

Applying the HACCP principles to selected hazards during goat kids rearing on milking goat farms in western France

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SUMMARY

The new EU hygiene regulations have suggested that primary producers (farmers) implement a HACCP-like programme to meet the demands regarding public health, animal health and welfare. The paper describes the development of a HACCP-like quality risk management programme for milking goat farms, and shows its feasibility, namely in the area of goat kid rearing using an example farm (here called Farm X or FX).

The programme development follows the formal 12 steps of HACCP development. A general production process flow diagram of a milking goat farm, as well as a detailed one regarding the specific part of goat kid rearing are supportive to the development of such a programme. After hazard identification and risk assessment, the identification of the Critical Control Points is introduced and illustrated according to the given example. Subsequently, the on-farm monitoring is addressed. The management of the HACCP programme is then presented and illustrated. It is discussed furthermore, how veterinary practitioners can play a paramount role as a coach-consultant for quality risk management programmes and support the farmer in his quality risk management activities.

Keywords: HACCP, Goat-kid rearing, Quality Risk management, Dairy goat production.

RÉSUMÉ

Application des principes de la méthode HACCP à une sélection de dangers affectant la phase d'élevage des chevrettes dans les troupeaux laitiers caprins de l'Ouest de la France

Les nouveaux règlements de l'UE suggèrent que les producteurs primaires (les éleveurs) mettent en place des programmes de type HACCP pour satisfaire la demande sociétale vis-à-vis de la santé publique ainsi que de la santé et du bien-être des animaux. L'article décrit la mise-en oeuvre d'un programme de gestion des risques de la qualité de type HACCP pour les troupeaux laitiers caprins et montre sa faisabilité dans le cas de l'élevage des chevrettes à partir d'un exemple de ferme (dénommée ici Ferme X ou FX).

La mise en oeuvre du programme suit les 12 étapes formelles de la mise en oeuvre de la méthode HACCP. Sa mise en oeuvre s'appuie sur un diagramme général du processus de production d'un élevage caprin laitier ainsi que sur celui, plus précis, de l'activité d'élevage des chevrettes de renouvellement. Après l'identification des dangers et l'évaluation de leur risque, l'identification des points critiques de maîtrise est présentée et illustrée à partir de l'exemple choisi. Dans son prolongement, un suivi pour la ferme est élaboré. La gestion du programme HACCP est ensuite présentée et illustrée. Enfin, une discussion envisage le rôle essentiel de consultant-entraîneur que pourraient jouer les praticiens dans des programmes de gestion des risques de la qualité et de soutien à l'éleveur dans ses activités de gestion des risques de la qualité.

Mots-clés : HACCP, Chevrete, Qualité, Gestion du risque, Chèvres laitières.

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 [1]. 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 [15]. In the west of France, the goat farms are rather intensified and reaching high production levels (788 kg/goat/lactation, [16]). 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 this western region, deduced from expenditures for treatment, in milking goats are listed in Table 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 [18].

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, comprise multifactorial disease entities, where risk factors in 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 domain of goat kid rearing and to the most important diseases that occur during this rearing period or might affect further productive life. There are two ways of approach: (1) developing and implementing a veterinary herd health & production management programmes focussing on operational management [4], and (2) developing and implementing a risk management programme based on the HACCP (hazard analysis critical control points) concept and principles [7, 8, 9, 21]. Comparing the two approaches was not in the scope of the paper but could be easily conducted based on the above mentioned references

Given the General Food Law (European Community regulation 178-2002) and the new Hygiene Regulations (EC 852/853/854-2004) where consumer protection is the driving force for safeguarding consumers from hazards in the areas of public health & food safety, as well as animal health & welfare in Europe, it may be worthwhile to consider the development and implementation of HACCP-like programmes

on milking goat farms. Moreover, the suggestion was already made in the EU (European Union) hygiene regulations that primary producers install a HACCP-like quality risk management programme for the elimination or reduction to an acceptable level of these hazards and their associated risks.

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– the clients*” [12]. 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 of this paper 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 X (FX). 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.

Disease 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 indications	7%	6%	5%
General hygiene measures	6%	4%	10%
Nervous disorders	5%	5%	-
Reproductive disorders	x	x	17%
Udder health	x	x	14%
Regulated prophylaxis	x	x	12%

TABLE 1: Distribution of cost elements related to disease treatment in milking goats (goat kids before and after weaning, and adults) in western France [18]. The ‘x’ means: ‘not applicable’.

The HACCP concept and principles

HACCP was originally developed in the 70’s for the NASA-USA space programme to safeguard astronauts from food-borne hazards being microbiological, physical or chemical in nature [26]. Since then it has been widely spread over the world among different food producing enterprises. It was made compulsory for European food producing and distributing companies to be implemented from January 1st, 2006. HACCP has now been incorporated into ISO 22000 (International Standardisation Organisation, 2005).

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*” [12]. It has been elaborated by NOORDHUIZEN & WELPELO [21] that the on-farm HACCP application would be the best choice, as compared to good manufacturing codes of practice and ISO-9000 series. Main reasons for such a choice were: farm-specificity, low labour input, few documentation needs, its focus on ope-

ration and tactical management, the fact that the health status and measures to improve that status were demonstrable, and that it could be linked with other parts in a Food Quality Assurance chain (hence certifiable).

The HACCP concept has 7 principles. These principles form part of the 12 developmental steps regarding a HACCP-like programme [8, 10, 17] and are listed in Table 2.

These 12 steps are the guideline for developing a quality risk management programme for goat kid rearing on an example milking goat farm in western France in the following paragraphs.

Characteristics of the example milking goat farm FX

Farm FX 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

Step (HACCP principle)	Short description of the respective step and principle
Step 1	Assemble a multidisciplinary HCCP team on the farm (e.g. farmer + veterinarian + specialist in a certain area)
Step 2	Describe the product(s) and its distribution; description of the farm premises
Step 3	Identify the intended use of the product(s) and the consumers of the product
Step 4	Develop flow diagrams of the specific farm
Step 5	Verify on-site the developed flow diagrams
Step 6 (Principle 1)	Conduct a hazard analysis to identify the most relevant ones and make an inventory of preventive measures Perform a Risk Analysis to find risks associated with these hazards
Step 7 (Principle 2)	Define of critical control points (CCP) and points of particular attention (POPA) in the context of finances and human resources
Step 8 (Principle 3)	Determine standards & tolerances for each CCP; set targets for POPAs in order to support process control; make an inventory of diagnostic options
Step 9 (Principle 4)	Establish a monitoring scheme comprising all CCP and POPA, as well as the method/test, frequency, reporting, corrective measures, and the person responsible for these actions
Step 10 (Principle 5)	Establish a plan of action comprising all corrective measures for situations where process control is lost
Step 11 (Principle 6)	Determine internal and external validation and verification procedures; when needed, define additional testing
Step 12 (Principle 7)	Install an appropriate system of recording and documentation related to previously named steps

TABLE 2: Overview of the 12 steps and 7 principles for developing a HACCP-like programme of quality risk management for goat-kid rearing on a milking goat farm (adapted after [8])

in a 2x 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 up till 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 [20]. General features, events and targets of the goat kid rearing process are schematically presented in Figure 1 (adapted after RICARD, [28]).

The farmer has the objective to provide a sufficient number of young, healthy replacement goats given the yearly culling rate of 30%. These replacements should have their first parturition in time in order to timely replace the culled ones. This means that kids must be ready for Artificial Insemination (AI) on time (between 7 and 9 month age), at an appropriate body weight (50-54% of adult weight), and a body condition score of 2.75-3.0 [20]. 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

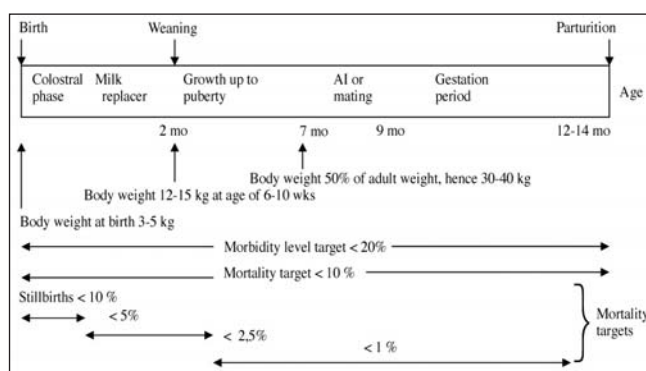


FIGURE 1: General schematic overview of the goat kid rearing period with major events and targets (adapted after [28]).

properly (e.g. synchronisation at 7 month age by intra-vaginal sponges impregnated with fluorogestone acetate (FGA) followed by an injection of eCG (equine Chorionic Gonadotrophin) to induce ovulation, and by AI or successful mating by approved bucks). The farmer may conduct 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 [25]. Growth rate target from month 4 to AI period is 50-110 g/day; from month 7 to parturition 40-50 g/day.

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 indicated in Table 3.

It is noticeable that this farmer has not the objective of marketing goat-kids. Therefore, we will not take into account

the hazards of early contamination for different specified diseases such as Caprine Arthritis Encephalitis Virus infection, paratuberculosis, mycoplasmosis which might impair the quality of these goat-kids to be marketed.

Hazard type	Category of disorders/diseases	Diagnosis of disorders/diseases	Rearing period details (age period) of highest risk
Microbiological	Respiratory disease	Enzootic pneumonia (<i>Pasteurella</i> & <i>Mycoplasma</i> spp)	After weaning
	Digestive disorders	<i>E.coli</i> diarrhoea	First week of age
		<i>Cryptosporidium</i> diarrhoea	2 nd and 3 rd weeks of age
		Ecthyma	Up to 2 months of age
	Coccidiosis	From 1 to 5 months 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 months of age	
	AI at too old age	7-9 months of age	

TABLE 3: General overview of hazard areas, disease categories, some disease diagnoses and details of the rearing period of goat kids.

Developing the HACCP-based quality risk management programme

In order to develop a HACCP-based quality risk management programme, we follow the 12 steps as listed in Table 2 (adapted after CULLOR [8]).

STEP 1, STEP 2 & STEP 3: ASSEMBLE A HACCP TEAM, DEFINE THE FARM PRODUCTS

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 of concern in a later stage (see step 6).

It is highly recommendable to design a site-map of the farm with 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* 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.

STEP 4; STEP 5: DESIGNING FLOW DIAGRAMS OF THE PRODUCTION PROCESS

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 2.

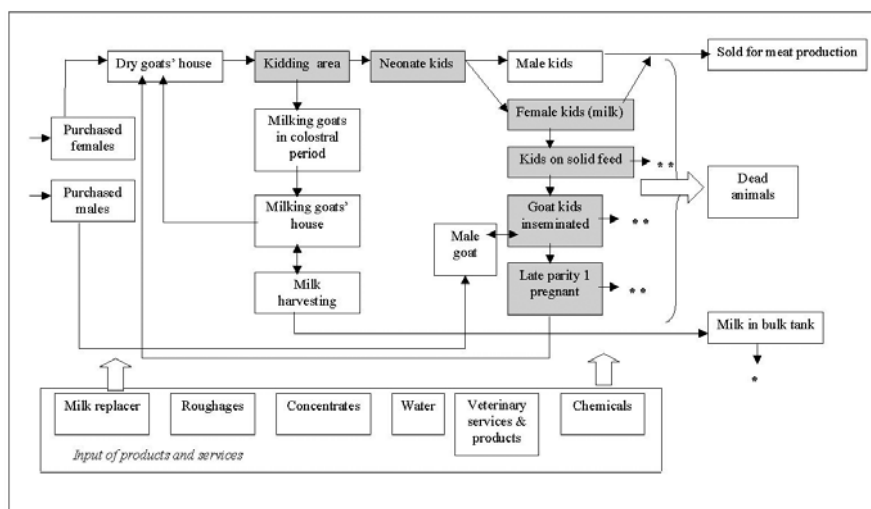


FIGURE 2: General Flow Diagram of a Milking Goat Farm (the grey areas appear in Figure 2 focussing on goat kid rearing).

* = some farms make raw milk cheese on their farm; ** = on several farms goat kids are being sold for rearing or replacement elsewhere.

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 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 3. shows a detailed flow diagram for the area of goat-kid rearing on Farm FX.

Flow diagrams have to be verified by *Team* members on-site for completeness and accuracy.

STEP 6: IDENTIFICATION OF HAZARDS, PREVAILING PREVENTIVE MEASURES AND RISK ANALYSIS

- For the particular example Farm FX we are addressing in this paper, the *Team* has to (1) 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 its 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 who might 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 at mating
 - goat kids failing to get pregnant at mating
 - goat kids bearing and transmitting infections, 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 exist like for foot-and-mouth disease, tuberculosis, brucellosis - the endemic-like respiratory diseases and ecthyma [28]. The highly contagious epidemic diseases are not dealt with in this paper.

Important chemical hazards are not identified in the present case, but one may consider residues from or contaminations by machinery oil, detergents and disinfectants.

Relevant physical hazards could be represented by the horns of the animals or poor dehorning procedure.

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 [19]. It should be born in mind that during the early rearing period a relatively low growth rate may well be caused by forenamed diseases and not by nutritional failures alone.

An overview of highly important diseases in goat-kids has been presented by CHARTIER *et al* [6] and Chambre d'agriculture des Deux-Sèvres [5].

As an example for farm FX, the most relevant diseases resorting under the forenamed hazards are listed in Table 3.

For the particular example Farm FX, the *Farm Quality Management Team* has defined the priority hazards to be addressed. The following hazards were identified by the *Team* (Table 4).

According to the 12 steps in HACCP (Table 2) the preventive measures which are currently prevailing on Farm FX have to

Hazard type	Disorders of high priority on Farm FX
Microbiological	E. coli diarrhoea in the first week of age Enzootic pneumonia
Chemical	None identified
Physical	Stress at dehorning
Managerial	Poor growth rate

TABLE 4: The major hazards on Farm FX as identified by the Farm Quality Management Team.

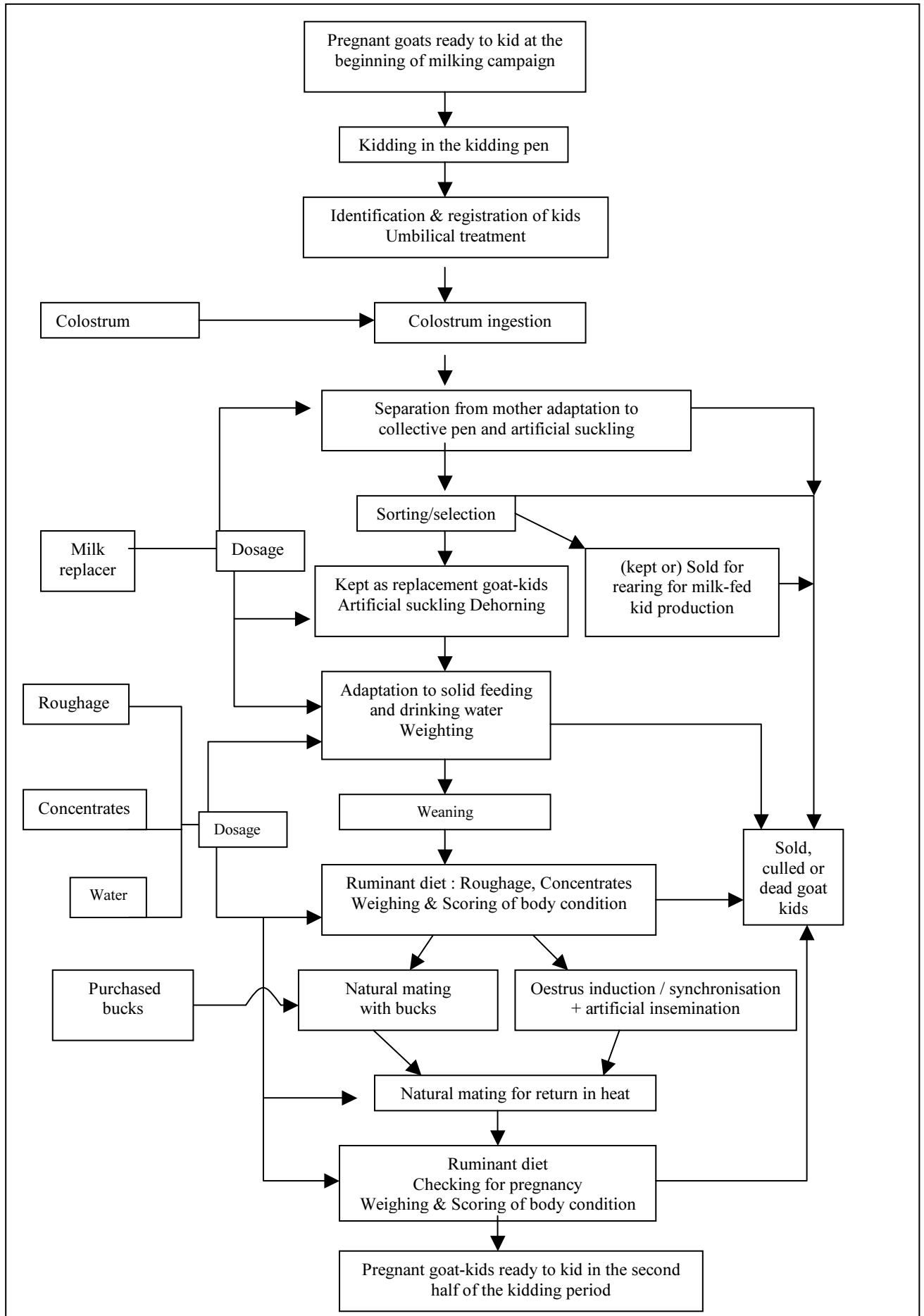


FIGURE 3: Detailed flow diagram regarding the specific part of goat kid rearing on the milking goat farm FX (an example).

be identified as well. These preventive measures have been short-listed in Table 5.

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 FX named in Table 4. The risk factors originate from literature reviewed by RICARD [28] and from regionally collected data [13] and, hence, are population-based. They have to be screened on farm FX and only those which are prevailing on this particular farm are retained.

The selected risk factors on farm FX associated with the named hazards are presented in Table 5 too.

Now that relevant risk factors for selected hazards have been identified (Table 5), the next phase is to weigh these risk factors in order to find the most relevant, true risks on farm FX.

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 [29];
3. Quantitatively, by conducting observational-analytic epidemiological field surveys [22, 30]

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 [27]:

Probability of occurrence (P) x Impact of occurrence (I) x Detection possibility (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. On a scoring scale from 1 (negligible, or probability of under 10%) via 3 (intermediate, or probability around 50%) to 5 (high level or probability near 100%) 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 (HACCP principle 1) is concluded with the identification and weighting of most relevant risk factors for the selected hazards on farm FX. The outcome is listed in Table 5 too; there have been 6 true risks defined through the process of weighing on farm FX.

Hazard type	Disorders of high priority on Farm FX	Preventive measures currently prevailing on Farm FX	Associated risk factors	Result of risk weighing (PxIxIxD) on Farm FX
Microbiological	<i>E.coli</i> diarrhoea in the first week of age	Anti-coccidial products applied routinely	Colostrum management is poor	3 x 5 x 3 = 45 true risk
		Vaccination against <i>Clostridium</i> enterotoxemia yearly	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
		Separation of replacement goat kids from kids to be sold	Automatic milk feeder adjustment is conducted infrequently	3 x 4 x 3 = 36
		Separation of goat-kids from adults until kidding	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

TABLE 5: Shortlist of hazards, disorders on Farm FX, preventive measures, risk factors and risk weighting results as related to major hazards named in Table 4. (Note that the threshold value for "weighted true risk" is set at >45).

STEP 7: CRITICAL CONTROL POINTS & POINTS OF PARTICULAR ATTENTION

In this step (HACCP principle 2) 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 [17].

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' determined the following CCP respectively POPA have been defined (Table 6) as related to the hazards determined.

As can be noticed from Table 6, the critical points on the farm 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.

STEP 8: ESTABLISH CRITICAL LIMITS, STANDARDS OR TARGETS FOR CCP AND POPA

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 FX. Therefore we handle the major hazards as defined in step 6 and presented in Table 6. These hazards were:

- *E. coli* diarrhoea
- Enzootic pneumonia (caused by *Pasteurella spp* 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 FX have also been identified (Table 6).

We have found that there are 6 POPA and no CCP (see Table 6) distinguished on farm FX. Targets can now be described. Table 6 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 [4].

STEP 9. DESIGNING THE ON-FARM MONITORING SCHEME INCLUDING CORRECTIVE MEASURES

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 6 (including corrective measures) and the monitoring items.

Checking on colostrum quality by a colostrometer should –most certainly in case of problems- be conducted by the farmer in 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.

Body weight estimations must be made by the farmer according to the schedule presented in Figure 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.

STEP 10. CORRECTIVE MEASURES

As already presented in Table 6, 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 6 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 A4 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 & FAO [11, 24]. 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 7.

STEP 11 AND 12. RECORD KEEPING AND SYSTEM VERIFICATION PROCEDURES

Like in every programme, records must be kept in programmes of quality risk management according to the HACCP concept [24]. Some of these records have already been addressed in the Figures and Tables presented in this paper. Additional to these are: a Medicine Log to record

Disorders of high priority on Farm FX	Control point	True risks defined	CCP or POPA	Standard & tolerance, or target values	Corrective measures and references
<i>E.coli</i> 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	>0.3m 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
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 670g/d of hay and 520g/ 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"

TABLE 6: Overview of identified priority disorders on Farm FX, control points, weighted risk factors, CCP or POPA identification, Standard & tolerance values or Target values, and corrective measures.

–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 teams. Only when farm certification, as part of a whole Food Chain Quality Assurance system, is warranted, such a farm-status certification is necessary.

Discussion and conclusions

This paper has been conceived to show that the application of the HACCP concept and principles is feasible at milking goat farm level. 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 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

Farm code:..... Date of last revision: Author:

Responsible person(s) for execution:

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° at 5 d. old (IR lamp may be provided). From 16°C to 10 °C after	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

TABLE 7: Working instruction for Climate Control in Neonatal Goat-kid barns, and frequency of checking, X refers to general lay-out and barn design principles.

beforehand. The corrective measures, for example, will commonly be weighted and discussed once a problem has arisen during a herd health & production management programme, while in quality risk management programmes they have been described already. In that way, a cost—benefit assessment of such measures has already taken place. 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” [14]. They feel better prepared to deal with problems once they are pending [3]. 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 are 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 paper closely relates to the initiative that has been taken by

ANICAP [2] 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 & FAO [24, 11]. 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 HACCP concept and principles, communicative skills, marketing and business administration, farm management, entrepreneurship, and farm economics [23]. Then, they would be able to function as coach—consultant for quality risk management on the three EU indicated domains on these farms.

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