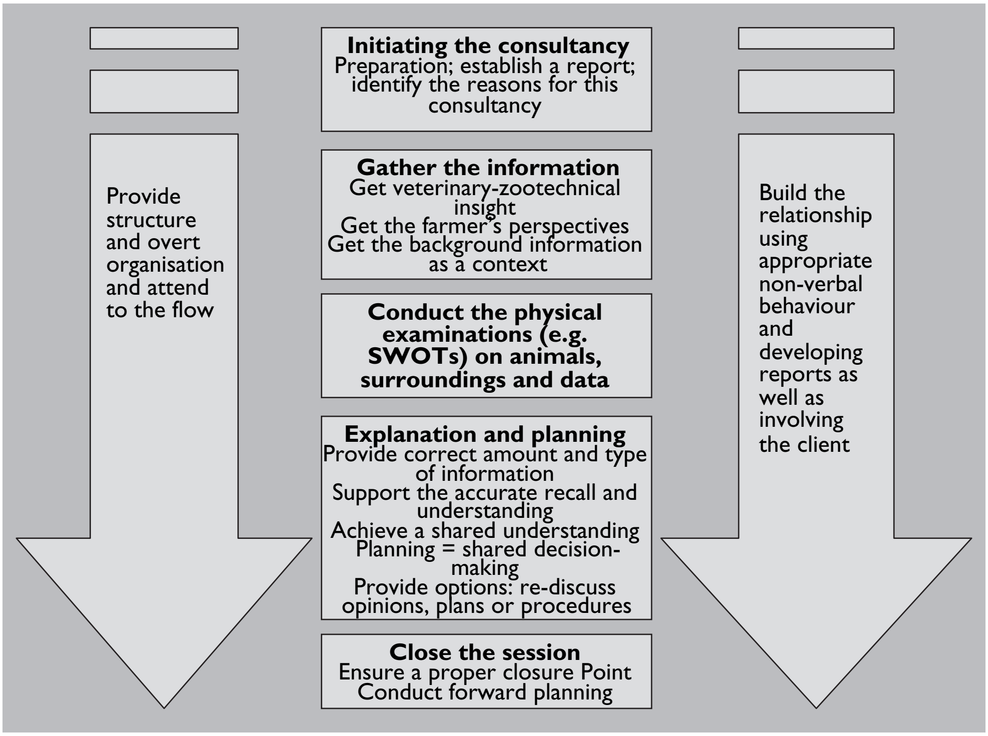


Figure 14.4. Schedule summarising the different components of communication in medical consultations, adapted from Kurtz (2006).

14.9. Conclusions

As the farming industry gets more and more complex, the veterinarian has to adapt himself to these changes. We as professionals in an increasingly competing environment will need to broaden our competencies in order to stand in the farm-advisory competition. Acquiring communication skills and learning how to use them is one aspect of this process. In a number of veterinary colleges, the teaching of communication skills has become a part of the curriculum (Adams and Kurtz, 2006). Particularly in curricula with Herd Health & Production Management or Quality Risk Management programmes, the teaching of communication skills should have a substantial position.

We have to realise that decisions are not based on rational and economic considerations alone. Understanding the principles of the process of decision making is the basis to influence it and to successfully offer products and services to our clients.

The use of SWOT-analyses, SW assessments (see Chapter 2) and benchmarking or farmers' study groups helps in overcoming the intrinsic reluctance to change a system which has been working for a long time. Bergevoet (2005) concludes that it is quite possible to improve the entrepreneurial competencies of dairy farmers by developing and discussing the farmers' strategic plans in study groups (benchmarking). All participants in such group activities appeared to benefit from such activities, irrespective of the farmer's or farm characteristics, or the level of competencies at the start of these activities.

The veterinary consultant should realise that communication consists of verbal and non-verbal communication and that the non-verbal part represents the major proportion in the outcome.

Most of the communication process is taking place subconsciously and deals with a lot more than just the contents of a conversation. We should take our time to analyse the status of the consultation and the role we are expected to play by our client. Acting according to this helps in avoiding misunderstandings and prevents unnecessary friction that is disturbing the consultation process.

Acknowledging some basic principles of decision-making and communication is therefore more than a kind of psychological magic. It helps veterinarians improving their stand in competition and helps in creating a more relaxed and more satisfying working atmosphere within the changing cattle industry in general, and with clients in herd health or Quality Risk Management in particular.

Chapter 15. Final remarks

15.1. HACCP is not a panacea for solving all (food safety or disease) hazards

When properly applied, HACCP comprises a set of principles and steps which provide a systematic methodology both for identifying significant hazards and their associated risk conditions, and for applying measures to prevent, eliminate or reduce such hazards and risks to an acceptable level (after Pierson, 1995).

The most important characteristics in HACCP are that *structure* is provided, that on-farm *organisation* and *planning* are needed, and that the various *steps and procedures are much more formalised* than in, for example, veterinary Herd Health & Production Management programmes.

Several attempts have been made to familiarise veterinarians and farmers with the ideas and principles of HACCP applications (Cullor, 1995, 1997; Griffin *et al.*, 1998) in both dairy and beef herds. Griffin *et al.* (1998) explained why and how a HACCP-like approach could ensure that food-borne pathogens would be reduced to an acceptable level in beef herds; they addressed this in the Quality Assurance Critical Management Points (QACMP) system for beef farms (feedlot; cow-calf operations; feeder cattle). In this system, hazards in the area of farm productivity, safety and quality were the main focus; their approach is –however- rather qualitative in nature. They asked the reader whether meeting with the requirements that were put forward to farmers could truly be asked from them. The answer was simple: these requirements represent simple economics related to retaining market access or improving their market access, based on the client's trust in what they buy.

We go further than others: we have adapted the HACCP concept and principles to their practical application at farm level (dairy farms; milking goat farms; children farms) and – at the same time – integrate such application with the daily (operational) farm management. The great difference with other attempts is right in this strong management orientation: with the focus on the prevention or reduction of operational managerial and quality failure costs, while at the same time we aim at preventing or controlling hazards and risks in the areas of public health, food safety, animal health and animal welfare on the farms.

It has been stated by Ryan (1997) that: '*Applying HACCP may seem unwieldy, but it is nothing more than what a truly good farmer would do anyway*'.

We did not address the issues of environmental quality in this book. Yet, dairy production is considered – among other animal production sectors – as a source of solid, liquid and gaseous emissions which can be environmentally harmful (Hartung, 2007). This author provides an overview of the predominant effluents from livestock farming, comprising N and P, heavy metals such as Zn and Cu, drug residues (e.g. from antibiotics and anti-parasitics), sludge and waste water, and bio-aerosols. Contemporary dairy farming requires a proper handling of such effluents, which are sometimes produced in large volumes, e.g. manure (Oliver *et al.*, 2005; Burton, 2007). The reason is that air, soil, crop, and or water pollution may occur due to a relative insufficient capacity of the local or regional environment. A review of the environmental effects of producing food animals have been provided by Burton *et al.* (2000). Environmental quality is closely related to public health and food safety; examples are *Cryptosporidium parvum, Salmonella spp., E. coli* STEC, *Leptospira spp*. (Oliver *et al.*, 2005).

Policies which aim at encouraging efficient production may threaten public health, food safety and animal health and welfare, but also environmental quality. On the other hand, policies for reducing pollution may damage (dairy) farming (Burton, 2007). In addition to developing and applying new technologies (see e.g. Burton 2007), also precision dairy farming may contribute to reduce environmental quality failures due to dairy production (Cox, 2005; Wathes, 2007). The HACCP-concept and principles may be applied to the forenamed issues of environmental quality too. Böhm (2007), for example, has presented such an approach to the microbiologically hygienic and safe recycling of waste water, organic waste materials and residues in animal production systems. However, it was outside the scope of this book to elaborate on these environmental quality issues extensively.

15.2. An overall assessment of quality control applied on dairy farms

Strong and weak points of dairy farm management with regard to applied overall quality control on dairy farms have been surveyed, for example, in The Netherlands by farmers and veterinarians (IKC, 1994). The different elements were scored on a scale from 1 (very poor) to 10 (very good), and the results are presented in Table 15.1.

Obviously in the Dutch situation of 1994 (other countries may show different outcomes) dairy farms do well in the area of handling cows, feedstuffs and rations, cleaning & disinfection procedures, bulk tank cooling, maintenance and surveillance, as well as pasturing, pasture exploitation, and milking machine maintenance. On the other hand, there are sufficiently other issues (scoring 5 or less) that need attention: feed additives or offal's, drinking water quality, cow treatment procedures, hygiene, management & prevention, barn climatic conditions, milking parlour procedures.

Table 15.1. Overview of scores on a scale from 0 to 10 regarding applied quality assurance practices on dairy farms in The Netherlands (IKC, 1994). Score 0 = very poor; score 10 = excellent.

Man-Cow interactions		6 to 7
Means	Roughage	8
	Concentrates	9
	Additives or offal	3
	Water	5
	Cleaning & disinfection	7
	Cow treatment	2
Methods	Legislation	4
	Hygiene	4
	Management & prevention	5
	Milking procedures	6
	Feeding procedures	6
Equipment	Bulk tank	9
	Cubicles & ventilation	4
	Pasturing	8
	Milking machine maintenance	8
	Milking parlour procedures	4

These are all managerial aspects. They are caused by a lack of observational skills, lack of knowledge and or awareness about e.g. risks, lack of implementing certain measures, inconsistencies in managerial procedures, lack of self-criticism, changes in attitude or perception, unawareness about losses involved (IKC, 1994).

Veterinary Herd Health & Production Management programmes, including *biosecurity assurance plans*, may strongly assist in pointing attention to such aspects, and by providing structure and coaching to their approach.

The same is valid for Quality Risk Management programmes which deal with good dairy farming guidelines and work instructions. Quality failure costs are either systems costs or true (management) failure costs, or a combination of both. Quality failure costs represent missed income, due to disease costs, decreased milk yield, poor milk quality, costs of barn renovation, spoiled labour (and often unknown losses which may be hard to identify). Such costs have been estimated at € 150 to 250 per average cow present in the herd; an improvement of € 100 per average cow present must be achievable (Dijkhuizen and Morris, 1996).

15.3. Interests of dairy farmers in HACCP-based Quality Risk Management

The benefits of programmes as introduced in this book may sometimes be insufficiently clear to dairy farmers. In those cases substantial time-investment and proper education is needed to change such scepticism (Gardner, 1997). For a HACCP-like programme to be successful, farm management must be committed to the HACCP-like approach. Such commitment includes awareness of benefits and costs of the programme, and applying on-site training and coaching of farmer or manager, and employees. Among the benefits are – next to enhanced assurance of food safety and quality – a better use of resources, reduction of (quality) failure costs, and a timely response to (pending) problems and legislation in the area of public health, animal health, and animal welfare (Anonymous, 1998).

In general it is assumed that farmers are willing to pay a certain price to reduce the exposure to risks. If farmers can manage the risk factors on their farm at acceptable costs, they can consider themselves as being better off as a result (Arrow, 1996; Harrington, 1999). The way to manage such risk factors depends on factors like the extent to which a farmer shows risk aversion, the costs and benefits involved in risk management, the relative importance of the risks, the correlation of risks with other risk conditions, other sources of indemnities, the farmer's perception of the nature of the risks, the farmer's income and wealth or social status (Hardaker, 1997; Harrington, 1999). Some of the latter issues have been addressed in Chapter 13 in the section about *behavioural economics*, because it appears that decisions are being taken partly on rational arguments, but largely on non-rational arguments too. Literature provides some techniques and hints about how to overcome the clients' reluctance or hesitance to accept or adopt the advises and interventions proposed by the veterinarian (Aguilar, 2005).

Appropriate communication between farmer and advisor-veterinarian is pivotal to and crucial for the adoption of the programme of Quality Risk Management by the farmer (Chapter 14).

15.4. The farm environment and the authorities (EU)

Consumer protection alongside the whole food chain is the central issue in new European food hygiene & safety legislation, which has been implemented since the 1st of January 2007 at the national level. The whole food chain includes primary producers (like dairy farmers). However, they do not have to produce according to HACCP-standards and do not have to be certified (yet).

In this new legislation (we mentioned before, EU directives 852, 853 and 854-2004) it is stressed that the producers are fully responsible and liable for food safety, hygiene, animal welfare and animal health on their farm. On the other hand, the EU gives much freedom regarding the controls and audits, which in most cases have to be executed by food producing companies themselves. Other important issues within the new legislation are: all controls have to be according to the HACCP-(like)-concept and production always has to meet minimum standards regarding hygiene and food safety. A special demand for the primary producers (e.g. farmers) is that 'all information about used veterinary products and pesticides has to be recorded in specific documents, which can be glanced over by the competent authority'. Any specialist, like veterinarians, can be consulted, in order to get specific information about these documents and recordings. We emphasise 'any' because besides the veterinarian, according to European legislation it could be another specialist too.

New European food hygiene legislation recognises three kinds of veterinarians: the official veterinarian (an official employed by the government), the practitioners (restricted official tasks) and the curative veterinarian in practice/ the field consulted by producers. In an Annex of EU directive 853-2004 is described in detail what knowledge and skills the official veterinarian has to have. Some examples are: knowledge about national & European legislation regarding food safety, animal health and welfare, public health and pharmaceutical products; agriculture policy, food processing and food technology; basics, concepts and methods regarding production, quality management and HACCP; control and watch over production systems/processes; audits and checks regarding food safety control; information and communication technology and the relation with veterinary public health (Borgmeijer, 2007). Although not explicitly described in that directive – since practitioners are thought to be the right person to conduct specific official controls and audits in the food chain on the behalf of the government – it is inevitable and obvious that practitioners have to meet many of the forenamed knowledge and skill standards.

As mentioned before, there lies a huge responsibility in the private sector (producers in the food chain, including primary producers, e.g. farmers) with respect to self control by means of Quality (Risk) Management systems. Producers will be forced to give guarantees regarding food safety, public health, animal health and welfare. Specialists will be consulted in order to support producers in this process, for veterinary related issues it is rational that veterinarians are seen as specialist. Besides this role, the official veterinarian and the practitioner will also play an important role in quality control in the food chain, since the government will board out controlling work to private, so-called control bodies. Note that the national government will always remain the final responsible body regarding issues like food safety, public health, animal health and welfare. In order to guarantee a certain 'basic quality', the control bodies have to meet minimal accreditation standards; e.g. are certified. Finally, the veterinarian in the field helping out farmers in case of emergencies, will never disappear; however veterinarians have to focus more than ever on the preventive and farmer supporting part of the job.

Some final remarks with respect to the role of the veterinarian in the future: Primary producers not only are in need of a curative veterinarian, but also are in need of a veterinary specialist who is able to interpret and communicate about food chain data. Note that veterinarians should develop themselves into such specialists in order to remain an essential partner for the farmer and to maintain their important position in the food chain. Therefore, much has to be invested in (post graduate) education and training of the official veterinarian and the practitioner in order to be ready for that job in the near future (Cannas da Silva *et al.*, 2006)!

15.5. Contracts, internal and external relations of the farm

European Union directives (e.g. 854-2004) made HACCP-like QRM programmes compulsory for food producing businesses in the food chain. In response to HACCP-like programmes which inevitably will become obligatory in primary food animal production within a few years from now, farmers will in return demand high quality standards for all the services and products the supplying enterprises provide on their farm. Just like (dairy) farmers, veterinarians also are part of this same food chain and are a supplier of the (dairy) farmer. In the last years, new developments in Quality Assurance in the dairy chain in e.g. The Netherlands are being speed up by the milk processing industries. Farmers are obliged to have contracts with feed suppliers and veterinarians. Quality is guaranteed through contracts between the different parties, in which both the buyer and the supplier agrees upon several conditions. These conditions include features of the delivered service or product, calamity plans (early warning systems; recall database) and even demands on the QRM programme of the production process of the supplying producer. These kinds of contracts already exist for the feed producing industries (these should be GMP+ and HACCP certified) and already contracts for veterinary herd health programmes are suggested (FDF, 2006) or legally required like in Belgium. Therefore, veterinarians should not only anticipate on the increasing demand of farmers for support in applying HACCP-like QRM programmes on farms, but also work on and improve certification of their own practice. In The Netherlands, for example, veterinarians are able to obtain a KRD-ISO 9001 certification, proving their practice meets quality guidelines for veterinary practices. In order to develop contracts between veterinarians and (dairy) farmers, these quality guidelines should be matched more closely to the quality demands of farmers and initially the dairy industries.

Economic benefits and an increase of the intrinsic value of the farm are important issues to convince farmers that changing their on-farm management into a HACCP-compatible approach is needed. Knowledge of psychological aspects, like behavioural economics, and good communication (see preceding chapters) are essential. Furthermore, for a successful HACCP programme to be properly implemented, management must be committed to fully adopt a HACCP-like approach. A commitment by management will indicate an awareness of the benefits and costs of HACCP and include education, training and coaching of employees (see Chapter 8). Benefits, in addition to enhanced assurance of food safety, are better use of resources, hence reduction of costs, and a timely response to problems (Anonymous, 1998). In general, it is assumed that farmers are willing to pay a price to reduce exposure to risk. If farmers can manage the risks on their farm at acceptable costs, they should consider themselves to be better off as a result (Arrow, 1996; Harrington, 1999). However, benefits of HACCP-like programmes – as stated above- often are unclear to livestock producers, and substantial education is necessary to change this scepticism (Gardner, 1997). According to Bergevoet (2005), for example Dutch farmers are mainly interested in labour joy, expressed in intrinsic values, like: public image; working with animals; food safety as a primary characteristic of their business; and the philosophy that 'challenges are chances and no threats'. They are not completely driven by economic targets; the pre-mentioned intrinsic values of the farm are at least as important.

Risk attitude of farmers (who are entrepreneurs these days) is in general based on positive evaluating behaviour and therefore farmers are often seen as 'risk-takers'. Farmers believe that the outcome of decisions is mostly determined by themselves, based on a feeling for their efficacy, keeping their own risk perception in mind (Bergevoet, 2005).

15.6. Potential drawbacks when implementing HACCP-like programmes

When implementing programmes of Quality Risk Management on dairy or other farms, which are based on the HACCP concept and principles, one may encounter the following drawbacks (adapted after Tompkin, 1990).

a. HACCP requires training and education, especially when farm workers, technicians, claw trimmers are involved, as well as veterinarians and nutritionists. Failure of understanding the concept and principles of HACCP by the veterinarian will undoubtedly lead to failures in the implementation; at the same time the farmer should get the relevant clues and understanding of the HACCP concept. For that reason we need to install a procedure of coaching parallel to the implementation track.
b. HACCP must be well adopted, accepted and applied by every stake-holder on the farm (that is, every member of the *Team,* as well as the farm workers and

service providers), otherwise the programme will not be sufficiently effective. One should bear in mind that the will to change is also a non-rational issue; commonly, humans (farmers) are not eager to change, they prefer to stick to a certain *status quo* (see also Chapter 13, behavioural economics).

c. Experts may differ in their opinion with regard to the definition of what exactly is a CCP and what is a POPA, and with regard to the best methods to monitor certain steps or a given CCP/POPA. When this phenomenon does occur, it is up to the Farm Quality Management *Team* to make the final decision about what is best and what is not. Otherwise any confusion will lead to loss of confidence in the HACCP programme in the early stages.
d. Poor levels of communication between farmer and advising veterinarian, and between farm advisors mutually, leading to misunderstanding, loss of confidence, and finally to non-adoption of the Quality Risk Management programme. This issue of communication has been elaborated in Chapter 14.
e. Acceptance of HACCP principles by the (dairy) production sector might give the consumers a false assurance idea, like there would be left just a zero-risk. Consumer information addressing hazards and risks regarding food safety and food preparation need to be continued.

It has been stated elsewhere (Chapter 3), that an essential prerequisite to HACCP is the adoption and implementation of Good Dairy Farming (GDF) codes of practice (after Pierson, 1995). The adoption of these GDF will create the appropriate mentality, attitude and, hence, the necessary foundation for HACCP-like applications. See in Chapter 3 the different types of GDF guidelines and working instructions as an illustration for this statement. These guidelines and working instructions are indeed management instruments to focus attention, create a better awareness and eventually a better performance of the farm.

Moreover, an appropriate and continuous training and coaching of all people involved in developing and implementing the HACCP-like Quality Risk Management programme will be paramount for reducing forenamed drawbacks, for keeping up the motivation and keep the programme running effectively.

15.7. Quantification of Quality Risk Management parameters

In several instances in this book, risk factors were weighted on the basis of knowledge and experience regarding the qualitative assessment of risk on the individual dairy farm by the Farm Quality Management *Team*.

Another option to prioritise risks is through the availability of quantitative results (e.g. odds ratios and relative risks) from observational-analytic epidemiological studies regarding specific diseases and disorders (Noordhuizen *et al.*, 2001; Thrusfield, 2005). However, these results are based on population studies; they do not necessarily apply all to the individual farm. Therefore, it is always necessary to 'translate' such results from the population level to the level of the individual farm. The latter may cause loss of reliability of outcome but is still preferable above qualitative assessment.

The third option to assess the priority of certain risk factors is through applying the methodology of *adaptive conjoint analysis*, ACA (Horst *et al.*, 1996; Van Schaik *et al.*, 1998; Bouma *et al.*, 2004). This has been shortly addressed in Chapter 6 and Annex 7A.

Process capability indexes have been proposed for evaluating quality performance in certain production processes over time (Evans and Lindsay, 1996). Although these may be valuable in physical processes, they are much harder to develop and implement in biological processes like on dairy farms due to the biological variation that occurs. Currently there are hardly any process capability indexes developed for dairy farming. Examples are presented by Niza-Ribeiro *et al.* (2004) regarding somatic cell counts in bulk tank milk deliveries in relation to udder infections.

Formal *risk assessment* has been proposed by the EU (Candiani *et al.*, 2007) and the FAO as the best choice methodology to investigate the risk background of certain disorders. Usually, animal diseases are comprised, in analogy to human health disorders. However, a major drawback is in the fact that there is a great lack of sufficient, sound, and quantitative risk assessment information in the animal production sector about disease incidence and prevalence, risk factors and their impact. When applying qualitative risk information, there is often a contradiction among experts (M.B.M. Bracke, personal communication). Further information on quantitative risk assessment issues can be obtained from Vose (2000).

Recently, *semantic modelling* was introduced (Bracke *et al.*, 2001, 2004), in particular for the area of animal welfare. This method has shortly been addressed in Chapter 8, paragraph 8.3. We further refer to the forenamed literature sources.

15.8. Responsibilities of the dairy farmer or manager

The dairy farmer (or his manager) must have a clear view on the scope, the prospects and limitations of the HACCP-like QRM programme. That is the only way he can 'educate' his farm workers in the proper attitude and strategy on the farm. He must be well aware of the goals of the HACCP-like QRM programme, as well as the use of the HACCP-like QRM-handbook. Some dairy farmers will indeed make a '*Quality*

Policy Statement' for their farm, and list that at the beginning of their HACCP-like QRM-handbook

The farmer or manager has to know the ultimate use of the (raw) products delivered by the dairy farm, in order to be better aware of the requirements and their rationale set by the industry or consumers (retailers).

As chairperson of the *Farm Quality Management Team* the farmer has to moderate the meetings of the *Team* and propose his targets. It would be best if he also provides the *Team* members (and farm workers) with an *Organisation & Management Diagram*, pointing out the different 'business units' on the farm, the respective tasks and responsibilities for each farm worker in a given unit, the performance parameters he wants to set, and the technical criteria for evaluating the performance within each unit. Examples of such organisation & management diagrams have been given elsewhere (Noordhuizen and Muller, 2003; van Egmond *et al.*, 2006; Noordhuizen *et al.*, 2006). Such diagrams are very helpful in illustrating the different hierarchical pathways, the task responsibilities of respective farm workers, and the development of a HACCP-like QRM programme, where for example production process diagrams need to be defined (see at Chapter 5 and Annex 5A).

The dairy farmer, manager (or owner) is also responsible for acquiring a proper training of farm workers (if any), as well as their appropriate conduct with regard to Quality Risk Management aspects, risk management issues, hygiene rules, guidelines and working instructions, and record keeping. These are crucial elements in the adequate implementation of the programme and should, therefore, not be neglected (OIE, 2006).

15.9. Quality risk management and economics

15.9.1. General issues

Integrating economics into quality risk assessment is very challenging, but also worthwhile. It gives more insight into both the economic and epidemiological aspects of the critical points in risk assessment and into the cost-effectiveness of advice and intervention measures. Inclusion of economic parameters in risk assessment has the following advantages (Hogeveen and Velthuis, 2007, personal communication).

First, it serves a more optimal decision-making process. A risk assessment model with integrated economics will provide, besides epidemiological information, also economic information concerning the complicated pathway of *quality hazards*. This combination gives more certainty than an intuitive feeling about the economic consequences of applying an advice or an intervention measure, and their cost-effectiveness. In Figure 15.1 the cost-effectiveness ratio is illustrated. For example, an intervention measure might reduce a certain risk to a low level at low cost (low cost / highly effective). The cost-effectiveness level of this measure is good and it would be a good measure to consider for implementation. If a measure reduces the human risk just a little at high cost (high cost / low effective) it will not be worthwhile to implement. There will be many measures with a medium cost-effectiveness, that is with low effectiveness and low costs, or with high effectiveness at high costs. The risk manager or decision-maker should decide whether such measures are to be considered for implementation. For this decision-making, the setting of a maximal budget and a minimal acceptance level of effectiveness might help in selecting only those measures or strategies that are fitting the requirements of farm management (Figure 15.1). The Quality Risk Management *Team* always will strive for optimum effectiveness at lowest costs.

For decision-makers, like farmers and food chain quality managers, it is important to know what the price is of an extra level of quality guarantee and the benefits. Through implementing economic assessment methods more insight can be gained into the costs and benefits of different levels of quality assurance. For example, it is easily

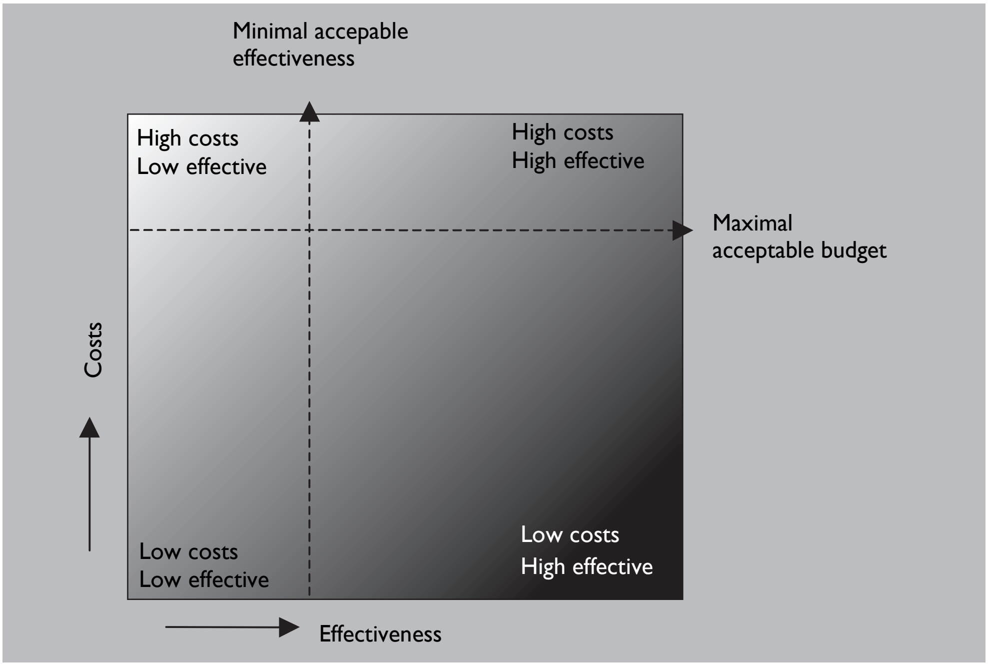


Figure 15.1. Schematic representation of different cost-effectiveness levels of an intervention measure to reduce the risk of quality problems (H. Hogeveen and A.G.J. Velthuis, 2007, personal communication).

said for a decision-maker to aim for a null percent risk (which is by the way often impossible to achieve) when not considering the costs. The direct or indirect costs of an intervention strategy to achieve this null percent risk level might be extremely high. It is very likely that the last percent decrease in quality risk is very expensive. Thus, economic aspects are important to include in the discussion about an optimal level of quality guarantee.

The second advantage of including economics into risk assessment models is more at the *dairy food chain level*. The distribution of costs spent and benefits gained when applying intervention strategies will become visible. Costs include the direct costs or losses related to the measure or the strategy applied, for example to build or facilitate a hygiene lock at the farm. Quality costs could also be made by the dairy processor, for instance to test milk for antibiotic residues. Benefits include the economic savings for society when the quality of the end product increases. Benefits might also include the extra benefit of selling more products or getting a higher price due to a better public image or to an improved human perception. Benefits might also include a higher price for half products at the individual company level and savings due to less disease or treatments at the animal level or higher production efficiency. Information about the distribution of costs and benefits along the supply chain is very useful in the discussion about the distribution of costs and benefits over all participants in a supply chain, as has been demonstrated for the pork supply chain (Den Ouden, 1996).

Summarising, economic arguments are very important in the (food chain and on-farm) decision-making process. Therefore, economic methodologies should be included in quality risk assessment approaches. In the next section two examples of economic estimations are presented to illustrate the forenamed statement.

15.9.2. Two examples

[1] Effectiveness of measures to reduce Escherichia coli VTEC on Dutch dairy farms

A transmission model developed to investigate the dynamics of *Escherichia coli* VTEC bacteria in a typical Dutch dairy herd was used to assess the effectiveness of vaccination, improvement of the ration, administration of probiotics (colicin) and improved hygiene (e.g. with water troughs and bedding material), in reducing the prevalence of infected animals. The assumed baseline prevalence (not necessarily being representative for the population prevalence) of the lactating group and the within-herd prevalence were estimated by the model to be 5% and 14% respectively (Vosough Ahmadi *et al.*, 2007). The forenamed interventions can reduce the prevalence of *E. coli* VTEC by 84% to 99%. However, for dairy farmers, *E. coli* VTEC is no problem, since animals do not become diseased by this pathogen and do not show signs. The advantage of the forenamed on-farm quality measures is a reduction of potential food safety problems due to this pathogen (low Probability + high Impact). Therefore, results of the transmission model were used to estimate the reduction of prevalence of *E. coli* VTEC on slaughtered animals, using the output of the farm model (prevalence of *E. coli* VTEC) as input for a slaughterhouse transmission model (Vosough Ahmadi, 2007). The slaughterhouse transmission model gave as output the prevalence of infected quarters of carcasses. Moreover, the costs for the various on-farm interventions were estimated and the cost-effectiveness of on-farm quality measures to reduce contamination of beef with *E coli* VTEC was calculated. A choice was made to use a cost-effectiveness and not a cost-benefit approach, because it is very difficult (if possible at all) to associate a cost level to human disease due to certain food safety problems, particularly when the prevalence can not be measured reliably such as in the case of the VTEC. The quality control measures (vaccination, colicin administration, hygiene improvement and improved ration) can be applied in various parts of the dairy farm (un-weaned calves, older calves, lactating cows and dry cows). In Table 15.3, the most cost-effective application is presented. It can be seen that, in terms of prevalence reduction, an improved ration for young stock is the best performing measure. However, the costs (in € per slaughtered quarter animal) is also the highest. The resulting cost-effectiveness ratio is even the lowest for this on-farm quality measure. Although the vaccination of un-weaned calves does not yield a very strong reduction of prevalence, this measure was the most cost-effective of the measures.

Table 15.3. Estimation of cost effectiveness of quality control measures on a dairy farm to reduce the prevalence of E. coli VTEC on beef (after Vosough Ahmadi, 2007).

	Estimated prevalence reduction (%)	Estimated costs (€ per slaughtered quarter animal carcass)	Cost-effectiveness ratio
Vaccination of un-weaned calves	1.81	1.67	1.08
Colicin application to un-weaned calves	1.51	1.41	1.07
Hygiene improvement in young stock	3.52	35.98	0.1
Improved ration for young stock	4.1	74.42	0.05

[2] Distribution of costs and benefits of quality control throughout the food chain

In many dairy producing countries, quality assurance systems are in place. In order to be able to deliver milk to a dairy processor, dairy farmers are required to take a certain number of measures which guarantee the quality of milk and/or the public image of milk production. Costs of these systems are taken by the dairy farmer. From some of the measures (e.g. health improvement through biosecurity), the dairy farmer might have some direct benefit. However, most of the benefit at farm level is indirectly through the public image of dairy products and the associated demand as related to milk price, and a prevention of recalls. Until recently, these questions were dealt with using qualitative risk analysis and it seems reasonable to prevent large costs of recalls by applying relatively cheap on-farm Quality Risk Management programmes with or without quantitative risk analysis. However, although for the dairy processor the benefits of prevention of recalls might be very large, one processor has many (sometimes several thousands) suppliers. When 8,000 suppliers (e.g. dairy farmers) have a yearly cost of € 1,000 to maintain a quality programme, the total yearly costs for the dairy sector of this programme are € 8 million!

In order to make a more quantitative analysis (Vose, 2000) of this distribution problem possible, a conceptual framework has been developed (Hanenberg, 2006). This framework (Figure 15.2) makes it possible to estimate the costs of certain measures at various levels (animal, dairy farm, dairy processor and sector) give a certain set of starting issues. Moreover, the benefits of these measures, in terms of prevented loss of public image and prevented losses due to recalls can also be estimated and compared with the costs made on the dairy farm. In a preliminary calculation, the costs for

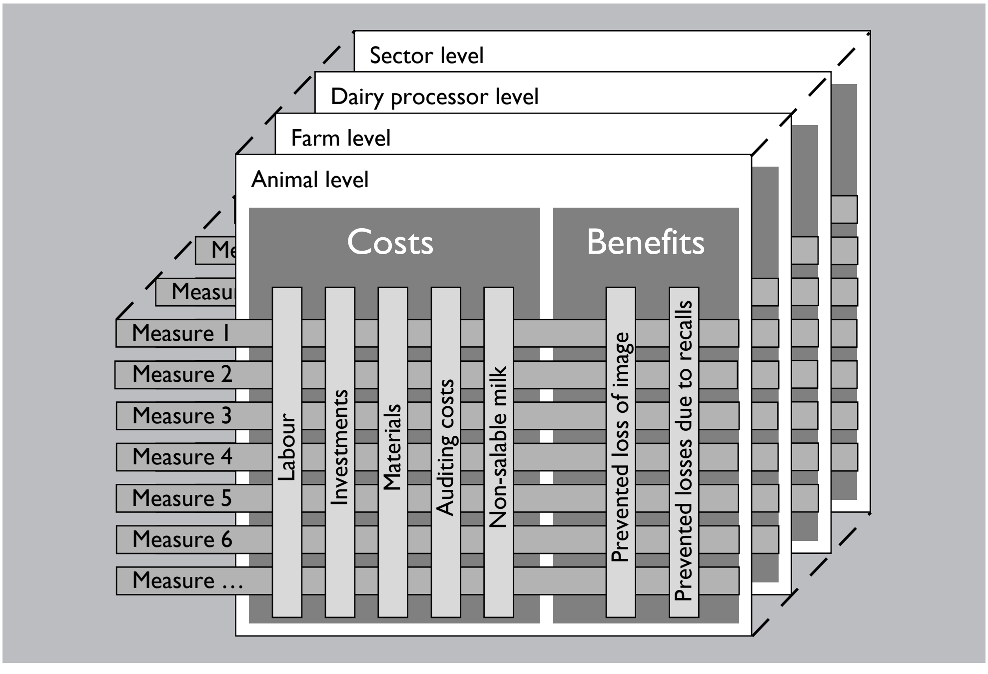


Figure 15.2. Schematic representation of a conceptual framework to estimate costs and benefits of quality control measures applied on the dairy farm, taking into account all levels of the dairy sector (after Hanenberg, 2006).

quality measures as they were applied on Dutch dairy farms in 2005 were calculated and related to benefits due to prevention of public image losses and recalls for one of the two large Dutch cooperative milk processors. The costs for the quality programme for the farmers could fairly well be estimated to be € 24,169 per year for an average farm. Most of these costs were due to preventive measures for animal health and welfare. These costs, which were made by the dairy farmer, were not compensated for by benefits in terms of improved public image and prevention of recalls. The only area of quality control, where costs were compensated for by benefits further up in the chain, was the area of feed and water.

Although the estimation of the value of public image and recalls was very rough in the study of Hanenberg (2006) due to its presumptions, it emphasises the fact that it is important to relate the benefits of quality control to the costs of them. It becomes clear from Table 15.2, that a large part (more than 60%) of the costs for quality control has to be earned by improving the dairy farming process itself. For the area of animal health and water quality, that is obvious. Measures to improve the health of animals, can be compensated by improved health and thus lower production losses (as is described in another chapter of this book). The measures as associated with the domains named in Table 15.2 have not been elaborated in detail here. The total costs of quality control measures as named in Table 15.2 should therefore be regarded as a sort of maximum investment in quality control; within countries, regions and farms, as well as between countries the cost levels of quality control will differ substantially. Hence, optimising such costs is more relevant than maximising. Hanenberg (2006) did not calculate the on-farm benefits of quality control on dairy farms. Results of this study should therefore not be regarded as basis for decision making, but merely as illustration of the concept of distribution of costs and benefits of on-farm Quality Risk Management.

Table 15.2. Estimation of costs (€ per dairy farmer per year) of on-farm quality control in relation to the benefits of quality control for prevention of public image loss and recalls for one large Dutch cooperative dairy processor; an illustration of the distribution of costs and benefits (after Hanenberg, 2006).

	Net result	Benefits	Costs
Quality control (total)	-14,675	9,494	24,169
Treatments and drugs	-4,501	760	5,261
Animal health and welfare	-8,436	3,765	12,202
Feed and water	856	1,022	165
Milking equipment and storage	-1,742	2,862	4,603
Hygiene	-852	1,085	1,938

15.10. Concluding remarks

The main purpose of this book on HACCP-like applications is to provide veterinarians and other extension people, as well as entrepreneur-like dairy farmers on large-scale operations with practical instruments for developing, implementing and validating HACCP-like Quality Risk Management programmes.

The adoption must be in the practical bottom-up approach, and the merger of operational and tactical affairs. This is contrary to the top-down approach that has been proposed earlier (Maunsell and Bolton, 2004) and where food safety management on farms is presented as a top-down approach. The latter will hardly or not work on (dairy) farms or is severely hampered because there is no common ground for adoption among farmers.

We started with a chapter on strengths-and-weaknesses assessments on the farm premises, because we feel that it is paramount to have an in-depth insight into the dairy farm operation before starting a Herd Health & Production Management programme or a HACCP-like Quality Risk Management programme. Strengths-and-weaknesses assessments should – preferably – not be executed as purely stand-alone methods, because they need to be integrated into the whole farm business (HHPM or QRM). During the evolvement of such programmes it can be highly beneficial to conduct regularly a strengths-and-weaknesses assessment as a means for evaluating progress or detecting drawbacks; it motivates the farmer to carry on.

Furthermore, the development and application of good dairy farming guidelines and associated practical working instructions for dairy farms (FAO, 2004; Cannas da Silva *et al.*, 2006) provide a good basis before and during the implementation of Quality Risk Management programmes. Not in the least because the adoption of these guidelines and working instructions by the farmer and farm workers is a sound foundation for installing Quality Risk Management programmes. They induce the proper mentality and attitude (Chapter 3). These guidelines and working instructions can also be part of operational Herd Health & Production Management programmes, the best examples being the implementation of biosecurity assurance plans for preventing infectious diseases from entering on the farm, and the Herd Treatment Advisory Plan.

The developmental process for a veterinary practice, evolving from a curative practice to a practice where curative work is coupled to advisory activities is illustrated in Figure 15.3. Each veterinary practice has to define for itself, which goals should be reached, how, by whom and at what pace.

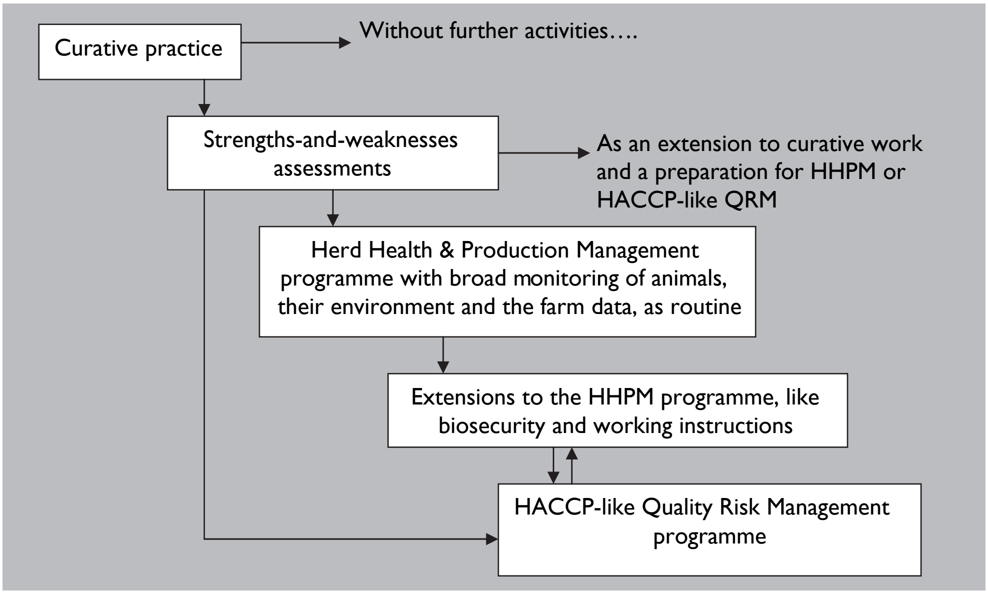


Figure 15.3. Schematic overview of different developmental steps from curative practice to advisory practice, or their combinations.

At the same time the forenamed issues show that operational Herd Health & Production Management programmes should and can easily be merged with the more tactical HACCP-like Quality Risk Management programmes (Noordhuizen and Welpelo, 1996; Lievaart *et al.*, 2005). These Herd Health & Production Management programmes also deal with monitoring of animals and their environment (i.e. risk factors), with animal health and welfare and with public health issues when they are adequately executed, but rather in a qualitative manner. Their main focus is operational farm management to increase income and reduce production costs (Brand *et al.*, 1996). HACCP-based programmes are, however, far more structured and quite formalised, have a more tactical orientation, and are based on proper farm organisation.

During field trials the farmers indicated that when Herd Health & Production Management programmes were executed through farm visits every month, it would be sufficient to address specific HACCP issues once every two months in these conditions. The merger between the two can then be visualised as is presented in Figure 15.4.

When one considers such a merger, it should be kept in mind that the consequence will be that the execution of the Herd Health & Production Management programme has to become much more formal, better organised and structured, exactly in the

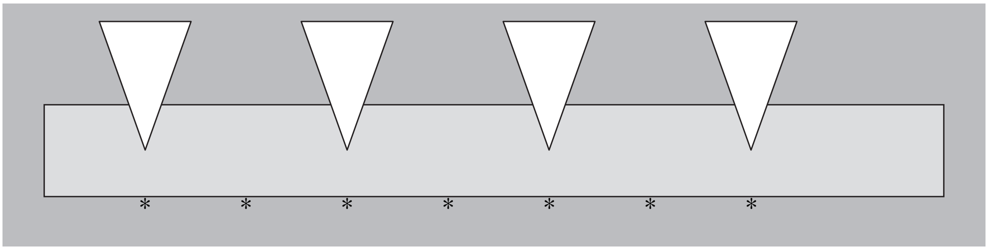


*Figure 15.4. Visualisation of the merger between Herd Health & Production Management and the HACCP-like Quality Risk Management programmes. The * represents a calendar month; the triangle the specific HACCP-based programme parts; the grey-shaded area represents the operational Herd Health & Production Management programme according to Brand* et al. *(1996).*

way like the HACCP-like programme is designed. Overall, the integration of both approaches makes the veterinary service to the (dairy) farm more professional, more efficient and more beneficial for both the dairy farmer and the veterinarian.

The *formalisation*, *organisation, planning* and *structuring* issues are elementary components of the HACCP concept, and are required by third parties to ultimately get a reliable insight into the functioning of the HACCP-like Quality Risk Management programme on the dairy farm. It should be clear to the farmer, his co-workers and the veterinarian that it is far better to apply all components of the HACCP-like programme to some extent (preferably the largest extent) instead of just applying some components! The latter will undoubtedly result in a zero-efficacy, because too many paramount domains remain untouched.

Hence, to determine whether the HACCP-like programme is working correctly, verification and validation procedures must be designed. Verification procedures are preferably not carried out by the person who is responsible for performing the monitoring and corrective actions. This task can be performed by a local veterinarian skilled in this area or by qualified external parties, such as an inspector from the dairy processing industry.

A verification procedure must include a review of the HACCP-like programme and its records, deviations and product dispositions and a confirmation that CCP's and POPA's are kept under adequate control. When possible, validation activities should include actions to confirm the efficacy of all elements of the HACCP-like programme. In addition to these internal validity screenings, it can be expected that in the near future external verification through auditing by qualified and accredited persons needs to be implemented. The latter could eventually lead to certification of these kinds of dairy farms.

By addressing the applications of HACCP-like Quality Risk Management on both commercial dairy farms, dairy farms open to the lay public, children or city farms, as well as milking goats farms, we have shown that the concept and principles of HACCP always remain the same. Indeed, the HACCP concept and principles can be applied to domains such as public health, food safety, animal health and animal welfare for different species of production animals. Hence, it must be feasible to apply the HACCP concept and principles to other farming sectors (e.g. swine, poultry, rabbits) too, as well as to other domains in farming such as waste management and environmental quality (Böhm, 2007; Hartung, 2007).

The Chapters 13 and 14 have been included in this book in order to provide the context in which veterinary advisory work should take place. Proper knowledge of entrepreneur-like farmers, adequate insight in one's own stronger and weaker points, and appropriate qualities regarding a professional communication, are domains that need attention when one desires to enter the field of veterinary farm advisory work.

In the past, many advice and intervention measures to improve quality of dairy products or the production process have been implemented or advised without properly considering the (direct or indirect) cost-aspects of these measures. Information about costs and benefits at different levels of quality control (e.g. at farm level, or further in the dairy food chain) is important to take good decisions. As the *E. coli* VTEC example illustrates, the most health-effective measure is not always the most optimal in economic terms. In order to accomplish this, an economic methodology should be added to or integrated with Quality Risk Management approaches. This would also allow the identification of costs and the distribution of benefits of the intervention measures along the supply chain. This distribution is important to know, while considering changes in on-farm Quality Risk Management

The application of HACCP principles on (dairy) farms can provide veterinarians with (additional) income if they assist, coach and advise farmers in developing and implementing the HACCP-like and associated programmes. Veterinarians can, however, only perform these activities in an adequate manner if they are *a priori* willing to invest in knowledge and skills in domains like hygiene, zoonoses, farm economics, Quality Risk Management and proper communication skills (Cannas da Silva *et al.*, 2006). If they do so, a new market segment lays ahead for veterinarians. Overall, the integration of approaches mentioned in Figure 15.1 makes the veterinary service to the (dairy) farm more professional, more efficient and more beneficial for both the dairy farmer and the veterinarian.

Finally, in this way veterinarians are better prepared too for the role of a more 'official veterinarian' like the EU has proposed in the chapter 4 of annex 1 to the Hygiene directive EC 853-2004. Veterinarians, hence, have a new role to play in the farming sector, namely in the area of Quality Risk Management.

'Take challenge by the hand, before it takes you by the throat!'
(Churchill, 1942)

Literature references

Adams, C.L., Kurtz, S.M. 2006. Building on existing models from Human Medical Education to Develop a Communication Curriculum in Veterinary Medicine. Journal of Veterinary Medical Education 33 (1): 28-37.

Aguilar, M. 2005. Vaincre les objections des clients. Les Editions du Point Vétérinaire, Maisons-Alfort, France (in French).

Angus, L.J., Bowen, H., Gill, L.A.S., Knowles, T.G., Butterworth, A. 2005. The use of conjoint analysis to determine the importance of factors that affect on-farm welfare of the dairy cow. Animal Welfare 14 (3): 203-213.

ANICAP. 2006. Code mutuel en élevage caprin: une démarche de progrès pour promouvoir le savoir-faire des éleveurs. Dossier technique pour les éleveurs de chèvres laitières. ANICAP-Institut d'Elevage, Paris, France (in French).

Animal Health Service. 1981. Annual Report, GD, Zwolle, The Netherlands (in Dutch).

Anonymous. 1998. Hazard analysis critical control points principles and application guidelines. Journal of Food Protection 61 (6): 762-775.

Argyle, M. 1994. Face, gaze and other non-verbal communication. In: The psychology of interpersonal behaviour, 5th ed., London, pp. 23-55.

Argyle, M., Salter, V., Nicholson, H., Williams, M., Burgess, P. 1970. The communication of inferior and superior attitudes by verbal and non-verbal signals. British Journal of Social and Clinical Psychology 9, 221-231.

Arrow, K.J. 1996. The theory of risk-bearing: small and great risks. Journal of Risk and Uncertainty 12: 103-111.

BAMN. 2000. An introduction to infectious disease control & biosecurity on dairy farms. Bulletin of the Bovine Alliance on Management and Nutrition, published by AFIA, Arlington VI USA.

Bender, J. 1994. Reducing the risk of salmonella spread and practical control measures in dairy herds. The Bovine Practitioner 28: 62-65.

Berckmans, D. 2004. Automatic on-line monitoring of animals by precision livestock farming. Laboratory of Agricultural Buildings Research, Catholic University, Leuven, Belgium.

Bergevoet, R.H.M. 2005. Entrepreneurship of Dutch dairy farmers. PhD thesis, Wageningen University, Dept. of Farm Management, Wageningen, The Netherlands.

Bertrand, M., Mullainathan, S., Shafir, E. 2007. Behavioral economics and marketing in aid of decision-making among the poor. Journal of Public Policy and Marketing 25(1): 8-23.

Boersema, J.S.C., Noordhuizen, J.P.T.M., Vieira, A., Lievaart, J.J., Baumgartner, W. 2007. Imbedding HACCP principles in dairy herd health and production management programmes: case report on calf rearing. The Irish Vet Journal (in press).

Böhm, R. 2007. Strategies for hygienic safe recycling of organic wastes and residuals to agriculture. In: Proceedings of the XIII Internat. Soc. of Animal Hygiene Congress, Tartu Estonia, pp. 899-908.

Borgmeijer, J. 2007. Nieuwe Europese Wetgeving Levensmiddelenhygiene. Dier-en-Arts nummer 3 (in Dutch).

Bouwknegt, M., Dam-Deisz, W.D.C., Wannet, W.J.B., van Pelt, W., Visser, G., van der Giessen, A.W. 2004. Surveilance of zoonotic bacteria in farm animals in The Netherlands. Report 330050001/2004. State Institute of Public Health & the Environment (RIVM), Bilthoven, The Netherlands.

Bouma, B.J., van der Meulen; J.H.P., van den Brink, R.B.A., Smidts, A., Cheriex, E.C., Hamer, H.P., Arnold, A.E.R., Zwinderman, A.H., Lie, K.I., Tijssen, J.G.P. 2004. Validity of conjoint analysis to study clinical decision making in elderly patients with aortic stenosis. Journal of Clinical Epidemiology 57: 815-823.

Bracke, M.B.M., Spruijt, B., Metz, J.H.M., Schouten, W.G.P. 2001. Decision support system for overall welfare assessment in pregnant sows: model structure and weighting procedure. Journal Animal Science 8: 1819-1834.

Bracke, M.B.M., Hulsegge, B., Keeling, L., Blokhuis, H.J. 2004. Decision support system with semantic model to assess the risk of tail-biting in pigs: Validation. Applied Animal Behaviour Science 87: 45-54.

Bramley, A.J., Dodd, F.H. 1984. Reviews of the progress of dairy science: mastitis control (progress and prospects). Journal of Dairy Research 51: 481-512.

Brand A., Noordhuizen, J.P.T.M., Schukken, Y.H. 1996. Herd health and production management in dairy practice. Wageningen Academic Publishers, Wageningen, The Netherlands.

Brandt, J.C., Batemann, S.W. 2006. Senior Veterinary Students' Perceptions of Using Role Play to Learn Communication Skills. Journal of Veterinary Medical Education 33(1): 76-80.

Bray, D.R., Shearer, J.K. 1994. Milking machine and mastitis control handbook. Cooperative Extension Service, IFAS circular 1136, University of Gainesville, Fl;, USA.

Bricher, J.L. 2004. Lights, Camera, HACCP! Food Safety Magazine, August/September issue: 38-50.

Brison, R.J., Pickett, W., Berg, R.L., Linneman, J., Zentner, J., Marlenga, B. 2006. Fatal agricultural injuries in preschool children: risks, injury patterns and strategies for prevention. Canadian Medical Association Journal 174 (12): 1723-1726.

Burton, C.H., Phillips, V.R., Wathes, C.M. 2000. A broiler industry perspective on environmental quality: strategies to reduce the impact. XXI World Poultry Congress, Montreal, Canada, August 20-24.

Burton, C.H. 2007. New challenges for environmental protection in terms of intensive animal production. In: Proceedings of the XIII Internat. Soc. of Animal Hygiene Congress, Tartu Estonia, pp. 375-383

CAC (Codex Alimentarius Commission). 1991. On food hygiene: draft HACCP principles. At www.codexalimentarius.net/web/publications.jsp

CAC (Codex Alimentarius Commission). 1999. Principles and guidelines for the conduct of microbiological risk assessment. CAC/GL-30. Available at htpp://www.codexalimentarius.net/download/standards/357/CXG_030e.pdf

Camerer, C. 1999. Behavioral economics: Reunifying psychology and economics. Proc. Natl. Acad. Sci. USA 96: 10575-10577.

Candiani, D., Ribo, O., Afonso, A., Aiassa, E., Correia, S., De Massis, F., Pujols, J., Serratosa, J. 2007. Risk Assessment challenges in the field of animal welfare. In: Proceedings of the XIII Internat. Soc. of Animal Hygiene Congress, Tartu Estonia, pp. 587-591.

Cannas da Silva, J., Noordhuizen, J.P.T.M., Vagneur, M., Bexiga, R., Gelfert, C.C., Baumgartner, W. 2006. The future of veterinarians in bovine health management. In: Proceedings of the World Buiatrics Congress. Navetat and Schelcher (eds.), Nice, France, October 2006. Also published in The Veterinary Quarterly 28 (1): 28-33.

Chambre d'Agriculture des Deux Sèvres. 2004. Guide sanitaire de l'élevage caprin, 36 pp. (in French).

Chartier, C., Paraud, C., Mercier, P. 2006. Les dominantes pathologies chez la chevrette d'élevage. In: Proceedings des Journées Nationales GTV, Dijon, France, 897-902 (in French).

Chauvin, A. 1994. Fasciolasis: a form of high-risk zoonosis. Le Point Vétérinaire, special issue on Ruminants & Public Health (M. Savey, ed.) 26: 39-41 (in French).

Cogbill, T.H., Busch, H.M., Stiers, G.R. 1985. Farm accidents in children. Pediatrics 76 (4): 562-565.

Cox, S. 2005. Precision Livestock Farming '05. Wageningen Academic Publishers, Wageningen, The Netherlands.

Cross, R, Smith, J. 1996. Customer bonding: Pathway to lasting customer loyalty. NTC Business Books.

Cullor J.S. 1995. Implementing the HACCP program on your clients' dairies. Veterinary Medicine/ Food Animal Practice, March: 290-295.

Cullor, J.S. 1997. HACCP: is it coming to the dairy? Journal of Dairy Science 80: 3449-3452.

Davis, S., Calvet, E., Leirs, H. 2005. Fluctuating rodent populations and risk to humans from rodent-borne zoonoses. Vector-borne and Zoonotic diseases 5: 305-314.

De Jong, J. 2006. Large-scale dairy farming in an economic perspective. MSc thesis (in Dutch), Wageningen University, Dept. of Farm Management, Wageningen, The Netherlands.

De Kruif, A., Mansfeld, R., Hoedemaker, M. 2007. Tierärztliche Herdenbetreuung beim Milchrind. 2nd Edition. Enke Verlag, Stuttgart, Germany (in German).

Den Ouden, M. 1996. Economic modelling of pork production-marketing chains. PhD thesis at the Wageningen University, Chair of Business Economics, Wageningen, The Netherlands.

De Rijcke, J., Oswald, E. 1994. Is cattle a significant source of *E. coli* O_{157}:H_7? Le Point Vétérinaire, special issue on Ruminants & Public Health (M. Savey, ed.) 26: 91-99.

Desachy, F. 2005. Les zoonoses, transmission des maladies des animaux à l'homme. Les Editions du Point Vétérinaire, Maisons-Alfort, France (in French).

Desler, G. 2003. Human Resource Management. Prentice Hall, Upper Saddle River, NJ USA

Dijkhuizen, A.A. 1990. The profitability of herd health control in cattle. Landbouwkundig Tijdschrift 102: 12-16 (in Dutch).

Dijkhuizen, A.A., Renkema, J.A., Stelwagen, J. 1991. Modelling to support animal health control. Agricultural Economics 5: 263-277.

Dijkhuizen, A.A., Morris, R.S. 1996. Animal health economics: principles and applications. University of Sydney, Australia, postgraduate formation in veterinary science.

Eelkman-Rooda, D.C. 2006. Communication: management problems within the veterinary practice is about communication. Dier-en-Arts 6/7 (in Dutch).

EFCF (European Federation of City Farms). 2005. Proceedings of the 15th EFCF Conference, Turin, Italy, 14-18 September 2005.

EFSA (European Food Safety Agency). 2005. Principles of risk assessment of food producing animals: current and future approaches. Parma, Italy. Available at htpp://www.efsa.europa.eu/etc/medialib/efsa/science/colloquium_series/no4_animal_diseases/1179.Par.0017.File.dat/ses_summary_report_coll4_en1.pdf

Elkington, J. 2002. Work and farm related injury. NSW Public Health Bulletin 13 (5): 93.

Esslemont, R.J., Bailie, J.H., Cooper, M.J. 1985. Fertility management in dairy cattle. Collins Publ. London, UK.

Evans, J.R., Lindsay, W.M. 1996. The management and control of quality. West Publ. Company, St. Paul, MN, USA.

FAO. 1997. Hazard Analysis Critical Control Points (HACCP) system and guidelines for its application. In: htpp://www.fao.org/docrep/005/y1579e/y1579e03.htm.

FAO. 2003. Good Agricultural Practice. Annex to the COAG-2003-6, FAO, Rome, Italy. at: htpp://www.fao.org/DOCREP/MEETING/006/Y8704f.HTM

FAO and International Dairy Federation IDF. 2004. Guide to good dairy farming practice, FAO Rome, Italy.

FAWC (Farm Animal Welfare Council). 1992. FAWC updates the five freedoms. The Veterinary Record 131: 357.

FDA. 1999. HACCP: a state of the art approach to food safety. August 1999, US FDA. At; htpp://vm.cfsan.fda.gov/~lrd/bghaccp.html

FDF (Friesland Dairy Foods). 2005. Handbook Quarant, a farmers guide. Friesland Foods, Meppel, The Netherlands (in Dutch).

Fels-Klerx, H.J., Van der Horst, H.S., Dijkuizen, A.A. 2000. Risk fators for bovine repiratory disease in dairy youngstock in The Netherlands: the perception of experts. Livestock Production Science 66: 35-46.

Fletcher, R.H., Fletcher, S.W., Wagner, E.H. 1984. Clinical Epidemiology: the essentials. Williams & Wilkins, Baltimore/London.

Frankena, K., van Keulen, K.A.S., Noordhuizen, J.P.T.M., Noordhuizen-Stassen, E.N., Gundelach, J., de Jong, D.J., Saedt, I. 1992. A cross-sectional study into prevalence and risk indicators of digital haemorrhages in female dairy calves. Preventive Veterinary Medicine 14: 1-12.

Franklin, R.C., Crosby, J. 2002. Farm-related injury in NSW: information on prevention. NSW Public Health Bulletin 13 (5): 99-102.

Franklin, R.C., Mitchell, R.J., Driscoll, T., Frager, L. 2000. Farm-related fatalities in Australia 1989-1992. Moree, NSW: Australian Centre for Agricultural Health and Safety, National Occupational Health and Safety Commission and the Rural Industries Research Development Corporation.

Gardner, I.A. 1997. Testing to fulfill HACCP (hazard analysis critical control points) requirements: principles and examples. Journal of Dairy Science 80 (12): 3453-3457.

Goodger, W.J., Collins, M.T., Nordlund, K.V., Eisele, C., Pelletier, J., Thomas, C.B., Sockett, D.C. 1996. Epidemiologic study of on-farm management practices associated with prevalence of *M. paratuberculosis* infection in dairy cattle. Journal of the American Veterinary Medical Association 208 (11): 1877-1881.

Griffin, D., Milton, T., Roeber, D., Grotelueschen, D. 1998. Putting NC-BQA to work through the quality assurance, critical management points (QACMP) system. The Bovine Proceedings of the 31st Annual Convention, Am. Assoc. of Bovine Practitioners.

Griffin, J. 1995. Customer loyalty: how to earn it, how to keep it. Lexington Books.

Hadley, G.L., Harsh, S.B., Wolf, C.A. 2002. Managerial and financial implications of major dairy farm expansions in Michigan and Wisconsin. Journal of Dairy Science 85: 2053-2064.

Halasa, T., Huijps, K., Hogeveen, H. 2007. Bovine mastitis: a review. The Veterinary Quarterly 29: 18-31.

Hancock, D, Dargatz, D. 1995. Implementation of HACCP on the farm. In: Proceedings of a Symposium on HACCP, 75th Meeting of Research Workers in Animal Diseases, November 12, 1995, Chicago, Ill., USA.

Hanenberg, J. 2006. Economic aspects of quality control on dairy farms. MSc thesis at the Wageningen University, Chair of Business Economics, Wageningen, The Netherlands (in Dutch).

Hardaker, J.B., Huirne, R.B.M., Anderson, J.R. 1997. Coping with risk in agriculture. CAB International, Wallingford, UK.

Harrington, S.E., Niehaus, G.R. 1999. Risk Management and Insurance. The McGraw-Hill Companies, Boston, USA.

Hartung, J. 2007. Assessment of environmental effects of airborne emissions and waste effluents from livestock production. In: Proceedings of the XIII Internat. Soc. of Animal Hygiene Congress, Tartu Estonia, pp. 695-701.

Hassan, L. 2001. Farm management and milking practices associated with the presence of *Listeria monocytogenes* in New York dairy herds. Preventive Veterinary Medicine 51: 63-73.

Heinrichs, A.J. 1993. Raising dairy replacements to meet the needs of the 21st century. Journal of Dairy Science 76 (10): 3179-3187.

Hendricks, K.J., Adekoya, N. 1998. Non-fatal animal related injuries to youth occurring on farms in the USA. Injury Prevention 2001 (7): 307-311.

Hensel, A, Neubauer, H. 2002. Human pathogens associated with on-farm practices: implications for control and surveillance strategies. In: Food Safety Assurance and Public Health, Vol.1. Food safety assurance in the pre-harvest phase (Smulders & Collins, eds.), Wageningen Academic Publishers, Wageningen, The Netherlands.

Heuchel, V., Parguel, P., David, V., Lenormand, M., Le Mens, P. 1999. Maîtrise de la qualité hygiénique en production laitière: l'application d HACCP en élevage. In: Proceedings du Renc. Rech. Ruminants, 291-297 (in French).
Heuvelink, A.E., van den Biggelaar, F.L., Zwartkruis-Nahuis, J.T.M., Herbes, R.G., Huyben, R., Nagelkerke, N., Melchers, W.J.G., Monnens, L.A.H., de Boer, E. 1998. Occurrence of verocytotoxin producing *Eschirichia coli* O_{157} on Dutch dairy farms. Journal of Clinical Microbiology 36 (12): 3480-3487.
Heuvelink, A.E., van Heerwaarden, C., Zwartkruis-Nahuis J.T.M., Van Oosterom, R., Edink, K, Van Duynhoven, Y.T.H.P., De Boer, E. 2002. *Eschericia coli* O_{157} infection associated with a petting zoo. Epidemiology & Infection 129 (2): 295-302.
Hogeveen, H, Osteras, O. 2005. Mastitis management in an economic framework. In: Mastitis in Dairy Production. Proceedings of the 4th IDF International Conference (H. Hogeveen, ed.), Maastricht, The Netherlands, 11-16 June 2005, Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 41-52.
Horst, H.S., Huirne, R.B.M., Dijkhuizen, A.A. 1996. Eliciting the relative importance of risk factors concerning contagious animal diseases using conjoint analysis. Prev. Veterinary Medicine 27: 183-195.
Hudson, C.B. 1991. Risk Assessment and Risk Management. Food Australia 43: 10-12.
Hugh-Jones, M.E., Hubbert, W.T., Hagstad, H.V. 1995. Zoonoses: recognition, control and prevention. Iowa State University Press, Ames USA.
Huijps, K., La, T.J.G.M., Hogeveen, H. 2007. Costs of mastitis: facts and perception (in press).
Huirne, R.B.M, Saatkamp, H.W., Bergevoet, R.H.M. 2002. Economic analsysis of common health problems in dairy cattle. In: Proceedings of the XIIth World Buiatrics Congress (Kaske, Scholz & Holtershinken, eds.), 18-23 August 2002, Hannover, Germany, pp. 420-431.
Hulebak, K.L., Schlusser, W. 2002. HACCP history and conceptual overview. Risk Analysis 22 (3): 547-552.
ICMSF (International Commission on Microbiological Specifications for Foods). 1988. Microorganisms in Foods, vol. 4: Application of the hazard analysis critical control point (HACCP) system to ensure microbiological safety and quality.
IKC. 1994. Quality control in dairy farming. IKC Lelystad & Landbouwschap, The Hague, The Netherlands (in Dutch).
Institut d'Elevage. 2005a. Maladies et pratiques d"elevage en caprins: résultats d'enquêtes en région Poitou-Charente, Vendée, Maine et Loire, 6 pp. (in French).
Institut d'Elevage. 2005b. Le Bon Cornage: bien écorner les jeunes caprins. Institut de l´Elevage – Equipe Caprine Midi Pyrénées, Fiche technique. At: www.Inst-asso.fr (in French)
Institut d'Elevage. 2006a. Résultats de contrôle laitier en France 2005. Compte rendu nr. 010677002 (in French).
Institut d'Elevage. 2006b. L'année économique caprine 2005, le dossier Economie de l'Elevage, March 2006, nr. 355 (in French).

Jayarao, B.M., Henning, D.R. 2001. Prevalence of food-borne pathogens in bulk tank milk. Journal of Dairy Science 84: 2157-2162.

King, L.J. 2004. Zoonoses et agents pathogens émergants importants pour la santé publique. Les Editions du Point Vétérinaire, Maisons-Alfort, France & Revue Sci. & techn. OIE, Paris, France 23 (2) (in French).

Kingwill, R.G., Neave, F.K., Dodd, F.H., Griffin, T.K., Westgarth, D.R., Wilson, C.D. 1970. The effect of a mastitis control system on levels of clinical and subclinical mastitis in two years. The Veterinary Record 84: 94-100.

Kivaria, F.M., Noordhuizen, J.P.T.M., Kapaga, A.M. 2004. Risk indicators associated with subclinical mastitis in smallholder dairy cows in Tanzania. Tropical Animal Health & Production 36 (6): 581-592.

Kurtz, S. 2006. Teaching and learning communication in veterinary medicine. Journal of Veterinary Medical Education 33 (1): 11-19.

Lehenbauer, T.W., Oltjen, J.W. 1998. Dairy cow culling strategies: making economical culling decisions. Journal of Dairy Science 81: 264-271.

LEI-CBS. 2006. Landbouweconomisch Instituut Wageningen – Centraal Bureau voor de Statistiek 'Landbouwcijfers 2006', Table 41c, p 96; Table 22-I, p 36 (in Dutch).

Lejeune, J.T., Davis, M.A. 2004. Outbreaks of zoonotic enteric disease associated with animal exhibits. Journal of the American Veterinary Medical Association 224 (9): 1440/1445.

Lievaart, J.J., Noordhuizen, J.P.T.M., van Beek, E., van der Beek, C., van Risp, A., Schenkel, J., van Veersen, J. 2005. The hazard analysis critical control points concept as applied to some chemical, physical and microbiological contaminants of milk on dairy farms. The Veterinary Quarterly 27 (1): 21-29.

Malher, X., Vasseur, C. 1999. Les dépenses de maîtrise de la santé dans les troupeaux caprins laitiers de Vendée et de Maine-et-Loire. Bulletin des GTV 3: 209-214.

Malher, X., Beaudeau, F., Poupin, B., Falaise, G., Losdat, J. 1999. Réforme et renouvellement dans les grands troupeaux laitiers caprins de l'Ouest de la France. INRA Productions Animales 12: 123-133.

Maunsell, B., Bolton, D.J. 2004. Guidelines for food safety management on farms. Report of an International EU-RAIN workshop, Athens, Greece, May 2004. Published by TEAGASC - The National Food Centre, Dublin, Ireland.

Mayes, T. 1992. Simple users guide to the hazard analysis critical control point concept for the control of food microbiological safety. Food Control 3: 14-19.

McFadden, D. 1999. Rationality for economists? Journal of Risks & Uncertainty 19 (1-3): 73-105.

McInerney, J. 1996. Old economics for new problems – livestock disease. Journal of Agricultural Economics 46: 295-314.

McNealy, R. 1994. Making customer satisfaction happen. Chapman & Hall Publishers.

Meens, E. 2006. La relation de conseil en élevage laitier. Journée Bovine Nantaise, Nantes, France, 2006, pp. 84-91 (in French).

Meijers, S., Baerg, J. 2001. Farm accidents in children: eleven years of experience. Journal of Pediatric Surgery 36 (5): 726-729.

Mills, J.N. 1998. Question: How can we better prepare professional (veterinary) students to successfully make the transition into life in the working world (veterinary practice)? In: Black, B. and Stanley, N. (eds.), Teaching and Learning in Changing Times. Proceedings of the 7th Annual Teaching Learning Forum, The University of Western Australia, Perth, pp. 225-227.

Mohrand-Fehr, P., Broqua, C., Bas, P., Lefrileux, Y. 1996. Recommendations et stratégies alimentaires des chevrettes destinés au renouvellement du troupeau laitier. In: proceedings du Renc Rech. Ruminants 3: 211-218.

Mourits, M.C., Dijkhuizen, A.A., Huirne, R.B.M., Galligan, D.T. 1997. Technical and economic models to support heifer management decisions: basic concepts. Journal of Dairy Science 80 (7): 1406-1415.

Mulligan, F.J., O'Grady, L., Rice, D.A., Doherty, M.L. 2007. A herd health approach to dairy cow nutrition and production diseases of the transition cow. Animal Reproduction Science 96: 331-353.

Neijenhuijs, F., Barkema, H.W., Hogeveen, H., Noordhuizen, J.P.T.M. 2001. Relationship between teat end callosity and occurring of clinical mastitis. Journal of Dairy Science 84: 2664-2672.

Neijenhuijs, F., Klungel, G.H., Hogeveen, H., Noordhuizen, J.P.T.M. 2005. Machine milking risk factors for teat end callosity in dairy cows on herd level. In: Mastitis in Dairy Production, Proceedings of the 4th IDF International Mastitis Conference (H. Hogeveen, ed.), Maastricht, The Netherlands, 11-16 June 2005, Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 376-382.

NEN-EN-ISO. 2005. Voedselveiligheid managementsystemen – eisen aan een organisatie in de voedselketen, CEN 2005, Delft, The Netherlands. (ISO 22000:2005 IDT). Translated from a report of the European Committee of Normalisation, Brussels, Belgium, 2005.

Niza-Ribeiro, J. 2003. The safe use of antibiotics in dairy farms. In: Good Dairy Farming practices, Proceedings of GTEMCAL XX-th Reunion, Porto, Portugal, 24-25 October 2003, pp. 27-36.

Niza-Ribeiro, J., Noordhuizen, J.P.T.M., Menezes, J.C. 2004. Capability index: a statistical process tool in aid to udder health control in dairy herds. Journal of Dairy Science 87: 2459-2467.

Noordhuizen, J.P.T.M., Welpelo, H.J. 1996. Sustainable improvement of animal health care by systematic Quality Risk Management according to the HACCP concept. The Veterinary Quarterly 18: 121-126.

Noordhuizen, J.P.T.M., Frankena, K., Thrusfield, M., Graat, E.A.M. 2001. Applications of quantitative methods in veterinary epidemiology. Wageningen Academic Publishers, Wageningen, The Netherlands.

Noordhuizen, J.P.T.M., Muller, K.E. 2003. Large scale dairies and health management. 54th Annual Meeting of the EAAP, Rome, Italy, Aug. 31-Sept.3, 2003. Book of Abstracts. Wageningen Academic Publ., Wageningen, The Netherlands, p. 301.

Noordhuizen, J.P.T.M. 2004a. Microbiological contaminants (zoonoses). Bulletin of the International Dairy Federation 386: 10-16 (as presented at the World Dairy Summit, Bruges, Belgium, September 7-12, 2003, Proceedings, pp 523-532).

Noordhuizen, J.P.T.M. 2004b. Dairy herd health and production management practice in Europe: state of the art. Proceedings of the 23d World Buiatrics Congress, Quebec, Canada, 11-16 July 2004.

Noordhuizen, J.P.T.M., Metz, J.H.M. 2005. Quality control on dairy farms with emphasis on public health, food safety, animal health and welfare. Livestock Production Science 94 (1-2): 51-59.

Noordhuizen, J.P.T.M., Hogeveen, H. 2005. The systems approach to udder health control. In: Mastitis in Dairy Production, Proceedings of the 4th IDF International Mastitis Conference (H. Hogeveen, ed.), 551-558, Maastricht, The Netherlands, 11-16 June 2005, Wageningen Academic Publishers, Wageningen, The Netherlands.

Noordhuizen, J.P.T.M., Lievaart, J.J. 2005. Cow comfort and welfare. In: Proceedings of the 1st Swiss Buiatrics Association Meeting (A. Steiner, ed.), Bern, Switzerland, October 2005, pp. 1-12.

Noordhuizen, J.P.T.M. 2006. Veterinary advisory programmes for dairy farms: evolution and future. In: Proceedings of GTEMCAL, 19th October 2007, Barcelona, Spain.

Noordhuizen, J.P.T.M., van Egmond, M.J., van Dellen, D.K.H., Jorritsma, R., Hogeveen, H., van Werven, T., Vos, P.L.A.M., Lievaart, J.J. 2006. Veterinary advice to entrepreneur-like dairy farmers. CD ROM issued by Pfizer Animal Health, Capelle a/d IJssel, The Netherlands; also appearing on www.vacqa-international.com.

Notermans, S, Beumer, H. 2002. Microbiological concerns associated with animal feed production. In: Food safety assurance in the pre-harvest phase, Vol. 1 in the series on Food Safety Assurance & Veterinary Public Health (Smulders & Collins, eds.), Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 49-63.

Nydam, D.V., Lindergard, G., Santucci, F., Schaaf, S.L., Wade, S.E., Mohammed, H.O. 2005. Risk of infection with *Cryptosporidium parvum* and *Crytosporidium hominis* in dairy cattle in the New York City watershed. American Journal of Veterinary Research 66 (3): 413-417.

OIE (Office Internationale des Epizooties). 2004. Handbook on Import Risk Analysis for animals and animal products, Vol. 1 & 2. OIE, Paris, France.

OIE (Office Internationale des Epizooties). 2006. Guide to good farming practices for animal production food safety. Revue Scientifique et Technique OIE 25 (2): 823-836.

Oliver, S.P., Murinda, S.E., Nguyen, L.T., Nam, H.M., Almeida, R.A., Headrick, S.J. 2005. On-farm sources of foodborne pathogens: isolation from the dairy environment. In: Mastitis in Dairy Production, Proceedings of the 4th IDF International Mastitis Conference (H.Hogeveen, ed.), Maastricht, The Netherlands, 11-16 June 2005, Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 665-670.

Petrau-Gay, C. 1986. L'alimentation de la chevrette d'élevage. Thèse docteur vétérinaire, Ecole Nationale Vétérinaire de Toulouse, France, 74 pp. (in French).

Pickett, W., Brison, R.J., Berg, R.L., Zentner, J., Linneman, J., Marlenga, B. 2005. Pediatric farm injuries involving non-working children injured by a farm work hazard: five priorities for primary prevention. Injury Prevention 11: 6-11.

Pierson, M. 1995. An overview of HACCP and its application to animal production food safety. In: Proceedings of the Symposium on Hazard Analysis Critical Control Points, Conference of Research Workers in Animal Diseases, November 12, 1995, Chicago, Ill. USA.

Poncelet, J.L. 1995. Ovin lait: démarche qualité (système HACCP). Bulletin des GTV 2: 59-63 (in French).

Prater, Ph. 2003. Zoonotic diseases: the human-animal connection. The Bovine Practitioner/ AABP proceedings 36: 125-130.

Prescott, M.L., Harley, J.P., Klein, D.A. 2002. Microbiology, 5th edition, The McGraw-Hill Companies, New York, USA.

Quinn, B.P. 2001. HACCP assessment of Virginia meat and poultry processing plants. In: htpp://scholar.lib.vet.edu/theses/available/etd-12072001-111227/unrestricted/brentpart1.pdf.

Rabin, M. 1998. Psychology and Economics. Journal of Economics Literature 36 (1): 11-46.

Radostits, O.M., Blood, D.C. 1985. Herd Health (a textbook of health and production management of agricultural animals). WB Saunders Company, Philadelphia.

Radostits, O.M., Gay, C.C., Blood, D.C., Hinchcliff, K.W. 2000. Veterinary Medicine: a textbook of the diseases of cattle, sheep, pigs, goats and horses. W.B. Saunders Company Ltd.

RCVS (Royal College of Veterinary Surgeons). undated. Maintaining practice standards; London, www.rcvs.org.uk/Templates/Internal.asp?NodellD=92570&int2ndParentNodeID=89737&int1stParentNodeID=89642, last accessed on 27/04/2007.

Ricard, F. 2001. L'élevage des chevrettes de renouvellement en troupeaux caprins laitiers: analyse des dangers et maîtrise des points critiques (mis à jour bibliographique). Thèse docteur vétérinaire, Ecole Nationale Vétérinaire de Nantes, France, 115 pp. (in French).

Ryan, D. 1997. Three HACCP-based programmes for quality management in cattle in Australia. Dairy Extension, NSW, Australia. Through the Dairy Discussion List Dairy-L@UMDD.UMD.EDU.

Sanaa, M. 1994. Listeriosis and the contamination of milk and milk products. Le Point Vétérinaire, special issue on Ruminants & Public Health (M. Savey, ed.) 26: 69-78.

Savey, M. 1994. Ruminants and Public Health, special issue of Le Point Vétérinaire 26: 1-172.

Sawtooth Software Inc. 2000. Adaptive Conjoint Analysis. Evanston 311. ACA User Manual Version 5. Sawtooth Software, Inc. Sequim WA, United States.

Schermerhorn, J.R. 2005. Management. 8th edition, John Wiley & Sons, New York USA.

Schiefer, G. 1997. Total Quality Management and Quality Assurance in Agriculture and Food. In: Qualty Management and Process Improvement for Competitive Advantage in Agriculture and Food. Vol. 1, Proc. 49th seminar of the Eur. Assoc. of Agric. Econom., Bonn (G), (Schiefer & Helbig, eds.), Friedrich-Wilhelms University, Bonn Germany.

Schlundt, J., Toyofuku, H., Jansen, J., Herbst, S.A. 2004. Emerging food-borne zoonoses. Revue Scientifique et Technique OIE 23: 513-53.

Schon, H., Artmann, R., Worstorff, H. 1992. The automation of milking as a key issue in future oriented dairy farming. In: Prospects for automatic milking, Proceedings of the International Symposium, (Ipema, Lippus, Metz & Rossing, eds.), EAAP publication 65, 23-25 November 1992, Wageningen, The Netherlands, Wageningen Academic Publishers, Wageningen The Netherlands, pp. 7-22.

Schouten, J.M., Graat, E.A., Frankena, K, van de Giessen, A.W., van der Zwaluw, W.K., de Jong, M.C. 2005. A longitudinal study of *Escherichia coli* O_{157} in cattle of a Dutch dairy farm and in the farm environment. Veterinary microbiology 107 (3-4): 193-204.

Schulz von Thun, F. 1981. Störungen und Klärungen. In: Miteinander Reden – Band 1 Rowohlt Verlag, Reinbek (in German).

Shrestha, R.D., Woolderink, M., Hogeveen, H. 2007. Economic effects of ketosis on Dutch dairy farms: a stochastic Monte-Carlo simulation (in press).

Sibley, R. 2006. Developing health plans for the dairy herd. In Practice 28: 114-121.

Sol, J., Renkema, J.A., Stelwagen, J., Dijkhuizen, A.A., Brand, A. 1984. A three year herd health and management programme on 30 Dutch dairy herds. The Veterinary Quarterly 6: 141-169.

SPSS, 2001. SPSS Inc. Chicago, United States of America: http://www.spss.com/contact_us/

Steeneveld, W., Swinkels, J.M., Hogeveen, H. 2007. Stochastic modelling to evaluate the economic efficiency of treatment of chronic subclinical mastitis. Journal of Dairy Research (in press)

Stup, R. 2001. Standard Operating Procedures, a writing guide. In: htpp://dairyalliance.psu.edu/pdf/ud011.pdf.

Swinkels, J.M., Zadoks, R.N., Hogeveen, H. 2005. Use of partial budgeting to determine the economic benefits of antibiotic treatment during lactation of chronic mastitis caused by *Staphylococcus aureus*. In: Mastitis in Dairy Production, Proceedings of the 4th IDF International Mastitis Conference, Maastricht, The Netherlands, 11-16 June 2005, Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 217-224.

Tesh, V.L., O'Brien, A.D. 1991. The pathogenic mechanisms of Shiga toxin and the Shiga-like toxins. Molecular Microbiology 5 (8): 1817-1822.

Thrusfield, M. 2005. Veterinary Epidemiology, 3d edition, Blackwell Sci. Publ., Oxford, UK & Les Editions du Point Vétérinaire, Maisons-Alfort, France, 590 pp.

Thrusfield, M., Ortega, C., de Blas, I., Noordhuizen, J.P., Frankena, K. 2001. WIN-EPISCOPE: improved epidemiological software for veterinary medicine. The Veterinary Record 148: 567-572.

Thorel, MF. 1994. Mycobacterioses. Le Point Vétérinaire, special issue on Ruminants & Public Health (M. Savey, ed.) 26: 33-39.

Tompkin, R.B. 1990. The use of HACCP in the production of meat and poultry products. Journal of Food Protection 53: 795-803.

Tozer, P.R., Heinrichs, A.J. 2001. What affects the costs of raising replacement dairy heifers: a multiple component analysis. Journal of Dairy Science84 (8): 1836-1844.

Tversky, A, Kahnemann, D. 1974. Judgement under uncertainty: heuristics and biases. Science 185: 1124-1131.

Tversky, A, Kahnemann, D. 1971. Belief in the law of small numbers. Psychological Bulletin 76: 105-110.

Valeeva, N.I., Lansink, A.G., Huirne, R.B.M. 2005. Improving food safety within the dairy chain: an application of conjoint analysis. Journal of Dairy Science 88 (4): 1601-1612.

Valeeva, N.I., Lam, T.J.G.M, Hogeveen, H. 2007. Motivation of dairy farmers to improve mastitis management. Journal of Dairy Science (in press).

Van Dellen, L. 2004. Good Animal Health is paramount for farm profitability. In: proceedings Symposium GGR/KNMvD, Animal Health Service & Intervet, (in Dutch) September 14 and 15^{th}, 2004.

Van der Meulen, B, van der Velde, M. 2004. Food Safety Law in the European Union, an introduction. Wageningen Academic Publishers, Wageningen, The Netherlands.

Van Egmond, M.J., Jorritsma, R., Vos, P.L.A.M., van Werven, T., Lievaart, J.J., van Dellen, D.K.H., Noordhuizen, J.P.T.M., Hogeveen, H. 2006. The veterinarian of tomorrow (Dutch version). CD ROM issued by Pfizer Animal Health BV, Capelle aan de IJssel, The Netherlands.

Van Schaik, G., Dijkhuizen, A.A., Huirne, R.B.M., Benedictus, G. 1998. Adaptive conjoint analysis to determine perceived risk factors of farmers, veterinarians and AI technicians for introduction of BHV1 to dairy farms. Preventive Veterinary Medicine 37: 101-112.

Vos, A. 1999. Critical control points for controlling risks of introduction and transmission of *M. paratuberculosis* on dairy cattle enterprises. MSc Thesis, Wageningen Agricultural University, Wageningen, The Netherlands

Vose, D. 2000. Risk Analysis: a quantitative guide. John Wiley & Sons, Chichester UK.

Vosough Ahmadi, B., Frankena, K., Turner, J., Velthuis, A.G.J., Hogeveen, H., Huirne, R.B.M. 2007. Effectiveness of simulated interventions in reducing the estimated prevalence of *E. coli* $O_{157}H_7$ in lactating cows in dairy herds. Veterinary Research (in press).

Vosough Ahmadi, B. 2007. Cost-effectiveness of *E. coli* $O_{157}H_7$ control in the beef chain. PhD thesis at Wageningen University, Chair of Business Economics, Wageningen, The Netherlands.

Walker, D. 1990. Customer first: a strategy for quality service. Gower Publ.

Waltner-Toews, D., Martin, S.W., Meek, A.H., McMillan, I. 1986. Dairy calf management, morbidity and mortality in Ontario Holstein herds. III. Association of management with morbidity. Preventive Veterinary Medicine 4: 137-156.

Wathes, C.M., Kristensen, H.H., Aerts, J.M., Berckmans, D. 2005. Is precision livestock farming an engineer's dream or nightmare, an animal's friend or foe, and a farmer's panacea or pitfall? In: Precision Livestock Farming '05 (S. Cox, ed.), Proceedings of the ECPLF 2005, Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 33-46.

Wathes, C.M. 2007. Precision livestock farming for animal health, welfare and production. In: Proceedings of the XIII Internat. Soc. of Animal Hygiene Congress, Tartu Estonia, pp. 397-404.

Webster, A.F.M., 2001. Farm animal welfare: the five freedoms and the free market. The Veterinary Journal 161: 229-237.

Zaaijer, D., Noordhuizen, J.P.T.M. 2003. A novel scoring system for monitoring the relationship between nutritional efficiency and fertility in dairy cows. The Irish Veterinary Journal 56: 145-151.

Zadoks, R.N., Allore, H.G., Hagenaars, T.J., Barkema, H.W., Schukken, Y.H. 2002. A mathematical model of *Staphylococcus aureus* control in dairy herds. Epidemiology & Infection 129: 397-416.

Examples of software options for HACCP

- doHACCP by Norback, Ley & Associates LLC, 3022 Woodland Trail, Middleton, Wisconsin USA. www.norbackley.com
- QSA Software Ltd., PO Box 306, St.Albans, Herts AL1 3 DW, UK: HACCP software packages via www.qsa.co.uk

Website indications for possibly interesting links

- Check websites of: APHIS (USA), USDA (USA), FDA (USA), OIE, FAO, EFSA
- www.sri.bbsrc.ac.uk/news/autumn99/biosensors.htm
- Eurosurveillance: www.b3e.jussieu.fr:80/ceses/eurosurv
- Food hygiene: sable.cvm.uiuc.edu/
- Food safety: www.foodsafetynetwork.ca/food/zoonoses.htm
- Food safety: www.cdc.gov/mmwr/preview/mmwrhtml/00000412.htm
- Food safety: www.europa.eu.int/comm/food/fs/sfp
- European Food Safety Authority (EFSA): www.efsa.europa.eu/etc/mediabib/efsa/science/colloquium_series/no4_animal_diseases/1179.Par.0017.File.dat/ses_summary_report_coll4_en1.pdf
- Codex Alimentarius Commission: www.codexalimentarius.net/download/standards/357/CXG_030e.pdf
- europa.eu.int/comm/internal_market/en/goods/liability/046.pdf
- europa.eu.int/comm./publications/booklets
- WIN-EPISCOPE (public domain software on veterinary epidemiological applications): see for the various websites the paper by Thrusfield *et al.* (2001)

Acknowledgements

The editors of this book gratefully acknowledge the contribution of several authors or co-authors to (parts of) various chapters or paragraphs in this book on HACCP-like Quality Risk Management on (dairy) farms.
These colleagues are – in alphabetical order of their name – the following:

Mrs. Dr. Mariska Barten, The Netherlands (chapter 11)
Mr. Dirk van Dellen, Pfizer Animal Health, The Netherlands (chapter 13)
Dr. Ryan van Egmond, Pfizer Animal Health, The Netherlands (chapter 13)
Dr. Henk Hogeveen, Wageningen University & Utrecht University, The Netherlands (chapters 8, 13, 15)
Dr. Ruurd Jorritsma, Faculty of Veterinary Medicine, Utrecht, The Netherlands (chapter 13)
Dr. Joachim Kleen, Veterinary Faculty, Glasgow Scotland, UK (chapter 14)
Dr. Jan Lievaart, School of Veterinary and Animal Science, Charles Sturt University, Wagga Wagga, Australia (chapter 13)
Dr. Len Lipman, IRAS, Utrecht University, The Netherlands (chapter 11)
Dr. Xavier Malher, Ecole Nationale Vétérinaire de Nantes, France (chapter 12)
Dr. Joao Raposo, Portugal (chapter 11)
Mrs.Dr. Annet Velthuis, Wageningen University, The Netherlands (chapters 8, 15)
Dr. Peter Vos, Faculty of Veterinary Medicine, Utrecht, The Netherlands (chapter 13)
Mrs. Dr. Tine van Werven, Faculty of Veterinary Medicine, Utrecht, The Netherlands (chapter 13)

Many thanks for your contribution to this book and for your understanding about editors changing texts, text positions, Tables or Figures all the time…
Your support contributes to a broader dissemination of the philosophy of us editors regarding the application of HACCP-like principles in the farming business as a paramount element in the food chain quality assurance programmes.

The editors,

Jos Noordhuizen,
Joao Cannas da Silva,
Siert-Jan Boersema,
Ana Vieira.

Keyword index