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A COMPREHENSIVE SYSTEM FOR MANAGING REPRODUCTIVE FAILURE IN SMALL DOMESTIC RUMINANTS

by

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ABSTRACT

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The Hazard Analysis and Critical Control Point (HACCP) system was used as a basis for describing a methodology for the management of reproduction in small ruminant flocks. The seven principles of the HACCP system are:

1. Conduct a hazard analysis
2. Identify critical control points
3. Establish critical limits for each control point
4. Establish monitoring procedure
5. Establish corrective actions
6. Establish a record keeping procedure
7. Establish verification procedures.

The first principle of HACCP requires a description of the production system. The small ruminant reproduction process was subdivided into four sub-processes with a total of 33 phases. The ewe management cycle consists of 12 phases and the ram management cycle, replacement ewe cycle and replacement ram cycle each consists of seven phases.

The reproductive process was described by a flow diagram. The hazards were categorized as management, environmental, nutritional, genetic, predatory, physiological and disease factors that could affect reproductive performance.

The second principle requires the establishment of Critical Control Points (CCP). Seventeen CCPs in the reproductive process were established and monitoring and diagnostic procedures for each of the

critical control points was described together with suggested corrective actions. The resulting HACCP plan formed the basis of consultations with 30 commercial small stock enterprises.

Each of the Critical Control Points was applied to at least three and up to 30 of the flocks over the period of the trial to establish the practicality and validity of the procedures which were described as standard operating procedures. Data forms were designed for the structured collection of data regarding the process as well as the CCPs.

The Critical Control Points and forms that were selected in this project were as follows:

- CC1. Ewe selection. Prior to Ewe preparation. Ewe selection data form
- CC2.Ram selection. Prior to Phase two of ram preparation. Ram selection data form
- CC3. Ewe preparation. Prior to start of mating (end of flushing period). Ewe preparation data form
- CC4. Ram preparation. Prior start of mating (end of flushing period). Ram preparation data form
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- CC11. Marking. After neonatal period. Marking data form
- CC12. Weaning. Separation of lambs from ewes. Weaning data form
- CC13. Ewe replacement. At ewe selection. Replacement maiden data form
- CC14. Ram replacement. At ram selection. Replacement ram data form
- CC15. Genital soundness. Prior to ram selection. Ram genital soundness data form
- CC 16. Ram recovery. About 8 weeks after mating. Ram recovery data form
- CC17. Last day of lambing. About 146 days after end of joining. Last day of lambing data form.

In addition to the specific procedures described in the seventeen CCP's three CCP's were described that can be performed to assist in monitoring the general health and welfare of the flock at strategic points in the management cycle:

- CC 18 Body condition score
- CC 19 Helminthic status
- CC 20 Nutritional status.

Qualitative aspects of the critical control point as well as certain quality control questions were described as a generic quality control form. This generic form is modified annually to reflect hazard issues that need to be followed up the following year. Specific questions are entered on the form which is diarised for the next year. The use of these generic forms assisted in the process of continuous improvement by ensuring that adjustments to the Flock Health and Production Plan are made to prevent repeating management failures.

Examples of the use of the CCP's are described on the basis of data that was collected from the flocks that participated in the project.

Upon conclusion a questionnaire was completed by 12/25 of the flock managers who participated. The results of the survey indicated that there was general acceptance of a HACCP – based management system for the management of reproduction in the small ruminant enterprises by the flock managers that responded to the questionnaire. Flock managers agreed that the program must be adapted to their individual needs, would not be a problem to implement but needed to be simple and many would need assistance. Training and information was considered important aspects. There was general consensus that financial results should form part of the program and that comparisons within the group on an anonymous basis is accepted. The two responses that showed the least variance were the needs to reduce production risk and to be informed of potential hazards. Flock managers disagreed the most in their response about the range of control points they would implement. This correlates with the expressed need to have individually adapted programs. Flock managers were not very positive about the benefits of a quality control and certification system. Predation proved to be the most important hazard followed by parasites and stock theft, all three being highly variable as indicated by a large variance.

The HACCP-based methodology should be applied in and extended form to all aspects of the flock production system to assist in improving sustainability.

Keywords: Small ruminant, reproduction, sheep, goats, HACCP, critical control points, sustainability, quality control, continuous improvement, hazards.

CHAPTER 1

INTRODUCTION

1.1 Overview

Reproductive success is the single most important factor determining the sustainability of a small ruminant enterprise (Radostits, Leslie & Fetrow 1994).

In the United Kingdom, where, according to Barlow *et al.* (1987) "it is well established that peri-natal lamb mortality is a source of serious loss to the sheep industry", losses amount to 15% and more. Haughey (1986) stated that peri-natal lamb losses in Australia and New Zealand were on average 25% and 15% with figures as high as 45% in certain flocks.

Hugo (1966) was of the opinion that the ability of the small stock breeds in South Africa to reproduce was at a much lower level than that of the same breed in other countries and that fertility was gradually declining. The important link between profitable livestock production and reproductive success was already of primary concern 40 years ago.

In South Africa it was estimated that the average weaning percentage may be as low as 75% in Merino sheep (De Klerk, Düvel & Terblanche 1983). A large number of sheep farmers do not produce an adequate number of replacement ewes to allow selection of superior breeding stock. In Angora goats it was found that less than 50% of 2-tooth does weaned a kid (Terblanche 1988).

The problem of peri-natal lamb losses is therefore well documented. It is, however, a complex problem and needs a holistic intervention for meaningful progress to be made. Although many investigators have described the multitude of etiological factors and possible solutions, comprehensive formal diagnostic and management approaches to the problem are lacking (Purvis, Kirby, Ostler, Baxter & Bishop 1985; Haughey 1986; Barlow, Gardiner, Angus, Gilmour, Mellor, Cuthbertson, Newlands & Thompson 1987; Radostits et al 1994).

Low conception rates pose a challenge to consultants because the problem is encountered months after the actual event (Morley 1994). The advent of ultrasound pregnancy diagnosis has shortened this period and made it possible to establish a more accurate determination of the time the actual reproductive failure occurred.

This study investigated a number of management and related disciplines with the purpose of developing a practical and effective methodology for managing reproductive failure in sheep and goats.

The aim of this study was to design a systematic methodology, which will formalize the record keeping, data collection, diagnostic backup and analysis to enable cost-effective and practical corrective measures to address reproductive failure in small ruminants. The project was named the HAMMER project (HACCP-based Management Methodology for Ewe Reproduction).

1.2 Objectives of this study

The objective of this study was to review veterinary and animal production literature on reproductive failure and to investigate applicable management and related disciplines with the purpose of:

1. Creating a diagnostic methodology for the investigation of reproductive failure in extensive small ruminant enterprises.

2. Testing this diagnostic methodology on at least 20 flocks experiencing varying degrees of reproductive failure.

3. Developing a methodology for managing reproductive failure in small ruminants.

4. Evaluating the effect of the management proposals on the reproductive performance and general sustainability of the flocks mentioned above.

5. Evaluating the acceptance by the participating farmers by means of a survey which will be designed during phase one of the study.

6. Making a manual, describing the comprehensive system available to consultants.

1.3 Problem statement

Reproductive failure and in particular peri-natal lamb and kid losses have a devastating economic impact on sheep and goat farmers, especially in the Merino sheep breed and the Angora goat breed. Losses of 20% from scanning to weaning may commonly be found. Many causes are assumed but very often little investigative work is done to confirm and quantify these causes so that corrective measures can be implemented. Farmers only become aware of the loss at the time of weaning, which makes retrospective diagnoses difficult or impossible.

In spite of the major importance of these losses, a systematic, comprehensive, practical and effective method of investigation, leading to correct diagnosis and appropriate remedial action, is lacking.

CHAPTER 2

LITERATURE REVIEW

2.1 Techniques for investigating reproductive failure

No suitable formal definition of overall reproductive failure was found in the literature. Failure to conceive, foetal losses and peri-natal problems are usually the target of investigations.

For the purpose of this study reproductive failure is defined as:
"*The inability of a small ruminant production system to meet management's goals for the number of offspring for replacement and marketing in a given period*."

Examples of investigations into the causes of lamb mortality in specific flocks can readily be found in veterinary literature (Turner & Dolling 1965; Johnston, Maclachlan & Murray 1980; Purvis et al 1985; Barlow et al 1987). The results of surveys on specific aspects of reproductive problems have been published (Thomas 1990). A comprehensive study on reproductive wastage in 12 flocks in New South Wales, Australia (Plant 1981a) described a methodology for the investigation of reproductive failure. It provides a useful basis for this study.

Plant (1981b) subdivided the "ewe infertility syndrome" into seven components:
1. The failure of the ewe to come into oestrus (anoestrus).
2. The failure of the ram to inseminate the ewe.
3. The failure of fertilisation, with the ewe returning to service in 17 days.
4. The failure of fertilisation, where the ewe does not return to service within the joining period.
5. Fertilisation occurs, but the ovulation rate is low.
6. Early embryonic death with the ewe returning to service at the next cycle.
7. Delayed or late embryonic death with the ewe having a prolonged return to service interval or failing to return to service.

This study is a valuable example of a systematic analysis of a subsection of the reproductive process.

Everett-Hicks and co-workers (2004) described methods for maternal behaviour score and its application in selection programmes. Thompson (1990a) provided details of investigations into low kidding percentages of fibre goats, providing an example of a questionnaire and nine case studies.

A study on clinical, biochemical and pathological parameters in the peri-natal period was done on a flock in Scotland by Barlow et al. (1987). Criteria for various parameters are given with abnormalities defined as variations of one standard deviation above or below the mean.

Causes of death were categorized as:

A. Placental insufficiency
B. Acute intra-partum hypoxemia
C. Inadequate thermogenesis
D. Starvation
E. No diagnosis

Quinlivan (1980) briefly described a methodology for investigating poor reproductive performance in flocks. It provides a practical approach but lacks structure. Eales *et al.* (1986) implemented a system for recording lamb mortality in an attempt to improve flock management. A simple form that is rubber-stamped into the herdsman's pocket book is described and some of the preliminary results analysed and discussed. Brand *et al.* (1995) described the management structure of a dairy farm that serves as an example of how the reproductive process in flocks can be analysed.

2.2 Documented causes of reproductive failure (hazards)

South African farmers suffer increasingly from losses of mature and young sheep and goats resulting from predation and theft (Snyman 2007). Losses resulting from theft are included in the category of predation in this study.

Husbandry plays a pivotal role in the success of reproduction in a flock. Climate, topography, breed, behaviour, economics, culture, predators and a host of other factors influence the husbandry techniques employed in managing reproduction (Austin 1943; Fraser 1954; Hugo 1966; Haughey 1986; Holmes 1986; Kimberling 1988; Radostits et al 1994; Van Tonder 1994).

The influence of the age of the dam on reproductive performance in the Australian Merino is described by Turner & Dolling (1965).

Nutrition, toxicology and metabolic diseases as cause of reproductive failure has been extensively investigated and reported (Cowan, Robinson, Mchattie & Pennie 1981; Plant 1981a; Haughey 1986; Dennis 1986; De Wet & Bath 1994; Boland, Brophy, Callan, Quinn, Nowakowski & Crosby 2005; Radostits, Gay, Hinchcliff & Constable 2007).

Genetic aspects of reproductive failure in general are very important in the corrective steps to be taken in improving reproduction (Cloete 1939; Austin 1943; Rae 1986). Specific genetic conditions are not an important part of the problem but examples of specific defects are well documented (Hugo 1966; Haughey 1986; Dennis 1986; Baxendell 1990; Radostits et al 2007).

Infectious causes of reproductive failure are comprehensively dealt with in various publications and are mentioned in the methodology at the appropriate phase of the process (Wilkinson 1981; Plant 1981a; Rahaley 1984; Haughey 1986; Fielden 1986; Smith 1986; Kimberling 1988; Baxendell 1990; De Wet & Bath 1994; Darrel, Rankins, Ruffin & Pugh 2002; Coetzer & Tustin 2004; Radostits et al 2007).

2.3 The HACCP system

2.3.1 Introduction

Hazard Analysis and Critical Control Points (HACCP) is a systematic preventative approach to food safety that addresses physical, chemical and biological hazards as a means of prevention rather than finished product inspection. HACCP is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCP's) can be taken to reduce or eliminate the risk of the hazards being realized. The system is used at all stages of food production and preparation processes (Codex Alimentatius Commission of the Food and Agricultural Organisation & World Health Organisation 2003).

Today HACCP is applied to industries other than food, such as cosmetics and pharmaceuticals. This method, which in effect seeks to plan out unsafe practices, differs from traditional "produce and test" quality assurance methods, which are less successful and inappropriate for highly perishable foods (Wikipedia Online Encyclopedia www.wikipedia.com).

HACCP originated when the National Aeronautics and Space Administration (NASA) of the United States of America approached H.E.E. Bauman of the Pillsbury company to design a system for ensuring the safety of foods to be used in NASA's space program .

Although all references to the HACCP methodology mention food and related products as the field of application the seven principles which form the basis of the methodology can be applied to livestock production. HACCP-like methodology has been described in organic egg production (Hegelund & Sørensen 2007), dairy farms (Bell, Bell, Knowles, Whay, Main & Webster 2009), organic pig production (Bonde & Sørensen 2004) and industry-wide beef, sheep and goat production (Horchner, Brett, Gormley, Jenson & Pointon 2006).

The internationally recognized Hazard Analysis Critical Control Point (HACCP) system is widely applied in the food industry as a management system to ensure food safety. It has been adapted to a number of other related industries. A generic HACCP plan will be described for a small ruminant production system where objective of food safety will be replaced by reproductive efficiency and food hazards is replaced by reproduction hazard. A system where both male and female replacement animals are produced on the farm forms the basis of the plan. The practise of sourcing male and females from outside the system is mentioned briefly as this is a common practice in small ruminant farming in South Africa.

The current standard source for HACCP is the Codex Alimentarius Commission (CAC), a commission of the Food and Agricultural Organization (FAO) and the World Health Organisation (WHO) of the United nations (UN). The CAC adopted a Recommended Code of Practice- General Principles of Food Hygiene (CAC/RCP) in 1997 which has been revised four times. The current revision was completed in 2003 and is referred to as CAC/RCP1-1969, Rev. 4-2003. This document sets the standards for food production internationally and is widely adopted by governments and standards organisations. (Codex Alimentatius Commission of the Food and Agricultural Organisation & World Health Organisation 2003).

The CAC/RCP defines HACCP as: "A system which identifies, evaluates and controls hazards which are significant for food safety". The small ruminant HACCP based methodology for managing ewe reproduction (HAMMER) can likewise be defined as: A system which identifies, evaluates and controls hazards which are significant for efficient reproduction. Efficient reproduction has been defined above as: "*The ability of a small ruminant production system to meet management's goals for the number of offspring for replacement and marketing in a given period*."

The HACCP system has seven principles that guide the application in a generic way. It does not prescribe any technical detail but provides the framework for an operation or production unit to set its own standards and apply them. The seven principles of the HACCP system are listed in Table 2.3.1.

Table 2.3.1. The Seven Principles of the HACCP system

Principle number	Description
1	Conduct a hazard analysis
2	Identify critical control points
3	Establish critical limits for each control point
4	Establish monitoring procedure
5	Establish corrective actions
6	Establish a record keeping procedure
7	Establish verification procedures

2.3.2 HACCP Principle 1: Conduct a Hazard Analysis

The Codex Alimentarius Commission's Hazard Analysis and Critical Control Point System and Guidelines for its Application defines hazard analysis as: "The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addresses in the HACCP plan." A hazard is defined as "A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect." Principle one can be reformulated for a small ruminant production system as follows: Hazard analysis is the process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant threats to reproduction and should be addressed in the HACCP plan. A hazard is defined as a potential threat to reproduction caused by diseases, management, genetics, normal physiology and behaviour (functional), nutrition, predation (including stock theft) and climatic events.

A prerequisite for a hazard analysis is the description of the production system. This is described by means of a flow diagram which is "A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item." In small ruminant reproduction the hazard analysis is based on a process flow analysis (PFA) which is a systematic representation of the sequence of phases that make up the sub-processes of the flock reproduction process as well as the interrelationship of the sub-processes.

The use of the words "ewe" and "ram" includes the female (doe) and male (buck) of the goat species in the discussion that follows unless specified otherwise.

2.3.2.1 Process Flow Analysis (PFA)

A review of literature on small ruminant flock health and production management provided the basis for a process flow analysis. The justification for each phase will be discussed individually. The main process of Flock Reproduction is divided into four sub-processes as listed in Table 2.3.2.1.a.

Table 2.3.2.1.a. The Small Ruminant Reproduction Process

Category	**Description**	**Phase numbers**
Main process:	Flock Reproduction	
Sub-processes:	1. Ewe management cycle	E1 – E12 (12 phases)
	2. Ram management cycle	R1 – R7 (7 phases)
	3. Replacement ewe cycle	F1 – F7 (7 phases)
	4. Replacement ram cycle	M1 – M7 (7 phases)

The process of reproduction consists of four related cycles. These cycles are continuous and repeat themselves, most commonly on an annual basis, although shorter cycles are practised on small ruminant production farms. These shorter cycles are briefly described. The evolution of the visual representation of the process of reproduction (Figure 1) was based on the application of the rich picture concept as described by Daellenbach (1994).

The ewe management cycle starts at the selection of the flock for reproduction and ends with a rest period. The replacement ewe cycle starts with the neonate and ends with the maturing period prior to introducing the replacement ewes to the breeding flock.

The ram management cycle starts at the selection of the flock of rams for mating to the ewes and ends with the preliminary preparation phase after a rest period. The replacement ram cycle starts with the neonate and ends with the maturing period prior to introducing the replacement rams tot the ram flock.

The mating period provides the link between the ewe and ram cycles. This generic Process Flow Analysis can be adapted to a specific small ruminant production system. The Process Flow Analysis is represented in Figure 1.

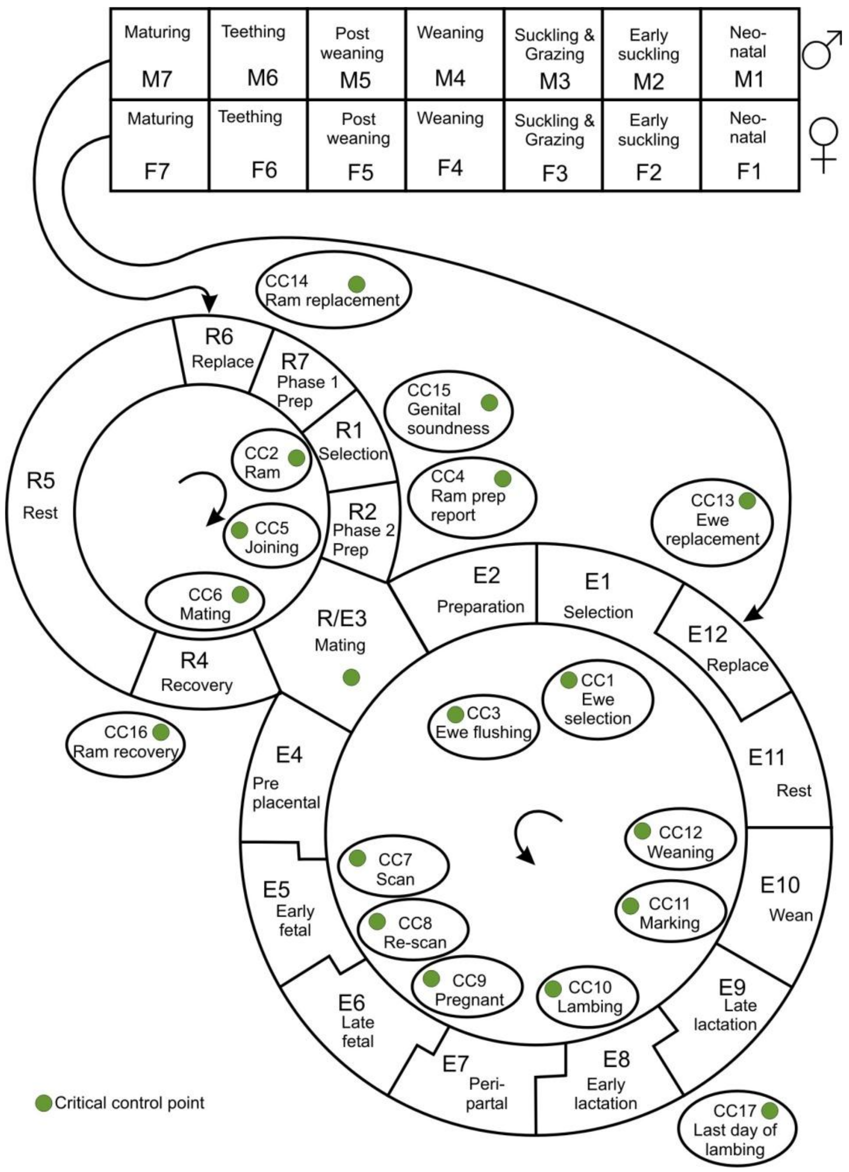

Figure 1. Process Flow Analysis for Small Ruminant Reproduction

The phases of the reproductive process are managed by the flock manager (FM) but the flock health and production consultant (FHPC) may assist in data processing and analysis. Critical control points are mostly performed or closely managed by the FHPC. The criteria used in describing each of the 33 phases of the reproductive process are described in Table 2.3.2.1.b.

Table 2.3.2.1.b. Description criteria for the phases of the small ruminant reproductive process

Phase subheading	**Descriptive criteria**
1. Description	What happens? Why should it happen?
2. Objectives	What outcomes are expected?
3. Key activities	What are the duties of the flock master? Checklist of activities.
4. Timing	When is it done? What precedes it? What follows? Does it coincide with other phases? How long does it take?
5. Records	What data has to be recorded? Data forms.
6. Hazards	What can go wrong? What can be done to prevent it?
7. Nutrition	What are the key issues What are the nutritional requirements?

The generic management objectives of each phase are to:

- Identify current and potential hazards to reproduction
- Assess the potential risk
- Perform a cost-benefit analysis
- Implement preventative control measures if financially viable to reduce or eradicate the hazard.

2.3.2.2 Hazards

A catalogue of typical hazards was compiled for each of the categories for a few phases of the cycle as examples. The categories of hazards are presented in Table 2.3.2.2.

Table 2.3.2.2. Hazard Categories

No	Hazard Category	Category Abbreviation
1	Diseases	D
2	Management	M
3	Genetics	G
4	Functional	F
5	Nutrition	N
6	Predation	P
7	Climatic	C

The information recorded for each hazard is: Description, Cause, Diagnosis, Prevention and Reference. Very few hazards are restricted to only one phase of the reproductive cycle. The hazards that do show a tendency to affect one phase of the cycle are recorded for that cycle. Hazards with a wider range of effect are recorded at the appropriate level of abstraction for example the ewe cycle, the ram cycle or both adult cycles. A very large number of hazards potentially affect all aspects of the reproductive cycle.

The hazards are defined as follows:

- Disease hazards. All biological, chemical and physical hazards that could lead to pathological changes in the male, female or lamb and result in reproduction failure.
- Management hazards. All human interventions or lack thereof that could result in reproduction failure.
- Genetic hazards. All traits, lethal and sub-lethal genes that could result in reproduction failure.
- Functional hazards. All physiological, behavioural or anatomical causes of reproduction failure. These hazards are not associated with pathological changes.
- Nutritional hazards. Deficiencies, imbalances and excesses in nutrition that could result in reproduction failure.
- Predation hazards. Death, injury, stress or disturbance caused by predators that could lead to reproduction failure. Theft and disappearance is included.
- Climatic hazards. Extreme heat, extreme cold, wind, precipitation and radiation that could result in reproduction failure.

2.3.3 HACCP Principle 2: Identify Critical Control Points

The establishment of Critical Control Points (CCP) is the second principle of the HACCP system. The Codex Alimentarius Commission's Hazard Analysis and Critical Control Point System and

Guidelines for its Application defines a CCP as: "A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level". In food production a critical control point is determined to eliminate a specific hazard. In a small ruminant production system a critical control point is established to address a group of hazards to reproduction.

2.3.4 HACCP Principle 3: Establish Critical Limits

Literature abounds with suggested levels for production parameters. These levels vary according to breed, environment and management system. The role of the Flock Health Consultant is to assess the current levels of performance and set targets in consultation with the Flock Manager on an on-going basis in the light of identified hazards and the potential for overcoming these hazards. These recommendations should be sensitive to biological and financial realities and management skills available.

2.3.5 HACCP Principle 4: Establish Monitoring Procedure

The Codex Alimentarius Commission's Hazard Analysis and Critical Control Point System and Guidelines for its Application defines monitoring as: "The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a critical control point is under control."

A collection of data forms for each critical control point was designed for use of the principle in livestock. A number of forms are of a general nature and should be completed monthly. These forms are attached as Addendum B:PC1 - PC4 The data recorded is kept as a record of the Flock Health & Production Plan and summarised as parameters.

A comprehensive list of parameters for describing the small ruminant reproductive cycle was compiled from literature and experience and is described in Addendum A2. Only 50 parameters are presented as an example. Further parameters may be added as required to suit each flock's unique management requirements.

2.3.6 HACCP Principle 5: Establish Corrective Actions

Where targets are not met, corrective actions are instituted by incorporation into the Flock Health and Production Plan (FHPP) as well as changes to the Data forms and Questionnaires.

2.3.7 HACCP Principle 6: Establish a Record Keeping Procedure

The records that were collected during the various phases and critical control points provide the inputs for an annual production report. The complete set of records that forms part of the HACCP plan are described in Addendum B

2.3.8 HACCP Principle 7: Establish Verification Procedures

2.3.8.1 Validation

Validation is the process of establishing whether monitoring procedures and control measures are effective in measuring correctly, reflecting the true state of affairs.

2.3.8.2 On-going verification

On-going verification is the process of ensuring that the data that was collected is correct.

2.3.8.3 Annual reassessment.

The Flock Health & Production Plan should be revised on an annual basis based on the comments and suggestions entered in the questionnaire.

2.4 Systems Science

Systems Science is a management science, which facilitates dealing with complexity. It creates a framework for the application of other sciences (Flood & Carson 1993; Daellenbach 1994). This study applied systems methodologies to gain an understanding of the reproductive process and describe it.

2.5 Herd Health Management

Herd health management has become a discipline in the veterinary profession with growing recognition in the fields of food animal production (Radostits et al 1994).

The following definition of herd health management is proposed: "*The holistic, pro-active management process of a group of animals to ensure sustainable production*."

The comprehensive system that results from this study includes most of the flock health management services provided by veterinarians.

2.6 Holistic Management™

Holistic Management™ or, as previously known, Holistic Resource Management, is an often controversial framework for decision-making especially in the farming sector. It considers humans, their economic activity and the environment as inseparable. The heart of the system is a testing system which asks seven basic questions about every activity or decision, forcing the decision-maker to consider social, economic and environmental aspects, both in short-term and in the long term. It has an increasing following in Southern Africa and forms the basis of farm management plans of many livestock producers (Savoury & Butterfield 1999). This approach to farm management provides insights into holistic thinking, which is incorporated into the comprehensive system.

2.7 Principles of sustainability of land use

A framework for evaluating sustainable management was developed by an International Working Group (IWG) as a recommended procedure by which sustainability of current and alternative land-use systems could be assessed. This group was composed of all major role players such as the World Bank and the Food and Agricultural Organisation (FAO) of the United Nations. The IWG defined sustainability as follows:

"Sustainable land management combines technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously:

- maintain or enhance production/services (Productivity)
- reduce levels of production risk (Security)
- protect the quality/potential of natural resources and prevent soil and water degradation (Protection)
- be economically viable (Viability)
- be socially acceptable (Acceptability)" (Smythe & Dumanski 1995).

The principles of sustainability will be considered as important guidelines for the implementation of corrective actions in the management of reproduction failure.

2.8 Quality management principles

Total Quality Management (TQM) is defined as: "Managing the entire organization so that it excels on all dimensions of products and services that are important to the customer" (Jacobs & Chase 2011).

Various systems of quality control exist in leading industries, both manufacturing and services companies. The recognized international standard is the ISO9000 standard.

ISO9000 is a series of standards agreed upon by the International Organization for Standardization and adopted in 1987. It is periodically revised and ISO9000:2008 is the current version. The ISO9000 standards consists of elements or subsections each relating to an aspect of the system's operation and how it is performing. The ISO9000 is intentionally vague. A user interprets the requirements as they relate to his or her business. It is a framework for assessing where the business stands and where it should be. It basically documents the processes and then facilitates implementing what has been documented (Jacobs & Chase 2011).

2.9 Theory of constraints (TOC)

This management philosophy is the result of the work of Goldrath and although it was designed for the manufacturing environment, it provides a valuable insight in dealing with complex production problems where certain processes are limiting (Jacobs & Chase 2011). The most applicable principle of the theory of constraints is the rule that any management effort aimed at any process other than the most limiting process (the bottle-neck) is wasted until the limitation has been addressed.

2.10 The "Clean, Green and Ethical" approach to small ruminant management

Consumers in the developed world are increasingly demanding that animal production should be free of chemicals (clean), environmentally friendly (green) and respectful of animal rights and welfare (ethical) (Martin & Croker 2006).

The principles described above (2.7 to 2.10) are incorporated in the HAMMER methodology.

CHAPTER 3

THE HACCP PLAN FOR SMALL RUMINANT PRODUCTION

3.1 Introduction

HACCP principle 1 (Conduct a hazard analysis) requires that a process flow analysis is performed as a subsection of the Hazard Analysis. This is defined as: "A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item." In small ruminant production terminology it can be re-defined as: "*A systematic representation of the cycles, sub-cycles and phases of the flock production process*."

The flock health and production plan (FHPP) is the backbone of the flock business plan. A pre-requisite of a successful small ruminant production system is the drafting of this FHPP. The flock health and production consultant (FHPC) assists the flock manager in drafting the plan that is specific for the flock based on previous experience. This plan describes the role of the flock manager as well as the contribution of the FHPC. The latter contribution will be described when HACCP principle 2 (Identify critical control points) is discussed.

HACCP principles 3 to 7 forms part of the FHPP and the discussion that follows:

- Establish critical limits for each control point
- Establish monitoring procedure
- Establish corrective actions
- Establish a record keeping procedure
- Establish verification procedures.

3.2 Subprocess 1. Ewe Management Cycle

3.2.1 Subprocess 1. Ewe management cycle – general principles

The ewe management cycle is a periodic repetition of mating, pregnancy and rest with old females being removed from the ewe flock and replacement maiden ewes being added. The ewe management cycle has been subdivided into twelve phases for the purpose of this study. It may be necessary to change the subdivisions as indicated by local conditions on a specific small ruminant farm. The length, frequency and timing of the ewe management cycle is an important determinant of the structure of the flock management plan (FMP).

Ward (1986) describes the 35th degree of latitude north and south as the limit to all-season breeding. In temperate climatic zones sheep and goats lamb once every 12 months and the breeding season usually coincides with a decrease in day-length. This results in lambs being born in spring when pastures provide nutrition for the high demands of lactation. Harsh environments usually prevent ewe management cycles that are shorter than one year. The phenomenon of seasonal anoestrus in certain breeds likewise dictates that mating can take place only once a year. In the tropical climatic zones the effect of photoperiodicity is lost as a result of the reduced variation in day length. High ambient temperatures and seasonal droughts with reduced availability of feed result in restricted breeding activity (Hafez & Hafez 2008).

Where the breed characteristics, day length and the climate allow a shorter cycle the ewe management cycle can be reduced to as little as 6 months although it is seldom sustainable. Various systems are practised and described in the literature. The most common accelerated lambing systems are listed in Table 3.2.1.a, with the relative advantage over a system of weaning a single lamb per ewe per year.

Table 3.2.1.a. Accelerated lambing systems

Mating Periods (p.a.)	**Lambing system**	**Relative advantage**
1	Annual	1.00
2	Six-monthly	2.00
3	Eight-monthly (3 times in 2 years)	1.50
3	Eight-monthly dual flock (2-3 times in 2 years)	1.00 – 1.50
4	Nine-monthly (4 times in 3 years)	1.33
5	STAR (5 times in 3 years)	1.67
6	CAMAL (2 to 4 times in 2 years)	1.00 – 2.00

3.2.1.1 Annual system:

Ewes are mated once a year in spring, summer or autumn. Ewes that fail to conceive may be re-mated in less than 12 months but ewes that do lamb are mated again one year later. Gestation is slightly less than 5 months, lactation lasts up to 4 months leaving a three month period of recovery. Ewes can build up adequate adipose reserves if nutrition allows and twinning rate is usually higher in this system than any other mating system.

The advantages of an annual ewe management cycle:

- Production levels of pastures supports the peak nutritional need.

- Higher ovulation rates and higher lambing percentage if mating coincides with the natural peak of seasonal breeding activity.
- Management efforts required for lambing time can be better managed.
- Slow maturing breeds may benefit from the prolonged lag time before maiden ewes are mated the first time.
- Seasonal incidence of parasites and disease can be better managed.

Disadvantages of an annual ewe management cycle:

- Climate hazards are concentrated on a single period.
- More rams are needed.
- Labour requirements are concentrated in one period.
- High number of twin and triplet lambs increases dependence on purchased feeds.
- Cash flow is erratic.
- Markets are oversupplied resulting in lower prices.
- Lower rate of genetic progress than in accelerated systems if the generation interval is longer.
- The prolonged lag time before maiden ewes are mated can be considered wasted.
- Peak lactation (with the negative energy balance) coincides with the onset of the follicle wave that will be mature in the following mating period. Severe malnutrition may have a negative effect on conception rates in the following season.

3.2.1.2 Six-monthly system:

Ewes are re-mated approximately 30 days after the lambing period started. Ewes reach peak lactation and therefore the peak energy deficit at about 21 days post lambing. During lactation there is also an inhibitory effect of prolactin on the secretion of follicle stimulating hormone (FSH) and luteinising hormone (LH), the primary drivers of the oestrus cycle (Hafez & Hafez 2008). The combined effect of a declining body condition score and the hormonal interactions lead to poor conception rates in this system. It has been observed that ewes conceive well for a short period 17 days post-partum but then appear to experience a 4 to 6 week anoestrus during peak lactation. Involution of the uterus is only complete at about 28 to 35 days post-partum (Hafez & Hafez 2008). A higher incidence (7% vs. 1.5%) of abortions was observed in Dorper ewes that were synchronized for mating at 21 days post-partum than in ewes mated at 90 days post-partum, managed in the same flock. Lochia can be observed in ewes at 21days post-partum. It implies that the uterus is still in the process of eliminating bacteria and cellular debris. The first ovulation at 21 days post-partum in sheep has been observed laparoscopically to be a silent heat.

The advantages of a six-month ewe management cycle:

- Improved cash flow

- Accelerated genetic progress
- Improved utilisation of facilities in an intensive lambing pen system
- Short lead time before maiden ewes are mated.

Disadvantages of a six month ewe management cycle:

- Ewes fail to re-conceive 30 days after lambing.
- Only one lambing period can be synchronised with peak levels of pasture productivity.
- Ewes do not build up fat reserves to provide negative energy balance during lactation.
- Ewes will require high levels of feeding.

3.2.1.3 Eight-monthly system:

Ewes are re-mated every eight months allowing a three month rest period after the 5 months of gestation. Producers consider the 3 to 4 months of rest and recovery that is allowed between weaning and mating in an annual system as wasteful. This management cycle repeats itself every two years.

The advantages of a eight month ewe management cycle are:

- The three month rest period allows the use of live vaccines while ewes are not pregnant.
- Ewes are provided an opportunity to produce more than one lamb per year as a single lamb rather than a twin which is often less thrifty than a single lamb.
- Improved cash flow from a more regular lamb crop.
- Maiden ewes can fall into the cycle at an earlier age (11 months) than with an annual breeding season (18 months).
- Mating maiden ewes at 11 months avoids the negative effects of mating or lactation at the time of eruption of the first two permanent incisors at 12 to 14 months.
- The increased availability of replacement maidens can result in an ewe flock with a lower average age.
- Reduced climatic risk compared to a single lambing period per year.

The disadvantages of an eight month ewe management cycle are:

- At least one of the mating periods will coincide with a low point in the natural breeding season.
- At least one lambing period will coincide with the climatic low point in respect of lamb survival.
- Many annual vaccinations may have to be repeated at eight monthly intervals.
- The system will function better if ewes are mated for one cycle of 17 (sheep) or 21 (goats) days only.

3.2.1.4 Dual flock eight monthly system:

Ewes are re-mated every eight months allowing a three month rest period after the 5 months of gestation. Producers consider the 3 to 4 months of rest and recovery that is allowed between weaning and mating in an annual system as wasteful. This management cycle repeats itself every two years. Ewe flocks can be divided in two groups allowing a tandem production cycle with a lamb crop every 4 months.

The advantages of a dual flock eight-month ewe management system:

- The three month rest period allows the use of live vaccines while ewes are not pregnant.
- Ewes that fail to conceive at 8 months can be re-mated at 12 months.
- Ewes are provided an opportunity to produce more than one lamb per year as a single lamb rather than a twin which is often less thrifty than a single lamb.
- Less rams are needed than if all ewes are mated in one period.
- Improved cash flow from a more regular lamb crop.
- Maiden ewes can fall into the cycle at an earlier age (7 or11 months) than with an annual breeding season (7 or 18 months).
- Mating maiden ewes at 11 months avoids the negative effects of mating or lactation at the time of eruption of the first two permanent incisors at 12 to 14 months.
- The increased availability of replacement maidens can result in an ewe flock with a lower average age.
- Reduced climatic risk compared to a single lambing period per year.

Disadvantages of a dual flock eight month ewe management system:

- At least one of the mating periods will coincide with a low point in the natural breeding season.
- At least one lambing period will coincide with the climatic low point in respect of lamb survival.
- If two flocks are run ewes will have to be marked in such a way that ewes cannot repeatedly be moved into the alternative flock if she fails to conceive.
- The natural seasonality coupled with periodic seasonal droughts may result in reduced pregnancy rates in the spring mated group leading to a disturbed balance in flock sizes.
- Annual vaccinations may have to be repeated at eight monthly intervals.

3.2.1.5 CAMAL system (Four flock eight-monthly system)

CAMAL is an abbreviation for the Cornell Alternate-Month Accelerated Lambing System and is a further subdivision of a dual-flock eight monthly system into 4 flocks. It results in a mating period every second month and consequently a lambing period every second month.

The advantages of a four flock eight-month ewe management cycle:

- Ewes have an opportunity to conceive at 6, 8, 10 or 12 months.
- Ewes are provided an opportunity to produce more than one lamb per year as a single lamb rather than a twin which is often less thrifty than a single lamb.
- Less rams are needed compared to when all ewes are mated in one period.
- Improved cash flow from a more regular lamb crop.
- Maiden ewes can fall into the cycle at an earlier age (7, 9, 11, 13 or 15 months) than with an annual breeding season (18 months).
- Mating maiden ewes at 11months avoids the negative effects of mating or lactation at the time of eruption of the first two permanent incisors at 12 to 14 months.
- The increased availability of replacement maidens can result in an ewe flock with a lower average age.
- Reduced climatic risk compared to a single lambing period per year.

Disadvantages of a four flock eight month ewe management cycle:

- At least one of the mating periods will coincide with a low point in the natural breeding season.
- At least one lambing period will coincide with the climatic low point in respect of lamb survival.
- Ewes will have to be marked in such a way that ewes cannot repeatedly be moved into the alternative flock if she fails to conceive.
- The natural seasonality coupled with periodic seasonal droughts may result in reduced pregnancy rates in the spring mated group leading to a disturbed balance in flock sizes.
- Vaccinations that need to coincide with the breeding cycle may have to be repeated at intervals of less than a year leading to increased input costs.
- The system is very complex and difficult to administer.

3.2.1.6 STAR system

This system, which was developed by the Cornell University, divides the year up into 5 periods of 73 days. Gestation is approximately two periods and a third period is allowed for rest. Mating takes place every 73 days for 17 days allowing an on-going production of lambs. It allows for the synchronisation of the onset of lambing after 146 days gestation with the start of a mating period every 73 days. It is more orderly than the CAMAL system. A visual representation on a circular calendar will form a five-pointed star if the first days of consecutive lambing or breeding periods for a "perfect" ewe are connected. Ideally a "perfect" ewe can lamb every 146 + 73 days, or 7.2 months. These ewes are called STAR ewes. If she manages a twin at every lambing she is referred to as an all-STAR ewe.

The advantages of the Cornell Star ewe management cycle are:

- Ewes that fail to conceive at 7.2 months can be re-mated at 12 months.
- Ewes are provided an opportunity to produce more than one lamb per year as a single lamb rather than a twin which is often less thrifty than a single lamb.
- Less rams are needed compared to when all ewes are mated in one period.
- Improved cash flow from a more regular lamb crop.
- Maiden ewes can fall into the cycle at an earlier age (7.3, 9.7. 12 or 14.6 months) than with an annual breeding season (18 months).
- The increased availability of replacement maidens can result in an ewe flock with a lower average age.
- Reduced climatic risk compared to a single lambing period per year.

The disadvantages of the Cornell Star ewe management system are:

- This system does not allow administration of live vaccines to ewes that are not pregnant or not lactating.
- At least one of the mating periods will coincide with a low point in the natural breeding season.
- At least one lambing period will coincide with the climatic low point in respect of lamb survival.
- Ewes will have to be marked in such a way that ewes cannot repeatedly be moved into the alternative flock if she fails to conceive.
- The natural seasonality coupled with periodic seasonal droughts may result in reduced pregnancy rates in the spring mated group leading to a disturbed balance in flock sizes.
- Many annual vaccinations may have to be repeated at more frequent intervals
- The system is complex and difficult to administer in large flocks.

All systems have the same sets of phases which combine to form a management cycle. The length of the rest phase differs between the lambing systems and the length of the mating period may also be adapted to suit the lambing system. The 12 phases of the ewe management cycle are listed in Table 3.2.1.b.

Table 3.2.1.b. Phases of the Ewe Management Cycle

Phase code	Phase name
E1	Selection
E2	Preparation
E3	Mating
E4	Pre-placental
E5	Early foetal
E6	Late gestation
E7	Peri-partal
E8	Early lactation
E9	Late lactation
E10	Weaning
E11	Rest period
E12	Replacement

Each of these phases will be discussed as guided by a defining phrase as well as the description criteria as listed in Table 2.3.2.1.b.

3.2.2 Sub-process 1: Ewe management cycle: Phase E1 – Selection of ewes

Defining phrase: HOW TO MANAGE THE SELECTION OF EWES

1. Description:

Ewe selection is the process of examining all potential breeding ewes with the objective of finalising the composition of the group of ewes that will be mated to the rams in the near future. The aim is to select a flock of ewes for mating that will maximise the reproductive efficiency and minimise the hazards to reproduction.

Ewes should be selected on own performance. Ewes that failed to wean a lamb during the preceding lambing opportunity should not be included in the ewe group from which future breeding ewes are selected but may be retained for cross-breeding purposes (Haughey 1991). No mitigating circumstances should be allowed to override this principle of "terminating the pedigree" of under-performing ewes. Ewes that are given another opportunity invariably fail again (Haughey 1991; Cloete 1992). The physiological basis of this may be the common role of hormones in reproductive and mothering behaviour. Inadequate hormone production will for example lead to late onset of lactation as well as poor shelter seeking behaviour. It has been observed that the conception rates of ewes that loose lambs in a cold spell are invariably significantly lower than the flock average in the following season. Likewise, ewes that loose lambs from predators have been observed to have lower conception rates in the following season in spite of the benefit of not lactating.

Ewes should also be selected based on parental performance. All lambs that were born as one of a twin or more should be identified. The most common practice is to apply a small ear notch to one of the lamb's ears for permanent identification.

In flocks where pedigree information is available and reliable the birth status of both parents of the ewe in question may be incorporated into a ranking list from which superior ewes can be identified. (Cloete 1992).

Ewe behaviour is increasingly considered as a selection criterion in selecting suitable breeding ewes. Ewes that fail to meet requirements in the peri-partal period should be permanently identified to make it possible to terminate her pedigree; (Haughey 1991; Cloete 1992; Everett-Hincks, Lopez-Villalobos, Blair & Stafford 2004).

Ewes should be selected after clinical examination to eliminate potential causes of poor reproductive performance. The criteria for selection are listed in Table E1-1

2. Objectives:

Ewe selection is performed to:

- establish a mating flock of a size that meets the requirements of the flock production plan
- select the ewes which are suitable for introduction into the breeding flock
- identify ewes which are no longer suitable for inclusion in the breeding flock
    - identify and deal appropriately with ewes that may be unsuitable for further breeding due to dental age
    - Identify and deal appropriately with ewes that have a body condition score that is lower than the required norm or that are below that of the majority of the group

3. Key activities

Mature and maiden ewes are examined for soundness and age. Maiden ewes are, in addition, examined to establish their suitability for production for example wool characteristics and conformation.

Selection can be performed by the flock manager, assisted by his helpers, an inspector from a breed society or by a trained technical official from a marketing organisation specialising in the primary product being produced. This may lead to emphasis on one or more specific breed characteristics and not necessarily a holistic approach that takes health, reproduction and production aspects into account. Flock health and production consultants (FHPC) may influence the process by structuring the process. An example of a checklist that could be used to ensure consistency and control of the process is provided in Table E1-1.

Table E1-1. Ewe selection checklist

Step	Characteristic	Standard
1	Dentition	Age: (correlated with year tag, tattoo or ear mark) 2 tooth : 15 months (± 3 months)[a] 4 tooth : 24 months (± 3 months)[a] 6 tooth : 33 months (± 3 months)[a] 8 tooth : 42 months (± 3 months)[a] Old : 60 months (teeth may be half worn) Worn : 72 months Excessive wear: More than 72 months (determined by feed). Broken mouth or missing molars.
2	Body condition score	BCS on a scale of 1 to 5 or 1 to 9 can be used. Previous lambing/weaning record could be used to allow differentiation. Differentiation on age may be allowed.
3	Feet and mobility	Overgrown and deformed feet should be a penalty if the vast majority of ewes have normal feet. Growth rings on claws may indicate a historical stress or disease period. Lameness in all degrees and forms.
4	Signs of disease	The 5 point examination for internal parasites. Abscesses especially in regional lymphnodes. Respiratory distress. Tender wool or broken fleece. Signs of eye disease. External parasites.
5	Udder	Fibrosis of the udder. Asymmetry. Regional lymph nodes: Enlarged or abscessated. Teat canal abscess or structural abnormality. (Bottle teat.). Inverted or damaged teats.
6	Record of lambing	Ewes that are marginal on points 1 to 3 above may be pardoned if they have an exemplary lambing/weaning record. Longevity of the flock will be improved.
7	Production characteristics	Ewes that are marginal on points 1 to 3 above may be pardoned if they have exceptionally good production characteristics.

[a] (Osterhoff, Couvaras, Genis & van Niekerk 1979)

4. Timing

Ewe selection takes place before the preparation of ewes for mating. It is usually done a few weeks after the previous weaning to allow udders to regress before examining the udder for fibrosis and abscesses and allow an opportunity for ewes to gain weight. Maiden ewes that have been selected can be vaccinated with live vaccines that provide life-long immunity as they are likely to remain in the flock for a number of years. Flock managers may prefer to apply this phase to maiden ewes after mating and scanning to ensure that only ewes with proven fertility are introduced into the breeding flock.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past events are observed during the ewe selection phase these will be recorded in the Hazard Events form (Addendum B-PC4)

Stud managers may also record individual ewe data pertaining to breed standards. The numbers of ewes from each age group, culled for different reasons, are recorded for the critical control point CCP1 – Ewes Selection (Addendum B-CC1).
The following reasons for culling are listed in the form:

- Abscess
- Blowfly
- Cancer
- Disease
- Locomotion
- Teeth
- Udder

These categories should be adapted to suit the prevailing conditions on each farm and flock.

6. Hazards

This phase of the ewe management cycle provides an excellent opportunity to identify ewes that pose a threat to reproduction by disease and genetic hazards. Ewes that are poorly adapted to the environment and that may contribute to functional hazards – leading to poor mothering ability can be eliminated.

Examples of potential hazards that could be identified in the hazard analysis during this phase are listed in Table E1-2.

Table E1-2. Examples of hazards: Ewe management cycle: Phase E1 – Selection of ewes

Hazard Category	**Description**	**Cause**	**Diagnosis**	**Prevention**
Diseases	Chronic mastitis	Bacterial	Palpation	Vaccination
	Caseous lymphadenitis	Bacterial	Clinical & Laboratory	Biosecurity Vaccination
	Pizzle disease	Venereal Mycoplasma etc.	Clinical	Biosecurity
Management	Worn teeth	Mineral deficiency	Laboratory	Mineral supplements
	Infertile ewes not culled	Poor records	History	System review
	Mis-mothering ewes not culled	Poor records	History	System review
Genetics	Inverted teats	Dominant gene	Clinical	Culling
	Undershot jaw	Recessive gene	Clinical	Culling
	Genotype environment mismatch	Multiple gene	System analysis	Performance testing
Functional	Excess facial wool	Poor selection and shearing	Clinical	Selection & Shearing
	Excess perineal wool	Poor selection and shearing	Clinical	Selection & Shearing
	Overgrown claws	Soft soils	Clinical	Hoof care
Nutrition	Poor BCS	Malnutrition	Clinical exam	Supplementation
	Trace element deficiencies	Malnutrition	Clinical & Laboratory	Supplementation
	Vitamin A deficiency	Malnutrition	Clinical	Supplementation
Predation	Existing bite wounds	Domestic dogs	History	Cull
	Stock theft	Criminal	History	Management
	Mortalities	Predators	History	Management
Climatic	Severe cold	Extreme weather	Low energy & Weight loss	Strategic feeding & Shelter
	Severe heat	Extreme weather	Low energy & Weight loss	Water provision & Shelter
	Excessive rain	Extreme weather	History & Fleece damage	Shelter & Camp selection

7. Nutritional requirements

The selection phase is very short and may be only a few hours long. Where large flocks are processed more time may be needed to gather ewes from their paddocks, waiting time and time for returning them. Ewes may spend long periods waiting for processing without food and water. Flock managers should ensure adequate water and, if necessary food intake. Supplementation with bales of hay may be practised to avoid nutritional stress. The most important aspect of the nutritional management of ewes during the selection phase is to ensure a first-in-first-out sequence of processing. There is no special requirements for ewes during the selection phase and the maintenance requirements as stated by the NRC (National Research Council. 2007) should be adequate.

The daily nutritional requirements of mature sheep ewes during the selection phase are summarized in Table E1-N1a and b.

Table E1-N1a. Nutritional requirements of sheep ewes during selection (Maintenance).

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
50	1.0 (2.0)	0.55	8.4	95	2.0	1.8	1.0
60	1.1 (1.8)	0.61	9.2	104	2.3	2.1	1.1
70	1.2 (1.7)	0.66	10.0	113	2.5	2.4	1.2
80	1.3 (1.6)	0.72	10.9	122	2.7	2.8	1.3
90	1.4 (1.5)	0.78	11.8	131	2.9	3.1	1.4

Adapted from: NRC : Nutrient Requirements of Sheep (National Research Council. 1985)

Table E1-N1b. Daily nutrient requirements of sheep ewes during selection (Maintenance).

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	0 91 (1.83)	0.49	7.3	69	2.0	1.5	1.0
60	1.05 (1.75)	0.56	8.4	79	2.2	1.8	1.1
70	1.18 (1.68)	0.62	9.4	89	2.4	2.0	1.2
80	1.30 (1.63)	0.69	10.4	98	2.6	2.2	1.4
90	1.42 (1.58)	0.75	11.4	107	2.8	2.5	1.6

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council. 2007).

The daily nutritional requirements of meat goat ewes during the selection phase are summarized in Table E1-N2.

Table E1-N2. Daily nutrient requirements of meat goat ewes during selection (Maintenance).

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	0.99 (1.99)	0.53	7.95	71	3.0	1.9	0.88
60	1.14 (1.90)	0.60	9.12	82	3.0	2.1	1.05
70	1.28 (1.83)	0.68	10.21	92	4.0	2.3	1.23
80	1.41 (1.77)	0.75	11.29	101	4.0	2.5	1.40
90	1.54 (1.72)	0.82	12.34	111	4.0	2.6	1.58

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council. 2007).

The daily nutritional requirements of Angora goat ewes during the selection phase are summarized in Table E1-N3.

Table E1-N3. Daily nutrient requirements of Angora goat ewes during selection (Maintenance).

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
40(low producer)	1.1 (2.74)	0.55	8.28	87	2.0	1.6	0.70
40(high producer)	1.3 (3.25)	0.65	9.87	111	2.3	1.9	0.70
50(low producer)	1.38 (2.76)	0.69	10.46	113	2.4	2.0	0.88
50(high producer)	1.58 (3.16)	0.80	12.00	136	2.7	2.3	0.88
60(low producer)	1.55 (2.58)	0.78	11.76	126	2.7	2.2	1.05
60(high producer)	1.75 (2.92)	0.88	13.35	149	2.9	2.5	1.05

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.2.3 Sub-process 1: Ewe management cycle: Phase E2-Preparation.

Defining phrase: HOW TO MANAGE THE PREPARATION OF EWES BEFORE MATING

1. Description.

Ewe preparation is the process of preparing ewes for mating with the objective of optimising the reproductive performance of the ewes. This includes preventative health procedures, increased nutrition (flushing) and the introduction of vasectomised rams (ram or buck effect) (Martin et al. 2004). The procedures followed during the preparation of the ewes before mating can lead to a high percentage of ewes conceiving in the first cycle. The compactness of the mating season will improve the management efficiency during lambing time. Labour and feed costs can be reduced (Gordon 1997).

Merino ewes, especially maiden ewes produce excessive wool in the perineal area which can in some instances interfere with coitus. Angora goats may pick up thorny branches and other foreign matter which become entangled in the hair between the back legs. The degree of soiled and matted hair and wool in the perineum and between the back legs was observed to be correlated with ewes diagnosed to be not pregnant. It is therefore a well-established practice to clip the area clean. This practice is commonly referred to as crutching.

Flushing is defined as a planned and monitored supply of feed that will result in an increase in the body condition score (BCS) of ewes in a period of about one oestrus cycle prior to the introduction of rams. The aim is to achieve a BCS of 3 to 3.5 at mating time. Ewes that are in BCS more than 4 may need to be restricted first before allowing flushing to take place. An improvement of up to 10% in ultrasound predicted lambing percentage has been observed in ewes that were flushed on grass pastures. Merino ewes weighing between 27 and 45 kg were reported to gain 6% in lambing percentage when flushed to gain 4.5 kg (Miller 1981). Autumn-bred ewes are reported to gain 2 to 2.5% in ovulation rate with an increase of 1.5 to 2.0% lambs born for every kilogram increase in mean live weight. Feeding with lupines is known to have highly beneficial effects on fertility. Feeding lupines for as short as 4 days in the final stage of oestrus can increase the twinning rate by as much as 20–30% (Martin, Milton, Davidson, Banchero Hunzicker, Lindsay & Blache 2004).

In an annual mating cycle, mating occurs exactly six months after the peak lactation period in ewes during which nutrition is unable to meet the requirements of lactation. This has been described as a major cause of poor ovulation and conception rates. Robinson et al. (2002) strongly recommends a pre-mating flush feeding regime to counteract this effect which has been described as the 180-day effect.

The male effect which is present in sheep as well as goats has been reported extensively (Pearce & Oldham 1984). The presence of rams create olfactory, behavioural and visual stimuli which result in an increase in the secretion of luteinizing hormone which stimulates folliculogenesis and ovulation (Pearce & Oldham 1984; Radostits et al 1994).

Delgadillo et al. (2009) reviewed the commonly held beliefs about the male effect and came to the conclusion that many dogmas may not be true. Complete isolation of females from males, even to the extent of considering the direction of the prevailing wind is not necessary. Ewes recognise novel males and respond to them even if they are running with other males. It is widely held that the ram effect is not of much use in cyclical females. It has however been found that the introduction of teaser rams can even override the effect of luteal progesterone resulting in a more robust response in sheep. It is also partially true in goats. Another widely held belief is that continuous contact is necessary for the male effect to take place. Although some studies indicate a response after only a few hours of exposure the overwhelming evidence is in favour of continuous exposure for 17 days rather than a short-term exposure every 17 days to create oestrus synchronization(Delgadillo, Gelez, Ungerfeld, Hawken & Martin 2009). Sheep and goats that are seasonal breeders can respond to the ram effect in the deep anoestrus period if a male is introduced that is “in season”. This effect in the male can be simulated with day length manipulation combined with melatonin treatment. The perception that the male effect is purely the result of smell has also been proven incorrect. Ewes respond to behaviour, smells and the novelty of the ram.

Adult rams are more efficient at creating the ram effect and this has been proven to be the result of an “improved” smell.(Ungerfeld, Ramos & Gonzales Pensado 2008). Flock managers should therefore ensure a constant supply of new young teaser rams to prevent the situation where all teasers have to be replaced at once by young rams.

Testosterone treated wethers can substitute for teaser rams for identification of ewes in oestrus and the ‘ram effect’ has also been reported. There is some uncertainty about the mechanism and effectivity of testosterone treated wethers in respect of their pheromone production. Treated wethers may be of value if used together with vasectomised males and are believed to assist in breaking up harem groups thereby ensuring higher levels of exposure of ewes to males (Reeve 1984).

Ronderib Afrikaner teaser rams are superior to Merino rams in the resulting ovulation rates in Merino ewes. The ovulation rates were 28.9% and 14.4% higher in the spring and autumn respectively (King 1994). Ronderib Afrikaner rams have a number of unique characteristics in their own response to the presence of ewes. Their basal LH levels are lower than that of Merinos but their response to the introduction of ewes is much higher. It is believed that the pheromone production and the smell of Ronderib Afrikaner rams is the key to their superior ram effect. Observations on Ronderib Afrikaner rams indicate that they exhibit some behaviour patterns in common with goats such as the soiling of the ventral abdomen with urine which leads to the characteristic “Goat ram smell” during the breeding season.

In sheep the introduction of a “novel” ram results in an ovulation in the ewe within 36 hrs. and again on the 6th day (Radostits et al 1994; Gelez & Fabre-Nys 2004; Delgadillo et al 2009). It is, however, usually recommended that teaser rams are introduced 14 to 17 days before mating. In the non-breeding season ewes return to anoestrus after one or two ovulations. About 50% of Merino ewes introduce to a teaser rams in October in the southern hemisphere became anovular after 50 days (Rosa & Bryant 2002). It may therefore be advisable to introduce teasers about 7 days before the breeding season in spring, gradually increasing the period to 17 days in autumn. The first heat after introduction of teaser rams in spring is usually a silent heat in sheep(Gelez & Fabre-Nys 2004). Ewes become anovular after one or two cycles during spring mating suggesting that photo-periodicity overrides the ‘ram effect’. It is suggested that ewes become accustomed to the presence of rams (Murtagh, Gray, Lindsay, Oldham & Pearce 1984).

In goats the buck effect induces oestrus in does after the “sudden” introduction of the male and it has been reported that 80% to 100% of the does can be induced if they are well fed and healthy. However, the conception rates remain low until one month prior to the natural mating season. The first 3 months post-partum is also less successful owing to the suppression of the oestrus cycle by lactation. The initial cycles are short as a result of the lack of a preceding luteal phase and progesterone priming. The cycles following the first short cycle will be normal (Howe 1990).

Goat ewes ovulate shortly after introduction of bucks and again on the 5 the day. About 60% of goats will exhibit heat with the first ovulation (Gelez & Fabre-Nys 2004). Teaser rams may be shared between flocks of ewes. Four hours of exposure per day for 15 days was as effective as longer or continuous exposure in producing oestrus in goat ewes (Bedos, Flores, Fritz-Rodriquez, Keller, Malpaux, Poindron & Delgadillo 2010).

2. Objectives.

Pre-breeding management should:

- Maximise ovulation rate when the rams are introduced
- Maximise the percentage ewes cycling at mating time

- Maximise the percentage of ewes conceiving in the first cycle
- Minimise the risk of diseases affecting reproduction and general health of the ewes
- Minimise losses of the early conceptus arising from nutritional deficiencies.

3. Key activities

Ewes are vaccinated as required and specified on the Flock Health Plan. Live vaccines protecting against abortions may need to be administered 28 days or more prior to mating. Vaccines protecting against enterotoxaemias may need to be administered before commencing flush feeding.

External and internal parasite control is practised to reduce the need for handling during mating time.

Autumn mating often coincides with an increase in ticks activity and prophylactic treatment may be required as part of the preparation of ewes for mating. Depending on the nematode species autumn is often a period of transition between species and it may be the end of the season for summer parasites and the start of the season for winter parasites. Appropriate steps need to be taken to ensure adequate flock immunity and resilience where prophylactic drenching is not advised in order to prevent the development of anthelmintic resistance in nematodes. Autumn is also the danger period for the development of liver fluke (*Fasciola*) and conical fluke (*Calicophoron* species) and environmental management activities may be practised to prevent infestation and the negative effects on reproduction in small ruminants.

Spring mating often coincides with an increase in summer parasite challenges. Appropriate steps need to be taken to ensure adequate flock immunity and resilience where prophylactic drenching is not advised in order to prevent the development of anthelmintic resistance in nematodes. The most common spring and summer parasite is *Haemonchus contortus*. The Targeted Selected Treatment method of monitoring and treatment is the preferred method for managing the *Haemonchus* challenge (van Wyk & Bath 2002).

Ewes are treated with nutritional supplements which will support the objectives of this phase. Trace element and vitamin supplements may be administered at the start of the preparation phase.

Ewes are provided with nutrition as supplement or natural grazing of sufficient quantity and quality to ensure weight gain during this period. Saved pastures with high nutritional value may be adequate to ensure that weight gain targets are met in the preparation or flushing period. Pasture should be at least 4 cm in length for goats (Thompson 1990a) although goats are more inclined to browse (McGregor

1990). Alternatively lick supplementation, hay, grains or complete feeds may be utilised to achieve the weight gain targets that are set in the flock health and production plan.

A sample of ewes from each flock may be weighed at regular (usually weekly) intervals to monitor weight gain. Ewes may be separated into peer groups to avoid dominance and competition during this period based on size, age and body condition score.

In fibre producing sheep and goats crutching may be practised to remove any excessive wool or hair from the perineal area to reduce interference with natural mating.

Vasectomised rams are introduced to the ewe flock. Teaser bucks are introduced two to three weeks before mating (Thompson 1990c); teaser rams are introduced between 7 and 17 days before mating in the spring and autumn respectively.

4. Timing.

Ewes are supplemented for 14 to 21 days prior to mating time.

Crutching, vaccinations and other health treatments are completed prior to the flushing period to ensure an uninterrupted period of weight gain.

Vasectomised rams are introduced into the ewe flock during this period. In spring the introduction is about 7 days before mating increasing to 17 days before mating in autumn.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The preparation data are recorded on the ewe preparation data form (Addendum B-CC3). The average body condition score (BCS) for each flock is recorded at the start and end of the flushing period. Different methods of flushing can be coded and recorded for each flock if the flocks are not treated the same. The dates and results of the weight monitoring are recorded. The data can be visually presented as a graph for each flock to enable historical comparisons with the resulting conception rate and to provide a basis for assessing the cost-benefit ratio of supplementary feeding.

The dates of introduction of vasectomised rams and the numbers of these rams that were introduced into each flock are recorded.

These records will form the basis of Critical Control Point 3- Ewe flushing.

6. Hazards

Hazards resulting from the change in feeding practices are the most common hazards seen during this period. Crutch shearing may present hazards that are similar to that experienced during shearing. These are usually associated with shearing wound infections most commonly caused by Clostridia.

Examples of potential hazards that could be identified in the hazard analysis during this phase are listed in Table E2-H1.

Table E2-H1. Examples of Hazards: Ewe management cycle: Phase E2 – Preparation of ewes before mating

Hazard Category	**Description**	**Cause**	**Diagnosis**	**Prevention**
Diseases	Enterotoxaemia	Bacterial	Clinical palpation	Vaccination
	Pasteurella pneumonia	Bacterial	Clinical & Laboratory	Stress reduction Vaccination
	Gas gangrene	Bacterial	Clinical	Vaccination with multi Clostridial
Management	Injury	Dominance at feed trough	Clinical	Feed space, peer groups
	Conjunctivitis	Dusty feed	Clinical	Feed composition and management
	Urea poisoning	Excess urea	Clinical	Managed adaption
Genetics	None			
Functional	Rumen acidosis	Dominant does at feed trough	Clinical	Increase space Peer grouping
	Under-nutrition	Subordinate does at feed trough	Clinical	Increase space Peer grouping
	Frothy bloat	Pasture wilt.	Clinical	Anti-froth remedies Management
Nutrition	Rumen acidosis	Change in carbohydrate	Clinical exam	Managed adaption
	Urinary alkalosis	High urea levels	Dysuria Urinary pH.	Reduce urea
	Infertility	Oestrogens in clover	Poor conception	Alternative feed
Predation	Existing bite wounds	Domestic dogs	History	Cull
	Stock theft	Criminal	History	Management
	Mortalities	Predators	History	Management
Climatic	Severe cold	Extreme weather	Low energy & Weight loss	Strategic feeding & Shelter
	Severe heat	Extreme weather	Low energy & Weight loss	Water provision & Shelter
	Excessive rain	Extreme weather	History & Fleece damage	Shelter & Camp selection

7. Nutritional requirements

In their 1985 publication the National Research Council (NRC) (1985) recommended dry matter requirements for flushing sheep ewes as between 42% and 60% higher than maintenance and it is aimed at achieving a weight gain of 100 g per day for 2 weeks before and 3 weeks during mating.

This will result in a body weight increase of 3.5 kg during this 5 week period. The nutrient requirements of sheep ewes during the preparation phase are summarized in Table E2-N1

Table E2-N1. Nutrient requirements of sheep ewes during preparation for mating.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.6 (3.2)	0.94	14.3	150	5.3	2.6	1.6
60	1.7 (2.8)	1.00	15.1	157	5.5	2.9	1.7
70	1.8 (2.6)	1.06	16.0	164	5.7	3.2	1.8
80	1.9 (2.4)	1.12	16.8	171	5.9	3.6	1.9
90	2.0 (2.2)	1.18	17.6	177	6.1	3.9	2.0

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The 2007 NRC recommendations for nutrition during the breeding time have a lower recommendation than the 1985 recommendations. It does not allow for weight gain during the breeding period. The 2007 recommendations for breeding in sheep is about 10% higher than maintenance for energy and TDN and about 17% higher than maintenance for crude protein. The daily nutrient requirements of mature sheep ewes during preparation for mating are listed in Table E2-N2.

Table E2-N2. Daily nutrient requirements of mature sheep ewes during preparation for mating.

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
50	1.01 (2.01)	0.53	8.0	81	2.4	1.8	1.1
60	1.15 (1.92)	0.61	9.2	93	2.2	1.8	1.3
70	1.30 (1.85))	0.69	10.4	104	2.9	2.4	1.5
80	1.43 (1.79)	0.76	11.4	115	3.1	2.7	1.7
90	1.56 (1.74)	0.83	12.5	126	3.4	2.9	1.9

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (2007).

The daily nutritional requirements of meat goat ewes during the selection phase are summarized in Table E2-N3.

Table E2 N3. Daily nutrient requirements of meat goat ewes during preparation for mating.

Body Weight (BW)	**Dry Matter (% of BW)**[a]	**TDN**	**Metab. Energy**	**Crude Protein** [b]	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	0.99 (1.99)	0.53	7.95	71	3.0	1.9	0.88
60	1.14 (1.90)	0.60	9.12	82	3.0	2.1	1.05
70	1.28 (1.83)	0.68	10.21	92	4.0	2.3	1.23
80	1.41 (1.77)	0.75	11.29	101	4.0	2.5	1.40
90	1.54 (1.72)	0.82	12.34	111	4.0	2.6	1.58

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The daily nutritional requirements of Angora goat ewes during preparation for mating are summarized in Table E2-N4.

Table E2-N4. Daily nutrient requirements of Angora goat ewes during preparation for mating.

Body Weight (BW)	**Dry Matter (% of BW)**[a]	**TDN**	**Metab. Energy**	**Crude Protein** [b]	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
40(low producer)	1.2 (3.01)	0.61	9.12	101	2.2	1.8	0.70
40(high producer)	1.43 (3.57))	0.72	10.88	128	2.5	2.1	0.70
50(low producer)	1.51 (3.03)	0.76	11.50	130	2.6	2.2	0.88
50(high producer)	1.74 (3.47)	0.88	13.22	157	2.9	2.5	0.88
60(low producer)	1.70 (2.84)	0.86	11.76	145	2.9	2.4	1.05
60(high producer)	1.93 (3.21)	0.97	14.64	172	3.2	2.7	1.05

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

Clover and lucerne pastures are reported to suppress fertility and it is therefore recommended that these pastures should not be used for flushing of ewes. The presence of phytogenic oestrogens are considered to be the cause of the problem (Pryor 1980; Hafez & Hafez 2008).

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.4 Sub-process 1: Ewe management cycle: Phase E3-Mating phase.

Defining phrase: HOW TO MANAGE THE MATING PHASE OF THE EWE MANAGEMENT CYCLE

1. Description.

The mating phase is the period of exposure of ewes to rams or artificial insemination.

Rams may be joined to ewe groups individually (single sire mating) or as a group (group mating). The ram may be left with the ewes or allowed to mate the ewes individually so that a successful mating can be recorded (hand-mating).

Rams may also be provided with harnesses with colour blocks or paint and dye applied to the sternum that mark the ewes to confirm the identity of the ram and the successful mounting. Vasectomised rams may be used with colour marking ability to identify ewes in oestrus that can be artificially inseminated.

Ewes can be synchronised with the use of progesterone in a form that can be withdrawn to allow synchronous oestrus. Prostaglandin treatment can be used as two injections spaced apart to ensure luteolysis in all ewes at the same time leading to synchronous oestrus. These synchronised ewes can be artificially inseminated, hand mated or group mated. The use of gonadotropins in synchronised ewes can focus the synchronization and increase the ovulation rate (Hafez & Hafez 2008).

The increased demand by consumer groups and environmental activists to move away from the use of drugs and hormones towards organic production methods has led to the concept of "Clean, green and ethical" production methods which promote the use of the phenomena of flushing and the ram effect to assist in achieving the same purposes as that of using drugs and hormones (Martin et al 2004; Martin & Croker 2006).

2. Objectives

The management of ewes during mating aims to:

- Ensure the maximum rate of fertilisation of available ova
- Minimise the risk of transmission of venereal diseases

- Minimise negative environmental effects that may affect conception rates

3. Key activities.

Rams are joined according to a pre-determined ratio. This ratio may be based on arbitrarily accepted norms such as 2 to 4% of rams or it may be the result of the determination of the Ram Mating Capacity during critical control point CC15 – Ram Genital Soundness.

Fresh rams may be introduced after the first cycle and second cycles. It has been observed that the number of ewes producing twin ewes and lambing in the second cycle can be increased by joining fresh rams during the second cycle. Normal mating practices where rams are mated to the ewes for 35 to 42 days mostly result in very few ewes conceiving twins in the second cycle. A number of flock managers initiated the practice of joining the second team of rams after 17 days with a resultant increase in twinning rate in the second cycle.

Rams may be provided with a marking harness and or colouring that can indicate successful mounting of ewes.

4. Timing.

The mating period is calculated as multiples of the length of the oestrus cycle of the species or breed. Sheep ewes are mated for 17, 34 or 51 days. Even though the oestrus cycle in sheep is 16 to 18 days long, flock managers that practice artificial insemination report that the number of ewes showing oestrus remains high until day 21 after which it rapidly decreases. This led to the erroneous belief that the oestrus cycle in sheep is 21 days. Goat ewes are mated for 21, 42 or 63 days.

Flock managers often observe rams mounting ewes during the process of herding the flock together to remove the rams. The mating period is then extended, based on the observation that the rams are still working. The subsequent scanning of the flocks then reveal that this was not the case and that rams were mounting ewes that were unable to move away. Rams will mount ewes that are not in oestrus if they are restrained. It is therefore seldom necessary to extend the mating period beyond two or three cycles.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or

current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B -PC4).

The information collected at joining is recorded on the Joining Data form (Addendum B-CC5:1 and CC5:2). The numbers of each age group of rams and ewes that make up each flock are recorded on form CC5:1 and the tag numbers of the rams and their calculated mating capacities that are joined to each flock are recorded on form CC5:2.

The data recorded during the mating period, the dates on which rams were joined and removed and the clinical examination data of the rams at removal are recorded on the Mating Data form (Addendum B- CC6:1 and B CC6:2 respectively).

6. Hazards

The hazards to reproduction during the mating phase are essentially the same as during the ewe preparation phase. The venereal transmission of infectious disease occurs in this phase but it is managed in the ram management cycle. Ewes can also be tested for the presence of venereal diseases. Examples of potential hazards that could be identified in the hazard analysis during this phase are listed in Table E3-H1.

Table E3-H1. Potential Hazards: Ewe management cycle: Phase E3 – Mating phase

Hazard Category	Description	Cause	Diagnosis	Prevention
Diseases	Brucellosis	Bacterial	Clinical palpation Serology	Vaccination
	Pizzle disease	Mycoplasma etc.	Clinical	Biosecurity Prophylactic antibiotics
	Ram disease	HPA group of bacteria	Clinical and bacteriological	Ram genital soundness examination
Management	Injury	Dominance at feed trough	Clinical	Feed space, peer groups
	Conjunctivitis	Dusty feed	Clinical	Feed composition and management
	Urea poisoning	Excess urea	Clinical	Managed adaption
Genetics				
Functional	Rumen acidosis	Dominant does at feed trough	Clinical	Increase space Peer grouping
	Under-nutrition	Subordinate does at feed trough	Clinical	Increase space Peer grouping
	Frothy bloat	Pasture wilt.	Clinical	Anti-froth remedies Management
Nutrition	Embryonic loss	Overfeeding	Reproduction records	Reduce feeding to maintenance levels
	Urinary alkalosis	High urea levels	Dysuria Urinary pH.	Reduce urea
	Infertility	Oestrogens in clover	Poor conception	Alternative feed
Predation	Stress	Domestic dogs	History	Security
	Stock theft	Criminal	History	Management
	Mortalities	Predators	History	Management
Climatic	Severe cold	Extreme weather	Low energy & Weight loss	Strategic feeding & Shelter
	Severe heat	Extreme weather	Low energy & Weight loss	Water provision & Shelter
	Excessive rain	Extreme weather	History & Fleece damage	Shelter & Camp selection

7. Nutritional requirements

The NRC (1985) recommended dry matter requirements for flushing sheep ewes is between 42% and 60% higher than maintenance and is aimed at achieving a weight gain of 100 g per day for the first 3 weeks during mating. This will result in a body weight increase of 2.1 kg during this 21 day period. The nutritional requirements of sheep ewes during the first cycle of mating are summarized in Table E3-N1.

Table E3-N1. Nutritional requirements of sheep ewes during the first cycle of mating.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.6 (3.2)	0.94	14.3	150	5.3	2.6	1.6
60	1.7 (2.8)	1.00	15.1	157	5.5	2.9	1.7
70	1.8 (2.6)	1.06	16.0	164	5.7	3.2	1.8
80	1.9 (2.4)	1.12	16.8	171	5.9	3.6	1.9
90	2.0 (2.2)	1.18	17.6	177	6.1	3.9	2.0

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

During the second cycle of mating the nutritional requirements can be reduced to the levels which will remain for the first 15 weeks of gestation. The NRC (1985) recommended dry matter requirements for flushing sheep ewes is between 14% and 20% higher than maintenance and is aimed at achieving a weight gain of 30g per day for the first and second cycle during mating and the initial 15 weeks (70%) of gestation. The nutritional requirements of sheep ewes during the second cycle of mating are summarized in Table E3-N2

Table E3-N2. Nutritional requirements of sheep ewes during the second cycle of mating.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.2 (2.4)	0.67	10.1	112	2.9	2.1	1.2
60	1.3 (2.2)	0.72	10.90	121	3.2	2.5	1.3
70	1.4 (2.0)	0.77	11.8	130	3.5	2.9	1.4
80	1.5 (1.9)	0.82	12.6	139	3.8	3.3	1.5
90	1.6 (1.8)	0.87	13.44	148	4.1	3.6	1.6

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.2.5 Sub-process 1: Ewe management cycle: Phase E4-Pre-placental phase.

Defining phrase: HOW TO MANAGE THE PRE-PLACENTAL PHASE OF THE EWE MANAGEMENT CYCLE

1. Description.

The pre-placental period is the period immediately after conception and before the attachment of the blastocyst. In the flock this period overlaps in varying degrees with the mating period.

The embryo is vulnerable during this time and underfeeding as well as overfeeding may cause substantial embryo losses (Viñoles Gil, Milton & Martin 2006). The administration of selenium during this phase may lead to embryo losses (Van Niekerk, Cloete, Heine, Van der Merwe, Wellington, Du Plessis & Bekker 1996).

2. Objectives

Management of ewes during the pre-placental phase of pregnancy is aimed at ensuring the survival of the pre-implantation embryo.

3. Key activities

Ewes need to be disturbed as little as possible during this period and no handling should take place unless it is impossible to postpone it. Treatments with drugs and supplements should also be avoided.

4. Timing.

The first attachment of the foetal membranes to the endometrium takes place between days 17 and 18. The first villi are formed on about day 30 (Cloete 1939). The pre-placental phase can therefore be defined as the period between conception and about 30 days of pregnancy.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard

Events form (Addendum B-PC4).These records can be used retrospectively to establish possible causes if losses in the pre-placental period becomes evident at a later stage. Resorptions and early abortions in this period are seldom clinically observed.

6. Hazards

It has been observed that nutritional stress during the first few weeks of gestation can lead to resorption or abortion of the early conceptus. Lack of drinking water as a cause of early foetal loss has been incriminated at a number of occasions. Predator chase as a cause of stress has been reported as a probable cause of foetal loss in the early stages of pregnancy but notably more in the pre-placental period.

Overfeeding and the administration of selenium in this period have been shown to lead to resorptions.

7. Nutritional requirements

During the pre-placental phase of gestation the nutritional requirements can be maintained at the levels which were required for the second half of the mating period and it can remain at that level for the remainder of the first 15 weeks of gestation. The NRC (1985) recommended dry matter requirements for flushing sheep ewes is between 14% and 20% higher than maintenance and is aimed at achieving a weight gain of 30g per day for the first and second cycle during mating and the initial 15 weeks (70%) of gestation. The nutritional requirements of sheep ewes during the second cycle of mating are summarized in Table E4-N1.

Table E4-N1. Nutritional requirements of sheep ewes during the second cycle of mating.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.2 (2.4)	0.67	10.1	112	2.9	2.1	1.2
60	1.3 (2.2)	0.72	10.90	121	3.2	2.5	1.3
70	1.4 (2.0)	0.77	11.8	130	3.5	2.9	1.4
80	1.5 (1.9)	0.82	12.6	139	3.8	3.3	1.5
90	1.6 (1.8)	0.87	13.44	148	4.1	3.6	1.6

Adapted from: NRC: Nutrient Requirements of Sheep (1985

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.2.6 Sub-process 1: Ewe management cycle: Phase E5-Early foetal phase.

Defining phrase: HOW TO MANAGE THE EARLY FOETAL PHASE OF THE EWE MANAGEMENT CYCLE

1. Description:

The early foetal period is the period during which the placenta forms and the growth of the foetus does not place a noticeable nutritional burden on the ewe.

2. Objectives

Management of these phases should ensure:

- Adequate nutrition for the development of the placenta and the survival of the foetus
- The prevention of diseases that cause early abortions
- The reduction of stress caused by handling, climate and predators

3. Key activities

Ultrasound pregnancy diagnosis is usually performed in this period.
Although ewes do not have markedly increased nutritional needs during this phase deficiencies should be avoided. Lack of water has been observed to lead to abortions in this period. Many infectious diseases cause abortions during this period and observation of the flock should be intensified to make observations of fresh abortions possible.

4. Timing

According to Cloete (1939)cotyledons appear on about day 44 and the placenta is fully developed by day 78. The foetus weighs about 400g at this stage. The early foetal phase can therefore be defined as the period between approximately 30 days and 80 days of pregnancy.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The results of ultrasound pregnancy diagnosis are recorded on the Scan data from (Addendum B – CC7)

6. Hazards

Examples of potential hazards that could be identified in the hazard analysis during this phase are Abortions resulting from infections, stress, severe climatic events and malnutrition.

7. Nutritional requirements

The 2007 NRC standards have reduced the recommended nutrient requirements in general but introduced a separate specification for ewes carrying three or more lambs. Table E5-N1 lists the requirements for sheep ewes in late pregnancy for the different pregnancy categories.

Table E5-N1. Nutrient requirements of pregnant mature sheep during early gestation.

Body Weight (Pregnancy status)	Dry Matter (% of BW)[a]	TDN	Metab. Energy	Crude Protein[b]	Ca	P	Mg
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.16 (2.32)	0.61	11.5	96	5.1	3.5	1.3
50 (Twin)	1.31 (2.62)	0.70	14.6	112	7.3	4.3	1.6
50 (Three or more)	1.46 (2.92)	0.77	16.9	129	8.7	4.7	1.7
60 (Single)	1.31 (2.19)	0.70	13.0	108	5.7	4.0	1.5
60 (Twin)	1.51 (2.52)	0.80	16.5	129	8.1	4.8	1.8
60 (Three or more	1.65 (2.74)	0.87	18.8	144	9.5	5.2	1.9
70 (Single)	1.46 (2.09)	0.78	14.4	120	6.1	4.4	1.8
70 (Twin	1.69 (2.41)	0.89	18.3	144	8.8	5.3	2.1
70 (Three or more)	1.82 (2.61)	0.97	20.7	159	10.8	6.4	2.2
80 (Single)	1.61 (2.01)	0.85	15.8	132	6.6	4.8	2.0
80 (Twin)	1.84 (2.30)	0.98	19.9	157	9.4	5.8	2.3
80 (Three or more)	2.00 (2.50)	1.06	22.6	174	11.6	6.9	2.5
90 (Single)	1.75 (1.95)	0.93	17.15	143	7.1	5.2	2.2
90 (Twin)	2.00 (2.22)	1.06	21.4	170	10.7	7.2	2.6
90 (Three or more)	2.17 (2.41)	1.15	24.4	188	12.3	7.4	2.8

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

Table E5-N2 lists the requirements for meat goat ewes in late pregnancy for the different pregnancy categories.

Table E5-N2. Nutrient requirements of pregnant mature meat goats during early gestation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein[b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.16 (2.33)	0.62	9.75	107	4.1	2.4	0.94
50 (Twin)	1.25 (2.51)	0.66	10.04	124	5.7	3.2	0.99
50 (Three or more)	1.31 (2.61)	0.69	10.46	134	7.2	3.8	1.02
60 (Single)	1.33 (2.21)	0.70	10.63	121	4.3	2.7	1.12
60 (Twin)	1.43 (2.38)	0.76	11.42	140	6.0	3.4	1.18
60 (Three or more	1.48 (2.47)	0.79	11.88	150	7.4	4.0	1.22
70 (Single)	1.48 (2.12)	0.79	11.88	134	4.5	2.9	1.31
70 (Twin	1.59 (2.27)	0.84	12.72	154	6.2	3.6	1.37
70 (Three or more)	1.65 (2.36)	0.88	13.22	167	7.7	4.2	1.41
80 (Single)	1.63 (2.04)	0.87	13.05	146	4.7	3.1	1.49
80 (Twin)	1.75 (2.19)	0.93	14.02	170	6.4	3.8	1.56
80 (Three or more)	1.82 (2.28)	0.97	14.56	182	7.9	4.4	1.60
90 (Single)	1.72 (1.97)	0.94	14.18	158	4.9	3.3	1.67
90 (Twin)	1.91 (2.12)	1.01	15.27	184	6.7	4.0	1.75
90 (Three or more)	1.98 (2.20)	1.05	15.86	198	8.1	4.7	1.79

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The daily nutritional requirements of Angora goat ewes during early gestation are summarized in Table E5-N3. The nutrient requirements for high fibre producers and low fibre producers are shown separately for either a single pregnancy status or a twin pregnancy status.

Table E5-N3. Daily nutrient requirements of Angora goat ewes during early gestation.

Body Weight (BW)	**Dry Matter (% of BW)**[a]	**TDN**	**Metab. Energy**	**Crude Protein**[b]	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**G**	**g**	**G**
40(low producer; single)	1.26 (3.14)	0.63	9.54	117	4.2	2.6	0.76
40(low producer; twin)	1.33 (3.33)	0.67	10.17	129	5.9	3.3	0.80
40(high producer; single)	1.46 (3.64))	0.74	11.09	142	4.5	2.8	0.76
40(high producer; twin)	1.54 (3.84)	0.78	11.72	153	6.1	3.5	0.80
50(low producer; single)	1.56 (3.11)	0.78	11.84	147	4.6	3.0	0.94
50(low producer; twin)	1.65 (3.29)	0.83	12.55	160	6.3	3.7	0.99
50(high producer; single)	1.76 (3.52)	0.89	13.39	171	4.9	3.3	0.94
50(high producer; twin)	1.85 (3.70)	0.93	14.10	185	6.6	4.0	0.99
60(low producer; single)	1.75 (2.91)	0.88	13.26	163	4.9	3.2	1.12
60(low producer; twin)	1.85 (3.08)	0.93	14.06	179	6.6	4.0	1.18
60(high producer; single)	1.95 (3.25)	0.98	14.85	188	5.2	3.5	1.12
60(high producer; twin)	2.05 (3.42)	1.04	15.65	203	6.9	4.2	1.18

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.2.7 Sub-process 1: Ewe management cycle: Phase E6- Late foetal phase

Defining phrase: HOW TO MANAGE THE LATE FOETAL PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The late foetal phase of the ewe management cycle is the period of rapid growth during which the nutritional needs for foetal growth require intervention by flock managers to ensure survival, growth and health of lambs and ewes. A number of flock health procedures are required to further support this aim. Observations of abortions and the investigation into the causes may need special interventions during this phase for example re-scanning ewes that were previously certified in lamb.

The nutritional requirements of ewes in the last third of gestation increase substantially to meet the requirements of maintenance, fibre production, the growing foetus, placenta and uterus. Ewes are adapted to increase their adipose tissue reserves at this time in anticipation of lactation which usually results in a negative energy balance (NRC, 1985). The nutrient requirements of ewes carrying single lambs are summarized in Table E6-N1.

Ewes carrying multiple lambs have even greater requirements as summarised in Table E6-N2. The physical volume occupied by the gravid uterus places a restraint on the volume of food that can be accommodated in the rumen. Ewes that have a high BCS with high levels of intra-abdominal fat deposition have a further restriction on the capacity of the rumen. A low nutrient concentration and a slow rate of breakdown of low quality roughage by rumen micro flora will add to the inability of ewes to supply their nutrient needs from natural pastures. The chemical composition and nutritive values of selected fodder plants are listed in Table E6-1.

Table E6-1. Nutritive value of selected fodder plants (as fed)

	Dry Matter	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
	%	**%**	**Mj/kg**	**g/kg**	**g/kg**	**g/kg**	**g/kg**
Lucerne	20	12.85	3.6	46.1	4.7	0.6	0.7
Oats (dry land)	22	14.74	4.0	48.0	0.5	0.5	
Oats (irrigated)	18	12.42	1.87	39.4	0.4	0.5	
Rye (perennial)	20	12.8	1.92	39.0	0.6	0.5	
Wheat	21.5	15.05	2.23	26.4	0.9	0.9	

Adapted from Bredon et al (1987) and NRC (1985)

The normal volume of the rumen in sheep is about 15 to 40 litres. An extreme case of atrophy of the rumen in a Mutton Merino ewe, grazing on irrigated annual ryegrass was observed. The ewe was presented for a caesarean in terminal pregnancy but died during preparation for surgery. On autopsy the ewe, weighing 84 kg was found to have a rumen with a capacity of 600 ml. The annual ryegrass was found to have an 80% water content. The resulting effect was severe under-nutrition.

Growth targets are usually set for the various classes of pregnant ewes and monitored by weighing a target group of ewes in each group weekly. Suggested minimum growth targets, based on observations of ewes that raised their lambs successfully in Controlled environment are listed in Table E6-2.

Table E6-2. Suggested minimum weight gain targets for pregnant ewes

Status of 50 kg sheep ewe	**Weight gain from scan to lambing (minimum)**	**Percentage of body weight gained**
Single	5 – 7 kg	10%
Twin[a]	8 – 10 kg	16%
Triplet[a]	12 – 14 kg	24%
Quadruplet[a]	16 – 18 kg	32%

[a] – Ewes carrying multiple foetuses are normally 10 to 20% heavier than single ewes

2. Objectives

Management of the late foetal stage of pregnancy aims to:

- Ensure adequate development of the foetus, thereby ensuring viability
- Ensure adequate deposition of adipose tissue reserves to provide for the anticipated negative energy balance during peak lactation.
- Ensure protection of the ewe against infectious disease that may result from feeding grains (Enterotoxaemia), partus (Uterine quarter evil) and lactation (Pasteurella, Staph. aureus)
- Ensure adequate collostral transfer of immunity to the lamb.

3. Key activities

Ewes are classed into smaller groups comprising of ewes with similar physiological needs. Ewes can be classed into groups according to the number of foetuses found at ultrasound pregnancy diagnosis, whether they are expected to lamb in the first, second or subsequent cycle of 17 (sheep) or 21 (goats) days.
A number of ewes from each group can be marked and weighed.
All ewes are vaccinated with vaccines as described in the Flock Health Plan to ensure protection of the ewe and to ensure adequate collostral immunity for the lamb.
Ewes may be subjected to CC8- Rescan to investigate the foetal losses from the original scan to lambing.

4. Timing

At about 80 days of pregnancy the placenta is fully formed and the Merino foetus weighs more than 400 grams. The weight of the foetus doubles every 20 days in the remaining 70 days of gestation. At 100 days it weighs more than 800 grams, at 120 days it is nearly 1900 grams and at full-term it weighs more than 4000 grams (Cloete 1939). Ninety per cent of the growth of the foetus therefore takes place in the second half of gestation and eighty per cent in the last 42 days or 6 weeks. It is generally accepted that pregnant ewes should receive substantially improved nutrition in the last 6 weeks before lambing starts. If mating took place over a 35 day period some ewes would receive supplementation for 2.5 months.

The late foetal phase can therefore be defined as the period between approximately 80 days and the normal termination of pregnancy at lambing time.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or

current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The results of ultrasound pregnancy diagnosis are recorded on the Re-scan Data from (Addendum B – CC8). The management of the ewes during this phase of pregnancy is recorded on the Pregnancy Management Data form (Addendum B-CC9)

6. Hazards

Hazards during this phase are commonly related to nutritional insufficiency and resulting metabolic abnormalities. The dramatic increase in body weight may predispose ewes to accidental falling, recumbency and injury. Malnourished ewes may undergo muscle atrophy to the extent that locomotion is impeded.

7. Nutritional requirements

The NRC (1985) recommended dry matter requirements for sheep ewes carrying a single foetus is between 42% and 60% higher than maintenance and is aimed at achieving a weight gain of 180 g per day for 4 weeks before lambing. This will result in a body weight increase of 5 kg during this 4 week period.

The nutritional requirements of sheep ewes carrying a single foetus during the last trimester of gestation are summarized in Table E6-N1

Table E6-N1. Nutritional requirements of sheep ewes carrying a single foetus during the last trimester of gestation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.6 (3.2)	0.94	14.3	175	5.9	4.8	2.4
60	1.7 (2.8)	1.00	15.1	184	6.0	5.2	2.6
70	1.8 (2.6)	1.06	16.0	193	6.2	5.6	2.7
80	1.9 (2.4)	1.12	16.8	202	6.3	6.1	2.9
90	2.0 (2.2)	1.18	17.6	212	6.4	6.5	3.0

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The NRC (1985) recommended dry matter requirements for sheep ewes carrying multiple foetuses is between 50% and 70% higher than maintenance and is aimed at achieving a weight gain of 225 g per day for 4 weeks before lambing. This will result in a body weight increase of 6.3 kg during this 4 week period. This recommendation is inadequate for ewes carrying more than two foetuses and conservative for ewes carrying twins. Weight gains in excess of 10 kg are often observed in ewes carrying twins and weight gains up to 25 kg have been observed in ewes carrying 3 or more foetuses.

The nutritional requirements of sheep ewes carrying multiple foetuses during the last trimester of gestation are summarized in Table E6-N2.

Table E6-N2. Nutritional requirements of sheep ewes carrying multiple foetuses during the last trimester of gestation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein (%)**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.7 (3.4)	1.10	16.8	196	6.2	3.4	2.6
60	1.8 (3.0)	1.17	17.6	205	6.9	4.0	2.7
70	1.9 (2.7)	1.24	18.5	214	7.6	4.5	2.85
80	2.0 (2.5)	1.30	19.8	223	8.3	5.1	3.0
90	2.1 (2.3)	1.37	21.0	232	8.9	5.7	3.15

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The 2007 NRC standards have reduced the recommended nutrient requirements in general but introduced a separate specification for ewes carrying three or more lambs. Table E6-N3 lists the requirements for sheep ewes in late pregnancy for the different pregnancy status categories.

Table E6-N3. Nutrient requirements of pregnant mature sheep during the last trimester of gestation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein[d]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.45 (2.89)[a]	0.77	11.5	126	5.1	3.5	1.3
50 (Twin)	1.47 (2.93)[b]	0.97	14.6	155	7.3	4.3	1.6
50 (Three or more)	1.41 (2.81)[c]	1.12	16.9	173	8.7	4.7	1.7
60 (Single)	1.63(2.71)[a]	0.86	13.0	141	5.7	4.0	1.5
60 (Twin)	1.65 (2.75)[b]	1.09	16.5	173	8.1	4.8	1.8
60 (Three or more	1.57 (2.61)[c]	1.25	18.8	192	9.5	5.2	1.9
70 (Single)	1.80 (2.58)[a]	0.96	14.4	156	6.1	4.4	1.8
70 (Twin	1.83 (2.61)[b]	1.21	18.3	192	8.8	5.3	2.1
70 (Three or more)	2.07 (2.96)[b]	1.37	20.7	222	10.8	6.4	2.2
80 (Single)	1.98 (2.47)[a]	1.05	15.8	170	6.6	4.8	2.0
80 (Twin)	1.99 (2.48)[b]	1.32	19.9	208	9.4	5.8	2.3
80 (Three or more)	2.26 (2.82)[b]	1.50	22.6	241	11.6	6.9	2.5
90 (Single)	2.15 (2.38)[a]	1.14	17.15	185	7.1	5.2	2.2
90 (Twin)	2.68 (2.97)[a]	1.42	21.4	241	10.7	7.2	2.6
90 (Three or more)	2.44 (2.71)[b]	1.62	24.4	261	12.3	7.4	2.8

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

Table E6-N4 lists the requirements for meat goat ewes in late pregnancy for the different pregnancy status categories.

Table E6-N4. Nutrient requirements of pregnant mature meat goats during late gestation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein[b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.16 (2.33)	0.62	9.75	107	4.1	2.4	0.94
50 (Twin)	1.25 (2.51)	0.66	10.04	124	5.7	3.2	0.99
50 (Three or more)	1.31 (2.61)	0.69	10.46	134	7.2	3.8	1.02
60 (Single)	1.33 (2.21)	0.70	10.63	121	4.3	2.7	1.12
60 (Twin)	1.43 (2.38)	0.76	11.42	140	6.0	3.4	1.18
60 (Three or more	1.48 (2.47)	0.79	11.88	150	7.4	4.0	1.22
70 (Single)	1.48 (2.12)	0.79	11.88	134	4.5	2.9	1.31
70 (Twin	1.59 (2.27)	0.84	12.72	154	6.2	3.6	1.37
70 (Three or more)	1.65 (2.36)	0.88	13.22	167	7.7	4.2	1.41
80 (Single)	1.63 (2.04)	0.87	13.05	146	4.7	3.1	1.49
80 (Twin)	1.75 (2.19)	0.93	14.02	170	6.4	3.8	1.56
80 (Three or more)	1.82 (2.28)	0.97	14.56	182	7.9	4.4	1.60
90 (Single)	1.72 (1.97)	0.94	14.18	158	4.9	3.3	1.67
90 (Twin)	1.91 (2.12)	1.01	15.27	184	6.7	4.0	1.75
90 (Three or more)	1.98 (2.20)	1.05	15.86	198	8.1	4.7	1.79

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The daily nutritional requirements of Angora goat ewes during early gestation are summarized in Table E6-N5. The nutrient requirements for high fibre producers and low fibre producers are shown separately for either a single pregnancy status or a twin pregnancy status.

Table E6 N5. Daily nutrient requirements of Angora goat ewes during late gestation.

Body Weight (BW)	Dry Matter (% of BW)[a]	TDN	Metab. Energy	Crude Protein [b]	Ca	P	Mg
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
40(low producer; single)	1.26 (3.14)	0.63	9.54	117	4.2	2.6	0.76
40(low producer; twin)	1.33 (3.33)	0.67	10.17	129	5.9	3.3	0.80
40(high producer; single)	1.46 (3.64))	0.74	11.09	142	4.5	2.8	0.76
40(high producer; twin)	1.54 (3.84)	0.78	11.72	153	6.1	3.5	0.80
50(low producer; single)	1.56 (3.11)	0.78	11.84	147	4.6	3.0	0.94
50(low producer; twin)	1.65 (3.29)	0.83	12.55	160	6.3	3.7	0.99
50(high producer; single)	1.76 (3.52)	0.89	13.39	171	4.9	3.3	0.94
50(high producer; twin)	1.85 (3.70)	0.93	14.10	185	6.6	4.0	0.99
60(low producer; single)	1.75 (2.91)	0.88	13.26	163	4.9	3.2	1.12
60(low producer; twin)	1.85 (3.08)	0.93	14.06	179	6.6	4.0	1.18
60(high producer; single)	1.95 (3.25)	0.98	14.85	188	5.2	3.5	1.12
60(high producer; twin)	2.05 (3.42)	1.04	15.65	203	6.9	4.2	1.18

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.2.8 Sub-process 1: Ewe management cycle: Phase E7-Peri-partal phase.

Defining phrase: HOW TO MANAGE THE PERI-PARTAL PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The perinatal period is defined as the period from the onset of parturition up to when the lamb is seven days old. (Haughey 1986). The peri-partal phase of the ewe management cycle is the combined period during which ewes are lambing up to the time that the youngest lamb is 7 days old.

This period is generally considered to be the bottle-neck in sheep and goat production and it therefore requires the most management effort. In many respects the management inputs aimed at other phases of the production cycle are wasted until neonatal mortalities are reduced to acceptable levels (Jacobs & Chase 2011).

Short term solutions involve management aimed at overcoming functional (behavioural), nutritional, climatic hazards but a more permanent and sustainable solution may come from selection for genetic improvements in mothering ability. Promising results are reported for selection of calm ewes. Lamb mortalities have been improved from 26% to 16% in Merino lambs (Paganoni, Nowak & Blache 2006). Although heritability of a maternal behaviour score (MBS) was found to be fairly low (less than 10%) flock managers who have persisted in applying the MBS have experienced substantial improvements in the lamb survival rate (Everett-Hincks et al 2004). An improvement in the protein content in milk of Merino ewes as well as an improvement in meat quality are possible positive benefits that may result from selection for improved MBS (Paganoni et al 2006). The standards for the MBS are listed in Table CC10-1.

The important role of olfactory recognition through the vomero-nasal organ in sheep should be borne in mind when planning the management of ewes at lambing time. Amniotic fluid (non-specific) increases the responsiveness of ewes at birth and at 4 hours after birth the ewe becomes selective and bonds with her own lamb(s). This can be used to create foster mothers if a strange lamb, still covered in amniotic fluid is introduced to a ewe within four hours of birth. This lamb will be recognised by the ewe as her own. Overcrowding and handling of ewe could disrupt this process. (Booth 2006; Nowak, Keller & Levy 2011).

Lambs require colostrum as soon as possible after birth to ensure adequate nutrition especially energy and also adequate uptake of antibodies from the colostrum. The onset of lactation may be delayed as a result of poor nutrition. Supplements fed in the last 14 days before lambing have increased colostrum production in Merino ewes by as much as 100%. It follows that this feeding strategy could be more focussed if ewes are managed in such a way that the supplements can be started just in time. The use of synchronisation, the ‘ram effect’ and ultrasound pregnancy diagnosis can assist in grouping ewes in synchronous peer groups (Paganoni et al 2006).

The use of urea to increase the crude protein content of feed in the perinatal period and during lactation has been shown to result in a decrease of the butterfat content of milk and should be avoided (Holon et al. 2002).

Lambing facilities and management during lambing time are factors that can be controlled and much improvement in lamb survival rates have been observed where a calm lambing environment has been created (Paganoni et al 2006). An aligned commitment in shepherds resulting from adequate training, a reward system and generally good labour relations are essential pre-requisites for a successful peri-partal period (Coetzee 1996). The peri-partal period is considered the time during the annual management cycle that requires the highest degree of management skills and leadership (Van Niekerk & Schoeman 1993). Flock managers may require management training in addition to technical training to enable them to lead the shepherd team (Moll 1984).

2. Objectives

Management of the peri-partal period is aimed at:

- Survival of the new-born lamb
- Survival of the ewe
- Ensuring adequate immunity in the neonate.

3. Key activities

Three key activities during this time are feeding, management and selection for temperament and good mothering ability.

4. Timing

The peri-partal period is defined as the period from birth to the age of 7 to 10 days old. This phase will therefore start at the birth of the first lamb to about 10 days after the last lamb was born,

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Neonatal mortality is the major hazard encountered during this phase. This is discussed in the neonatal phase of the replacement ewe and replacement ram cycles.

Ewe mortality from dystocia, prolapse of the vagina and uterus, uterine infections (for example *Clostridium septicum* and others) are the major hazards to the ewe that may be encountered during this phase.

Failure of transfer of maternal antibodies and the delay of the onset of parturition are further contributions of ewes to reproductive failure.

7 Nutritional requirements

This phase of the ewe management cycle is managed the same as late gestation until parturition then according to lactation requirements.

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.9 Sub-process 1: Ewe management cycle: Phase E8-Early lactation.

Defining phrase: HOW TO MANAGE THE EARLY LACTATION PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The early lactation phase is defined as the phase where the neonate is entirely dependent on his dam's milk for nutrition. A number of hazards to milk production need to be managed well to ensure growth and health in the young lamb and kid.

The nutritional needs of ewes increase dramatically in this phase and loss of weight in the ewes is inevitable but requires high levels of management. In an annual mating system this phase is about six months or 180 days before the next mating season. The nutritional status of the ewe at this stage influences the ovulation rate 6 months later, the next mating season. The process of maturation of the follicle takes six months. The cause of poor conception rates may therefore be traced back to poor nutrition during the previous peak lactation (Robinson, Rooke & McEvoy 2002).

This phase coincides with the Early Suckling phases of the Replacement Ewe Cycle (F2) and the Replacement Ram Cycle (M2).

2. Objectives

Management activities during the early lactation phase of the ewe reproduction cycle are aimed at ensuring adequate milk production and health of the lamb.
The prevention of excessive weight loss will also be of benefit in the next mating phase.

3. Key activities

Flock managers need to pay special attention to the problem of mastitis in ewes and ensure adequate nutrition, differentiated according to the number of lambs ewes suckle and the stage of lactation.

4. Timing

This period is generally considered to be 6 to 8 weeks long (NRC 1985).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards associated with the early lactation phase are hypomagnesemic tetany, hypocalcaemia, acute gangrenous mastitis and secondary problems related to loss of body weight.

7. Nutritional requirements

The NRC (1985) recommended dry matter requirements for lactating sheep ewes suckling a single lamb during the first 6 to 8 weeks of lactation is between 190% and 200% higher than maintenance and is aimed at restricting weight loss to 25 g per day during this period. This will result in a body weight decrease of 1.0 to 1.5 kg during this 6 to 8 week period.

The nutritional requirements of lactating sheep ewes suckling a single lamb during the first 6 to 8 weeks of lactation are summarized in Table E8-N1.

Table E8-N1. Nutritional requirements of lactating sheep ewes suckling a single lamb during the first 6 to 8 weeks of lactation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	2.1 (4.2)	1.36	14.3	304	8.9	6.1	3.8
60	2.3 (3.8)	1.50	15.1	319	9.1	6.6	4.1
70	2.5 (5.5)	1.63	16.0	334	9.3	7.0	4.5
80	2.6 (3.2)	1.69	16.8	344	9.5	7.4	4.7
90	2.7 (3.0)	1.75	17.6	353	9.6	7.8	4.9

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The NRC (1985) recommended dry matter requirements for lactating sheep ewes suckling multiple lambs during the first 6 to 8 weeks of lactation is between 230% and 240% higher than maintenance and is aimed at restricting weight loss to 60 g per day during this period. This will result in a body weight decrease of 2.5 to 3.4 kg during this 6 to 8 week period.

The nutritional requirements (1985) of lactating sheep ewes suckling multiple lambs during the first 6 to 8 weeks of lactation are summarized in Table E8-N2.

Table E8-N2. Nutritional requirements of lactating sheep ewes suckling multiple lambs during the first 6 to 8 weeks of lactation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	2.4 (4.8)	1.56	23.5	389	10.5	7.3	4.3
60	2.6 (4.3)	1.69	25.6	405	10.7	7.7	4.7
70	2.8 (4.0)	1.82	27.7	420	11.0	8.1	5.0
80	3.0 (3.8)	1.95	29.4	435	11.2	8.6	5.4
90	3.2 (3.6)	2.08	31.5	450	11.4	9.0	5.8

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The 2007 NRC standard for the supply of nutrients to sheep ewes is a substantial revision of the 1985 standards (National Research Council 1985; National Research Council 2007). Table E8-N3 lists the requirements for sheep ewes in early lactation for the different litter sizes.

Table E8-N3. Nutrient requirements of sheep ewes during early lactation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein[d]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.26 (2.51)[b]	0.83	12.55	177	4.6	3.9	1.7
50 (Twin)	1.61 (3.22)[b]	1.07	16.11	254	6.7	5.7	2.1
50 (Three or more)	1.88 (3.76)[b]	1.24	18.79	311	8.3	7.0	2.4
60 (Single)	1.77 (2.96)[a]	0.94	14.18	210	5.4	5.0	1.6
60 (Twin)	1.80 (3.01)[b]	1.20	18.03	281	7.3	6.3	2.4
60 (Three or more	2.09 (3.48)[b]	1.38	20.88	343	9.1	7.8	2.8
70 (Single)	1.96 (2.80)[a]	1.04	15.69	229	5.9	5.5	2.2
70 (Twin	1.98 (2.83)[b]	1.31	19.79	306	7.9	6.9	2.7
70 (Three or more)	2.29 (3.27)[b]	1.52	22.93	373	9.8	8.5	3.2
80 (Single)	2.13 (2.67)[a]	1.13	17.07	248	6.3	5.9	2.4
80 (Twin)	2.15 (2.69)[b]	1.43	21.55	330	8.5	7.4	3.0
80 (Three or more)	3.11 (3.89)[a]	1.65	24.85	404	11.3	10.3	3.5
90 (Single)	2.30 (2.56)[a]	1.22	18.45	266	6.7	6.4	2.6
90 (Twin)	2.32 (2.57)[b]	1.54	23.18	353	9.0	8.0	3.3
90 (Three or more)	3.34 (3.71)[a]	1.77	26.69	452	12.0	11.0	3.8

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The 2007 NRC standards for the supply of nutrients to meat goats is a substantial revision of the 1981 standards (National Research Council 2007). Table E8-N4 lists the requirements for meat goat ewes in early lactation for the different litter sizes.

Table E8-N4. Nutrient requirements of meat goat ewes during early lactation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein[b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50 (Single)	1.36 (2.72)[a]	0.72	10.88	153	5.5	3.5	1.57
50 (Twin)	1.54 (3.08)[a]	0.82	12.30	202	8.9	5.3	2.17
50 (Three or more)	1.61 93.23)[a]	0.86	12.89	233	12.1	6.9	2.71
60 (Single)	1.55 (2.58)[a]	0.82	12.38	172	5.8	3.8	1.82
60 (Twin)	1.75 (2.91)[a]	0.93	13.97	207	9.2	5.6	2.48
60 (Three or more	1.83 (3.04)[a]	0.97	14.60	261	12.4	7.2	3.08
70 (Single)	1.73 (2.47)[a]	0.92	13.81	191	6.0	4.0	2.07
70 (Twin	1.93 (2.76)[a]	1.02	15.44	248	9.4	5.8	2.78
70 (Three or more)	2.03 (2.90)[a]	1.07	16.23	287	12.7	7.5	3.43
80 (Single)	1.90 (2.37)[a]	1.01	15.15	208	6.2	4.2	2.31
80 (Twin)	2.11 (2.64)[a]	1.12	16.90	270	9.7	6.1	3.07
80 (Three or more)	2.22 (2.77)[a]	1.18	17.74	311	12.9	7.7	3.77
90 (Single)	2.05 (2.28)[a]	1.09	16.40	224	6.5	4.4	2.54
90 (Twin)	2.29 (2.55)[a]	1.22	18.37	291	9.9	6.3	3.36
90 (Three or more)	2.40 (2.66)[a]	1.27	19.16	334	13.2	8.0	4.11

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The daily nutritional requirements of Angora goat ewes during early gestation are summarized in Table E8-N5 The nutrient requirements for high fibre producers and low fibre producers are shown separately for either a single pregnancy status or a twin pregnancy status.

Table E8 N5. Daily nutrient requirements of Angora goat ewes during early lactation.

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
40(low producer; single)	1.38 (3.46) [a]	0.73	11.085	139	4.0	2.8	1.16
40(low producer; twin)	1.26 (3.15) [b]	0.83	12.64	169	5.4	3.4	1.48
40(high producer; single)	1.26 (3.16) [b]	0.84	12.68	164	3.8	2.6	1.16
40(high producer; twin)	1.18 (2.95) [c]	0.94	14.20	193	5.3	3.3	1.48
50(low producer; single)	1.67 (3.34) [a]	0.89	14.03	172	4.4	3.2	1.40
50(low producer; twin)	1.48 (2.96) [b]	0.98	14.83	205	5.7	3.7	1.75
50(high producer; single)	1.49 (2.99) [b]	0.99	15.00	197	4.1	2.9	1.40
50(high producer; twin)	1.64 (3.27) [b]	1.08	16.42	219	5.9	3.9	1.75
60(low producer; single)	1.84 (3.06) [a]	0.97	14.74	192	4.6	3.4	1.63
60(low producer; twin)	1.60 (2.67) [b]	1.06	16.09	217	5.8	3.8	2.02
60(high producer; single)	2.03 (3.39) [a]	1.08	16.34	216	4.9	3.6	1.63
60(high producer; twin)	1.76 (2.93) [b]	1.17	17.68	241	6.1	4.0	2.02

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.10 Sub-process 1: Ewe management cycle: Phase E9-Late lactation.

Defining phrase: HOW TO MANAGE THE LATE LACTATION PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The late lactation phase is defined as the phase where the neonate is no longer entirely dependent on his dam's milk for nutrition. A number of hazards to milk production still need to be managed well to ensure growth and health in the young lamb and kid but the effect on the lamb is not as great as during the Early Lactation phase.

The nutritional needs of ewes decrease during this phase and ewes may start recovering the weight loss that was suffered during the peak lactation phase.

This phase coincides with the Suckling/Grazing phases of the Replacement Ewe Cycle (F3) and the Replacement Ram Cycle (M3).

2. Objectives

The nutritional demands of lactation can decrease during this phase and ewes should start gaining weight or at least stop losing weight as the lamb increasingly finds other sources of nutrition.

3. Key activities

Flock managers should continue observing for cases of mastitis and ewes that have an exceptionally low body condition score. Ewe flocks will increasingly be moved to camps that are less easily observed and problems such as blowfly strike and mastitis may go unnoticed for longer periods.

4. Timing

This period is generally considered to be 4 to 6 weeks long, leading up to weaning at 10 to 14 weeks after which the lamb has to meet its nutritional requirements entirely from grazing.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the late lactation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards most commonly associated with late lactation are mastitis and hypocalcaemia

7. Nutritional requirements

The NRC (1985) recommended dry matter requirements for lactating sheep ewes suckling a single lamb is between 42% and 60% higher than maintenance and is aimed at achieving a weight gain of 45 g per day for the last 4 to 6 weeks of lactation. This will result in a body weight increase of 1.25 to 2.0 kg during this 4 week period.

The nutritional requirements of sheep ewes suckling a single lamb during the last 4 to 6 weeks of gestation are summarized in Table E9-N1.

Table E9-N1. Nutritional requirements of lactating sheep ewes suckling a single lamb during the last 4 – 6 weeks of lactation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.6 (3.2)	0.94	14.3	175	5.9	4.8	2.4
60	1.7 (2.8)	1.00	15.1	184	6.0	5.2	2.6
70	1.8 (2.6)	1.06	16.0	193	6.2	5.6	2.7
80	1.9 (2.4)	1.12	16.8	202	6.3	6.1	2.9
90	2.0 (2.2)	1.18	17.6	212	6.4	6.5	3.0

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The NRC (1985) recommended dry matter requirements for lactating sheep ewes suckling multiple lambs during the last 4 to 6 weeks of lactation is between 190% and 200% higher than maintenance and is aimed at achieving a weight gain of 90 g per day during this period. This will result in a body weight decrease of 2.5 to 3.5 kg during this 4 to 6 week period.

The nutritional requirements of lactating sheep ewes suckling multiple lambs during the last 4 to 6 weeks of lactation are summarized in Table E9-N2.

Table E9-N2. Nutritional requirements of lactating sheep ewes suckling multiple lambs during the last 4 to 6 weeks of lactation.

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	2.1 (4.2)	1.36	14.3	304	8.9	6.1	3.8
60	2.3 (3.8)	1.50	15.1	319	9.1	6.6	4.1
70	2.5 (5.5)	1.63	16.0	334	9.3	7.0	4.5
80	2.6 (3.2)	1.69	16.8	344	9.5	7.4	4.7
90	2.7 (3.0)	1.75	17.6	353	9.6	7.8	4.9

Adapted from: NRC: Nutrient Requirements of Sheep (1985dapted from: NRC: Nutrient Requirements of Sheep (1985)

The 2007 edition of Nutrient requirements for small ruminants provides tables for nutrient requirements of lactating for single, twin and three or more lambs. The lactation period has been divided up into three phases with the mid-lactation phase indicating the highest nutrient requirements. The late lactation phase differs very little from the early lactation phase.

The nutritional requirements of lactating sheep ewes suckling multiple lambs during the last 4 to 6 weeks of lactation are summarized in Table E9-N3.

Table E9-N3. Nutrient requirements of sheep ewes during mid-lactation.

Body Weight (Pregnancy status)	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein[d]**	**Ca**	**P**	**Mg**
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
50 (Single)	1.40 (2.80)	0.64	9.63	134	3.5	3.1	1.2
50 (Twin)	1.72 (3.44)[a]	0.91	13.77	210	5.4	4.9	1.3
50 (Three or more)	1.97 (3.93)[a]	1.04	15.74	254	6.6	6.0	1.6
60 (Single)	1.58 (2.63)[a]	0.844	12.64	172	4.3	4.0	1.4
60 (Twin)	1.94 (3.23)[a]	1.03	15.48	235	6.0	5.5	1.6
60 (Three or more	2.20 (3.67)[a]	1.17	17.62	281	7.2	6.6	1.8
70 (Single)	1.75 (2.51)[a]	0.93	14.02	190	4.6	4.4	1.6
70 (Twin	2.14 (3.05)[a]	1.13	17.11	257	6.5	6.1	1.9
70 (Three or more)	2.42 (3.46)[a]	1.28	19.38	307	7.8	7.3	2.1
80 (Single)	1.91 (2.39)[a]	1.02	15.32	206	5.0	4.8	1.8
80 (Twin)	2.33 (2.91)[a]	1.23	18.62	278	6.9	6.6	2.1
80 (Three or more)	2.63 (3.29)[a]	1.39	21.01	331	8.4	7.8	2.3
90 (Single)	2.07 (2.30)	1.10-	16.57	221	5.3	5.2	2.0
90 (Twin)	2.51 (2.79)a	1.33	20.08	298	7.4	7.1	2.3
90 (Three or more)	2.83 (3.15)	1.50	22.64	354	8.9	8.4	2.5

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.11 Sub-process 1: Ewe management cycle: Phase E10-Weaning.

Defining phrase: HOW TO MANAGE THE WEANING PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The weaning phase is defined as the phase where the lambs are separated from the ewes as there is no longer any benefit to the lamb to stay with its mother

The nutritional needs of ewes return to maintenance levels during this phase and ewes will be recovering the weight loss that was suffered during the lactation phase.

This phase coincides with the Weaning phase of the Replacement Ewe Cycle (F4) and the Replacement Ram Cycle (M4).

Weaning can be managed in a number of ways:

- Lambs can be removed from their mothers and moved to a new camp.
- Ewes can be removed from the lambs and moved to a new camp.
- Ewes from two flocks can be swopped around.
- Lambs can be left with their mothers with nose-rings applied to prevent them from suckling.

Weaning can be staggered with lambs being weaned as they reach a target weight. This weight can be determined by marketing requirements or by previous experience of a suitable cut-off weight that will prevent post weaning stress. Ram lambs that are not castrated may be weaned earlier than ewe lambs if they become sexually active.

Early weaning may be applied for one or more of the following reasons:

- A prevailing drought
- As part of an accelerated lambing system (Jelbart & Dawe 1984)
- Predation
- Milk producing sheep
- To overcome carrying capacity limitations of the farm.

The prerequisites for early weaning are:

- A short lambing period
- Viable lambs

- Solid immunity
- Full rumen development (Abou Ward, Tawila, Sawson, Gad, El-Nagger & El-Nagger 2008; Abou Ward 2008)
- Adequate facilities
- Available foster mothers.

The earliest age at which weaning can be practised will be determined by the lamb's body weight. Lambs weaned below 2.7 kg seldom survive. Lambs should weigh at least 7 kg. Weaning at 28 days has limited success, at 42 days it can be successful if well managed and at 56 days of age it is usually highly successful.

The decision to wean should be taken after answering the following questions:

- Is it to the advantage of the lamb if it is weaned now?
- Is it to the advantage of the ewe if the lamb is weaned now?
- What are the cost implications of weaning now?
- What lies ahead for the ewe and the lamb?

Hoon et al. (2008) have found no difference in growth for male and female Angora kids from weaning, swopping or not weaning. Does had a slight body weight benefit from weaning but no difference in reproduction rate in subsequent years. No unwanted pregnancies occurred up to the stage where the Angora ram kids became 10 months old. The decision to wean Angoras may therefore be related to other management requirements and not the effect on the kids or does.

2. Objectives

Weaning is managed to:

- Limit the stress experienced by the weaned lambs
- Ensure adequate immunity in the weaned lamb
- Limit the stress experienced by the ewes at weaning.

3. Key activities

Flock managers focus on the lambs during weaning time and may neglect observation of ewes. This can be managed by planning a flock inspection for targeted selective treatment soon after weaning. An udder inspection can be added to the five point check.

4. Timing

The actual time of weaning will differ from flock to flock. The generally accepted time of weaning is about 90 to 100 days after lambing.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

Weaning weights as a percentage of ewe weights is a commonly accepted measure of ewe efficiency and can be applied either individually (if pedigree information is available) or to the flock as a whole.

6. Hazards

Very few specific hazards play a role in this phase. Ewes that are still producing milk at this time may develop mastitis.

7. Nutritional requirements

At weaning the additional burden of a suckling lamb is no longer present and ewes do not need more than maintenance level nutrition.

The nutritional requirements of sheep ewes after weaning are summarized in Table E10-N1.

Table E10-N1. Nutritional requirements of sheep ewes after weaning (Maintenance).

Body Weight	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
50	1.0 (2.0)	0.55	8.4	95	2.0	1.8	1
60	1.1 (1.8)	0.61	9.2	104	2.3	2.1	1.1
70	1.2 (1.7)	0.66	10.0	113	2.5	2.4	1.2
80	1.3 (1.6)	0.72	10.9	122	2.7	2.8	1.3
90	1.4 (1.5)	0.78	11.8	131	2.9	3.1	1.4

Adapted from: NRC: Nutrient Requirements of Sheep (1985)

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.12 Sub-process 1: Ewe management cycle: Phase E11-Rest phase.

Defining phrase: HOW TO MANAGE THE RESTING PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

The rest phase is defined as the period after weaning where the ewe is allowed to recover fully from the previous gestation and lactation. The regression of udder tissue and the recovery of body fat reserves can take place. Ewes also need to restore muscle mass to the levels before the previous pregnancy.

Live vaccines that cannot be administered during pregnancy and lactation are used now. The upward curve of growth also contributes to an improved level of immunity.

2. Objectives

The ewes should increase in weight and body condition score to ensure good reproductive performance at the next mating.

3. Key activities

As udders regress lesions may become more noticeable and abscesses may develop. Abscesses of the teat canal can be treated if observed early.

4. Timing

This period is 120 days or less, depending on the mating system.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or

current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards that may be encountered during this phase are similar to the hazards that are listed in the Ewe selection phase: E1.

7. Nutritional requirements

The nutritional requirements of sheep ewes during the rest phase are met by the maintenance level as listed in table E1-N1, E1-N2 and E1-N3

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.2.13 Sub-process 1: Ewe management cycle: Phase E12-Replacement.

Defining phrase: HOW TO MANAGE THE REPLACEMENT PHASE OF THE EWE MANAGEMENT CYCLE

1. Description

Ewe replacement is the process of procuring maiden ewes to replace the number of ewes that are culled during the Ewe Selection phase. Replacement maiden ewes are normally raised on the farm but may also be purchased from other breeders.

Biosecurity concerns are paramount in the introduction of new ewes to the flock. Biosecurity procedures should be in place when replacement ewes are introduced from external sources as well as from internal sources.

2. Objectives

The maintenance of the required ewe flock size by introducing replacement maiden ewes.

3. Key activities

A thorough examination and classing of the maiden ewe flock to select the replacement maidens and the re-establishment of flocks should be performed bearing in mind the potential biosecurity hazards of moving sheep on the farm or introducing them from outside.

4. Timing

Replacement usually takes place after the classing of the mature ewe flock. (CC1 – Ewe selection).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewes require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards that may be encountered during this phase are similar to the hazards that are listed in the Ewe selection phase: E1.

7. Nutritional requirements

Mature ewes require nutrients at maintenance levels during this phase. The requirements for sheep, meat goats and Angora goats are listed in table E1-N1, E1-N2 and E1-N3 respectively.

The flock health and production plan may require that ewes are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.3 Subprocess 2. Ram Management Cycle

3.3.1 Introduction

The ram management cycle consists of one or more mating periods preceded by preparatory phases and followed by rest phases. Rams that are used for one mating period per year will therefore be in a rest phase for a large proportion of the year whilst rams that are used repeatedly during the year may be in a preparatory phase for a large proportion of the year. Accelerated lambing systems may require that rams are kept at an optimal nutritional status throughout the year. For the sake of this study the ram management cycle will be described for a single mating season per year. The phases of this cycle are described in table 3.3.1.

Table 3.3.1. Phases of the Ram Management Cycle

Phase number	**Description**
R1	Selection
R2	Preparation (2)
R3	Mating
R4	Recovery
R5	Rest
R6	Replacement
R7	Preparation (1)

3.3.2 Sub-process 2: Ram management cycle: Phase R1-Selection.

Defining phrase: HOW TO MANAGE THE SELECTION PHASE OF THE RAM MANAGEMENT CYCLE

1. Description:

Ram selection is the process of examining all potential breeding sires with the objective of finalising the composition of the group of rams that will be prepared before performing CC15 Ram genital soundness in the near future. Rams that no longer meet the requirements can be culled before incurring feeding costs and the cost of performing a genital soundness examination on them.

2. Objectives:

Ram selection is performed to:

- Select the rams which meet breed standards for introduction into the breeding flock
- Identify rams which are no longer suitable for use in the breeding flock
- Identify and eliminate rams that present a threat to internal bio-security

3. Key activities

Mature and young rams are examined for soundness and age. Young rams are, in addition, examined to establish their suitability for production for example wool characteristics and conformation.

Selection can be performed by the flock manager, assisted by his helpers, an inspector from a breed society or by a trained technical official from a marketing organisation specialising in the primary product being produced. This may lead to emphasis on one or more specific breed characteristics and not necessarily a holistic approach that takes health, reproduction and production aspects into account. Flock health and production consultants (FHPC) may influence the process by structuring the process. An example of a checklist that could be used to ensure consistency and control of the process is provided in Table R1-1.

Table R1-1. Ram selection checklist

Step	**Characteristic**	**Standard**
1	Dentition	Age: (correlate with year tag, tattoo or ear mark) 2 tooth : 15 months 4 tooth : 24 months 6 tooth : 36 months 8 tooth : 48 months Old : 60 months Worn : 72 months Excessive wear : More than 72 months Broken mouth or missing molars.
2	Body condition score	BCS on a scale of 1 to 5 or 1 to 9 can be used. Previous use records could be used to allow differentiation. Differentiation on age may be allowed.
3	Feet and mobility	Overgrown and deformed feet should be a penalty if the vast majority of rams have normal feet. Growth rings on claws may indicate a historical stress or disease period. Lameness in all degrees and forms.
4	Signs of disease	The 5 point examination for internal parasites. Abscesses especially in regional lymph nodes. Respiratory distress. Tender wool or broken fleece. Signs of eye disease. External parasites.
5	Scrotum and contents	Injuries, asymmetry, dermatitis, parasites Regional lymph nodes: Enlarged or abscessated. Severe fibrosis/ hardening of testes. Severe atrophy/ loss of tone (Previous use record could be used to allow differentiation).
6	Record of performance	Rams that are marginal on points 1 to 3 above may be pardoned if they have an exemplary lambing/weaning record. Longevity of the flock will be improved.
7	Production characteristics	Rams that are marginal on points 1 to 3 above may be pardoned if they have exceptionally good fertility characteristics. Longevity of the flock will be improved

4. Timing:

Ram selection takes place before the preparation of rams for genital soundness examination and later mating. It is usually done a few weeks after the first phase of preparation has commenced. Young rams that have been selected can be vaccinated with live vaccines that provide life-long immunity as they are likely to remain in the flock for a number of years.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

Stud managers may also record individual ram data pertaining to breed standards.
The findings for each ram as well as the totals from each age group, culled for different reasons, are recorded for the critical control point CCP2 – Ram Selection of the Ram selection data form (Addendum B-CC2). The following reasons for culling are listed in the form:

- Abscess
- Blowfly
- Cancer
- Famacha score
- Feet
- Teeth
- Scrotum
- Body weight
- BCS.

These categories should be adapted to suit the prevailing conditions on each farm and flock.

6. Hazards

The potential hazards to reproduction that may be identified during this phase are listed in the data form described above (Addendum B-CC2).

7. Nutritional requirements

Table R1-N1. Daily nutrient requirements of sheep rams, meat goat rams and Angora rams for maintenance.

Body Weight (BW)	Dry Matter (% of BW)[a]	TDN	Metab. Energy	Crude Protein [b]	Ca	P	Mg
Kg	Kg	Kg	Mega joules	Gram	Gram	Gram	Gram
Sheep ram 75[c]	1.46 (1.95)	0.77	11.63	104	2.8	2.5	1.4
Sheep ram 100	1.77 (1.77)	0.94	14.14	128	3.3	3.1	1.8
Sheep ram 125	2.09 (1.67)	1.11	16.74	152	3.8	3.7	2.2
Meat buck 75	1.55 (2.06)	0.82	12.38	105	2.7	2.2	1.31
Meat buck 100	1.92 (1.92)	1.02	15.36	130	3.2	2.7	1.75
Meat buck 125	2.27 (1.82)	1.20	15.93	153	3.7	3.2	2.19
Angora ram 40[d]	1.45 (3.62)	0.73	11.00	116	2.5	2.1	0.70
Angora ram 50[d]	1.76 (3.52)	0.89	13.34	136	2.9	2.5	0.88
Angora ram 60[d]	1.96 (3.26)	0.99	14.85	157	3.2	2.8	1.05

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

[c] By extrapolation

[d] High fibre growth accepted as standard

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.3.3 Sub-process 2: Ram management cycle: Phase R2-Preparation (2)

Defining phrase: HOW TO MANAGE THE PREPARATION PHASE 2 OF THE RAM MANAGEMENT CYCLE

1. Description

Ram preparation is the process of preparing rams for mating with the objective of optimising their reproductive performance. This includes preventative health procedures and increased nutrition.

2. Objectives

The objectives of this phase are an increase in body condition score and semen quality of the rams.

3. Key activities

Rams are vaccinated as required and specified on the Flock Health Plan. Vaccines protecting against enterotoxaemias may need to be administered before commencing concentrate feeding.

External and internal parasite control is practised to reduce the need for handling during mating time.

Autumn mating often coincides with an increase in ticks activity and prophylactic treatment may be required as part of the preparation of rams for mating. Depending on the nematode species autumn is often a period of transition between species and it may be the end of the season for summer parasites and the start of the season for winter parasites. Appropriate steps need to be taken to ensure adequate flock immunity and resilience where prophylactic drenching is not advised in order to prevent the development of anthelmintic resistance in nematodes. Autumn is also the danger period for the development of liver fluke (*Fasciola*) and conical fluke (*Calicophoron* species) and environmental management activities may be practised to prevent infestation and the negative effects on reproduction in small ruminants.

Spring mating often coincides with an increase in summer parasite challenges. Appropriate steps need to be taken to ensure adequate flock immunity and resilience where prophylactic drenching is not advised in order to prevent the development of anthelmintic resistance in nematodes. The most common spring and summer parasite is *Haemonchus contortus*. The Targeted Selected Treatment method of monitoring and treatment is the preferred method for managing the *Haemonchus* challenge (Bath & van Wyk 2009).

Rams are treated with nutritional supplements which will support the objectives of this phase. Trace element and vitamin supplements may be administered at the start of the preparation phase.

Rams are provided with nutrition as supplement or natural grazing of sufficient quantity and quality to ensure weight gain during this period. Saved pastures with high nutritional value may be preferred to ensure that weight gain targets are met in the preparation period. Pasture should be at least 4 cm in length for goats (Thompson 1990b) although goats are more inclined to browse (McGregor 1990). Alternatively lick supplementation, hay, grains or complete feeds may be utilised to achieve the weight gain targets that are set in the flock health and production plan.

A sample of rams from each flock may be weighed at regular (usually weekly) intervals to monitor weight gain or a formal individual body condition score may be recorded to monitor weight gain. Rams may be separated into peer groups to avoid fighting during this period based on size, age and body condition score. In fibre producing sheep and goats, bellies may be clipped to remove any excessive wool or hair from the lower abdomen where sharp plant material may attach and interference with mating.

4. Timing

The total time for preparation of rams (R7 -phase 1 and R2 – phase 2) should be more than 7 weeks. The sperm production cycle is 49 days long dictating at least 8 weeks of supplementation or superior nutrition (Lapwood 1986).

Ram selection and Genital soundness examinations should be completed 4 weeks before mating to allow time for corrective actions and retesting. It leaves an additional 4 weeks of preparation during Phase 2 preparation.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The preparation data are recorded on the Ram Preparation data form (Addendum B-CC4). The average body condition score (BCS) for each group is recorded at the start and end of the flushing period. Different methods of flushing can be coded and recorded for each flock if the flocks are not treated the same. The dates and results of the weight monitoring are recorded. The data can be visually presented as a graph for each flock to enable historical comparisons with the resulting conception rate and to provide a basis for assessing the cost-benefit ratio of supplementary feeding.

These records will form the basis of Critical Control Point 4- Ram preparation.

6. Hazards

Hazards that may be encountered during this phase are related to the increased nutrition, possible increased fighting and seasonal disease and parasite threats that may influence fertility.

7. Nutritional requirements

Rams should be fed at a higher than maintenance level during the ram preparation phase. Good quality bio-diverse natural grazing is the preferred source as the risk for metabolic diseases and digestive disturbances is minimal. However, supplementary feeding may be required to ensure adequate "flushing" of rams, maximum semen production and the build-up of reserves for the mating period which may be stressful. If supplementary feed is supplied to ewes during mating time it is important to adapt rams to the feed that they will receive while running with the ewes. Feeding levels should also not be at such a level that a sudden decrease when the rams are joined to the ewes leads to digestive and metabolic disturbances. The recommended nutrient requirements for rams and goats are listed in table R2-N2.

Table R2-N2. Daily nutrient requirements of sheep rams, meat goat rams and Angora rams for breeding.

Body Weight (BW)	**Dry Matter (% of BW)[a]**	**TDN**	**Metab. Energy**	**Crude Protein [b]**	**Ca**	**P**	**Mg**
Kg	**Kg**	**Kg**	**Mega joules**	**Gram**	**Gram**	**Gram**	**Gram**
Sheep ram 75[c]	1.61 (2.14)	0.84	12.55	119	3.0	2.7	1.6
Sheep ram 100	1.95 (1.95)	1.03	15.56	150	3.6	3.4	1.9
Sheep ram 125	2.30 (1.84)	1.22	18.41	179	4.2	4.1	2.3
Meat buck 75	1.70 (2.27)	0.90	13.64	115	2.9	2.4	1.31
Meat buck 100	2.11 (2.11)	1.12	16.90	143	3.4	3.0	1.75
Meat buck 125	2.50 (2.00)	1.32	20.00	168	4.0	3.5	2.19
Angora ram 40[d]	1.59 (3.98)	0.80	12.09	128	2.7	2.3	0.70
Angora ram 50[d]	1.76 (3.52)	0.89	14.68	157	3.2	2.7	0.88
Angora ram 60[d]	1.96 (3.26)	0.99	16.36	172	3.5	3.0	1.05

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

[c] By extrapolation

[d]. High fibre growth accepted as standard

Adapted from: Nutrient Requirements of Small Ruminants (National Research Council 2007)

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.3.4 Sub-process 2: Ram management cycle: Phase R3-Mating

Defining phrase: HOW TO MANAGE THE MATING PHASE OF THE RAM MANAGEMENT CYCLE

1. Description

The mating phase is the period during which rams run with the ewes individually or as groups, or are used for hand-mating or artificial insemination.

2. Objectives

The supply of sufficient, genitally sound rams or semen to ensure the best possible conception rate and lambing percentage is a vital management objective.

3. Key activities

Rams should be disturbed as little as possible during mating time. However regular inspections for blowfly strike especially poll strike should be undertaken. Venereally transmitted diseases such as necrotic balanoposthitis may require weekly inspection of rams.

4. Timing

Rams are joined with the ewes for variable periods as described in Phase E3- mating

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The mating period may be stressful to rams and decrease their immunity. Parasites and infectious diseases may follow on this. The possibility of the transmission of venereal diseases is however the major concern during this period. Behaviour patterns may also contribute to injuries and even deaths.

7. Nutritional requirements

Nutrition is managed to prevent or minimise weight loss in ewes and rams. Rams that are running with the ewe flock during mating time will receive the same nutrition as the ewes. Rams may be removed from the ewe flock for the purpose of resting and supplementary feeding. The standards for breeding rams (Table R2-N1) will meet with the requirements of the rams. The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.3.5 Sub-process 2: Ram management cycle: Phase R4-Recovery

Defining phrase: HOW TO MANAGE THE RECOVERY PHASE OF THE RAM MANAGEMENT CYCLE

1. Description

The period following mating where rams are allowed to recover body reserves and immunity may be a passive management action but can contribute to reproductive failure in accelerated lambing systems if recovery is prolonged.

2. Objectives

Rams should be restored to full genital soundness and general health as soon as possible after the end of the mating period.

3. Key activities

Rams should be thoroughly examined and findings recorded at the onset of this phase and monitored at selected intervals to ensure that recovery is complete.

4. Timing

Rams should recover fully in six to eight weeks. The rest phase follows as soon as it has been established that rams have recovered fully.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Hazards that may be identified during this phase relate to the effects of nutrition and stress during the mating period as well as the effects of venereally transmitted diseases. Injuries resulting from re-establishing the pecking order may be found when rams are re-introduced to the ram flock.

7. Nutritional requirements

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.3.6 Sub-process 2: Ram management cycle: Phase R5-Rest

Defining phrase: HOW TO MANAGE THE REST PHASE OF THE RAM MANAGEMENT CYCLE

1. Description

Rams are maintained at their required body condition score for the entire rest period after recovery from the mating season. The rams may be neglected during this period and are often placed in camps that are not managed well. Increased exposure to parasites and toxic or damaging plants may occur.

2. Objectives

Rams should be maintained in good health for the entire rest period. Rams are more valuable animals and increased monitoring should prevent unnecessary losses.

3. Key activities

Regular monitoring of weight, body condition score and parasite status with the five point check as well as faecal egg counts should be performed.

4. Timing

This phase is usually extended and may be as long as 8 months. In accelerated lambing systems it may be as short as one month.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or

current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Rams are subject to general hazards during the rest phase but fighting may contribute to higher rates of injury and mortalities.

7. Nutritional requirements

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.3.7 Sub-process 2: Ram management cycle: Phase R6-Replacement

Defining phrase: HOW TO MANAGE THE REPLACEMENT PHASE OF THE RAM MANAGEMENT CYCLE

1. Description

Rams that have become genitally unsound are replaced by young rams that have been raised and performance tested on the farm by rams purchased from stud breeders or other farmers.

2. Objectives

The number and quality of the rams that are introduced should ensure the maintenance of sufficient mating capacity to ensure that targets for conception rates and predicted lambing percentages are met.

3. Key activities

Rams are introduced to the ram flock and care is taken of the following:

- Biosecurity measures to prevent the introduction of diseases and parasites
- Prevention of fighting and injury to new rams.

4. Timing

This phase is determined by the scheduling of ram sales. The introduction of replacement rams from the farm's own lamb crop should take place before the phase 1 preparation of rams start to ensure that all rams have received the same treatment up to the selection phase and the genital soundness examination.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards that may be identified during this phase relate to the potential bream in bio-security resulting from the introduction of rams from other flocks. New rams may also contribute to the disruption of the social structure of the ram group resulting in fighting and injury.

7. Nutritional requirements

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1

3.3.8 Sub-process 2: Ram management cycle: Phase R7-Preparation (1)

Defining phrase: HOW TO MANAGE THE PREPARATION PHASE (1) OF THE RAM MANAGEMENT CYCLE

1. Description

The preparation of rams may be performed on natural pastures which carries the lowest risk for potential hazards. Supplementary feeding may be inevitable if the natural grazing is unable to ensure adequate weight gain and semen improvement. Exercise will occur naturally on pastures but may be necessary for stall-fed rams.

The use of lupines to improve fertility in rams is well documented. Testicular size increases after only 4 weeks of feeding lupines but an increase in the production of spermatozoa is only seen after eight weeks (Viñoles Gil et al 2006).

Urea in supplements may lead to alkaline urine and discomfort in rams. This manifests as poor groin colour and reduced libido in some instances. Alkaline urine may also contribute to a higher incidence of phosphate crystals if grains are fed and uroliths may lead to obstruction of the urethra.

2. Objectives

Rams should increase in body condition score, fitness, semen quality and libido during this phase.

3. Key activities

Ram nutrition and exercise as well as close observation for diseases and parasite problems that could negatively impact on genital soundness are the main functions of the flock manager during this phase.

4. Timing

Rams have to received improved levels of nutrition for at least 8 weeks to result in an improved level of sperm production (Viñoles Gil et al 2006). Spermatogenesis takes 47 days to complete (Hafez & Hafez 2008). The preparation of rams should therefore commence at least eight weeks to two months before mating time.

The ram preparation phase 1 is preceded by the replacement phase where new rams are introduced and old rams are removed from the ram flock.

The ram preparation phase 1 is followed by the ram selection phase during which rams are evaluated for their suitability as breeding sires as well as their genital soundness.

This phase should be at least 28 days long to allow for some response to improved nutrition to be seen. Sufficient time should be left for corrective action after the selection phase and before mating time.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or rams require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the ewe preparation phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The major hazards that occur during this phase will be related to the onset of supplementary feeding. Rumen acidosis, urea poisoning and urolithiasis are the most commonly found hazards.

7. Nutritional requirements

The flock health and production plan may require that rams are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.4 Subprocess 3. Replacement Ewe Cycle

3.4.1 Introduction

The management of replacement ewes is an important aspect of the management of the flock. This cycle should result in sufficient numbers of replacement ewes that allows for selection so that genetic progress can be achieved. The management of this cycle requires a balance between ensuring that replacement ewe lambs grow sufficiently well to become productive, fertile members of the adult ewe flock and, on the other hand, not allowing replacement ewes to grow out to a body size with nutritional requirements that exceed the available resources in the environment. Extensive farmers often fail to ensure the survival of adequate numbers of replacement ewe lambs and consequently have to purchase replacement ewes. This poses a large biosecurity and genetic risk.

Flock managers, especially in extensive production systems, should aim to create a genotype that is maximally adapted to its environment. This would mean that some culling by the environment should take place. Poor survival rates of replacement ewe lambs makes this difficult to achieve and flock managers are forced to care for replacement ewe lambs to ensure that they are grown out well and contribute to production and cash flow. The “environmental culling” can be achieved by raising replacement ram lambs that are exposed more too environmental hazards. These rams can contribute to the goal of creating an adapted genotype.

The replacement ewe cycle is divided into 7 phases as listed in Table 3.4.1.a.

Table 3.4.1.a. Phases of the Replacement Ewe Cycle

Phase code	Phase description
F1	Neo-natal
F2	Early suckling
F3	Suckling/grazing
F4	Weaning
F5	Post weaning
F6	Teething
F7	Maturing

One of the most important aspects of managing the replacement ewe cycle is to monitor growth rates throughout the cycle to ensure that growth targets are met – resulting in replacement maiden ewes that will be fertile and productive. Each flock will build up a record of weights and the resulting conception rates that will become the norm for the flock. Table 3.4.1.b provides target weights for goats that may be used as guidelines in flocks where historical records are not available.

Table 3.4.1.b. – Target weights for goat ewes

	Birth (kg)	6 months (kg)	12 months (kg)	18 months (kg)	Adult (kg)
Angora	2.5 – 3.0	18 - 25	28 - 33	35 - 45	50 - 60
Proportion of mature weight [b]	0.04 - 0.06 (0.05)[a]	0.30 - 0.50 (0.36)[a]	0.46 - 0.66 (0.56)[a]	0.58 - 0.90 (0.70)[a]	1.00
Cashmere	2.5 – 3.0	13 - 18	20 -25	25 - 30	35 - 65
Proportion of mature weight [b]	0.04 – 0.09 (0.07)[a]	0.20 – 0.51 (0.37)[a]	0.31 – 0.71 (0.57)[a]	0.38 – 0.86 (0.38)[a]	1.00
Meat breeds	3.5 – 4.5	25 - 30	35 - 45	45 - 55	55 - 65
Proportion of mature weight [b]	0.05 – 0.08 (0.06)[a]	0.38 - 0.54 (0.45)[a]	0.54 – 0.81 (0.64)[a]	0.69 – 1.00 (0.82)[a]	1.00

[a] value in brackets is the proportion of the minimum values

[b] range of (minimum to maximum) proportion to (maximum to minimum) proportion

(Adapted from Thompson (1990a))

The seven phases of the replacement ewe cycle will be discussed separately.

3.4.2 Sub-process 3: Replacement ewe cycle: Phase: F1-Neo-natal

Defining phrase: HOW TO MANAGE THE NEONATAL PHASE OF THE REPLACEMENT EWE CYCLE

1. Description

The neonatal phase of the replacement ewe cycle is the period from birth until the lamb is seven to ten days old. It is the most limiting period of the entire production cycle in many flocks. It is a period that requires high levels of management even in extensive systems. This phase deals with the requirements of the lamb. The requirements of the ewe are described in Phase E7, the peri-partal phase of the ewe management cycle.

2. Objectives

This cycle should be managed to ensure that:

- The maximum number of viable lambs survive
- Adequate transfer of collostral antibodies from the dam to the neonate.

3. Key activities

The duties of the flock manager during this phase are exactly the same as described for the Peri-partal phase of the ewe reproduction cycle (E7). The treatment of lambs to prevent navel chord infection, the administration of colostrum by stomach tube and tagging are activities that form part of this phase of the replacement ewe cycle.

4. Timing

The perinatal period is defined as the period from the onset of parturition up to when the lamb is seven days old (Haughey 1986). The peri-partal phase of the ewe management cycle is the combined period during which ewes are lambing up to the time that the youngest lamb is 7 days old.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the neonatal phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The main hazard during this phase is described by Haughey as the stillbirth, mis-mothering, exposure (SME) complex (Haughey 1981; Haughey 1986; Haughey 1991). Predation of newly born lambs and diseases such as Colibacillosis and Lamb Dysentery contribute to the losses. Mis-mothering includes the perinatal pathology caused by dystocia, lack of milk and failure to nurse.

7. Nutritional requirements

The only requirement of a ewe lamb during this phase is an adequate supply of colostrum in the first few hours of life. Lambs that have received adequate energy via the colostrum are able to withstand adverse weather conditions and will be protected against infections by the transfer of passive immunity.

3.4.3 Sub-process 3: Replacement ewe cycle: Phase: F2-Early suckling

Defining phrase: HOW TO MANAGE THE EARLY SUCKLING PHASE OF THE REPLACEMENT EWE CYCLE

1. Description

The early suckling phase is the phase during which the ewe lamb is entirely dependent on the dam for its nutrition. Lambs begin eating solid food by the age of 14 to 21 days. Creep feed can therefore be offered at this early age. During this phase lambs may be tagged, tailed and under certain circumstances even vaccinated although the lamb may not be able to respond very well.
Ill-thrift, which is defined as lambs growing slower than normal can be seen during this phase but will require careful monitoring. A methodology for assessing the growth rate of lambs requires the recording of birth weight and date and can be used to identify ill-thrift (Erasmus 1978).

2. Objectives

This cycle should be managed to ensure that:

- The maximum number of lambs survive
- Lambs are introduced to good quality solid food that will ensure an early start to rumen development
- Lambs are protected against climatic and predator hazards
- Growth rates targets are met and cases of ill thrift identified and managed separately.

3. Key activities

Lambs may be marked during this phase. This process will include tagging, tattooing, ear notching, and tail docking. Tailing is done as early as possible to minimise post-tailing complications. Lambs that are born in lambing pens can be docked under the age of 7 days which, if performed correctly, can be without any side-effects.

Lambs that did not receive adequate collostral transfer of antibodies may be susceptible to diseases such as enterotoxaemia and pasteurellosis. Mortalities from enterotoxaemia (*Clostridium perfringens D*) occur at the age of 21 days when they start eating solid food. Vaccination at this early stage is successful in protecting lambs. Booster doses will be needed.

Management of the environment is extremely important in this phase if lactating ewes and lambs are housed intensively. Foot rot, coccidiosis, omphalophlebitis, opthalmia and spinose ear tick infestations are a few examples of hazards that occur in lambing ewes that are confined in small camps.

4. Timing

This phase is defined as the phase during which lambs are dependent on milk for survival and normal growth. It follows the neonatal phase which ends at 7 to 10 days old and precedes the phase during which the lamb's nutritional needs are met mostly by grazing. This phase therefore ends at the age of 40 to 60 days depending on the breed and the environment. This phase coincides with the early lactation phase of the ewe reproduction cycle (E8).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the suckling phase these will be recorded in the Hazard Events form (Addendum B-PC4)

Accurate statistics about lambing is often not available until marking time. The number of lambs alive at marking therefore forms an important point in appraising the reproductive efficiency of a flock.

6. Hazards

Lambs that have reached the age of 7 to 10 days are usually not considered to be in danger of dying from peri-partal problems. The major hazards in this phase will be related to environmental hygiene if lambs are housed or kept in small paddocks. Lambs that have received inadequate passive immunity may be under threat from infectious agents. Some genetic defects may become apparent during this phase when lambs become more active and less closely associated with their dams. Predation remains a threat especially if ewes and lambs are moved out of the protected environment onto natural grazing. Management factors that may influence the quality and quantity of the dam's milk may influence lambs through malnutrition. For example: Vaccination of ewes with live viral vaccines such as Blue-tongue during this phase may indirectly result in coccidiosis in lambs, the result of nutritional stress. Poor quality roughage or urea fed to ewes may result in reduced butterfat levels in milk and undernourishment of lambs.

7. Nutritional requirements.

Lambs are dependent on milk from their mothers. Creep feeding is becoming increasingly popular as an aid to ensuring adequate growth in lambs and preparing the lambs for earlier weaning. Creep feeding is provided to lambs inside an enclosure with adjustable openings to prevent ewes form entering.

Lambs can be weaned form milk onto a complete meal at the age of 30 days on condition that they weigh at least 9 kg (Van der Merwe 1977).

The NRC does not provide detailed requirements for creep feed but suggests that it is composed of ground forage and a protein source (for example soya bean meal) with less than 15 per cent fermentable carbohydrate to avoid enterotoxaemia and rumen content putrefaction (National Research Council. 2007).

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.4.4 Sub-process 3: Replacement ewe cycle: Phase: F3-Suckling/Grazing

Defining phrase: HOW TO MANAGE THE SUCKLING/GRAZING PHASE OF THE REPLACEMENT EWE CYCLE

<u>1. Description</u>

The suckling/grazing phase of the replacement ewe cycle is the phase during which the ewe lamb can no longer be sustained by the dam's milk. The rumen has developed sufficiently to allow the intake of forage and supplements.

<u>2. Objectives</u>

This cycle should be managed to ensure that:

- Maximum numbers of replacement ewes survive
- Adequate growth rates are achieved so that targets for the body weights of maiden ewes are met at first mating.

<u>3. Key activities</u>

In extensive systems predation becomes a serious problem at this stage as the lambs become favoured targets for predators. Regular inspection, the provision of guard dogs and overnight protection in paddocks are required to prevent losses of large numbers of lambs.

If the production system requires early weaning onto pastures or into a feedlot, early vaccination against Enterotoxaemia (*Clostridium perfringens D*), Blood gut (*Clostridium perfringens A*) and Pasteurellosis may be required.

The general health of the lamb flock can be monitored from this phase onward by critical control points CC18, CC19 and CC20.

<u>4. Timing</u>

This phase is defined as the phase during which lambs are less dependent on milk for survival and more on grazing. Lambs have a fully developed rumen function at the age of 6 to 8 weeks (Erasmus 1978). This phase follows the early suckling phase which ended at 40 to 60 days old and precedes the weaning phase. This phase therefore ends at the weaning age which can be between 90 days and 5 to 7 months, depending on the breed and the environment. This phase coincides with the late lactation phase of the ewe reproduction cycle (E8).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the suckling/grazing phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Inexperienced lambs may consume toxic plants. Supplements containing urea may be dangerous for lambs as the rumen micro-flora are not sufficiently well developed to convert urea to protein and absorption of urea may occur, resulting in toxicity.

Predation causes large losses in flocks during this phase as the lambs are a\easy targets and have grown sufficiently to provide a sought after meal for most smaller predators.

Lambs are more exposed to digestive disturbances and parasites during this phase when grazing activities increase and suckling decreases. Nematode and cestode parasites, coccidiosis and enterotoxaemias are common disease problems that start in this phase.

7. Nutritional requirements.

As grazing takes over from milk as a food source, the deficiencies experienced on the pastures start playing a role. The provision of lick supplements and full feeds may be required at this stage. As the rumen development is still in progress the use of urea may not be as successful as natural protein in supplying protein needs. Good quality roughage is essential to stimulate rumen development. Mineral requirements are high and may need to be supplemented.

The nutrient requirements of growing lambs are listed in Table F5-1 in paragraph 4.3.6.

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.4.5 Sub-process 3: Replacement ewe cycle: Phase: F4-Weaning

Defining phrase: HOW TO MANAGE THE WEANING PHASE OF THE REPLACEMENT EWE CYCLE

1. Description

Weaning is the phase during which lambs are removed from their dams to terminate the supply of milk to the lamb. Weaning can be achieved by physically separating the lambs form the ewes, swopping the lambs and ewes or applying nose rings that will prevent lambs from suckling (Hoon, Olivier & Griessel 2008).

Lambs wean themselves progressively more and may become nutritionally totally independent even before flock managers take the decision to enforce weaning.

Flock managers are often confronted with the situation where lambs are no longer benefiting from the presence of the ewe but, instead, find themself in competition for scarce resources.

The weaning phase and the early post-weaning phase may be stressful to lambs and lead to a reduction of flock immunity. It is therefore important to prevent losses by vaccination, parasite control and nutritional management before weaning takes place.

2. Objectives

This phase should be managed to ensure that:

- Weaning stress is reduced as much as possible
- Lambs receive adequate nutrition
- The immunity of the lambs is kept at optimal level.

3. Key activities

Lambs should be vaccinated before weaning against Enterotoxaemia and Pasteurellosis.

Vaccination against viral diseases for example, Bluetongue, Rift Valley Fever, and Wesselsbron Disease may be administered at this stage or postponed until after the weaning stress period to ensure adequate life-long immunity. These live vaccines may contribute to the stress by causing a variable febrile reaction.

Lambs should receive supplements before weaning to allow adaption of the rumen flora. Lambs should be moved to the camp in which they will run after weaning a few days before weaning to enable them to find the water sources together with their more experienced mothers. This will also reduce the potential of injury and the negative effect of lambs attempting to return to their mothers. A few old ewes may be left with the lambs to provide leadership.

4. Timing

Weaning should take place when the benefits of weaning outweigh the possible negative effects for both the lamb and the dam. The age of weaning is determined by the breed, nutritional level, climate and the management priorities on the farm. Marketing considerations are less important for ewe lambs than ram lambs as most, if not all, ewe lambs will not be sold at weaning. Weaning is mostly practised at 90 to 100 days of age but may be as late as 150 and even 210 days where resources are limiting. Vaccinations should however not be postponed as lambs lose passive immunity at a certain age irrespective of weaning status. A nominal weaning age of 90 days is considered to be a good benchmark for the implementation of a weaning immunisation program even if the physical weaning takes place much later.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the weaning phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Weaning hazards follow from the stress of changed nutritional patterns and social disruption. Lambs often consume toxic plants after weaning. The intake of food and water may be disrupted as lambs attempt to return to their mothers and often lie waiting at the gate of fence for a few days after weaning. This can be overcome by correct management as stated above. The flock health and production plan should provide detailed instructions about weaning time to prevent these hazards.

7. Nutritional requirements

The changes accompanied by moving to new camps, the removal of the source of milk and changed behaviour patterns can have a negative influence on the nutritional status of the weaned ewe lamb. Supplements in the form of a lick, full feed, grains or hay can be introduced to lambs prior to weaning to allow adaption of the rumen micro-flora as well as allowing the lambs to learn from the example of their mothers. The continued supply of these supplements for a period after weaning will reduce the potential negative effects of weaning.

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.4.6 Sub-process 3: Replacement ewe cycle: Phase: F5-Post weaning

Defining phrase: HOW TO MANAGE THE POST WEANING PHASE OF THE REPLACEMENT EWE CYCLE

1. Description

The post weaning period requires continued growth of ewe lambs towards the targets set by the flock health and production plan for minimum weight of maiden ewes at first mating. A target weight of 65 to 70 % of potential adult weight is considered adequate. The historic weights can provide guidelines for monthly targets taking seasonal fluctuations into consideration. Management of the post weaning phase is monitored by the critical control point Ewe replacement (CC13).

2. Objectives

This phase should be managed to ensure that:

- Ewe lambs meet growth targets at first mating
- Minimise losses from predation and other hazards.

3. Key activities

A sample of weaner ewes from each flock should receive a permanent marking (red tags are suggested) and weighed monthly. The average weights are recorded in graph format and compared with the targets and historical results. This allows for early diagnosis of ill-thrift and corrective actions.

The weaner ewe lambs are often considered to be the most vulnerable group in the flock and should receive attention at least every month as to body condition score (CC18), helminthic status CC19) and nutritional status (CC20).

4. Timing

This phase follows on weaning and continues to first mating as required by the flock health and production plan. Where ewe lambs are mated at 18 months old this phase ends at phase F6 – teething and resumes as the maturing phase F7.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the post weaning phase these will be recorded in the Hazard Events form (Addendum B-PC4).

Monthly weights of the target ewes are recorded for the purpose of evaluation in critical control point E13 – Ewe replacement.

Records of body condition score, helminthic status and nutrition status are described in critical control points CC18 , CC19 and CC20.

6. Hazards

The steady, gradual erosion of the replacement ewe flock is a commonly reported phenomenon in small ruminant production. Predators are reported to be the most common cause of losses whilst parasites, malnutrition and infectious disease are also commonly found. Animals that are poorly adapted to their environment are more prone to hazards. A sustainable solution to ill-thrift in the post weaning phase is to select animals for their genetic ability to thrive in the specific environment.

7. Nutritional requirements

Lambs are in a growing phase and requirements for energy, protein and minerals are relatively high during this phase. Selected aspects of nutrient requirements of sheep and goats during the post-weaning phase are listed in tables F5-N1 and F5-N2 respectively.

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

Table F5-N1. Daily nutrient requirements of 4 month old growing sheep lambs during the post-weaning phase.

Body Weight (maturity status)	**Growth rate**	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein[d]**	**Ca**	**P**	**Mg**
Kg	g/d	Kg	Kg	MJ	Gram	Gram	Gram	Gram
20 (late)	100	0.57 (2.86)[a]	0.30	4.56	76	2.3	1.5	0.6
20 (late)	300	0.61 (3.04)[c]	0.48	7.28	155	5.10	3.5	1.1
20 (early)	100	0.63 (3.16)[b]	0.42	6.32	70	2.1	1.5	0.6
20 (early)	300	1.20 (6.00)[c]	0.95	14.39	149	4.9	4.0	1.1
30 (late)	200	1.05 (3.51)[a]	0.56	8.45	137	4.1	2.9	1.0
30 (late)	400	1.12 (3.72)[b]	0.74	11.17	218	6.9	5.0	1.5
30 (early)	200	1.20 (3.99)[b]	0.79	11.97	125	3.7	3.0	1.0
30 (early)	400	1.62 (5.38)[c]	1.28	19.37	198	6.4	5.4	1.5
40 (late)	250	1.32 (3.31)[a]	0.70	10.58	171	5.0	3.7	1.3
40 (late))	500	1.40 (3.51)[b]	0.93	14.01	271	8.6	6.3	1.9
40 (early)	250	1.50 (3.76)[b]	1.00	15.06	155	4.6	3.8	1.3
40 (early)	500	2.03 (5.08)[c]	11.62	24.39	247	7.9	6.7	1.9

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

The nutrient requirements of 8 month old lambs are very similar to the requirements listed in Table F5-N1

Table F5-N2. Daily nutrient requirements of growing doeling kids during the post-weaning phase.

Body)	**Growth rate**	**Dry Matter (% of BW)**	**TDN**	**Metab. Energy**	**Crude Protein[d]**	**Ca**	**P**	**Mg**
Kg	g/d	Kg	Kg	MJ	Gram	Gram	Gram	Gram
10 (meat)[e]	100	0.36 (3.64)[c]	0.32	4.85	86	3.5	1.5	0.38
10 (meat)	200	0.52 (5.15)[c]	0.47	7.15	146	6.1	7.2	
10 (hair low)[f]	20	0.42 (4.17)[b]	0.28	4.18	46	1.6	0.9	0.22
10 (hair high)	40	0.44 (4.37)[c]	0.37	5.52	64	2.0	1.0	0.26
20 (meat)	100	0.65 (3.26)[b]	0.44	6.57	103	3.9	1.9	0.55
20 (meat)	250	0.74 (3.70)[c]	0.67	10.04	194	7.6	3.4	0.85[g]
20 (hair low)	20	0.81 (4.03)[a]	0.40	6.07	65	2.1	1.4	0.39
20 (hair high)	40	0.74 (3.72)[b]	0.49	7.45	84	2.5	1.5	0.43
30 (meat)	100	1.11 (3.69)[a]	0.54	8.12	119	4.5	2.5	0.73
30 (meat)	300	0.94 (3.14)[c]	0.84	12.72	239	9.1	4.2	1.13[g]
30 (hair low)	20	1.03 (3.43)[a]	0.51	7.74	82	2.4	1.7	0.57
30 (hair high)	40	0.97 (3.24)[b]	0.65	9.75	110	2.8	1.8	0.61
40 (meat)	100	1.29 (3.23)	0.63	9.50	133	4.7	2.8	0.90
40 (meat)	300	1.41 (3.51)	0.94	14.10	253	9.8	4.8	1.30

[a] Based on an energy content of 8.0 Mj/kg (for example Lucerne hay).

[b] Based on an energy content of 10.0 Mj/kg (for example 65% Lucerne hay + 35% Maize).

[c] Based on an energy content of 12.0 Mj/kg (for example 25 % Lucerne hay + 75% Maize).

[d] Based on 20% undegradable intake protein (UIP or bypass protein) (for example Lucerne hay).

[e] Boergoat; [f] Angora; [g] By extrapolation

Adapted from NRC Nutrient Requirements of Small Ruminants (National Research Council 2007)

3.4.7 Sub-process 3: Replacement ewe cycle: Phase: F6-Teething

Defining phrase: HOW TO MANAGE THE TEETHING PHASE OF THE REPLACEMENT EWE CYCLE

<u>1. Description</u>

The first pair of permanent incisors in sheep erupts at the age of 15 ±3 months). Natural grazing can wear down temporary incisors to such a degree that replacement ewes have difficulty ingesting grazing in the period immediately prior to the eruption of the permanent incisors. The actual process of eruption may cause swollen painful gums that further contribute to ill-thrift.. Some ewes appear to experience a reduction in immunity.

Replacement ewes that were vaccinated against enterotoxaemia at weaning (in many cases 12 months before this phase) may experience a loss of immunity in this phase requiring a booster vaccination. Outbreaks of coccidiosis and nematode parasites have been observed to be more prevalent during this phase.

The effect of poor nutrition 180 days before mating time has been documented. In some mating systems this phase precedes the first mating of maiden ewes by about the period that is required for the development of the follicular wave that will be present at mating time. Careful management and especially improved nutrition at this time has been observed to contribute positively to improved health, production and reproduction in maiden ewes.

2. Objectives

This cycle should be managed to ensure that:

- The negative effects on nutrition are counteracted
- The natural resistance of the flock is enhanced
- Ovulation rate at mating time (180 day effect) is not affected negatively.

3. Key activities

Replacement ewes should be vaccinated against enterotoxaemia and other endemic diseases that may occur following the reduction of immunity during this phase. Supplementary feeding should be considered especially if this phase coincides with poor nutritional value in pastures, a high worm parasite challenge or adverse climatic conditions.

The critical control points for body condition scoring (CC18), helminthic control (CC19) and nutritional evaluation (CC20) should be applied.

4. Timing

This phase occurs when replacement ewes are 12 to 18 months old.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the teething phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The hazards during this phase are associated with nutritional stress and reduced flock immunity resulting in outbreaks of Enterotoxaemia, parasitism and general ill-thrift. The negative effects of poor nutrition may also have an influence on the ovulation rate and conception rate at a subsequent mating phase.

7. Nutritional requirements

Although the normal requirements for growth should supply the needs of ewes during this phase the replacement ewe flock could be subdivided into groups based on body condition score to enable differentiated nutritional management.

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.4.8 Sub-process 3: Replacement ewe cycle: Phase: F7-Maturing

Defining phrase: HOW TO MANAGE THE MATURING PHASE OF THE REPLACEMENT EWE CYCLE

1. Description

This phase is in most respects a continuation of phase F5- Post weaning phase. Ewe lambs may require vaccinations against diseases of reproduction which are administered prior to mating. Vaccination against Enzootic abortion (Chlamydophila) is an example of a vaccine that should be administered at least 28 days before mating.

2. Objectives

This phase should be managed to ensure that:

- Ewe lambs meet growth targets at first mating
- Minimise losses from predation and other hazards.

3. Key activities

A sample of maiden ewes from each flock should receive a permanent marking (red tags are suggested) and weighed monthly. The average weights are recorded in graph format and compared with the targets and historical results. This allows for early diagnosis of ill-thrift and corrective actions.

The maiden ewes are often considered to be the most vulnerable group in the flock and should receive attention at least every month as to body condition score (CC18), helminthic status CC19) and nutritional status (CC20).

4. Timing

This phase is the final period before first mating and follows on phase F6- Teething phase. In flocks where the FHPP requires mating before the age of 12 months this phase may follow on phase 5 – Post weaning.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the maturing phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Following the teething phase (Phase F6) replacement ewes are less prone to hazards related to immaturity and stress resulting from changes in dentition. Mortality rates in this phase are generally much lower than in any other phase of the replacement ewe cycle. Parasites and predators remain the most important hazard classes affecting replacement ewes in this phase.

7. Nutritional requirements

The nutrient requirements in this phase are determined by the growth rate. In early maturing breeds the requirements may be similar to maintenance levels for mature animals whilst the slow maturing breeds may still require nutrients at the levels stated in Table F5-N1 and F5-N2.

The flock health and production plan may require that replacement ewe lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5 Subprocess 4. Replacement Ram Cycle

3.5.1 Introduction

The replacement of rams from the off-spring allows flock managers to take full control of the genetics of a flock. It prevents the biosecurity risks normally associated with purchasing breeding material form other flocks. This sub-process does not apply to rams that are purchased. Purchased rams will enter Sub-process 2 - Ram management cycle at the appropriate phase.

Ram lambs that are sold at weaning or kept as castrated males are of no concern in the control of reproduction and will therefore not be discussed.

Genetic adaption to the specific environment of the flock can be achieved by allowing the environment to cull poorly adapted individuals. This is best achieved by not supplying supplementation and other management inputs beyond the level that would be normally applied to the ewe breeding flock. Ideally ram lambs should be tested in environments that are more restrictive than that in which the ewe flock is required to produce. The "environmental culling" can be achieved by raising replacement ram lambs that are exposed more too environmental hazards. These rams can contribute to the goal of creating an adapted genotype.

The production of stud rams are commonly done exactly the opposite of allowing environmental culling and will therefore not be discussed any further.

The replacement ram cycle is divided into 7 phases as listed in Table 3.5.1.

Table 3.5.1. Phases of the Replacement Ram Cycle

Phase code	Phase description
M1	Neo-natal
M2	Early suckling
M3	Suckling/grazing
M4	Weaning
M5	Post weaning
M6	Teething
M7	Maturing

The neonatal, early suckling, suckling/grazing and weaning phases of the replacement ram cycle is not different from the replacement ewe cycle and the two sexes are only separated at or after weaning.

The most important management aspect of the post weaning, teething and maturing phases is the performance testing of the replacement rams. As these tests are usually done in the most limiting environment on the farm hazards may be more common and need attention for the sole reason of salvaging individuals that suffer negative effects from these hazards. Prevention is contra-indicated as the hazards are the tools employed to identify individuals that are susceptible for the purpose of culling.

The seven phases of the replacement ram cycle are discussed individually.

3.5.2 Sub-process 4: Replacement ram cycle: Phase: M1-Neo-natal

Defining phrase: HOW TO MANAGE THE NEONATAL PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

The neonatal phase of the replacement ram cycle is the period from birth until the lamb is seven to ten days old. It is the most limiting period of the entire production cycle in many flocks. It is a period that requires high levels of management even in extensive systems. This phase deals with the requirements of the lamb. The requirements of the ewe are described in Phase E7, the peri-partal phase of the ewe management cycle.

2. Objectives

This phase should be managed to ensure that:

- Ram lambs that were in any way assisted are clearly marked for culling.

3. Key activities

The duties of the flock manager during this phase is exactly the same as described for the Peri-partal phase of the ewe reproduction cycle (E7). The treatment of lambs to prevent navel chord infection, the administration of colostrum by stomach tube and tagging are activities that form part of this phase of the replacement ram cycle.

4. Timing

The perinatal period is defined as the period from the onset of parturition up to when the lamb is seven days old. (Haughey 1986). The peri-partal phase of the ewe management cycle is the combined period during which ewes are lambing up to the time that the youngest lamb is 7 days old.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the neonatal phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

The main hazard during this phase is described by Haughey as the stillbirth, mis-mothering, exposure (SME) complex (Haughey 1981; Haughey 1986; Haughey 1991). Predation of newly born lambs and diseases such as Colibacillosis and Lamb Dysentery contribute to the losses. Mis-mothering includes the perinatal pathology caused by dystocia, lack of milk and failure to nurse.

7. Nutritional requirements

The only requirement of a ram lamb during this phase is an adequate supply of colostrum in the first few hours of life. Lambs that have received adequate energy via the colostrum are able to withstand adverse weather condition and will be protected against infections by the transfer of passive immunity.

3.5.3 Sub-process 4: Replacement ram cycle: Phase: M2-Early suckling

Defining phrase: HOW TO MANAGE THE EARLY SUCKLING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

The early suckling phase is the phase during which the ram lamb is entirely dependent on the dam for its nutrition. Lambs begin eating solid food by the age of 14 to 21 days. Creep feed can therefore be offered at this early age. During this phase lambs may be castrated, tagged, tailed and under certain circumstances even vaccinated although the lamb may not be able to respond very well.

Ill-thrift, which is defined as lambs growing slower than normal, can be seen during this phase but will require careful monitoring. A methodology for assessing the growth rate of lambs requires the recording of birth weight and date and can be used to identify ill-thrift (Erasmus 1978).

Ram lambs should be weighed at the age of 40 days and their weights recorded for performance testing purposes. As there is very little benefit in weighing lambs individually at the age of 40 days a nominal 40th day can be selected based on the week during which the highest number of ewes lambed. This is usually the second week of lambing in well managed flocks.

2. Objectives

This phase should be managed to ensure that:

- Ram lambs that were assisted in any way are clearly marked for culling.
- Accurate 40 day weights are recorded for ram lambs
- Data is grouped into contemporary groups.

3. Key activities

Lambs may be marked during this phase. This process will include tagging, tattooing, ear notching, and tail docking. Tailing is done as early as possible to minimise post-tailing complications. Lambs that are born in lambing pens can be docked under the age of 7 days which, if performed correctly, can be without any side-effects.

The recording of a 40- day weight is done approximately 6 weeks after the peak weekly lambing frequency. Ram lambs that are below average (50% of ram lambs) and ram lambs that required assistance can be castrated immediately. Ram lambs that are above average are numbered and their 40 day weights recorded for later evaluation in critical control point 14 – Ram replacement data. The birth status and flock or camp of the ram lamb is also recorded to allow the creation of contemporary groups in later evaluation.

Lambs that did not receive adequate collostral transfer of antibodies may be susceptible to diseases such as enterotoxaemia and pasteurellosis. Mortalities from enterotoxaemia (*Clostridium perfringens* D) occur at the age of 21 days when they start eating solid food. Vaccination at this early stage is successful in protecting lambs. Booster doses will be needed.

Management of the environment is extremely important in this phase if lactating ewes and lambs are housed intensively. Foot rot, coccidiosis, omphalophlebitis, opthalmia and spinose ear tick infestations are a few examples of hazards that occur in lambing ewes that are confined in small camps.

4. Timing

This phase is defined as the phase during which lambs are dependent on milk for survival and normal growth. It follows the neonatal phase which ends at 7 to 10 days old and precedes the phase during which the lamb's nutritional needs are met mostly by grazing. This phase therefore ends at the age of 40 to 60 days depending on the breed and the environment. This phase coincides with the early lactation phase of the ewe reproduction cycle (E8).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the early suckling phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The performance data for the ram lambs are recorded for evaluation in critical control point 14 – Replacement ram data.

6. Hazards

All individual ram lambs that are affected by hazards that could in any way be genetically controlled should be culled.

Lambs that have reached the age of 7 to 10 days are usually not considered to be in danger of dying from peri-partal problems any more. The major hazards in this phase will be related to environmental hygiene if lambs are housed or kept in small paddocks. Lambs that have received inadequate passive immunity may be under threat from infectious agents. Some genetic defects may become apparent during this phase when lambs become more active and less closely associated with their dams. Predation remains a threat especially if ewes and lambs are moved out of the protected environment onto natural grazing. Management factors that may influence the quality and quantity of the dam's milk may influence lambs through malnutrition. For example: Vaccination of ewes with live viral vaccines such as Blue-tongue during this phase may indirectly result in coccidiosis in lambs, the result of nutritional stress. Poor quality roughage or urea fed to ewes may result in reduced butterfat levels in milk and undernourishment of lambs.

7. Nutritional requirements.

Lambs are dependent on milk from their mothers. Creep feeding is becoming increasingly popular as an aid to ensuring adequate growth in lambs and preparing the lambs for earlier weaning. Creep feeding is provided to lambs inside an enclosure with adjustable openings to prevent ewes form entering.

Lambs can be weaned from milk onto a complete meal at the age of 30 days on condition that they weigh at least 9 kg (Van der Merwe 1977). Only ram lambs that form part of the normal procedure in the flock are retained for possible replacement rams. Those that had to be treated for diseases or received nutrition that was not supplied to the whole flock are culled.

The NRC does not provide detailed requirements for creep feed but suggests that it is composed of ground forage and a protein source (for example soya bean meal) with less than 15 per cent fermentable carbohydrate to avoid enterotoxaemia and rumen content putrefaction (National Research Council. 2007).

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5.4 Sub-process 4: Replacement ram cycle: Phase: M3-Suckling/grazing

Defining phrase: HOW TO MANAGE THE SUCKLING/GRAZING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

The suckling/grazing phases of the replacement ram cycle is the phase during which the ram lamb can no longer be sustained by the dam’s milk. The rumen has developed sufficiently to allow the intake of forage and supplements.

Ill-thrift may be observed during this phase although the onset of ill-thrift may be identified by weighing and comparison with normal growth values at the age of less than 21 days. Minimum growth targets for Dohne merino lambs (singles and twins) for the first 9 weeks of life are listed in Table CC11-1 and Table CC11-2 in paragraph 3.6.12 (Erasmus 1978). These target weights may be used to identify and quantify ill-thrift and further investigation can be based on normal diagnostic procedures, body condition score (CC18), helminthic status (CC19) and nutritional status (CC20).

2. Objectives

This cycle should be managed to ensure that:

- Maximum numbers of replacement rams survive
- Ram lambs that require special treatment are identified and marked for culling.

3. Key activities

In extensive systems predation becomes a serious problem at this stage as the lambs become favoured targets for predators. Regular inspection, the provision of guard dogs and overnight protection in paddocks are required to prevent losses of large numbers of lambs.

If the production system requires early weaning onto pastures and or feedlotting early vaccination against enterotoxaemia (*Clostridium perfringens D*), Blood gut (*Clostridium perfringens A*) and Pasteurellosis may be required.

The general health of the lamb flock can be monitored from this phase onward by critical control points CC18, CC19 and CC20.

4. Timing

This phase is defined as the phase during which lambs are less dependent on milk for survival and more on grazing. Lambs have a fully developed rumen function at the age of 6 to 8 weeks (Erasmus 1978). This phase follows the early suckling phase which ended at 40 to 60 days old and precedes the weaning phase. This phase therefore ends at the weaning age which can be between 90 days and 5 to 7 months, depending on the breed and the environment. This phase coincides with the late lactation phase of the ewe reproduction cycle (E8).

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the suckling/grazing phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Inexperienced lambs may consume toxic plants. Supplements containing urea may be dangerous for lambs as the rumen micro flora are not sufficiently well developed to convert urea to protein and absorption of urea may occur, resulting in toxicity.

Predation causes large losses in flocks during this phase as the lambs are easy targets and have grown sufficiently to provide a sought after meal for most smaller predators.

Lambs are more exposed to digestive disturbances and parasites during this phase when grazing activities increase and suckling decreases. Nematode and cestode parasites, coccidiosis and enterotoxaemias are common disease problems that start in this phase.

7. Nutritional requirements.

As grazing takes over from milk as a food source, the deficiencies experienced on the pastures start playing a role. The provision of lick supplements and full feeds may be required at this stage. As the rumen development is still in progress the use of urea may not be as successful as natural protein in supplying protein needs. Good quality roughage is essential to stimulate rumen development. Mineral requirements are high and may need to be supplemented.

The nutrient requirements of growing lambs is listed in table F5-N1 in paragraph 3.4.6.

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5.5 Sub-process 4: Replacement ram cycle: Phase: M4-Weaning

Defining phrase: HOW TO MANAGE THE WEANING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

Weaning is the phase during which lambs are removed from their dams to terminate the supply of milk to the lamb. Weaning can be achieved by physically separating the lambs form the ewes, swopping the lambs and ewes or applying nose rings that will prevent lambs from suckling (Hoon et al 2008).

Lambs wean themselves progressively more and may become nutritionally totally independent even before flock managers take the decision to enforce weaning.

Flock managers are often confronted with the situation where lambs are no longer benefiting from the presence of the ewe but, instead, finds itself in competition for scarce resources.

The weaning phase and the early post-weaning phase may be stressful to lambs and lead to a reduction of flock immunity. It is therefore important to prevent losses by vaccination, parasite control and nutritional management before weaning takes place. However, if flock managers are willing to risk losses from endemic disease preventative measures against these diseases may be omitted. This will allow selection for natural resistance. Animals that fall ill will be treated and culled.

Ram lambs receive the same treatment as ewe lambs up to this phase although all individuals that require assistance are culled and sold so that they cannot contribute to the genetic pool any further.

The weaning weight of ram lambs are recorded in the same way as the 40-day weight.

2. Objectives

This phase should be managed to ensure that:

- Weaning stress is reduced as much as possible
- Lambs receive adequate nutrition
- The immunity of the lambs is kept at optimal level.

3. Key activities

Lambs should be vaccinated before weaning against Enterotoxaemia and Pasteurellosis.

Vaccination against viral diseases for example, Bluetongue, Rift Valley Fever, and Wesselsbron Disease may be administered at this stage or postponed until after the weaning stress period to ensure adequate life-long immunity. These live vaccines may contribute to the stress by causing a variable febrile reaction.

Lambs should receive supplements before weaning to allow adaption of the rumen flora. Lambs should be moved to the camp in which they will run after weaning a few days before weaning to enable them to find the water sources together with their more experienced mothers. This will also reduce the potential of injury and the negative effect of lambs attempting to return to their mothers. A few old ewes may be left with the lambs to provide leadership.

Ram lambs that are below average (50% of ram lambs) and ram lambs that required assistance can be castrated immediately. Ram lambs that are above average are numbered and their weaning weights recorded for later evaluation in critical control point 14 – Ram replacement data.

4. Timing

Weaning should take place when the benefits of weaning outweigh the possible negative effects for both the lamb and the dam. The age of weaning is determined by the breed, nutritional level, climate and the management priorities on the farm. Marketing considerations are less important for ewe lambs than ram lambs as most, if not all, ewe lambs will not be sold at weaning. Weaning is mostly practised at 90 to 100 days of age but may be as late as 150 and even 210 days where resources are limiting. Vaccinations should however not be postponed as lambs lose passive immunity at a certain age irrespective of weaning status. A nominal weaning age of 90 days is considered to be a good benchmark for the implementation of a weaning immunisation program even if the physical weaning takes place much later.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the weaning phase these will be recorded in the Hazard Events form (Addendum B-PC4).

The performance data for the ram lambs are recorded for evaluation in critical control point 14 – Replacement ram data.

6. Hazards

Weaning hazards follow from the stress of changed nutritional patterns and social disruption. Lambs often consume toxic plants after weaning. The intake of food and water may be disrupted as lambs attempt to return to their mothers and often lie waiting at the gate of fence for a few days after weaning. This can be overcome by correct management as stated above. The flock health and production plan should provide detailed instructions about weaning time to prevent these hazards.

7. Nutritional requirements

The changes accompanied by moving to new camps, the removal of the source of milk and changed behaviour patterns can have a negative influence on the nutritional status of the weaned ewe lamb. Supplements in the form of a lick, full feed, grains or hay can be introduced to lambs prior to weaning to allow adaption of the rumen micro-flora as well as allowing the lambs to learn from the example of their mothers. The continued supply of these supplements for a period after weaning will reduce the potential negative effects of weaning.

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5.6 Sub-process 4: Replacement ram cycle: Phase: M5-Post weaning

Defining phrase: HOW TO MANAGE THE POST WEANING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

The post weaning phase of the replacement ram cycle is characterised by the lack of assistance and preventative health measures against endemic diseases. This will allow "environmental culling" to take place so that a positive genetic change in disease resistance and adaption to the environment can be achieved.

Overwintering is often a serious problem in small ruminant production. The recording of a pre- and post-winter weight for ram lambs can provide the opportunity to select rams that show superior overwintering ability.

Ram lambs should be moved to the most restricting environment available on the farm and only assisted if it becomes clear that they cannot cope. These individuals should then be culled.

2. Objectives

This phase is managed in such a way that environmental culling can take place and the fittest individuals are identified for future breeding.

3. Key activities

Regular monitoring of animals to identify individuals that are affected by disease, malnutrition and parasites are identified. The replacement ram flock should be subjected to critical control points CC18 and CC19 on a regular basis. Monthly application of these CCPs should be sufficient to prevent losses.

Critical control point CC14 is performed during this phase. Ram lambs are evaluated for 300 day weight and genital soundness to enable selection for early maturity if this is indicated in the flock health and production plan.

4. Timing

This phase continues until the rams are 12 months old.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ram lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. Ram lambs that require treatment will be culled and the reason recorded on the Replacement ram data form (CC14)
If any past or current events are observed during the post weaning phase, these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Hazards that may have a genetic basis that occur during this phase are controlled only after recording the number of the individual that is affected. The replacement rams are placed in a limiting environment and are therefore more prone to malnutrition and predation. Parasites may provide an opportunity to identify more susceptible individuals which can then be treated and culled.

7. Nutritional requirements

Supplementation should ideally not be supplied during this phase as it could mask the ability of an individual to survive without help. If supplementation is indicated to correct known deficiencies it should be at a level below that which is normally provided to the mature ewe flock.

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5.7 Sub-process 4: Replacement ram cycle: Phase: M6-Teething

Defining phrase: HOW TO MANAGE THE TEETHING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

Replacement rams lambs have completed their evaluation and performance testing during phase M5. Potential sires will have been selected and the rest of the ram lambs castrated or sold. The management can now proceed in much the same way as the management of the replacement ewes. Rams that show poor natural resistance to disease or an inability to cope in the environment should still be identified for culling during this phase.

The first pair of permanent incisors in sheep erupts at the age of 15 ±3 months. Natural grazing can wear down temporary incisors to such a degree that replacement rams have difficulty ingesting grazing in the period immediately prior to the eruption of the permanent incisors. The actual process of eruption may cause swollen painful gums that further contribute to ill-thrift. Some rams appear to experience a reduction in immunity.

Replacement rams that were vaccinated against Enterotoxaemia at weaning (in many cases 12 months before this phase) may experience a loss of immunity in this phase requiring a booster vaccination. Cases of Coccidiosis and nematode parasite infection that occur in this phase should be culled after treatment.

2. Objectives

This cycle should be managed to ensure that:

- The negative effects on nutrition are counteracted
- The natural resistance of the ram flock is enhanced
- Rams that require special treatment are identified and marked for culling.

3. Key activities

Replacement rams should be vaccinated against Enterotoxaemia and other endemic diseases that may occur following the reduction of immunity during this phase. Supplementary feeding should be considered especially if this phase coincides with poor nutritional value in pastures, a high worm parasite challenge or adverse climatic conditions.

The critical control points for body condition scoring (CC18), helminthic control (CC19) and nutritional evaluation (CC20) should be applied.

4. Timing

This phase occurs when replacement rams are 12 to 18 months old.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the teething phase these will be recorded in the Hazard Events form (Addendum B-PC4)

6. Hazards

The hazards during this phase are associated with nutritional stress and reduced flock immunity resulting in outbreaks of Enterotoxaemia, parasitism and general ill-thrift. The negative effects of poor nutrition may also have an influence on the semen quality and at a subsequent mating phase.

7. Nutritional requirements

Although the normal requirements for growth should supply the needs of rams during this phase flock managers may wish to supplement rams to ensure good conception rates at their first mating.

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.5.8 Sub-process 4: Replacement ram cycle: Phase: M7-Maturing

Defining phrase: HOW TO MANAGE THE MATURING PHASE OF THE REPLACEMENT RAM CYCLE

1. Description

This phase is in most respects a continuation of phase M5- Post weaning phase although replacement rams may no longer be subjected to restrictive environmental conditions.

2. Objectives

This phase should be managed to ensure that:

- Rams have a body condition score at mating that will ensure good mating performance
- Rams that show lack of natural resistance to disease and poor adaption to the environment are identified for possible culling.

3. Key activities

The replacement ram flock should receive attention at least every month as to body condition score (CC18), helminthic status CC19) and nutritional status (CC20).

4. Timing

This phase is the final period before first mating and follows on phase M6- Teething phase. In flocks where the FHPP requires mating before the age of 12 months this phase may follow on phase 5 – Post weaning.

5. Records

Flock count numbers are recorded in the Stock Counts form (Addendum B-PC1). If any flocks or ewe lambs require treatment these treatments are recorded on the Flock Treatment form (Addendum B-PC2) and the Individual Events/Treatments form (Addendum B-PC3) respectively. If any past or current events are observed during the maturing phase these will be recorded in the Hazard Events form (Addendum B-PC4).

6. Hazards

Following the teething phase (Phase F6) replacement rams are less prone to hazards related to immaturity and stress resulting from changes in dentition. Mortality rates in this phase are generally much lower than in any other phase of the replacement ewe cycle. Parasites and predators remain the most important hazard classes affecting replacement rams in this phase.

7. Nutritional requirements

The nutrient requirements during this phase are determined by the growth rate. In early maturing breeds the requirements may be similar to maintenance levels for mature animals whilst the slow maturing breeds may still require nutrients at the levels stated in Table F5-N1 and F5-N2.

The flock health and production plan may require that replacement ram lambs are supplemented during this phase as indicated in Addendum A1-10: Phase: feed matrix. A comprehensive guide to supplementation is included in Addendum A1.

3.6. HACCP Principle2: Identify Critical Control Points

3.6.1 Introduction

The establishment of Critical Control Points (CCP) is the second principle of the HACCP system. The Codex Alimentarius Commission's Hazard Analysis and Critical Control Point System and Guidelines for its Application (Codex Alimentatius Commission of the Food and Agricultural Organisation & World Health Organisation 2003) defines a CCP as; "A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level".

In food production a critical control point is determined to eliminate a specific hazard or group of hazards. In a small ruminant production system a critical control point is established to address a broader group of hazards. Seventeen critical control points were identified as represented in Table 3.6.1.

Table 3.6.1. Critical Control Points in Small Ruminant Reproduction

Code	Description	Point in cycle	Data forms
CC1	Ewe selection	Prior to E2 – Preparation	Ewe selection data form
CC2	Ram selection	Prior to R2 – Phase 2 Preparation	Ram selection data form
CC3	Ewe preparation	Prior to E3 – Mating (end of flushing period)	Ewe preparation data form
CC4	Ram preparation	Prior to R3 – Mating (end of flushing period)	Ram preparation data form
CC5	Joining	Start of R3/E3 – Mating period	Joining data form
CC6	Mating	End of R3/E3 – Mating period	Mating data form
CC7	Scan	>35 days after mating	Scan data form
CC8	Rescan	≥ 30 days after initial scanning	Rescan data form
CC9	Pregnant	Prior to start of lambing	Pregnancy management data form
CC10	Lambing	End of lambing period	Lambing data form
CC11	Marking	After neonatal period	Marking data form
CC12	Weaning	Separation of lambs form ewes	Weaning data form
CC13	Ewe replacement	At E1 - Selection	Replacement maiden data form
CC14	Ram replacement	At R1 – Selection	Replacement ram data form
CC15	Genital soundness	Prior to R1 – Selection	Ram genital soundness data form
CC16	Ram recovery	≈8 weeks after mating	Ram recovery data form
CC17	Last day of lambing	≈146 days after end of joining.	Last day of lambing data form

Critical Control points are described as standard operating procedures which form the basis of the involvement of the Flock Health Practitioner's service to small ruminant farms, the data collected and report back to flock manager.

In addition to the 17 Critical Control Points which are positioned at specific points in the production cycle Critical Control Points for Body condition score (CCP 18), Helminthic status (CCP19) and Nutritional status (CCP20 can be included in the other critical control points or placed at strategic points as indicated by the specific requirements on a farm.

Additional generic aspects of the quality control process are recorded through the application of a Generic Quality Control Questionnaire (QQ1 Addendum B-QQ1).

Critical Control Points can be performed by the Flock Manager or by the Clock health Consultant during Farm visits. These visits are determined on an individual basis for each flock.

All data are consolidated in an annual report which will form the basis of the on-going planning process.

3.6.2 Critical Control Point CC1: Ewe Selection

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC1 – EWE SELECTION

1. Description and literature review.

The critical control point – Ewe Selection involves the evaluation of the flock composition and the culling data form which is the results of the Ewe selection phase (E1) which includes a detailed recording of the categories for which ewes were culled or judged to be unavailable for inclusion into the ewe flock. These include the hazard groups: disease, management, genetics, functional, nutritional, predation and climate.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point (See par. 3.2.21.)

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the following year. Specific questions are entered on the form which is diarised for the following year.

2. Aim and objectives

The aim of this critical control point is the review of the status of the ewe flock that has been selected for the following mating season.

The objectives are to:

- Identify and act upon the reasons for culling ewes
- Ensure that management processes are in place to ensure genetic progress in reproductive efficiency
- Identify and act upon expected hazards to reproduction
- Plan for a successful approaching mating season.

3. Materials, forms and checklists

- Data for this critical control point are collected on the Ewe Selection form (Addendum B-CC1).
- Quality control questions are answered in form QQ1 (Addendum B-QQ1).
- If the Critical Control Points for Body condition score (CCP 18), Helminthic status (CCP19) and Nutritional status (CCP20) are applied, the appropriate materials, forms and checklist will be required.

4. Methods

This critical control point takes the form of a critical discussion and, if necessary inspection of flock and collection of samples.

5. Data

The data collection form for this CCP is attached as Addendum B1: CC1-Ewe Selection Data.

6. Parameters and critical limits

The parameters and critical limits for this CPP will be determined by the replacement needs of the ewe flock. Historical trends will form the basis of assessment to ensure continuous improvement. Examples of parameters that could be applicable are listed in Table CC1-1.

Table CC1-1. Parameters for critical control Point – Ewe selection

Reason for culling	**Current year**	**Previous year**	**Target**
Ewes culled for abscesses	1,6%	4.3%	<1%
Ewes culled for blowfly strike	1.2%	2.7%	<1%
Ewes culled for skin cancer	1.0%	0.7%	0
Ewes culled for signs of other diseases	2.1%	2.9%	<2%
Ewes culled for abnormalities of locomotion	2.5%	7%	<2%
Ewes culled for abnormalities of the teeth	1.3%	1.5%	<1%
Ewes culled for udder defects	4.4%	7.5%	<3%
Total ewes culled at selection[a]	11.5%	22.7%	10%

[a] Ewes may be culled for more than one reason.

7. Corrective actions and report

The report will be in a free form format with a summary of findings, target parameters and recommendations.

3.6.3 Critical Control Point CC2: Ram Selection

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC2 – RAM SELECTION

1. Description and literature review.

Critical Control Point CC2 is the results of the Ram selection phase (R1) which includes a detailed recording of the categories for which rams were culled or unavailable for inclusion into the ram flock These include disease, management, genetics, functional, nutritional, predation and climate.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

2. Aim and objectives

The aim of this critical control point is the review of the status of the ram flock that has been selected for the following mating season.

The objectives are to:

- Identify and act upon the reasons for culling rams
- Ensure that management processes are in place to ensure genetic progress in reproductive efficiency
- Identify and act upon expected hazards to reproduction
- Plan for a successful approaching mating season.

3. Materials forms and checklists

- Data for this critical control point are collected on the Ram Selection form (Addendum B-CC2).
- Quality control questions are answered in form QQ1 (Addendum B-QQ1).
- If the Critical Control Points for Body condition score (CCP 18), Helminthic status (CCP19) and Nutritional status (CCP20) are applied, the appropriate materials, forms and checklist will be required.

4. Methods

This critical control point takes the form of a critical discussion and, if necessary inspection of flock and collection of samples. The selection of rams can be performed by the flock manager, optionally assisted by a livestock advisor or veterinarian.

5. Data

The data collection form for this CCP is attached as Addendum B1: CC2-Ram Selection Data.

6. Parameters and critical limits

The parameters and critical limits for this CPP will be determined by the replacement needs of the ram flock. Historical trends will form the basis of assessment to ensure continuous improvement. Examples of parameters that could be applicable are listed in Table CC2-1.

Table CC2. Parameters for critical control Point – Ram selection

Reason for culling	Current year	Previous year	Target
Rams culled for abscesses	2%	4%	<1%
Rams culled for blowfly strike	4%	0%	<1%
Rams culled for skin cancer	0%	2%	0
Rams culled for anaemia	2%	0%	<1%
Rams culled for abnormalities of feet	6%	0%	<1%
Rams culled for abnormalities of the teeth	10%	12%	<10%
Rams culled for defects of scrotum	0%	6%	<1%
Total rams culled at selection[a]	20%	18%	<10%

[a] Rams may be culled for more than one reason.

7. Corrective actions and report

The report will be in a free form format with a summary of findings, target parameters and recommendations.

3.6.4 Critical Control Point CC3: Ewe Preparation

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC3 – EWE PREPARATION

1. Description and literature review.

This Critical Control Point is the results of the Ewe preparation phase (E2) which includes a detailed recording of the treatments, joining of vasectomised rams and the weight gains recorded for each flock.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point (See par 3.2.19)
- Helminthic status critical control point (See par. 3.2.20)
- Nutritional status critical control point (See par. 3.2.21)

2. Aim and objectives

The aim of CC3 – Ewe Preparation is to monitor the change in body condition score (BCS)and/or body weight (BW) in ewes that are being flushed prior to mating.

The objectives are to achieve a measurable increase in BCS or BW in the 3 week period in u sustainable way without a subsequent decrease at mating time.

The timing and records of the introduction of teaser rams is also recorded

3. Materials forms and checklists

Data for this critical control point is collected on the Ewe Preparation form (Addendum B- CC3). Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

A sample of ewes from each flock is marked with a tag or paint mark and subjected to BCS evaluation or weighing at pre-planned intervals, usually weekly. Weighing should take place at the same time of day to avoid differences in food and water intake levels as far as possible. The BCS and BW is averaged and recorded. The resulting change over the flushing period is correlated with the eventual scanning, lambing and weaning results. This can be in the form of a graphic with the weaning percentage indicated in a text box with each flock's trend line.

5. Data

The data collection form for this CCP is attached as Addendum B1: CC3-Ewe Preparation Data

6. Parameters and critical limits

Various standards are used in practice but the following principles should be followed:

- Ewes should gain weight during the 3 or more weeks before mating starts
- Each farm and flock should be managed according to historically proven results for that flock
- The procedure should be cost-effective

Recommendations in literature vary between 1.5 and 10% increase in BW and suggestions of a target BCS of 3 to 5 at mating is found but these may be adapted to local conditions (Robinson, Rooke, & McEvoy 2002;Martin, Milton, Davidson, Banchero Hunzicker, Lindsay, & Blache 2004).

7. Corrective actions and report

The management of nutrition can be adapted as soon as a trend is noticed after weekly weighing or body condition scoring. The report to the flock manager could consist of a graph and a copy of the form and possibly a table of historical results.

3.6.5 Critical Control Point CC4: Ram Preparation

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC4 – RAM PREPARATION

1. Description and literature review.

This CCP is the recording and evaluation of data collected during the Ram preparation phases 1 and 2 (R2 & R7) which includes a detailed recording of treatments, shearing, nutrition and weight gains for each ram.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

2. Aim and objectives

The aim of CC34– Ram Preparation is to monitor the change in body condition score BCS and/or body weight BW in rams that are being prepared for mating.
The objectives are to achieve a measurable increase in BCS or BW in the 3 week period in u sustainable way without a subsequent decrease at mating time.

3. Materials forms and checklists

Data for this critical control point is collected on the Ram Preparation Data form (Addendum B-CC4).

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

Rams are weighed and BCS recorded at least 8 weeks before mating date. The weights and/or BCS are then recorded weekly or fortnightly to monitor change and provide a basis for taking decisions about nutrition. Weighing should take place at the same time of day to avoid differences in food and water intake levels as far as possible. The BCS and BW is averaged and recorded. The genital soundness examination is usually scheduled during the period of preparation (between phase 1 and 2) and can provide further evidence in support of changes in nutritional management.

5. Data

The data collection form for this CCP is attached as Addendum B1: CC4-Ram Preparation Data.

6. Parameters/ critical limits

Standards for weight gain and body condition scoring can be the result of previous experience on each farm but overweight (BCS >4) and unfit rams are probably the most important hazard related to this CCP.

7. Corrective actions/report

The management of nutrition can be adapted as soon as a trend is noticed after weekly weighing or body condition scoring. The report to the flock manager could consist of a graph and a copy of the form and possibly a table of historical results.

3.6.6 Critical Control Point CC5: Joining

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC5 – JOINING

1. Description and literature review.

This CCP is the recording and evaluation of data collected during the Ewe Preparation Phase (E2) and at the time of introducing the rams to the ewes.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

2. Aim and objectives

The aim of CC5 – Joining Data is to record the identity, mating capacity and numbers of rams that are joined to each mating group at the time of joining.

3. Materials forms and checklists

Data for this critical control point is collected on the Joining Data form (Addendum B- CC5:1&2)

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

The rams that are placed in each flock are marked on the ram list that was provided after the genital soundness examination. The rest of the form is completed from the information provided in the ram genital soundness report. The generic QQ1 form is filled in at the same time.

5. Data

The records collected during this CCP are needed for retrospective interpretation and analysis of scanning and lambing results. If a fresh set of rams are added after a time, the data for this follow-up joining is recorded on a separate form.

6. Parameters and critical limits

The group of rams that is joined to a flock is selected to have equal numbers of each age group and similar total ram `mating capacity (RMC) as far as this is possible.

7. Corrective actions and report

No reports are generated other than the completed forms that are used for analysis and evaluation at scanning and/or lambing time.

3.6.7 Critical Control Point CC6: Mating

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC6 – MATING

1. Description and literature review.

This CCP is the recording and evaluation of data collected during the Mating Phase (R/E3)

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

2. Aim and objectives

The aim of CC6 – Mating is to record the events relating to the mating period as well as the effect of the mating period on the rams. The dates at which the rams were joined and removed, dates at which specific events that could affect mating and conception took place and the changes in the clinical parameters of the ram as well as BW and BCS are recorded. The hazard events will be a duplication of the events entered on the monthly PC4 report.

3. Materials forms and checklists

Data for this critical control point is collected on the Mating Data form (Addendum B- CC6).

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

The data relating to the timing of adding or removing rams and hazardous events are entered in the CC6:1 form.

Rams are weighed, BCS recorded and the scrotal circumference measured on the day of removal from the ewes. The Famacha© anaemia score and the tone of the tests can also be recorded to give an indication of the possible need for treatment and supplementation.

5. Data

The records collected during this CCP are needed for retrospective interpretation and analysis of scanning and lambing results. The information on each ram is essential to performing CC16 –Ram Recovery.

6. Parameters and critical limits

The degree of atrophy of the testes as reflected by the decrease in scrotal circumference can be as much as 30% during the mating period. The recovery to the levels before the mating season is usually within 8 weeks. These parameters can be interpreted in the light of nutritional deficiencies such as a zinc deficiency which will cause a delay in recovery.

7. Corrective actions and report

Corrective actions indicated by this CCP will form part of changes to the flock health and production plan for future mating periods. Hazards recorded during mating may also lead to an extension of the mating period.

3.6.8 Critical Control Point CC7: Scan

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC7 – SCAN

1. Description and literature review.

Scan refers to the recording and evaluation of the data collected after the examination of the ewe flock to determine pregnancy status. The examination is most commonly done by ultrasound imaging and is referred to as Ultrasound Pregnancy Diagnosis (UPD) or Ultrasound Pregnancy Examination (UPE).

2. Aim and objectives

The following observations are made:

- Is the ewe pregnant or not?
- Did conception take place in the first or subsequent cycles of the mating period?
- What number of foetuses is present?
- Are the foetuses normal?
- Are there any signs of abortion or resorption?

- All udder abnormalities are noted: Fibrosis, teat canal abscesses, abscesses in the udder, abscesses in the udder lymph nodes, inverted teats, ticks and tick bite wounds on the teats or udder.
- All signs of disease are observed and noted,
- The body condition scores are observed in selected groups for example dry ewes, twin and triplet carrying ewes.

The classification of ewes into two or more categories based on the age of the foetus at scanning is essential for the application of focussed feeding strategies and the management process during lambing time. If used together with the 'ram effect' it could provide a reduction in feeding costs and enhance the survival rate through improved management at lambing time (Hawken & Viñoles Gil 2006).

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

Faecal samples are collected from each group from each flock. The resulting faecal egg counts can be compared between for example the pregnant and non-pregnant ewes from each flock.

3. Materials, forms and checklists

Observations can be recorded on a tally sheet. (Addendum B7: CC7 – Scan tally sheet).

Data for this critical control point is collected on the Scan Data form (Addendum B- CC7).

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods (Van Rooyen J.A. 2009b)

Rectal scanning is preferred by many operators but the risk of penetrating the rectum as well as the potential of spreading diseases such as Johne's should be considered. Trans-abdominal scanning seems to be practiced more commonly.

Ewes that are starved for at least 8 hours make scanning a lot easier for handlers and also lead to improved results. Angora does should not be starved. Sheep in poor condition should not be starved as the collapsed abdomen makes sound contact difficult.

Brushing the groins of sheep ewes with hot water and a good domestic dishwashing soap to remove the fat and dirt makes scanning much easier although it does require two extra workers.

The scanner head should be covered with a thick gauge, high density plastic bag after applying a layer of gel. The bag can be taped onto the head with electrical insulation tape. Low density sandwich or freezer bags contain air and reduce quality.

Boer goats and Angoras should be clipped in their left groin with a high powered horse clipper. Paraffin can be used to make the clipper more efficient. The area is also washed with hot water and dishwashing soap immediately before scanning.

Sheep are presented sitting in dorsal recumbency in a deck chair position. The handler presses down on the sternum with his right elbow and uses both hands to lift the fleecy belly so as to expose the bare patch to the maximum. No gel is need for the scanner as the area will be wet. The majority of ewes present the gravid uterus in the right flank because of the rumen pushing it to the right. In older ewes with a longer uterus it often happens that the gravid uterus is pushed deep into the left pelvis by the rumen. These cases are often misdiagnosed. In very rare cases the two gravid horns are visualised separately on the two sides.

Goats are placed on their right side. Goats have a righting reflex that makes them very difficult to keep still in dorsal recumbency. When placed on their side they are more relaxed and their horns do not pierce the chair and get hooked. The uppermost leg is pulled upward by the handler and gel is applied to the scan head from a flat dish before scanning every ewe.

Identifying singleton pregnancies mostly do not present a problem. The principle involved in identifying multiples is an integration of the position of the probe and the picture on the screen, Two lambs are mostly not seen simultaneously. The direction of the probe at the time of seeing, for example, the two (or more) foetal heads will allow counting the number of foetuses.

Between 35 and 70 days the full foetus and the heads are easy to visualise. As the foetus increases in size the thoracic triangle is often an easier feature to identify. The cranial diameter is however the only way to make an accurate assessment of the age of the foetus.

False twinning may appear where foetuses are more than 120 days old because of the internal echo created by the calcified rib cage. It is best identified by the fact that the false second foetus moves in exact synchrony with the superficial foetus.

Age determination is done by the parameters in Table CC7-1.

Table CC7-1. Measurements of the foetus in the sheep.

Age of the foetus in days	**Crown-rump length in cm.**	**Diameter of cranium in cm.** [b]	**Size of foetal echo-dense blot in cm.**[b]
30	1.5 [a]		
35			0.5
40			1.0
50			4.0
60	5.0 [a]	1.0	
65		2.0	
70		3.0	
80		4.0	
90	15 [a]	4.5	
100		5.0	
110		6.0	
120	27 [a]	7.0	
130		8.0	
150	50 [a]		

[a] Adapted from Roberts (1971)

[b] Data recorded during UPE.

Superfecundation occurs commonly in two consecutive oestrus cycles and the difference in size is estimated to be about 1.5 cm in cranial diameter. The outcome may be two lambs born 14 to 17 days apart, only one live lamb born, a premature lamb born together with a normal lamb or total loss of the conception.

The following observations confirm that the foetus is alive:

- The heart is beating
- The umbilical cord is filled with blood (it collapses and is not easily visible when foetus dies)

- The amniotic fluid is relatively clear (it becomes gritty after death of the foetus)
- The cotyledons condense and become more echogenic initially
- The aorta line is clearly visible.

The following abnormalities may be seen:
Anasarca, these foetuses abort. A limited number of histo-pathological examinations indicate myocardial changes resembling Selenium deficiency. Some have been positive for Chlamydophila on smear examination.

Excessive amniotic fluid with a normal foetus. These ewes invariably abort.

Recent abortion. The decomposing foetus and placenta may be seen. Later only remnants of cotyledons are seen. Some present as a fluid-filled uterus with many echo-dense particles. Later they present as a homogenous large echo dense area indicating a partly involuted uterus. Uterine folds may sometimes present as radiating bands.

Sexing of the foetus can be done but it is time consuming. The scrotum with its contents is seen as two adjoining round dense areas situated between the hind legs.

Marking of the ewe is done with animal marking wax crayons according to the scheme in Table CC7-2.

Table CC7-2. Marking system for ewes after ultrasound pregnancy examination.

Observation	**First Cycle Conception**	**Second Cycle Conception**	**Announcement**
Dry	Blue on nose		Droog!
Single	Green on nose	Green on lower nose	Single!
Twin	Red on nose	Red on lower nose	Mafahla (Sotho) or Amawela (Xhosa)
Triplet	Red on nose, green both cheeks	Not identified as treatment is the same.	Three!!
Quadruplet	Red on nose, red on both cheeks	Not identified as the treatment is the same.	Four!!!
Damaged udder	Blue on head		Bele (udder in Xhosa)
Definite cull	Blue on both ears		Ndlebe (ears in Xhosa)
Lamb before normal time	Red on head		Bomvo (red in Xhosa)

5. Data

The following parameters are recorded for each flock of ewes:

- Dry ewes
- Total number of ewes carrying single foetuses
- Ewes carrying singles from a conception in the first cycle
- Ewes carrying singles from a conception in the second cycle
- Total number of ewes carrying two foetuses
- Ewes carrying twins from a conception in the first cycle
- Ewes carrying twins from a conception in the second cycle
- Ewes carrying triplets. If more than three foetuses are observed an additional field can be added to the form
- Total number of ewes that are observed to be pregnant
- Total number of ewes scanned in each flock
- Conception rate is calculated as the number of ewes observed to be pregnant as a percentage of the total number of ewes scanned
- Lambing percentage is calculated as the total number of foetuses observed as a percentage of the total number of ewes scanned
- Udder damage is recorded as the number of observations of udder damage recorded on the tally sheet
- Twin re-conception rate is calculated as the percentage of ewes that were observed to carry twins at the previous UPD that reconceived as twins

- Twin first conception is the percentage of maiden ewes that were born as one of a twin (or more) that are pregnant
- Faecal egg count of each flock as a whole
- Faecal egg count of the dry ewes can be determined separately. This could be further extended to include are groups that were determined by UPD such as twin carrying ewes.
- The date on which the rams were joined to the ewes
- The date on which the rams came out.

6. Parameters and critical limits

Each flock manager determines the required performance of the flock in terms of conception rate and the predicted lambing percentage. These parameters and critical limits will form part of the flock production plan.

7. Corrective actions and report

Corrective actions indicated by this CCP will form part of changes to the flock health and production plan for future mating periods. Depending on the results flock managers may consider immediate re-mating the dry ewes.

The scanning report will be in the format of the completed data form with recommendations for the immediate future management.

3.6.9 Critical Control Point CC8: Rescan

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC8 – RESCAN

1. Description and literature review.

This CCP is the recording and evaluation of data collected from the re-scanning of a selected group or groups of ewes to enable an assessment of the time of foetal losses and to create an opportunity to identify recent abortions to enable laboratory investigation.

If flock managers complain about ewes that have incorrectly been diagnosed to be non-pregnant, re-scan can also be used to investigate the problem.

A loss of 2% of foetuses from scanning to lambing is considered normal (Gordon 1997). If flock records show that the number of ewes diagnosed pregnant at scanning but failing to form an udder exceeds 2% to 6%, an investigation into the cause should be conducted. In extensively managed flocks it is not possible to identify ewes that have recently aborted. Rescanning a sample of ewes a month after the original flock scan may allow the identification of recently aborted ewes. The re-scan may even be repeated a month later.

Remains of the placenta, uterine discharges and even the foetus may be found at re-scan. Impression smears are made of the cotyledons and the tissue samples are submitted to the laboratory for microbiological investigation. Blood can be collected for serology and a paired sample, three weeks later can reveal a rising titre.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock at the time of re-scan:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

A comparison between the groups of ewes that had aborted with those that still carried their foetus in respect of the BCS, helminthic and nutritional status may also reveal causes or predisposing factors leading to the post-scanning foetal losses.

2. Aim and objectives

The aim of this critical control point is to investigate the problem of foetal losses from scanning to lambing. The objectives are to:

- Identify ewes that have aborted since the previous ultrasound pregnancy diagnosis
- Identify ewes that are in the process of aborting
- Collect specimens of the aborted foetus and uterine discharges
- Collect serum for the determination of titres against infective agents suspected of causing abortion
- Gather a complete history to assist in diagnosing the cause of foetal losses.

3. Materials, forms and checklists

Data for this critical control point is collected on the rescan Data form (Addendum B- CC8)

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

The scanning procedure is described at CCP7 –scan. Ewes that no longer have a viable foetus in the uterus are then subjected to a vaginoscopic examination and blood collection for serology. The ewe is tagged with a unique number to allow follow-up investigations.

5. Data

The following information is recorded:

Flock name

Camp name

NON-PREGNANT EWE:

- Now scanned dry
- Now scanned single
- Now scanned twin
- Now scanned triplet

SINGLE EWE:

- Now scanned dry
- Now scanned single
- Now scanned twin
- Now scanned triplet

TWIN EWE

- Now scanned dry
- Now scanned single
- Now scanned twin
- Now scanned triplet

Total number of abortions (n)

The following parameters are then calculated:

Recalculated conception %

Recalculated lambing %

The specimens are recorded in the normal way for practice records and laboratory submission.

6. Parameters and critical limits

If a 2% to 6% level of losses from scan to lamb is considered normal then the proportion allocated to the time that lapsed since the previous scan (assuming the losses are evenly distributed over the period) will form the upper limit of normality.

7. Corrective actions/report

Depending on the results received from the laboratory investigation corrective actions will be considered in the light of the risk and a cost: benefit analysis. The most important aspect of the response to the diagnosis is that the changes in the flock health and production plan are implemented to prevent the re-occurrence of the hazard.

3.6.10 Critical Control Point CC9: Pregnancy Management

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC9 – PREGNANCY MANAGEMENT

This CCP is the recording and evaluation of the weight monitoring data of a sample of ewes from each flock during the last 6 weeks of pregnancy as well as a detailed recording of treatments, nutrition and any events that may result in reproduction failure during pregnancy. Data for this critical control point is collected on the Pregnancy Management form (Addendum B- CC9).

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.20)
- Nutritional status critical control point(See par. 3.2.21).

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

3.6.11 Critical Control Point CC10: Lambing

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC10 – LAMBING

<u>1. Description and literature review.</u>

This CCP is the recording and evaluation of the lambing phase data in respect of perinatal mortalities, dystocias, deviations from the scanning results and the daily or weekly frequency of lambing.

The perinatal period is defined as the period "before, during or within 7 days of birth" (Haughey 1986) although some authors consider the period up to 28 days after birth as the perinatal period (Dennis 1970). The perinatal period starts about 7 days before lambing (Johnston et al 1980). The neonatal period is defined as the period from successful birth to the age of 28 days (Dennis 1970). For the purpose of this study the neonatal period is defined as the period from birth to the age of ten days (Haughey 1986) although in practice, this definition is difficult to adhere to if the exact date of lambing is not observed and recorded.

Maternal behaviour plays an important role in lamb survival. A maternal behaviour score has been in use for decades and has contributed to an improvement in lamb survival rates. The scoring standards are listed in Table CC10-1.

Table CC10-1. Maternal Behaviour Score 12 to 36 hours post-partum at tagging.

Score	Description of maternal behaviour
1	Ewe flees at the approach of the shepherd, shows no interest in the lamb(s) and does not return
2	Ewe retreats further than 10m but comes back to her lamb(s) as the shepherd leaves them
3	Ewe retreats to a distance that tag identification is difficult (5 to 10 meters)
4	Ewe retreats but stays within 5 meters
5	Ewe stays close to the shepherd during handling of her lamb(s)

(Everett-Hincks et al 2004)

In the reported study ewes with scores of two or less were culled as they were considered poor mothers. More than 95% of ewes scored 3 in all age groups and were considered good mothers whilst a very small number of animals scoring four and five were classed as excellent mothers. This scoring system could assist flock managers to improve the lamb survival rate.

Dystocia is defined as "difficult or prolonged parturition that may or may not be assisted"(Dennis 1970) or as "parturition that results in hypoxic or traumatic injury to the foetus or traumatic injury to the ewe that is prejudicial to its survival" (Haughey 1986). The definition of Dennis (1970) is preferred as many dystocias do not result in pathological changes. Although dystocias that do not result in pathological change is of no consequence when considering reproductive success, an increase in the incidence of dystocias indicates a higher risk of hazards to reproduction in the Ewe management cycle: Phase E7-Peri-partal phase.

Deviations from the predicted lambing results are recorded for the purpose of identifying operator errors and post scanning foetal losses. The former can assist the scanning operator in identifying possible causes of error that may be eliminated in an effort to improve his or her accuracy. The identification of post scanning losses could indicate the need to actively find the causes of foetal losses if the percentage losses exceed the norm for the flock, environment and management level.

Causes of peri-natal losses in sheep lambs have been well documented (Dennis 1970; Johnston et al 1980; Purvis et al 1985; Hinch, Davis, Crosbie, Kelly & Trotter 1986; Haughey 1986; Eales, Small, Gilmour, Armstrong & Gittus 1986; Rook, Scholman, Wing-Proctor & Shea 1990). Hinch et al. (1986)) proposed six categories into which the causes of peri-natal mortalities can be grouped: Prenatal (ante-parturient), dystocia (parturient), prolonged birth, starvation, starvation/CNS and others. Rook et al. (1990) was of the opinion that a high proportion of peri-natal deaths fall into only 4 categories namely: hypothermia/starvation, abortion, stillbirth/dystocia and pneumonia. A lamb post-mortem protocol as proposed by Everett-Hincks and Duncan (2008) used four categories namely viability at birth, dystocia, starvation/exposure and other causes. Purvis (1985) classified the cause of death in lambs into six categories in a survey that included stillbirths and abortions, starvation and other causes in the lambing house and chilling/starvation, infection and other causes in the field. The general classification of hazards as proposed in paragraph 3.1.2 was used in this CCP: Diseases, management, genetics, functional (including behaviour and dystocia), nutritional, predation and climatic.

Peri-natal mortalities are generally accepted to be the most limiting aspect of the sheep reproductive cycle (Dennis 1970; Haughey 1986; Radostits et al 1994; Everett-Hincks & Duncan 2008). The theory of constraints proposes that management efforts aimed at any aspect of a production cycle could be wasted until the most production limiting problem or restraint has been sufficiently resolved. Flock Health and Production Consultants and Flock managers should therefore concentrate management efforts on improving the peri-natal mortality rate to acceptable levels.

The most sustainable solution to the problem of neonatal mortality and mis-mothering is to manage the genetic basis for the problem to support the disease management, nutrition and husbandry changes required of flock managers (Haughey 1991).

2. Aim and objectives

The aim of the Critical Control Point CC10 – Lambing is to manage the peri-natal period so that the hazards to reproduction can be identified and quantified and that corrective actions can be established.

The objectives of the Critical Control Point CC10 – Lambing are to:

- Record the lambing results
- Compare the results with the results predicted by Critical Control Point CC7 – Scan and the Critical control Point CC8 – Rescan
- Record peri-natal mortalities
- Diagnose and classify the causes of peri-natal mortalities
- Record dystocias
- Diagnose and classify the causes of dystocias
- Record qualitative aspects of this CCP.

3. Materials, forms and checklists

Data for this critical control point is collected on the Lambing form (Addendum B- CC10:1)
The results of autopsies performed on lambs are recorded in the Lambing : Neonatal Autopsy Data form (Addendum B CC-10:2).

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

Neonatal autopsy technique.

4.1 Record the identity, sex, breed and history of the lamb.

4.2 Weigh the lamb.

4.3 Inspect the lamb externally and note the following:

Presence of the golden slipper. (stillborn lambs have soft, rounded clean soles. Soles become hardened and soiled if a lamb was strong enough to stand and walk after birth (Rook et al 1990)

- Presence of foetal membranes (indication of cleaning behaviour by dam) If the placenta is available it is visually inspected, impression smears and swabs made and a portion including a cotyledon is placed on ice for laboratory investigation
- Remnants of the umbilical cord (The chord shrivels up by day 3 and falls of by day 7) (Rook et al 1990)
- Discharges from natural openings
- Damage to the skin and results of tail docking, castration or injections
- Soiling.

4.4 Place the lamb in dorsal recumbency and remove the ventral abdominal wall from the pubis to the xiphoid. Cut through the chosto-chondral junction to remove the ventral wall of the thorax and continue to remove the skin covering the ventral neck and mandible. The parietal surface of the removed abdominal wall is inspected for inflammatory changes to the vessels entering the abdomen at the umbilicus. The thyroid glands are dissected from the surrounding tissue and weighed in grams. A thyroid: bodyweight ratio of less than 0.4g/kg is considered to be an indication of iodine deficiency.

The contents of the abdomen and thorax are inspected as well as the sub cutis of the neck and mandible. Swabs of the abdominal and thoracic cavity may be collected for bacteriological culturing. Heart blood for bacteriology may be collected by extraction with a syringe and hypodermic needle. The abdominal and thoracic organs are removed and inspected. The liver is examined for traumatic, degenerative, inflammatory and post mortem changes. The contents of the abomasum is recorded and the mucous membrane evaluated. The pericardial and peri-renal fat is inspected. The presence of brown fat indicates that the lamb received sufficient energy or did not utilise the fat stores. The urinary bladder and the urachus is inspected for integrity. The fluid contents of the abdomen and thorax is noted. All organs are removed and examined according to standard techniques. The lung is inspected for atalectasis and signs of pneumonitis. A small portion of lung tissue may be placed in water to check for aeration. Aerated lung tissue floats whilst non-aerated tissue sinks. The thoracic pleura are examined for inflammatory changes. Impression smears are made of all affected organs for staining and microscopic examination. Tissue samples of all affected organs are collected and placed in formalin for histopathology. A portion of intestine is collected for toxin evaluation and culture or other tests for infectious organisms.

The skin is removed from the head end distal limbs to determine the presence of haemorrhage or oedema which can indicate dystocia and injury. Freezing may cause red discoloration of the sub-cutis which can be confused with birth injury. The brown fat deposit in the pre-scapular area is examined. If indicated the entire skin may be removed to enable inspection of the subcutaneous tissue. Muscles are transected to evaluate the possibility of selenium deficiency. Samples of muscle may be collected for histopathology. The strength of the skin as well as the breaking strength of the ribs is evaluated.

The oral cavity is examined for deformities and injury. The cranium is removed to allow examination of the durae and swabs for bacteriological examination. Haemorrhages and oedema are noted. The brain is removed and transected to determine the presence of hydranencaphaly and other degenerative changes. A number of specimens may be collected for histopathology.

4.5 The results of the examination are recorded in the Lambing : Neonatal Autopsy Data form (Addendum B CC 10:2). A pathological and etiological diagnosis should be recorded as well as the possible time or age of death.

5. Data

The following flock data is recorded:

- Date 1st pre lamb. The date on which the first lambs that were not the result of the normal mating period, were born
- Date 1st lamb. The date on which the first lamb that was the result of the normal mating period, was born
- Date last lamb. The date on which the last lamb that was the result of the normal mating period, was born
- Lambed 1st cycle (n). The number of lambs that were born in the period corresponding to the first cycle (17 days in sheep and 21 days in goats)
- Lambed 1st cycle %. The calculated percentage of lambs born in the first cycle
- Lambed 2nd cycle (n). The number of lambs that were born in the period corresponding to the second cycle (18 - 34 days in sheep and 22-42 days in goats)
- Lambed 2nd cycle %. The calculated percentage of lambs born in the second cycle
- Lambed 3rd cycle (n). The number of lambs that were born in the period corresponding to the third cycle (35 -51 days in sheep and 43-63 days in goats)
- Lambed 3rd cycle %. The calculated percentage of lambs born in the third cycle
- Total ewes lambed. The number of lambs born
- Lambs died < 10d (n). The number of lambs that died in the period from birth to 10 days old
    - - lamb stuck. The number of lambs that died a.r.o. dystocia
    - - diseases. The number of lambs that died a.r.o. disease
    - -did not walk. The number of lambs that were born unassisted but never walked
    - -did not breathe. The number of lambs that were stillborn

    - -did not suckle. The number of lambs that died of severe under-nutrition
    - -unknown. Lambs that died but no information is available
- Deviations from scan:
    - -scanned dry but lambed
    - -singles did not lamb
    - -single lambed twin
    - -twin did not lamb
    - -twin lambed single
    - -triplet did not lamb
    - -triplet lambed twin
    - -triplet lambed single.

<u>6. Parameters and critical limits</u>

Key parameters

Lambs that died less than 10 days old by causes:

- Lamb stuck
- Diseases
- Did not walk
- Did not breathe
- Did not suckle
- Lambs caught
- Not seen

Deviations from scanning for each group:

- Ewes died
- Scan dry but lambed
- Scanned single but did not lamb
- Scanned single but lambed twin
- Twin did not lamb
- Twin lambed single
- Triplet did not lamb
- Triplet lambed twin
- Triplet lambed single

Lambing frequency per day or week of lambing.

Birth weight (lambs weighing less than 3 kg at birth are not considered viable(Purvis et al 1985).

7. Corrective actions/report

Ewes should be selected for the ability to produce twin lambs that weigh at least 3 kg (Purvis et al 1985). Single lambs should weigh at least 3.5 kg. Ewes that do not produce sufficient milk or do not nurse her lambs should be culled from the flock (Purvis et al 1985). Ewes should be culled for lack of tameness (Everett-Hincks et al 2004).

3.6.12 Critical Control Point CC11: Marking

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC11 – MARKING

1. Description and literature review.

This CCP is the recording and evaluation of data collected at the time of marking the lambs.

In addition to the specific procedures described in this CCP the following procedures can be performed to assist in monitoring the general health and welfare of the flock:

- Body condition score critical control point(See par 3.2.19)
- Helminthic status critical control point(See par. 3.2.10)
- Nutritional status critical control point(See par. 3.2.21).

Ill-thrift may be observed during this phase. The onset of ill-thrift may be identified by weighing and comparison with normal growth values at the age of less than 21 days.. Minimum growth targets for Dohne merino lambs (singles and twins) for the first 9 weeks of life are listed in Table CC11-1 and Table CC11-2 (Erasmus 1978). These target weights may be used to identify and quantify ill-thrift and further investigation can be based on normal diagnostic procedures, body condition score (CC19), helminthic status (CC20) and nutritional status (CC21).

Table CC11-1. Minimum weight of single Dohne lambs in first 9 weeks of life

Birth mass Kg	**Minimum single mass at week:**									**Growth Kg/d**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
2.27	3.05	3.82	4.59	5.36	6.09	6.86	7.64	8.36	9.14	0.11
2.73	3.59	4.45	5.27	6.14	6.59	7.87	8.64	9.45	10.27	0.12
3.18	4.09	5.05	5.95	6.86	7.77	8.68	9.59	10.50	11.36	0.13
3.64	4.64	5.64	6.59	7.59	8.55	9.50	10.50	11.45	12.44	0.14
4.09	5.14	6.18	7.23	8.27	9.32	10.32	11.36	12.36	13.41	0.15
4.55	5.64	6.77	7.86	8.95	10.05	11.06	12.18	13.27	14.32	0.16
5.00	6.14	7.32	8.45	9.59	10.73	11.86	13.00	14.09	15.23	0.16
5.45	6.64	7.86	9.05	10.23	11.41	12.59	13.77	14.91	16.09	0.17
5.91	7.14	8.41	9.64	10.86	12.09	13.23	14.50	15.76	16.95	0.18
6.36	7.64	8.95	10.23	11.45	12.73	14.00	15.27	16.50	17.73	0.18
6.82	8.14	9.45	10.77	12.09	13.36	14.68	15.95	17.27	18.55	0.19

Adapted from Erasmus (1978)

Table CC11-2. Minimum weight of twin Dohne lambs in first 9 weeks of life

Birth mass Kg	**Minimum twin mass at week:**									**Growth Kg/d**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
2.27	2.86	3.50	4.18	4.82	5.50	6.14	6.82	7.45	8.14	0.09
2.73	3.41	4.14	4.86	5.64	6.36	7.09	7.86	8.59	9.36	0.11
3.18	3.95	4.73	5.55	6.36	7.18	8.00	8.82	9.68	10.50	0.12
3.64	4.45	5.32	6.18	7.09	7.95	8.86	9.73	10.64	11.55	0.13
4.09	4.95	5.86	6.83	7.77	8.68	9.64	10.59	11.55	12.50	0.13
4.55	5.45	6.41	7.41	8.41	9.36	10.36	11.36	13.36	14.41	0.14
5.00	5.95	6.95	7.95	9.00	10.05	11.09	12.09	13.14	14.18	0.15
5.45	6.45	7.45	8.55	9.59	10.64	11.73	12.77	13.86	14.95	0.15
5.91	6.91	8.00	9.05	10.14	11.27	12.36	13.45	14.55	15.64	0.15
6.36	7.41	8.50	9.59	10.73	11.82	12.95	14.09	15.18	16.32	0.16
6.82	7.86	9.00	10.09	11.23	12.36	13.55	14.68	15.82	16.95	0.16

Adapted from Erasmus (1978)

2. Aim and objectives

The aim of this critical control point is to collect and interpret the data collected at marking time as an evaluation of the result of the neonatal period. This period is considered the most restrictive phase of the ewe production cycle.

The objectives of this critical control point is to:

- Summarize the data of the lamb losses from lambing to marking
- Identify the hazards that led to these losses
- Identify and implement corrective actions.

3. Materials, forms and checklists

Data for this critical control point is collected on the Marking Data form (Addendum B- CC11)

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

3.6.13 Critical Control Point CC12: Weaning

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC12 – WEANING

This CCP is the recording and evaluation of data collected at the time of weaning. Data for this critical control point is collected on the Weaning Data form (Addendum B- CC12).

The minimum growth targets for the determination of ill-thrift for single Dohne merino lambs are listed in Table CC11-1 and for twin lambs in Table CC11-2 (Erasmus 1978). Although these tables may not be accurate for other breeds and species it can provide a standard for use until a more specific standard is established for the specific flock, breed or species . These tables provide data up to 9 weeks of age . An expansion of the range can be achieved by collecting data for the flock, breed or species. Local climatic, seasonal and management factors must be taken into account when evaluating data for this critical control point

3.6.14 Critical Control Point CC13: Ewe Replacement

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC13 – EWE REPLACEMENT

This CCP is the recording and evaluation of data collected at the time of evaluation of the replacement ewe flock for introduction into the breeding flock and the selection of old ewes for culling. Data for this critical control point is collected on the Ewe Replacement Data form (Addendum B- CC13).

3.6.15 Critical Control Point CC14: Ram Replacement

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC14 – RAM REPLACEMENT

This CCP is the recording and evaluation of data collected at the time of evaluation of the replacement rams for introduction into the ram flock and the selection of old rams for culling. Data for this critical control point are collected on the Ram Replacement Data form (Addendum B- CC14).

3.6.16 Critical Control Point CC15: Genital Soundness

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC15 – GENITAL SOUNDNESS.

<u>1. Description and literature review.</u>

This CCP is the recording and evaluation of data collected at the time of the veterinary genital soundness examination (GSE). Although it is often termed a fertility examination, especially in layman's terms, or even a clinical examination for fertility this examination cannot guarantee the production of live offspring (Fthenakis, Karagiannidis, Alexopoulus, Brozos, Saratsis & Kyriakis 2001). . The term genital soundness examination is used by veterinarians in South Africa rather than the commonly used term breeding soundness examination (BSE). Breeding soundness evaluation of rams is defined as: "An overall assessment of the ram's capacity for serving and impregnating a number of ewes during a breeding season" (Kimberling & Parsons 2007). Breeding soundness examination (BSE) and genital soundness examination is therefore more accurate descriptions and can be used interchangeably. The conventional scope of the BSE and GSE is restricted to the ram flock without including the wider context. The term economical soundness evaluation is used by one author to describe the management, economic and genetic aspects of evaluating the ram. It is not clear how this is used in practice. There is a need for a broader involvement of flock health practitioners in the flock health and production activities . The critical control point: Genital soundness examination will therefore be defined broader than what is commonly accepted to be the scope of the BSE and GSE (Ott & Memon 1980). These authors describes the breeding soundness examination as physical examination, libido and semen quality examination. Kimberling and Parsons (2007) describe breeding soundness examination in terms of libido, physical examination, examination of reproductive organs and semen evaluation.

The Critical control point: Genital soundness examination of rams and bucks is proposed to include the following steps:

a. History
b. Clinical examination
c. Semen evaluation
d. Mating behaviour evaluation
e. Hazard analysis
f. Ram flock assessment
g. Report.

CC15-1 History

The history of the ram flock consists of the following information:

- CC2 Ram selection data
- CC4 Ram preparation data of the current season
- PC1 Stock counts
- PC2 Flock treatments
- PC3 Individual event/treatments
- PC4 Hazard events of the preceding months
- CC14 Ram replacement data
- CC15 Ram genital soundness data of the preceding seasons
- CC16 Ram recovery data of the preceding seasons.

If the data is recorded electronically an individual ram report can be created or individual ram data can be recorded on a ram record card.

In addition to the above data on file the following information will be relevant to the evaluation of the ram flock and the interpretation of the findings: Description of the camp, feed, water supply, handling and behaviour observed over past weeks. History of rams that have been used in partnerships or that have been away from the farm will be recorded separately. A freeform history is recorded for the flock and where applicable individual rams.

CC15- 2 Clinical examination

A full clinical examination is not required for routine genital soundness examinations of breeding sires but may be indicated for rams that have been purchased, are offered for sale or for legal purposes such as insurance.

Individual rams are examined in the following way:

Before sitting ram down:

1. Condition score

   The body condition score technique and standards are presented in critical control point 18. The standards for sheep are listed in Table CC18-1 and CC18-2.

2. Hip dysplasia test

   A normal sheep and meat goat ram should be able to carry the weight of an average person on his hind-quarters (Van Tonder 1975). As a standardisation it is proposed that a person as close as possible to 70kg be selected to perform the test.

3. General inspection of dorsal aspect

   A full clinical examination can now be done (Gouletsou & Fthenakis 2010).

After sitting the ram down the identity of the animal is verified and noted:

4. Ear tags and microchip scan
5. Tattoos
6. Ear notches
7. Brands on horn
8. Eyes and eyelids

   Eyes are examined for abnormalities that have an influence in the ram's normal functions. Pigmentation of the eyelids and *Membrana nictitans* protect rams against damage by ultraviolet radiation. Irradiation may contribute to cancer of the eyelid or *Membrana nictitans*. Exposure to solar radiation may also cause swelling of the eyelid resulting in improper function. Foreign material is caught behind the eyelid resulting in abrasion of the cornea and increased tear flow. This attracts insects that may be carrying infectious agents. In outbreaks of infectious opthalmia a higher incidence has been observed in animals with poor pigmentation of the eyelids. The incidence of carcinoma of the eye in flocks has been reduced by selecting animals with complete pigmentation of the eyelids and *Membrana nictitans.*

If the flock breeding plan prescribes selection in favour of pigmentation of the eyelids a score as listed in Table CC15-1 is proposed to rate rams for further selection and records.

Table CC15-1 Eye pigmentation score for sheep and goats

Structure evaluated	**Left eye**	**Right eye**	**Maximum score**
Nictitating membrane	Black triangle 2 points Small spot 1 point Un-pigmented 0 points	Black triangle 2 points Small spot 1 point Un-pigmented 0 points	4 points
Lower eyelid	Black or brown over full length: 2 points or pro rata if incomplete	Black or brown over full length: 2 points or pro rata if incomplete	4 points
Upper eyelid	Black or brown over full length: 1 point or pro rata if incomplete	Black or brown over full length: 1 point or pro rata if incomplete	2 points
Total	5 points	5 points	10 points

9. Famacha© anaemia score

The Famacha© anaemia score technique, a clinical estimation of the haematocrit of the rams is used to evaluate each ram (van Wyk & Bath 2002). The upper eyelid is closed and light pressure applied to the eye through the eyelid whilst the lower eyelid is pulled down to evert the mucus membrane of the lower eyelid. The colour is compared to a standard chart and the corresponding score (1 to 5) is recorded. Rams with scores of 3 and higher may pose a risk of reduced fertility if the cause of the anaemia is not corrected. The heritability of resilience to the effect of *H contortus* has been estimated as 0.44. Selecting rams with a low Famacha© score in the presence of a *Haemonchus* infestation may contribute to breeding a flock that will require less intervention to control this parasite. The Famacha© Anaemia Score is described in Table CC15-2

Table CC15-2. The Famacha© Anaemia Score

Score 1	Deep red
Score 2	Red
Score 3	Pink
Score 4	Light pink
Score 5	White

10. Teeth (ageing) and bite.

The ram's teeth are examined to determine age and any abnormalities such as malocclusion and absence of molars. The estimated age of sheep and goats as indicated by the number and condition of lower incisivi is listed in Table CC15-3.

Table CC15-3. Classification of rams by dental age.

Teeth	**Age**	**Proposed penalty in calculating mating capacity**
2–tooth	12 to 14 months but less than 24 months	50% penalty
4-tooth	24 months but less than 36 months	30% penalty
6-tooth	36 months but less than 48 months	No penalty
8-tooth or full-mouth	48 months or older	20% penalty
Old (full-mouth teeth half of normal length)	48 months or older (if no other information 60 months or older)	40% penalty
Worn (full-mouth teeth less than half normal length)	48 months or older (if no other information 72 months or older)	60% penalty
Severely worn (full-mouth teeth broken or only small protrusions)	48 months or older (if no other information 84 months or older)	80% penalty

14. Groin skin colour in sheep

The skin colour in the groin area of sheep is an indication of the degree of 'ram flush'. It is easily observed in sheep with no pigment in the skin of the groin area but may be more difficult to quantify in pigmented breeds such as the Karakul, Suffolk and Hampshire (Terblanche 1979).

The proposed classification or the degree of skin discoloration as an indicator of 'ram flush' is listed in Table CC15-4

Table CC15-4. Groin skin colour score for sheep rams.

Skin colour score	Description
0	Pale white
1	Slightly pink or purple area of 3 cm
2	Very pink or purple area of 6 cm
3	Purple area of 10 cm
4	Entire groin purple
5	Entire groin and scrotal neck, around anus and face purple

15. Scrotal surface and scrotal cover in sheep

The presence of inflammation, exudates, injuries, parasites, scars or any other abnormality of the surface of the scrotum is noted.

The degree of wool cover of the scrotum is observed and noted. The degree of wool cover in wool sheep breeds can predispose to a number of reproduction hazards. It has been observed that rams with a thick and often matted wool cover of the scrotum suffer from a reversible loss of testis size and tone and reduced semen quality. This is confirmed by Bruere (1986). Recovery following clipping occurs within a few weeks. Many young rams retain a matted cover of hogget wool which does not re-grow after clipping. A heavy wool cover can also predispose to a number of hazards. Eczema has been observed under a matted wool cover. Grass seeds and other plant material that could potentially inflict trauma to the scrotum become entangled in the scrotal wool cover. The presence of ticks under the wool cover may go unnoticed and lead to pyodermatitis and abscesses. *Hyalomma* spp. on the scrotum have been observed to affect the quality of the ejaculate. The wool covering of the scrotum may become so matted (resembling a woven bird's nest) that the normal action of the dartos muscle can no longer perform its thermoregulatory function. Flock managers often avoid clipping the scrotum because of a fear of injury. Clipping of the scrotum can be done at another opportunity when there is less pressure to complete the process. It is suggested that clipping of the scrotum is done at the start of the preparation phase of the ram management cycle.

The proposed classification or the degree of wool cover on the scrotum is listed in Table CC15-4.

Table CC15-5. Wool cover score of sheep rams.

Skin colour score	**Description**
0	No wool only fine hair
1	Sparsely covered in short wool
2	Some long wool around neck of scrotum
3	Long wool covers half of scrotum
4	Long wool covers full scrotum
5	Wool severely matted and restrictive

Rams with cover scores of 4 and 5 should be clipped. If the wool is clipped 6 to 8 weeks before mating season it should not affect the ram's performance. If it is closer to mating season the mating capacity rating of the ram should be reduced according to the severity of the potential effect on semen production.

16. Palpation of testes, epididymides, lymphnodes and spermatic chords.

The palpation of the contents of the scrotum is the most important part of the examination of the ram. If there is marked asymmetry the left and right observations are recorded separately. The following aspects are observed and all abnormalities noted:

- The presence of both testes
- Size, shape and symmetry of testis
- Lesions in the testis
- Tone of the testis
- Adhesions of the testis to the tunica vaginalis
- The presence of both epididymi
- Size, shape and symmetry of epididymi
- Lesions in the head, body and tail of the epididymi
- Length, uniformity along the length and symmetry of the spermatic chords
- Abnormal contents of the scrotum, transudates, exudates, abscesses
- The regional lymphnodes.

Table CC15-6. Testis tone score of rams.

Testis tone score	Description	Corresponds to:
1	Extremely flabby and atrophied	
2	Flabby	
3	Gives on pressure	Male biceps muscle, arm hanging relaxed
4	Firm but epididymis not prominent	Male biceps, arm elevated 45 degrees palm of hand facing upward
5	Very firm with prominent epididymis	Male biceps, arm elevated and flexed 90 degrees
6	Testes fibrosed or calcified	Male biceps, consciously contracted

17. Scrotal measurements

The following measurements are made and recorded in centimetres:

- Scrotal circumference
- Testis length
- Extent of ventral split in the scrotum.

The testes are pushed down into the scrotum and the circumference measured around the widest point usually in the middle of the testis. The scrotal circumference is the generally accepted measure of testes mass for performance testing and genetic recording.

The length of the testis is measured excluding the tail of the epididymis. A firm ruler or calliper can be used. If there is a marked difference in size the length is recorded separately for the left and the right testis.

The length and circumference can be used to estimate testes volume which may provide a more accurate comparison between rams when testes are extremely long or globular in shape. The volumetric estimate has been found to be more accurate than scrotal circumference in predicting the mass of testis collected from the abattoir {van Rooyen, 2002 170 /id}.

A split scrotum is not reported to contribute to infertility but is considered to be undesirable by some breed societies. A limit to the split is usually prescribed in the breed standards. It has been observed that rams with split scrotums lose the ability to bring the testes closer to the body for temperature control. The surface area of the scrotum is also increased which may contribute to greater exposure of the scrotum and its contents to extreme environmental temperatures. This may explain the finding that rams with split scrotums in excess of 4 cm in the cold mountainous areas of the north eastern cape have a noticeable increase in secondary sperm abnormalities when examined in the spring.

18. Ultrasound examination of the testis.

    This procedure is indicated after finding an uneven consistency or abnormal contents of the scrotum (Sargison 2008).

19. Examination of the sheath and penis.

    The sheath, mucous membrane colour, glans, processus, scars and or lesions are examined for inflammation, parasites, scars and anatomical defects. The protrusion distance is noted.

CC15-3 Semen evaluation

The following is evaluated and recorded:

Semen is collected by artificial vagina or electro-ejaculation (Martin 1986;Evans & Maxwell 1987).

Volume

Mass motility

Density

Colour

Smell

pH

The volume may not be a true reflection of the capacity of the ram if electro-ejaculation is used.

The mass motility is scored according the scoring system for mass motility listed in table CC15-7.

Table CC 15-7 Scoring system for mass motility of semen (Evans & Maxwell 1987)

Score	**Class**	**Description**
5	Very good	Dense, very rapidly moving waves. Individual sperm cells cannot be observed. 90% or more of the spermatozoa are active.
4	Good	Vigorous movement, but the waves and eddies are not as rapid as for score 5. About 70 - 85% of sperm cells are active.
3	Fair	Only small, slow moving waves. Individual spermatozoa can be observed. 45 - 65% of sperm cells are active.
2	Poor	No waves are formed, but some movement of spermatozoa is visible. Only 20 - 40% of sperm cells are alive, and their motility is poor.
1	Very poor	Very few spermatozoa (about 10%) show any signs of life, with weak movement only.
0	Dead	All spermatozoa are motionless.

The density of semen is scored by the consistency as described in Table CC15-8.

Table CC15-8 Density score of ram and buck semen (Evans & Maxwell 1987).

		Number of spermatozoa ($x10^9$) per ml	
Score	Consistency	Mean	Range
5	Thick creamy	5.0	4.5 - 60.0
4	Creamy	4.0	3.5 - 4.5
3	Thin creamy	3.0	2.5 - 3.5
2	Milky	2.0	1.0 - 2.5
1	Cloudy	0.7	0.3 - 1.0
0	Clear (watery)	Insignificant	Insignificant

The following smears are examined microscopically in the laboratory:

Nigrosin-eosin smear examined to determine percentage live and morphology

Spermac© stained smear examined for sperm morphology

Diff quick stained smear examined for foreign cells.

Stamp's stain smear examined for the presence of Brucella organisms.

CC15-4 Mating behaviour evaluation

Failure of insemination by rams has been identified as one of the contributing factors in reproductive failure in small ruminants (Plant 1981b; Purvis, Edey, Kilgour & Piper 1984). The serving capacity test (SCT) can be used to identify rams with poor potential. Some researchers have found no correlation between the results of mating behaviour evaluation and conception (Mickelsen, Paisley & Dahmen 1982) but it is generally considered to be of value (Blockey & Wilkins 1984; Purvis et al 1984).

The serving capacity test (SCT) is described as the number of successful services achieved in a Controlled situation over a period of time. It has been proven that there is an acceptable correlation between the pen test and the actual performance of the ram in the real life situation and that higher SCT scores have led to higher pregnancy rates. Rams have been observed to mate as many as 38 times in 11 hours whilst many do not mate at all or only achieve one or two successful matings in 33 hours. A commercially viable test has been suggested by Blockey and is described below. Rams with a mating potential above 100 are considered to be highly fertile. Rams with poor SCT results should be culled (Blockey & Wilkins 1984).

Table CC15 9. Proposed mating potential for rams of varying serving capacity and scrotal circumference (Blockey & Wilkins 1984).

<table>
<tr><th>Mating potential (no. of ewes)</th><th>Serving capacity test performance [a]</th><th>Evaluation</th></tr>
<tr><td>50</td><td>2</td><td>Acceptable</td></tr>
<tr><td>75</td><td>3</td><td>Good</td></tr>
<tr><td>100</td><td>4 -5</td><td rowspan="2">Excellent</td></tr>
<tr><td>125</td><td>6 or more</td></tr>
</table>

[a] Defined as the number of successful matings in 20 minutes with restrained ewes and a group of rams equal to the number of tethered ewes.

CC14-5 Hazard analysis

Excess wool

Mange

Tick toxicoses

CC15-6 Ram flock assessment

The ideal flock composition is a flock with equal numbers of rams from 4 age groups. This means that young rams can be introduced annually at a constant rate. A summary of the flock composition with a pie-chart graphic should form part of the report to the flock manager.

Each ram is rated in terms of a calculated ram mating capacity (RMC) which is based on the findings during the genital soundness examination. This calculation is not a guarantee of performance but merely seeks to make a comparison between rams. This estimated RMC is used to select rams in the process of forming the groups of rams that will be joined to each ewe flock.

CC15-7 Recommendations

The recommendations following the CCP15 Ram genital soundness should be based on the experience of the flock health practitioner, the history of the flock, the level of management and the known hazards that exists in the flock. These recommendations could include suggestions such as a minimum of three rams per ewe flock wherever possible and mixing age groups in each flock to avoid problems with inexperienced rams or ewes alone in each group. The recommendations should also include anticipated problems which the current climatic and epidemiological information may dictate.

2. Aim and objectives

The aim of Critical Control Point 15: Genital Soundness is to evaluate the potential fertility of the ram flock to ensure the maximum conception rate at mating time and to reduce the risk of reproductive failure at mating time.

The objectives are to evaluate:

- The general health status of individual rams in the ram flock
- The health and physiological status of the reproductive system of individual rams
- The mating dexterity and libido of individual rams
- The potential mating capacity of individual rams
- The genetic suitability of individual rams to support the breeding objectives of the flock
- The composition of the flock
- The historical data and performance of the flock.

3. Materials, forms and checklists

Qualitative aspects of the critical control point as well as certain quality control questions are described in form QQ1 (Addendum B-QQ1). This generic form is modified annually to reflect hazard issues that need to be followed up the next year. Specific questions are entered on the form which is diarised for the next year.

4. Methods

Comprehensive test procedure for rams:

A. Before sitting ram down:

1. Condition score

2. Hip dysplasia test (Normal person carried on rump or collapsed?)
3. General inspection of dorsal aspect

B. Full clinical examination could now be done

C. After sitting the ram down:

4. Ear tags (Microchip scan)
5. Tattoos
6. Ear notches
7. Brands on horn
8. Eyes and eyelids
9. Famacha© anaemia score
10. Teeth (ageing) and bite.
11. External parasites
12. Front legs and feet
13. Back legs and feet
14. Groin skin colour
15. Scrotal cover
16. Palpation of testes, epididymi, lymphnodes and chords
17. Scrotal measurements
    - Testis length (left and right if asymmetrical)
    - Scrotal circumference
    - Degree of split scrotum
18. Ultrasound examination of testes
19. Sheath and penis: mucous membrane colour, glans, processus, scars and or lesions.
20. Protrusion distance
21. Skin colour and ticks around anus
22. Tail length and perineal stability.

D. Semen collection

23. Semen density, colour
24. Transfer semen to sterile container for bacteriology. (Optional)
25. Direct examination note mass motility
26. 3-4 Smears prepared after direct examination
    - Nigrosin-eosin
    - Unstained for Diff quick
    - Unstained (possible Stamp’s stain)
    - Unstained for Spermac © stain
27. Blood specimens (Optional)

- In plain tube for serology (external laboratory)
- In EDTA for DNA reference (recommended for semen sales, insurance and possible legal consequences)

28. Mating dexterity/serving capacity test can now be done.

E. Laboratory tests

29. Smear evaluation
    - Sperm count (Dead/live) Morphology
    - Examination for foreign cells
        - If foreign cells present: Stamps stain examination.
30. Interpret serology and bacteriology

F. Administration

31. Certificate issued or declined, carbon copy or photocopy of signed certificate.
32. Storage and data retention (minimum 3 years):
    - Three smears preserved with cover slip
    - Data record stored
    - Full clinical examination form stored for three years.
    - Laboratory results stored for three years.
    - Blood placed on numbered blotting paper and allowed to dry. Placed in cleaned and dried EDTA tube.

5. Data

Data for this critical control point is collected on the Genital Soundness Data form (Addendum B-CC15)

6. Parameters and critical limits

Key parameters

- Ram flock composition by age group
- Individual ram rated capacity

7. Corrective actions/report

Flock health practitioners supply a written report to the flock manager . The report is a summary of findings and recommendations in the format:

1. Summary
2. Results of clinical examination
3. Results of semen evaluation
4. Results of mating behaviour evaluation

5. Hazard analyses
6. Results of ram flock assessment
7. Recommendations

3.6.17 Critical Control Point CC16: -Ram Recovery

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC16 – RAM RECOVERY

This CCP is the recording and evaluation of data collected at the time of examining the rams after the Ram Recovery Phase (R4). Data for this critical control point is collected on the Ram Recovery form (Addendum B- CC16)

3.6.18 Critical Control Point CC17: Last Day of Lambing

STANDARD OPERATING PROCEDURES FOR THE HAMMER CRITICAL CONTROL POINT CC17 – LAST DAY OF LAMBING

This CCP is the recording and evaluation of data collected at the end of lambing and consists of the numbers of ewes that failed to raise a lamb by flock and reason. Ewes may be scanned to determine the presence of remnants of pregnancy. Data for this critical control point is collected on the Last day of Lambing Data Form (Addendum B- CC17:1 & CC17:2)

3.6.19 Critical Control Point CC18: Body Condition Score (BCS)

STANDARD OPPERATING PROCEDURE FOR BODY CONDITION SCORING

Body condition score is a subjective assessment of the degree of fat deposition and muscle mass in the lumbar region of sheep and goats. It allows for the comparison of animals with differing body weights and is generally accepted to be sufficiently reliable to use in managing the nutrition of flocks and in scientific research (Russel 1991; Darrel et al 2002; Sargison 2008).

A six-point scale is the most commonly used scale where a score of 0 indicates near fatal emaciation and 5 is given to an obese animal. Experienced flock managers allocate half scores to differentiate between animals that differ in the most commonly found range of 2 to 4. A change of 1 point on the 6 point scale is equivalent to about 13% change in body weight for ewes in moderate condition(Codex Alimentatius Commission of the Food and Agricultural Organisation & World Health Organisation

2003). The standards for the body condition scoring of sheep are listed in Table CC18-1 and the standards for goats are listed in Table CC18-2

Table CC18-1 Body condition scoring of sheep (Russel 1991).

Score	Dorsal spinous process of vertebrae	Transverse process of lumbar vertebrae	Eye muscle area
0	No subcutaneous fat or muscle can be palpated in lumbar area		
1	Prominent and sharp	Sharp fingers pass underneath	Shallow with no fat
2	Prominent but smooth		Moderate depth little fat cover
3	Only small elevations	Smooth and well covered, fingers pass underneath with firm pressure	Full with moderate fat cover
4	Detected only with pressure	Ends cannot be felt	Full with a thick fat cover
5	Cannot be detected	Cannot be detected	Very full with thick fat cover

Table CC18-2 Body condition scoring of goats (Darrel et al 2002).

Score	Dorsal spinous process of vertebrae	Sternum	Chondro-sternal joints	Transverse process of lumbar vertebrae	Articular process of lumbar vertebrae
0	No subcutaneous tissue seen				
1	Continuous ridge	Fat easily moved laterally	Easily palpable	Easily visualised	Easily palpated
2	Continuous ridge	Moveable 1-2 cm thick	Tissue seen subcutaneously	Soft tissue seen less easily palpated	Need slight pressure to palpate
3	Less prominent	Thick and barely moveable	Palpated with difficulty	Thick tissue covering	Cannot be palpated
4	Not palpable	Continuous with rib fat	Fat continuous with sternal fat	Difficult to palpate	Cannot be palpated
5	Not palpable	Bulges when pressed	Fat continuous with sternal fat	Cannot be palpated	Cannot be palpated

A practical method of assessment has been suggested by Malan (personal communication Dr FS Malan). The spinous process is compared with that of a human hand. This system is illustrated in Figure CC18-1

Body Condition Score 1	
Body Condition Score 2	
Body Condition Score 3	
Body condition Score 4	
Body Condition Score 5	

Figure CC18-1. A practical method for determining Body Condition Scoring by using the human hand as standard.

The ideal score is determined by breed, age, phase of reproduction or lactation and environment. Suggested target scores are listed in Table CC18-3.

Table CC18-3. Selected target body condition scores for sheep.

Animal	**Phase**	**BCS**	**Reference**
Sheep ewes	At lambing	Should be 3.5 or more	(Russel 1991)
Sheep ewes	At mating	Should be 3 to 3.5	
Sheep ewes	Eight weeks before lambing	Ewes below 2.5 separated and supplemented	
Sheep ewes	At lambing	Ewes prevented from falling below 2.0	
Sheep ewes	Ewes 2 -3 m of pregnancy	Ewes above 3.5 can lose maximum 0.75	
Sheep ewes	At mating	Ewes above 3.5 tend to be poor producers	
Sheep ewes	At lambing	Should be 2.5 to 3	(Darrel et al 2002)
Sheep ewes	At mating	Should be more than 3	
Sheep ewes	45 days pre lambing	Ewes below 2.5 to 3 should be fed	
Sheep ewes	30 days before mating	Ewes below 3 should be flushed	
Rams	At mating	Should be 3.5 to 4	(Sargison 2008)
Rams	At mating	Above 4 may reduce libido	
Rams	During mating	May lose 0.5 per week	
Sheep ewes	At mating	Best results if 3 to 3.5	
Sheep ewes	Flushing	Best response if 2.5 to 3, poorer at 4	
Sheep ewes	Flushing	Increase of 0.5 to 1.00 in 4 to 6 weeks	
Goats	All	BCS of 1 urgently needs supplements	(Thomas 1990)
Goats	Breeding ewes	May be barren or abort at BCS of 2	
Goats	All	BCS of 3 or more provides barrier against post shearing weight loss	

3.6.20 Critical Control Point CC19: Helminthic Status

Standard procedures for the determination of helminthic infections are described in the literature. (Reinecke 1984; Bath 2006).

The aim of this procedure is to determine the helminthic parasite status of a flock.
The objectives are to determine the status of a group of animals in a flock with respect to the following:

- Faecal egg counts for nematodes
- Faecal egg counts for trematodes
- Faecal egg count for coccidia
- Famacha© anaemia status.

These parameters are interpreted together with the data obtained in Body condition score critical control point (See par 3.2.18) as well as the Nutritional Status critical control point (See par. 3.2.20. Identification of larvae can assist in determining the nematode genera present in the flock and the limitations of faecal egg counts can be overcome by performing a complete autopsy for the identification of helminths (Reinecke 1983; Reinecke 1984).

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3.6.21 Critical Control Point CC20: Nutritional Status

1. Description and literature review.

This critical control point (CCP) is the evaluation of the nutritional status of animals as part of monitoring of the general health and welfare of the flock. The range of procedures that are performed will be determined by the breed, management and environment of each flock. The procedure can be a pro-active routine monitoring or in response to problems experienced during other critical control points. Feed and pasture samples may be collected for analysis as part of this CCP.

Nutritional deficiencies is the most important hazard to reproduction and production (Freer & Dove 2002). Adequate nutrition can partially counteract the threats of climate, genetics, behaviour and even disease. The major hazards encountered in small ruminant production are digestive disturbances, primary or secondary protein, energy and mineral deficiencies. This CCP describes a number of procedures that could assist in providing a nutritional profile of a flock that could assist in selecting corrective actions where poor reproductive performance and ill-thrift are encountered.

Body condition score is the most important single parameter of the nutritional status of an animal and is described in critical control point CC18.

Nutritional deficiencies often act as limiting factors to production and reproduction. The provision of supplementation is often futile if the limiting factor or primary constraint is not addressed. These limiting factors are often trace elements or minerals. For example: Magnesium deficiency was suspected as the cause of been observed to cause extreme poor performance in adult sheep in spite of abundant pastures and supplementation. After laboratory confirmation, supplementation resulted in an increase of 1.5 points in BCS in lactating ewes within 3 weeks.

The routine and strategic evaluation of the nutritional status of animals is widely recognised as an important aspect of flock health and production management (Thompson 1990b; Caple 1994).

2. Aim and objectives

The aim of this procedure is to create a profile of the nutritional status of a flock.
The objectives are to determine the status of a group of animals in a flock with respect to the following:

- Protein
- Minerals such as calcium, phosphorus and magnesium
- Trace elements such as selenium, copper, cobalt, zinc, iodine, manganese, iron and molybdenum
- Urinalysis to determine pH, sediments, protein, ketones, blood/haemoglobin, specific gravity,
- Rumen fluid analysis to determine pH, microbial activity, smell, colour and consistency.

The tests should be repeated in the different growing seasons, for the groups of animals in different physiological stages, ages and even in different camps, if a comprehensive status appraisal is needed

3. Materials forms and checklists

The data form that is used for data collection is attached as appendix B CC20-1
The checklist of items required for CC20-Nutrional status is listed in Table CC20-1

Table CC20-1. Packing list for Critical Control Point CC20- Nutritional status

Item	**Number**
Needles, double sided 18g	100
Holders for needles (Screw in, “shoulders”)	10
Plain collecting tube (Red stopper, serum)	100
Heparinised collecting tube (Green stopper)	25
Specimen jar, screw-top 50ml	25

Pathologists bags, plastic	100
Feed specimen bags, plastic	100
Stomach tube small	1
Stomach tube medium	1
Test strip for urinalysis (ketones, pH at least)	100
pH meter for rumen content	1
Refractometer for serum protein and urine SG	1
Distilled water and cleaning tissues	
Methylene blue solution (.03%)	50ml
Syringe 1ml	10
Test tubes 15 ml	10
Flock data forms	25
Stationary for marking specimens	
Insulated containers and ice packs	2
Buckets, table, water	

4. Methods

Blood is collected by venepuncture from the jugular vein in containers as indicated in Table CCP20-2 on the data form CCP20-1

Urine specimens are collected by closing the nose of the animal for a short while. Animals that are transported to a veterinary facility often urinate and defecate immediately after the vehicle has stopped. Assistants should be ready with urine containers to collect urine and faeces. Urine tested with commercial strip tests as well as a refractometer.

Rumen specimens are collected by passing a2 cm stomach tube, suction applied to aspirate the fluid and placed in a suitable container. PH is determined by pH strips or pH meter. Microbial activity is tested with the methylene blue reduction test. Colour, odour and consistency are noted.

The methylene blue reduction test is performed as follows: Ten ml. of fresh rumen fluid is added to a test tube containing 0.5ml of a 0.03% solution of methylene blue. The blue colour should disappear in 1 to 4 minutes in a sheep indicating adequate numbers of anaerobic bacteria. The test is invalid at pH below 5.5 (Grünberg & Constable 2009).

Liver specimens can be collected at an abattoir or by biopsy.

5. Data

The results of the tests are entered on the standard report form (CC20-1) and kept on file.

6. Parameters and critical limits

The parameters and critical limits for the tests are listed in Table CC20-2

Table CC20-2. Tests, specimens and normal values for creating a profile of the nutritional status of a flock.

Test	**Specimen**	**Specie**	**Lower value**	**Upper value**	**Adequate range** [a]	**Unit**	**Reference**
Protein[d]	Serum	Ov Cap	60.0 64.0	79.0 70.0	72.0 ± 5.2 69 ± 4.8	g/l	d
Ca	Serum	Ov Cap	2.88 2.23	3.20 2.93	3.04 ± 0.07 2.58 ± 0.18	mmol/l	d
PO4	Serum	Ov Cap	1.62	2.36	2.07 ± 0.06 4.62 ± 0.25	mmol/l	d d
Mg	Serum	Ov Cap	0.90 0.31	1.31 1.48	1.03 ± 0.12 1.32 ± 0.14	mmol/l	d d
K	Serum	Ov Cap	3.9 3.5	5.4 6.7	 4.3 ± 0.5	mmol/l	d d
Na	Serum		138 142	152 155	 150 ± 3.1	mmol/l	d
Cl	Serum, blood in heparin		95 99	103 110.3	 105.1 ± 2.9	mmol/l	d
Cu	Serum	Ov	9.13	25.2		µmol/l	d
	Liver	Ov	20		>200 - 350	µmol/Kg	e
Zn[b]	Serum	Ov	12.2	18.2		µmol/l	e
	Liver						
Se	Blood in heparin		0.13	38	1.0 -1.5	µmol/l	d
	Liver						
Co	Serum	Ov Cap	0.17	0.51		µm/l	e
	Liver	Ov Cap	0.1			µg/g (wet)	d
Vit. B12	Serum	Ov	0.20-0.25		0.5-1.0	µg/l	e

Table CC20-2. Tests, specimens and normal values for creating a profile of the nutritional status of a flock. (cont.)

Test	**Specimen**	**Specie**	**Lower value**	**Upper value**	**Adequate range** [a]	**Unit**	**Reference**
Fe	Serum	Ov	17.9	35.8		µmol/l	e
Fe	Liver		29.7	39.7	34.5 ± 1.25	mmol/l	d
I	Plasma		2.4	14		µg/100ml	e
Mn	Liver	Bo			0.21	mmol/kg	e
Mo	Blood	Ov			0.21	µmol/l	d
Rumen pH	Rumen content	Pasture Feedlot	6.0 5.5	7.0 6.0			f
Rumen MBRT[c]	Rumen content		1	4		Min	f
Urine pH	Urine						
Urinary ketones	Urine						
Urine SG							

[a]The range that does not require intervention or mean ± standard deviation

[b] Red stopper of serum container may contaminate specimen – cover with plastic wrap

[c] Methylene blue reduction time

[d] Adapted from Kaneko (Ed.)(1989)

e. (Radostits et al 2007)

f. (Grünberg & Constable 2009)

7. Corrective actions/report

The proposed corrective actions are communicated to the flock manager in a written report and the proposed changes to the Flock Health and Production Plan are recorded in the quarterly annual report and incorporated in the future business plan to ensure that the recommendations are implemented.

3.6.22 Generic Quality Control Questionnaire

Table 3.6.22. Generic quality control questions for each Critical Control Point

Generic question	**Specific hazards. Historically or currently relevant hazards**	**Corrective actions**
Is there any evidence that diseases could affect flock reproduction?	Diseases:	Actions required to reduce disease risk.
Is there any evidence that management could affect flock reproduction?	Management:	Actions required to reduce management risk.
Is there any evidence that genetics could affect flock reproduction?	Genetics:	Actions required to reduce genetic risk.
Is there any evidence of functional (conformation, physiology and behaviour) factors that could affect flock reproduction?	Functional:	Actions required to reduce functional risk.
Is there evidence that nutrition could affect flock reproduction?	Nutrition:	Actions required to reduce nutrition risk.
Is there any evidence that predation could affect reproduction?	Predation:	Actions required to reduce predation risk.
Is there any evidence that climate could affect flock reproduction?	Climatic:	Actions required to reduce climatic risk.
Feedback required?		
Insights gained?		
Changes to flock health plan?		
Changes to data form and questionnaire?		
Diary entries required?		
Matters to be reported on?		
Continuous improvement potential?		

3.6.23 Farm visits

Although farm visits by the Flock Health Practitioner can be arranged for all critical control points they can also be handled as office visits by the Flock Manager, telephone, electronic mail or written interactions. A minimum of six or seven visits per year are however recommended to ensure adequate interaction.

Each visit should be retrospective, concern itself with the current critical control point and also discuss planning for the phase ahead. Five or six visits should coincide with critical points in the cycle as suggested in table 3.6.23 and one visit should be the discussion of the annual Flock Health & Production Report and the future Flock Health & Production Plan. In HACCP terminology these would be referred to as the HACCP report and plan respectively.

Table 3.6.23.. Farm visits to perform Critical Control Points

	Description	**Flock Health Practitioner activities**	**Data forms**
CC1 CC2	Ewe selection Ram selection	Review flock composition, culled ewes, body condition scoring, parasite control and flushing period, planning	CC1 Ewe selection data form CC2 Ram selection data form QQ1 generic questionnaire
CC7	Scan	Perform ultrasound pregnancy examinations and/or assess scan results. Review BCS, nutrition and parasite control and planning.	CC7 Scan data form QQ1 generic questionnaire
CC8 &9	Rescan Pregnancy management	Perform re-scan. Review BCS, nutrition and parasite control and planning	CC8 Rescan data form CC9 Pregnancy management data form. QQ1 generic questionnaire
CC10	Lambing	Peri-natal mortality investigation. Review BCS, nutrition and parasite control and planning	CC10 Lambing data form QQ1 generic questionnaire
CC11	Marking	After tail docking/marking to collect accurate lambing results. Review BCS, nutrition and parasite control and planning	CC11 Marking data form QQ1 generic questionnaire
CC15	Genital soundness	Perform genital soundness examinations. Review BCS, nutrition and parasite control and planning	CC15 Ram genital soundness data form QQ1 generic questionnaire

3.6.24 Annual report

The report for each critical control point contribute to the comprehensive annual Flock Health and Production Report (FHPR) which is the full record of the flock's performance. This comprehensive report forms the basis of future strategic planning for the flock{van Rooyen, 2009 174 /id}. The structure of the annual report is presented in Table 3.6.24.

Table 3.6.24. Structure of annual Flock Health & Production Report

Nr	Sub	Chapter heading	Chapter content
1		Summary	
2		Introduction	
3		Flock Process	
	1	Reproduction	Ram management, Ewe management, mating, lambing, weaning and post weaning growth.
	2	Fibre/milk production	Optimal production technology shearing/milking.
	3	Meat/skin production	Marketing lambs and mature animals.
	4	Genetics	Purchasing of rams, semen and ewes. On farm performance testing or classing.
	5	Prophylaxis	Prevention of disease, ill thrift or production and reproduction losses.
	6	Diagnostics	Determination of causes of disease, ill-thrift or reproduction failure.
	7	Records	Recording of all inputs, processes and outcomes.
	8	Predator control	Prevention of predation and stock theft.
	9	Grazing management	Management of natural and artificial pastures. Veld assessment.
	10	Nutrition	Supplementation matched to physiological cycle.
	11	Treatments	All handling and human contacts.
	12	Monitoring	Body condition score or weight recorded as indicated in flock plan.
4		Recommendations	Summary of changes to Flock Health & Production Plan
5		Management rating	Overall management rating [a]
6		Strategic outlook	A brief summary of political, economic, social, technological, legal and ecological issues that may impact on the FHPP in the coming year.
7		Conclusion	General comments on achievements and challenges.

[a.] The Shepert management rating provides a graphic assessment of management and a single management score {van Rooyen, 2009 174 /id}.

CHAPTER 4

RESULTS

4.1 Introduction

The Hazard Analysis Critical Control Point (HACCP) system was adapted to form the basis of a methodology for the management of reproduction in small ruminant flocks. Seventeen Critical Control Points (CCP) were described to be applied at various points in the flock production cycle during 2008, 2009 and 2010. The 17 Critical Control Points were applied to selected farms as indicated in Table 4.1 to evaluate their practicality, validity and acceptance by flock managers.

Flocks are identified by bird names to ensure confidentiality. Thirty flocks formed part of the original project. Four of these flocks did not supply information for lambing and marking in 2008 and were removed from the project. (Flocks 8, 9, 26 and 27). More flocks became inactive or only partly active as the project progressed. The response from many flock managers was slow and often non-existent. Obtaining feedback proved rather difficult and in many instances repeated phone calls, e-mails and letters were needed to obtain data. This poor response was overcome in part by requesting flock managers to at least submit their flock numbers monthly. Further information was then obtained by telephone or during subsequent visit. This aspect of providing flock health services is a universal problem and is the primary challenge in the design of the service.

The data that were collected during the application of the Critical Control points as well as the Process Control Data (Forms PC 1-4) was not used in management at the time that it was collected but forms a valuable record for the interpretation of later results. In many cases the data was more valuable in making retrospective evaluations.

Notwithstanding these limitations it was possible to apply all the Critical Control Points to at least three flocks to make it possible to evaluate the design and acceptance of the CCP

Table 4.1. List of flocks in the study and the Critical Control points that were applied to each farm.

Number	Farm Code	CC1	CC2	CC3	CC4	CC5	CC6	CC7	CC8	CC9	CC10	CC11	CC12	CC13	CC14	CC15	CC16	CC17
1	Crane		X		X			X	X			X	X			X	X	
2	Cuckoo							X				X	X			X		
3	Eagle							X				X	X					
4	Falcon							X				X	X					
5	Francolin							X				X	X					
6	Grouse	X						X				X	X					
7	Gull							X				X	X					
8	Hawk							X										
9	Heron				X			X								X		
10	Hoopoe	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
11	Ibis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
12	Kestrel				X			X				X	X			X		
13	Korhaan				X			X				X	X					
14	Lark							X				X	X					
15	Lourie				X			X				X	X					
16	Ostrich							X				X	X					
17	Owl							X				X	X					
18	Pelican				X			X				X	X			X		
19	Petrel	X	X	X	X	X	X	X		X	X	X	X			X		
20	Plover				X			X				X	X			X		
21	Quail				X			X				X	X			X		
22	Raven			X	X			X				X	X			X	X	
23	Robin							X				X	X					
24	Shrike			X	X			X				X	X			X		
25	Sparrow							X				X	X					
26	Starling							X	X									
27	Stork							X	X							X	X	
29	Swallow							X										
28	Swift							X				X	X					
30	Warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
	Totals	**5**	**5**	**6**	**14**	**4**	**4**	**30**	**6**	**4**	**4**	**25**	**25**	**3**	**3**	**14**	**3**	**3**

4.2 Results of the application of Critical Control Points to selected flocks

4.2.1 CC1-Ewe selection

This CCP was applied to five farms as listed in Table 4.1. It is a procedure that forms part of the normal management cycle on sheep farms. It was performed on the day of weaning on two farms which has the benefit of observing ewes that have a low BCS and are suspected of having a poor constitution. Ewes that have above average milk production and wean heavier lambs may be unfairly judged as a result of their lower BCS. Many udders were still actively lactating and it was difficult to identify abscesses or fibrosis of the udder Ewes that were examined after a rest period allowed the udder to regress and ewes to restore their body reserves. Even though udder pathology was observed and the ewes culled, additional cases were observed at Critical Control Point 7 – Scanning. The number of cases in the report forms underrepresents the actual number of cases as many cases of mastitis, blowfly strike, foot rot and foot abscess are removed from the flock during the lactation period. These cases can be collated from the monthly PC3 – Individual event/treatments form submitted by the flock managers.

The monthly stock counts provided on the PC1 – Stock counts form, formed an important part of the evaluation of CC1 – Ewe selection.

The age composition of the ewe flock is determined by the longevity of the ewes which in turn is primarily determined by the degree of wear on their teeth and mineral nutrition. Ewes may have only three lambing opportunities in pastures that are highly abrasive to teeth compared to the normal four opportunities in “softer” pastures and up to 6 or more lambing opportunities on irrigated pastures with adequate mineral supplementation. Stud ewes still lambing at 10 years old may be found on irrigated pastures. The flock age group composition from three farms with different environments and nutritional practices, used to illustrate this point is presented in Table 4.2.1.2.

The generic questionnaire QQ1 form was completed during telephonic or office discussions and the results of this discussion as well as the data collected was used to write a short report as feedback to the flock managers. The Body Condition Score (BCS) of the ewes, the general climatic and pasture conditions and strategies for preparation of ewes for mating time were discussed at this time. The results of CCP1 – Ewe selection applied to five farms are listed in Table 4.2.1.a.

Table 4.2.1.a. Abnormal findings at ewe selection from five farms for 2008 and 2009 as percentage of the flock examined

Farm code	Year	Incidence of abnormal findings (%) [a]							Total flock
		Abscess	Blowfly	Cancer	Disease	Loco-motion	Teeth	Udder	
Grouse	2008	0.13	0.20	0.54	0.13	0.00	9.91	0.54	1484
	2009	0.08	0.31	0.00	0.08	0.00	15.74	0.86	1277
Hoopoe	2008	0.07	1.10	0.27	0.00	0.48	12.42	0.96	1457
	2009	0.00	1.50	0.07	0.00	0.00	12.13	0.43	1401
Ibis [b]	2008	0.00	0.19	0.00	0.19	0.00	18.06	0.00	537
	2009	0.00	0.00	0.00	0.00	0.00	15.44	0.00	544
Petrel [b]	2008	0.00	0.14	0.00	0.00	0.00	15.55	0.28	1428
	2009	0.00	1.55	0.00	0.21	0.49	14.20	0.92	1415
Warbler	2008	0.14	0.00	0.00	0.14	0.00	19.14	0.00	700
	2009	0.00	0.00	0.00	0.00	0.68	11.39	0.17	588

[a] Ewes may present with more than one abnormal finding.
[b] Closed flocks where rams are strictly selected for full eyelid pigmentation and culled for abscesses.

The flock age composition of three flocks indicating the effect of nutrition and dental attrition on the longevity of ewes is illustrated in Table 4.2.1.b.

Table 4.2.1.b. Flock age composition of three flocks at scanning in 2008

	Flock age composition in 2008					
Farm code	**Eagle [a]**		**Pelican [b]**		**Heron [c]**	
Age group	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**
2 Tooth	350	29%	447	35%	261	39%
6 Tooth	311	26%	348	27%	226	34%
8 Tooth	314	45%	472	37%	180	34%
Older	231					
Total	1206		1267		667	

[a] High rainfall grass pastures with high mineral supplementation.

[b] High rainfall grass pastures with low mineral supplementation.

[c] Low rainfall shrub pastures with no mineral supplementation

Feedback was provided to the flock managers listed in table 4.1 in the form of a short report.

The Critical Control Point CC1 – Ewe Selection does not require much additional effort to perform on the farm. It is performed by all farmers at some stage between weaning and mating time, often in conjunction with livestock agents who class ewes on conformation, wool and sometimes breed standards. The process of identifying hazards to reproduction at this point is formalised by using a standard form to record the numbers after completion. The use of a form can also act as a checklist to remind the flock managers to observe certain abnormalities. The QQ1 questionnaire adds further aspects to the CCP that can contribute to improved risk management.

The use of a flock composition analysis was useful in drawing attention to the importance of managing ewes in such a way that their productive life is extended and also to select for longevity by allowing ewes to remain in the flock longer if they still meet requirements. There is a direct positive correlation between longevity and the degree to which replacement ewes can be selected for production allowing increased rates of genetic improvement because of a reduced number of old ewes that are culled for poor dentition.

Flock manager who perform CC1 – Ewe selection could consider doing a secondary examination closer to mating time with particular emphasis on further cases of udder abscesses, teat abscesses and induration that may become apparent.

This CCP, the monthly stock counts and the QQ1 questionnaire should form part of the core data collected for all flocks that are part of a flock health scheme.

4.2.2 CC2-Ram selection

This CCP is performed before or soon after the start of the ram flushing period. The main objective is to reduce the number of rams that have to be fed and subjected to the veterinary genital soundness examination. Most flock managers who purchase rams also base their decision about the number of rams to buy on the result of this selection process. It is therefore a normal procedure on most farms although some flock managers present all rams for genital soundness examination (CC15) to allow rams with high longevity to remain part of the flock for as long as possible. Rams with worn teeth can be retained if the genital soundness parameters remain excellent.

The Critical Control Point 2 – Ram Selection was performed on five farms listed in Table 4.2.2.a. An example of the printout for the Hoopoe flock for 2008 is presented as Table 4.2.2.b.

Table 4.2.2.a. Summary of abnormal findings at ram selection from 5 farms for 2008 and 2009 as percentage of the rams culled and the culling rate as percentage of flock size.

		Rams with abnormalities as a percentage of the number culled [a]									
Farm code	**Year**	**Abscess**	**Blowfly**	**Cancer**	**Famacha©**	**Feet**	**Teeth**	**Scrotum**	**Culled**	**% of flock**	**Flock size**
Crane	2008	16.6	0.0	0.0	0.0	16.7	100.0	0.0	6	20	30
	2009	0.0	0.0	0.0	25.0	0.0	75.0	0.00	8	26	31
Hoopoe	2008	6.2	50.0	0.0	0.0	6.3	68.8	6.3	16	38	42
	2009	0.0	20.0	0.0	0.0	0.0	100.0	0.0	10	23	44
Ibis	2008	0.0	0.0	0.0	0.0	0.0	100.0	0.0	3	21	14
	2009	0.0	0.0	0.0	0.0	25.0	75.0	0.0	4	33	12
Petrel	2008	0.0	14.3	0.0	0.0	0.0	92.9	0.0	14	42	33
	2009	0.0	0.0	0.0	0.0	0.0	93.3	0.0	15	42	36
Warbler	2008	0.0	0.0	0.0	0.0	0.0	100.0	0.0	4	29	14
	2009	0.0	0.0	0.0	0.0	0.0	100.0	0.0	4	29	14

[a] Rams may have more than one abnormality

Table 4.2.2.b. Abnormal findings at ram selection on the Hoopoe farm in 2008

HAMMER CRITICAL CONTROL POINT FORM – RAM SELECTION DATA										**CC2**	
Ram number	**Age**	**Abscess**	**Blowfly**	**Cancer**	**Famacha©**	**Feet**	**Teeth**	**Scrotum**	**Body wt.**	**BCS**	**Cull?**
3:14	Older						1			2.5	1
2.07	Older					1	1			2.5	1
3.45	Older							1		3.0	1
1.04	Older						1			3.0	1
3.31	Older						1			2.5	1
3.20	Older						1			2.5	1
2.54	Older		1				1			2.0	1
3:13	Older						1			3.0	1
3.27	Older						1			3.5	1
3.46	Older						1			2.5	1
02351	Older						1			3.0	1
01006	Older						1			2.0	1
EN03:423	Older		1							2.0	1
4:16	8 Tooth		1							3.0	1
4.06	8 Tooth	1								3.0	1
5.49	6 Tooth		1							3.0	1
5:13	6 Tooth		1							3.0	
6.32	2/4 Tooth		1							3.0	
6.33	2/4 Tooth		1							3.0	
6.02	2/4 Tooth		1							3.0	
Total	2/4 Tooth	0	3	0	0	0	0	0			0
Total	6 Tooth	0	2	0	0	0	0	0			1
Total	8 Tooth	1	1	0	0	0	0	0			2
Total	Older	0	2	0	0	1	11	1			13
TOTAL		1	8	0	0	1	11	1			16
Percentage		6%	50%	0%	0%	6%	69%	6%			
FARM CODE	Hoopoe	FLOCK CODE	SD1	DATE	28-Feb-08	Total	42				

Feedback was not provided to the flock managers as the full evaluation of the ram flock was performed during CC15 - .Ram genital soundness. Abnormally high incidences of hazards leading to culling were discussed, for example the problems encountered with blowfly strike, because of the genetic and fertility implications. These aspects were further acted on during CC15. The data tables were, however, printed and supplied to the flock managers for their records.

This critical control point does not need much effort and the data can be recorded at the time of the normal ram classing exercise which many flock managers perform either by themselves or with the help of livestock agents or breed advisors. The form can assist in the process by providing a checklist.

This CCP is not essential if rams are examined for genital soundness at a later stage. It can be a valuable record for retrospective trend analysis if the number of rams culled becomes a problem especially in relation to the cost of purchased rams. In flocks where replacement rams are selected on the farm the culling rates may provide information for future selection and culling of replacement rams. The data collected during this CCP need not form part of the core data set for inter flock comparisons.

4.2.3 CC3-Ewe preparation

The CCP Ewe Preparation was performed on six farms. Flushing is performed on most farms where ewe flocks are moved to rested camps or given energy or protein supplementation or even moved to artificial pastures such as lucerne and grass-clover combinations. Farmers rely on observation and can rarely be convinced that a more formal system of monitoring can assist in ensuring success and provide a basis for future decision-making. The six farms for which data was recorded each had a different approach to flushing as is reported in Table 4.2.3.

Flock managers preferred weighing to body condition scoring for two reasons: The relatively short time span and small groups make BCS less reliable and farmers are not comfortable and sufficiently trained with the BCS standards. The generic questionnaire QQ1 form was completed during telephonic or office discussions and the results of this discussion as well as the data collected was used to write a short report as feedback to the flock managers.

Table 4.2.3. Flushing results of six farms indicating BW change responses to various feeding practices during ewe preparation**.**

Farm	**Year**	**Flock**	**Start date**	**BW gain**	**Comment**
Hoopoe	2008	SD01	April	2.4	Rested camp
		SD02	May	-1.2kg	Rested camp. Severe cold during May
Ibis	2008	All	April	0,7	No change in management
	2009	All	April	0.0	No change in management
Petrel	2008	LN01	-21 days	3.2	Lick (18% protein) , lambing prediction 104%
		LN02	-7 days	0.7kg	Lick (18% protein), lambing prediction 94 %
		LN03	-14 days	1.4 kg	Best camp, lambing prediction 120% [a]
Raven	2008	DI01	May	1.8kg	*Merxmuelleria*[b] pasture plus chocolate grain, experienced rumen acidosis.
		DI02	May	3.7kg	*Tetrachne*[c] veld plus chocolate grain
Shrike	2008	SR01	April	2.5 kg	Fed energy blocks: 6% dry, 3,5% twins
	2009	SR01	April	2.7 kg	Fed energy blocks: 7% dry, 5% twins
	2010	SR01	April	3.1 kg	Fed lupines: 4 % dry, 17% twins
Warbler	2007	700 ewes	April	1.5 kg	Wheat lands conception 90.5%
	2008	588 ewes	April	2.7 kg	Wheat lands conception 95.5%

[a] All ewes that lambed twins the previous year were in this flock

[b] *Merxmuelleria* has a low nutritional value

[c] *Tetrachne* has a very high nutritional value

Flock managers are not readily convinced that the application of CC3 – Ewe preparation is a very important tool in managing the mating process. Disappointing results at scanning time can often be traced back to the preparation period and a measured and controlled process will provide early warning to flock managers that additional measures may be necessary to ensure good results. The use of historic data coupled with the eventual result of flushing can provide valuable benchmarks for a cost: benefit analysis when making decisions about purchasing supplementary feed for flushing. The use of a form can also act as a checklist to remind the flock managers to keep records. The QQ1 questionnaire adds further aspects to the CCP that can contribute to improved risk management.

The period of preparation of ewes presents a number of hazards to reproduction as was observed in the flocks listed in Table 4.2.3. Insufficient flushing (Ibis), digestive disturbances such as rumen acidosis (Raven, Flock DI01), severe cold spell (Hoopoe, flock SD02), starting too close to mating time (Petrel, flock LN02) and overstocking (Warbler, 2007) are examples observed during this trial.

The benefit of using lupines for flushing as reported in literature was observed in one instance (Shrike in the 2010 season). The effect of phyto-oestrogens in lucerne and clover and high levels of urea are also suspected of having a negative effect on the flushing period after observations at the time of genital soundness examination.

Flock managers should be encouraged to adopt CC3 – Ewe preparation as a standard practice and it should form part of the core data to be recorded in a flock health advisory service.

4.2.4 CC4-Ram preparation

The CC4 – Ram Preparation was performed on 13 farms.

Weight gain data form the 13 farms did not provide much insights but the correlation between feeding practice and observations made during genital soundness examination provided some insights. The feeding practices performed on thirteen farms and the general findings at the time of genital soundness examination for testis tone and groin colour of the majority of 6 tooth and 8 tooth rams are listed in Table 4.2.4

Table 4.2.4. Feeding practice and clinical observations on selected farms.

			Protein percentage		Observation at genital soundness examination	
Farm code	**Year**	**Feed source**	**From urea or other**	**Natural**	**Testis tone**	**Groin colour**
Crane	2008	Commercial protein lick			4	0
Heron[a]	2008	Commercial protein lick			3	1
Hoopoe [a]	2009	Self-mixed urea lick	90%		3	1
Ibis	2008	Pasture		All	5	4
Kestrel	2009	Self-mixed oil cake lick		All	4	5
Lourie	2009	Lucerne land		All	4	3
Pelican	2009	Rested pasture		All	5	5
Petrel	2008	Rested pasture		All	4	5
Plover	2009	Self-mixed urea lick	> 50%		4	2
Quail	2008	Self-mixed urea lick	>50%		4	4
Raven	2008	Self-mixed urea lick	>50%		4	2
Shrike	2009	Energy block			4	2
	2010	Lupines		All	5	5
Warbler	2008	Clover & grass pasture		All	4	2

[a] Rams were shorn at the onset of the preparation period

The information about flock treatments, individual ram events and hazard events recorded on forms PC2, PC3 and PC 4 respectively may provide important historical data for managing ram preparation.

Formal reports were not produced for this CCP. The ram genital soundness examination falls within the preparation period and the management of the rams were always discussed and evaluated during ram genital soundness examination. The completed data forms were appended to the genital soundness report.

Flock managers generally adopt this CCP more readily than CC3 – Ewe preparation as it is less work to collect and weigh the ram flock. No flock manager recorded the BCS and this was done during genital soundness examination.

The weight gain achieved during the ram preparation period is highly variable but generally tends to be less if rams start off with a high BCS. Rams that are not supplemented or moved to rested pastures generally tended to lose weight as a result of fighting and the onset of the colder season in autumn mating.

The effect of flushing of rams on measurable criteria such as testes tone and groin colour is complex. It varies from year to year and different results are seen from the same feeding practice. However, the observations made during genital soundness examination tend to favour the use of natural pastures and natural protein supplements as feeding practices that prepare rams well. Shearing too close to mating time may also be a hazard to reproduction and it is generally accepted that rams should be shorn at least 8 weeks prior to the mating season.

This CCP should form part of the core data set of any flock health management program. It is a valuable management tool that can be applied even in very large flocks and very extensive farms. The application of BCS as an evaluation tool should be encouraged.

4.2.5 CC5-Joining

This CCP consists of the recording of the identity, mating capacity and counts of rams joined to each mating flock and no summary, interpretation or reporting was done. The records were however used in the evaluation of the scanning results.

It requires very little additional effort to perform and was applied at four farms to test the forms and practicality. It was well accepted by the flock managers. The QQ1 form was also completed by the four flock managers.

The records for the Petrel farm indicated that a group of mostly 2 Tooth rams were joined to the 2 Tooth ewes in 2009 which was considered to be the possible reason for a larger than normal percentage dry ewes.

It is recommended that CC5 – Joining as well as the completion of the Generic QQ1 form should form a part of the core record set of a flock health and production program.

4.2.6 CC6-Mating

This CCP consists of the recording of the identity, mating capacity and counts of rams joined to each mating flock and no summary, interpretation or reporting was done. The records were however used in the evaluation of the scanning results.

It requires very little additional effort to perform and was applied at four farms to test the forms and practicality. It was accepted by the flock managers. The QQ1 form was also completed by the four flock managers.

The Hazard events that were recorded by the four flock managers who applied CC6 – Mating Data are listed in Table 4.2.6 together with the hazards that were noted on PC4 by other flocks. Climatic hazards were not repeated

Table 4.2.6. Hazard events recoded during critical control point CC6 and monthly process control PC4 that relate to mating period.

Farm code	**Month**	**Year**	
CC6:1 Mating Data			
Hoopoe	May	2010	Domestic dogs attack ewes about 7 days
Ibis	May	2008	Severe wind preceding cold front
	March (21)	2010	Severe early frosts – poor grazing
Petrel	May	2008	Severe wind preceding cold front
	March (21)	2010	Severe early frosts – poor grazing
Warbler	March	2010	Severe Conical Fluke (*Calicophoron*) outbreak
PC4 –Hazard events			
Crane	May	2009	Theft of 30 mature ewes
Cuckoo	March	2008	Stray Hampshire mating twin ewes. Reduced twinning rate and reduced replacements
Falcon	April	2009	Ewes shorn immediately post mating. Reduced 2nd cycle conceptions - foetal loss.
Francolin	March	2008	Poor management – farm expansion. Foot rot, Opthalmia and Red Lice in Merinos
	May	2008	Brucellosis in Dormers
Grouse	April	2010	Severe infestation of *Haemonchus* in 2 tooth ewes
Heron	April	2009	Poorly planned synchronization program. Total failure of artificial insemination.
Robin	May	2010	Part-time farmer. Ewes without water for 7 days after staff deserted.
Starling	January to April	2008	No mineral supplements on irrigated lucerne pastures. Clinical Hypomagnesaemia in lactating ewes and White Muscle Disease in young ewes.
Swift	April	2008	Poor fertility of rams, very small testes. Possible phyto-oestrogens on lucerne lands.

The data collected on CC6:2 relating to the clinical observations in rams was tabulated and discussed at CC16 – Ram recovery.

The information recorded during this CCP was used to assist in the planning process to ensure that procedures are in place to limit the negative effect of these hazards as far as is possible.

It is recommended that CC6 – Mating as well as the completion of the Generic QQ1 form should form a part of the core record set of a flock health and production program.

4.2.7 CC7-Scan, CC11-Marking and CC12-Weaning

Ultrasound pregnancy examination was performed on all 30 flocks in 2008. Four flocks were not included in 2009. The resulting numbers of lambs marked and subsequently weaned were obtained from most flock managers and the data are included in the summary of the results. Detailed marking and weaning data were recorded in only two instances. These will be discussed in par 4.2.11 and 4.2.12. The summarized data from all the flocks during 2008 and 2009 are presented in Tables 4.2.7.a and 4.2.7.b respectively.

Table 4.2.7.a. Results of ultrasound scanning, marking and weaning during 2008.

Flock Name	Total	Dry	Single	Twin	Triplet	Quad	Lambs exp.	Marked	Marking%	Weaned	Weaning %	Loss %	Conc%	Lamb%
Crane	1100	72	851	177	0	0	1205	1130	102.7	997	90.6	17.3	93.5	109.5
Cuckoo	2662	131	2075	456	0	0	2987	2867	107.7	2827	106.2	5.4	95.1	112.2
Eagle	1200	74	876	250	0	0	1376	1305	108.8	1235	102.9	10.2	93.8	114.7
Falcon	2655	133	2252	270	0	0	2792			2241	84.4	19.7	95.0	105.2
Francolin	3589	352	2878	359	0	0	3596			2813	78.4	21.8	90.2	100.2
Grouse	1484	50	1282	152	0	0	1586			1260	84.9	20.6	96.6	106.9
Gull	1316	132	1117	67	0	0	1251	1101	83.7	969	73.6	22.5	90.0	95.1
Hawk	650	56	471	123	0	0	717						91.4	110.3
Heron	810	168	326	193	0	0	712						79.3	87.9
Hoepoe	1242	205	998	1	0	0	1000	802	64.6	751	60.5	24.9	83.5	80.5
Ibis	537	46	459	32	0	0	523	407	75.8	398	74.1	23.9	91.4	97.4
Kestrel a	1773	104	1598	71	0	0	1740	1594	89.9	1471	83.0	15.5	94.1	98.1
Kestrel b	967	79	778	110	0	0	998	938	97.0	812	84.0	18.6	91.8	103.2
Korhaan	841	63	637	161	20	0	1019			716	85.1	29.7	92.5	121.2
Lark	1215	48	1047	118	2	0	1289	1239	102.0	1230	101.2	4.6	96.0	106.1

Table 4.2.7.a. (cont.). Results of ultrasound scanning, marking and weaning during 2008.

Flock Name	Total	Dry	Single	Twin	Triplet	Quad	Lambs exp	Marked	Marking%	Weaned	Weaning %	Loss %	Conc%	Lamb%
Lourie	1037	30	846	220	0	0	1286	1070	103.2	1055	101.7	18.0	97.1	124.0
Ostrich	2348	88	1540	652	84	4	3112			2745	116.9	11.8	96.3	132.5
Owl	646	21	404	205	16	0	862						96.7	133.4
Pelican a	1782	75	1564	143	0	0	1850	1759	98.7	1730	97.1	6.5	95.8	103.8
Pelican b	1619	47	1342	228	2	0	1804			1617	99.9	10.4	97.1	111.4
Petrel	1428	58	1251	119	0	0	1489			1280	89.6	14.0	95.9	104.3
Plover	1827	269	1462	96	0	0	1654	1386	75.9	1323	72.4	20.0	85.3	90.5
Quail	1895	439	1226	228	2	0	1688						76.8	89.1
Raven	1096	55	917	124	0	0	1165	1038	94.7	981	89.5	15.8	95.0	106.3
Robin	922	92	809	21	0	0	851			702	76.1	17.5	90.0	92.3
Shrike	1104	214	852	38	0	0	928	755	68.4	689	62.4	25.8	80.6	84.1
Sparrow	1269	21	951	297	0	0	1545						98.3	121.7
Starling	1425	423	928	74	0	0	1076						70.3	75.5
Stork	504	12	299	187	6	0	691						97.6	137.1
Swallow	1006	67	872	67	0	0	1006	965	95.9	807	80.2	19.8	93.3	100.0
Swift	1241	57	797	387	12	0	1607						95.4	129.5
Warbler	588	26	481	81	0	0	643	611	1.0	575	97.8	10.6	95.6	109.4
							Average:		**85.62**		**87.20**	**16.86**	**91.61**	**106.04**

Table 4.2.7 b. Results of ultrasound scanning, marking and weaning during 2009.

Flock Name	Total	Dry	Single	Twin	Triplet	Quad	Lambs exp	Marked	Marking%	Weaned	Weaning %	Loss %	Conc%	Lamb%
Crane	1764	295	1285	184	0	0	1653	1257	71.3	1246	70.6	24.6	83.3	93.7
Cuckoo	2690	213	2062	414	0	0	2890	2645	98.3	2621	97.4	9.3	92.1	107.4
Eagle	1180	74	826	300	0	0	1426	1368	115.9	1285	108.9	9.9	93.7	120.8
Falcon	2525	94	2186	244	1	0	2677	2208	87.4	2194	86.9	18.0	96.3	106.0
Francolin	4088	438	3235	415	0	0	4065			3151	77.1	22.5	89.3	99.4
Grouse	1508	52	1262	194	0	0	1650			1353	89.7	18.0	96.6	109.4
Gull	1265	132	1117	67	0	0	1251	1116	88.2	998	78.9	20.2	89.6	98.9
Hawk														
Heron														
Hoepoe	1201		996		0	0	996	169	14.1	198	16.5	80.1	100.0	82.9
Ibis	544	46	481	17	0	0	515	396	72.8	387	71.1	24.9	91.5	94.7
Pelican a	1804	85	1638	81	0	0	1800	1669	92.5	1512	83.8	16.0	95.3	99.8
Pelican b	1003	78	800	125	0	0	1050	981	97.8	852	84.9	18.9	92.2	104.7
Korhaan	1073	52	745	159	3	0	1072			756	70.5	29.5	95.2	99.9
Lark	1620	60	1451	216	3	0	1892	1670	103.1	1650	101.9	12.8	96.3	116.8

Table 4.2.7 b.(cont.). Results of ultrasound scanning, marking and weaning during 2009.

Flock Name	**Total**	**Dry**	**Single**	**Twin**	**Triplet**	**Quad**	**Lambs exp**	**Marked**	**Marking%**	**Weaned**	**Weaning %**	**Loss %**	**Conc%**	**Lamb%**
Lourie	1093	27	876	190	0	0	1256	1009	92.3	940	86.0	25.2	97.5	114.9
Ostrich	2348	105	1424	712	105	2	3171			2711	115.5	14.5	95.5	135.1
Owl	599	18	389	162	30	0	803						97.0	134.1
Pelican a	1815	160	1525	128	1	0	1784	1730	95.3	1701	93.7	4.7	91.2	98.3
Pelican b	1640	44	1321	272	3	0	1874	1739	106.0	1724	105.1	8.0	97.3	114.3
Petrel	1415	48	1169	198	0	0	1565			1331	94.1	15.0	96.6	110.6
Plover	1486	180	1229	77	0	0	1383	1361	91.6	1235	83.1	10.7	87.9	93.1
Quail	1003	191	673	139	0	0	951			751	74.9	21.0	81.0	94.8
Raven	1106	48	899	159	0	0	1217	1042	94.2	973	88.0	20.0	95.7	110.0
Robin	895	85	790	20	0	0	830			739	82.6	11.0	90.5	92.7
Shrike	1085	185	856	44	0	0	944			221	20.4	76.6	82.9	87.0
Sparrow	1098	24	761	312	1	0	1388						97.8	126.4
Starling														
Stork														
Swallow	768	32	668	68	0	0	804	756	98.4	719	93.6	10.6	95.8	104.7
Warbler	602	18	547	37	0	0	621	596	99.0	571	94.9	8.1	97.0	103.2
								Average:	**89.3**		**82.8**	**21.2**	**93.1**	**105.7**

The completed CC7 – Scan Data and QQ1 – Generic Questionnaire forms were returned to flock managers. The results were discussed after completion of the service or by telephone after receiving final data from flock managers.

The results support the generally accepted view that farmers seldom experience problems in achieving good conception rates. Lambing percentages are more variable and determined by breed and environment, feeding practices and the use of gonadotropins. The primary constraint to successful small ruminant reproduction is however in the period following CCP7. The detailed data collected at ultrasound pregnancy examination forms the basis of planning the management of the ewes from that point forward.

This CCP forms the core of a flock health service to small stock farms. It is accepted by flock managers and very little persuasion is needed to get full cooperation. All flocks will not require the collection of all data as indicated on form CC7. However the summarized results for mature ewes separately from that of maiden ewes as well as the incidence of udder abnormalities should form the core set of data that are collected from all flocks to allow between –flock comparisons.

4.2.8 CC8-Rescan

Five flocks were subjected to CCP8 Rescan during 2008 for the reasons as stated in Table 4.2.8. The main indication for rescanning is an unacceptable number of ewes that fail to form udder and are observed to be no longer pregnant at lambing time.

Table 4.2.8. Results of Critical Control Point 8 – Rescan in five flocks during 2008.

	Crane [a]	**Hoopoe** [b]	**Ibis** [c]	**Starling** [d]	**Stork** [e]
NON-PREGNANT EWE:		95		423	
Now scanned dry				146	
Now scanned single		40		264	
Now scanned twin				13	
Now scanned triplet					
SINGLE EWE:	100		176		70
Now scanned dry	1		13		8
Now scanned single	99				
Now scanned twin					
Now scanned triplet					
TWIN EWE					30
Now scanned dry					2
Now scanned single					
Now scanned twin					
Now scanned triplet					
Total number of abortions	1		13		10

[a] – Rescanned single ewes to establish if lambs were lost pre-or post-lambing. Cultures negative.

[b]. – Rescanned barren ewes to determine the success of a follow-up mating after predator stress.

[c] – Rescanned maiden ewes to determine extent of abortions noticed at primary scan..

[d] - Flock manager practices continuous mating.

[e]– Rescanned to establish recent abortions for lab investigation. Q fever identified.

The completed CC8 – Rescan Data and QQ1 – Generic Questionnaire forms were returned to flock managers. The results were discussed after completion of the service and by telephone after receiving laboratory results.

Flock managers often express doubts about the accuracy of ultrasound pregnancy examinations when large numbers of identified lambs are no longer present at marking. This CCP can assist in finding the reason for this observation. Rescanning in the Crane flock, for example, led to the discovery of theft of three week old lambs by a member of staff as the cause of the large difference between scanning and marking results.

The flock manager of the Hoopoe flock discovered domestic dogs amongst his ewes immediately following mating and was advised to place rams back with the flock to mate ewes that may have suffered early foetal loss. Rescan was done to establish the success of the action as the ewes were scanned not pregnant at the normal scanning time.

The cause of abortion in the Ibis flock was a donkey stallion that was placed with the flock to prevent predation but the aggressive behaviour of the donkey prevented drinking, leading to dehydration and abortions.

The flock manager of the Starling flock attempted to use scanning as a means of managing a flock running on irrigated pastures with a continuous mating system. Repeated re-scanning at 60 day intervals to group ewes according to expected lambing date was performed but it was abandoned after the marking system and records failed and perinatal losses became excessive.

The Stork flock suffered a very severe outbreak of abortions (>35%) during 2007. The cause could not be established. During 2008 re-scanning led to the discovery of 4 recent abortions where fresh placental material allowed the diagnosis of Q fever.

Rescanning is a valuable method for determining the time and cause of abortions. It can facilitate the identification of recent abortions which improves the chances of identifying infectious agents. Rescanning can be applied where the last day of lambing, lambing, marking or weaning results indicate the need to establish the time and cause of losses. Rescanning will be performed selectively and can therefore not form part of a core dataset for inter flock comparison.

4.2.9 CC9-Pregnancy Management

This CCP was applied in four flocks. The dates at which feeding and vaccinations were applied during the last six to eight weeks of pregnancy were recorded as well as the average weights of the different target groups of ewes in each flock. The groups varied in size between ten and twenty ewes and were weighed as close to midday as possible. The interval between weighing differed between flocks. A fortnightly measurement was considered to be the minimum required but one flock recorded the weight at weekly intervals. The average weights of nine ewe groups from the four flocks are presented in table 4.2.9

Table 4.2.9 Average weights in kilogram, body condition score and nutritional management of a sample of pregnant ewes from 4 flocks lambing in spring.

Flock	**Hoopoe**		**Ibis**		**Petrel**			**Warbler**	
Environment	Mountain grassveld		Mixed plains		Mixed plains			Winter grass pastures	
Supplement	Protein lick		Lucerne		Chocolate grain	Protein lick		Lucerne	
Group	Mature single	Maiden single	Twin	Single	Twins	Single A	Single B	Twin	Single
Breed	Dohne	Dohne	Dohne	Dohne	Dohne	Dohne	Dohne	Letelle	Letelle
BCS at start	2.7	2.5	3.1	3.4	2.9	3.1	3.1	3.2	3.1
Week 1	33.1	28.4	54.8	51.3	56.2	52.1	53.0	55.7	49.5
Week 2			55.2	52.2				56.1	50.8
Week 3	34.9	29.8	59.0	53.8	60.3	56.9	56.7	57.9	52.1
Week 4			62.0	55.9				58.6	53.9
Week 5	37.5	31.9	63.9	56.9	67.5	60.4	60.1	60	54.0
Week 6				58.4				61.2	55.0
Gain	4.4	3.5	9.1	7.1	11.3	8.3	7.1	5.5	5.5

This CCP is a valuable tool in managing the potential hazard of under-nutrition during late pregnancy. Weighing of a target group of ewes can be substituted by performing body condition scoring on a sample of the flock. It requires regular handling of ewes but the potential benefit outweighs the negative aspects. This CCP is not practical to apply in all flocks and will not form part of a core dataset for inter-flock comparisons.

4.2.10 CC10-Lambing

Four flock managers submitted partial data for this Critical Control Point and a number of lambs for autopsy. The general consensus of flock managers is that they would like to collect more data during this phase but that the management of the ewes and lambs require so much effort that it is impossible to collect accurate data. Even counting lambs accurately is often impossible in camps because it is preferable to avoid disturbing ewes. The collection and freezing of dead lambs for autopsy at a later stage is the only practical activity that can be performed in extensive lambing systems.

The results of neonatal autopsies performed on the lambs from the four flocks are summarised in Table 4.2.10.

Table 4.2.10. Summary of findings at autopsy in four flocks.

Farm code	N	Dystocia	Disease	Did not walk	Did not breathe	Did not suckle	Unknown	Comment
Hoopoe	12		0	8/12	6/12	12/12		Severe cold
Ibis	7	7						Energy deficiency
Petrel	23	6	4	2/13	2/13	13/13		Lamb dysentery
Warbler	17	6	7	1/4	1/4	3/4	1/4	Lamb dysentery

The flock health consultant should visit all flocks during lambing time to assist in evaluating the management as well as discussing the current and potential hazards as indicated in form QQ 1. The data as required by the CC10 form can be collected in intensive lambing systems with greater ease. The large number of lamb losses indicated in Tables 4.2.7.1 and 4.2.7.2 indicate the importance of identifying and managing hazards in the period from lambing to weaning.

This CCP cannot form part of a core data-set for inter-flock comparisons although it will be valuable for trend analysis within a flock.

4.2.11 CC11-Marking and CC12 Weaning

The numbers of ewe lambs and ram lambs marked were recorded separately together with the numbers of lambs lost from the age of ten days to marking (at three weeks of age) by one flock manager only. The total lambs marked was obtained from the monthly stock count numbers and the individual events/treatments form PC3. It was therefore not necessary to request the flock manager to complete this form. After completion of the form it was returned to the flock manager with comments on the steps that needed to be taken in future to improve the results. The general hazard questionnaire GG1 was an integral part of this control point to ensure that corrective steps are taken.

The marking data from most flocks were obtained and are listed in Tables 4.2.7.1 and 4.2.7.2. Marking data provide valuable information for determining the phase at which reproduction failure occurs and should form part of the core data for all flocks so that comparisons can be made.

4.2.12 CC13-Ewe replacement

This CCP was applied by three flock managers but the data from one flock provides valuable information because of the fact that it was available for the period 2005 to 2009.

A sample of ewe lambs were weighed from 4 months old to 18 months old and the average weights recorded in a graph. The historical conception rates for each year were available to make a comparison between the conception rate and growth curve possible. The average weights are listed in Table 4.2.12 and graphically illustrated in Figure 4.2.12.

Table 4.2.12. Average weights of samples of replacement ewe lambs for the Hoopoe flock for 2005 to 2009 with resulting conception rates at scanning.

	Year				
Age (m)	**2005**	**2006**	**2007**	**2008**	**2009**
4	18.4	17.8	18.9	19.0	17.6
5	19.1	17.2	17.8	19.4	17.6
6	20.4	17.5	18.5	18.5	18.7
7	21.4	17.3	19.4	19.2	19.3
8	20.5	16.2	20.0	19.4	19.9
9	20.6	17.2	20.1	19.7	20.4
10	20.1	18.1	20.5	20.4	21.3
11	21.0	19.4	22.2	22.0	22.9
12	22.1	20.7	23.4	22.9	24.1
13	23.4	21.8	24.7	23.8	25.6
14	23.9	21.5	25.2	25.0	26.1
15	24.2	23.2	26.9	26.1	26.1
16	25.3	25.1	28.7	27.8	27.7
17	26.3	26.9	30.3	29.0	29.6
18	27.2	29.2	31.8	30.4	31.4
Conception%	22%	42%	75%	68%	62%

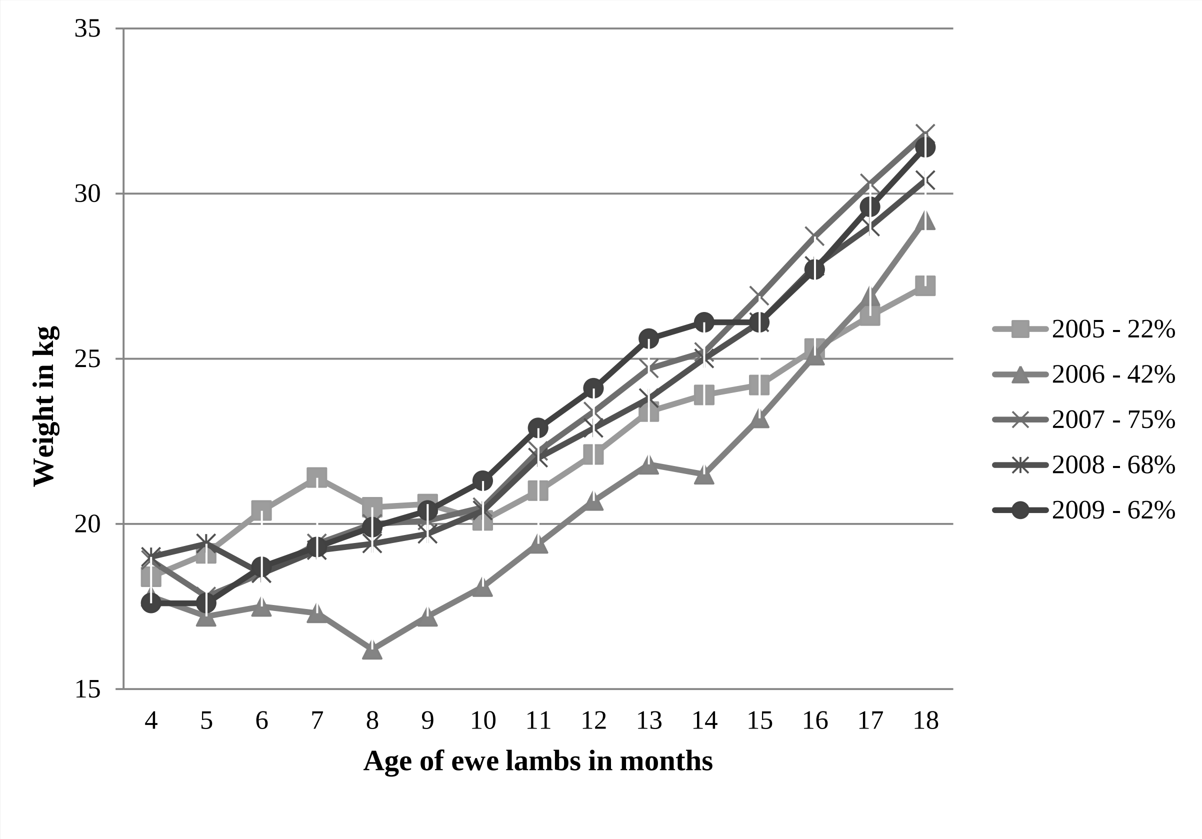


Figure 4.2.12. Graphic representation of the average weights of samples of replacement ewe lambs for the Hoopoe flock for 2005 to 2009 with resulting conception rates at scanning.

The data for this CCP clearly illustrates the value of monitoring the growth of replacement females. Most flock managers realize too late that the growth is inadequate. A historical set of data such as the data above can provide parameters for decision-making. Flock managers can predict within a few months after weaning that the growth rate may eventually lead to a lower conception rate and can then decide if there would be a financial benefit in supplying additional feed to the maiden ewes.

All hazards that play a role in the growth and survival of maiden ewes should be recorded and pro-actively managed. The replacement phase is one of the more important bottle necks to reproduction and many flock managers experience losses especially during the winter months and at the time of cutting the first two incisors.

The application of this CCP should be encouraged not only for the direct management benefit but also because of the long term effect of this phase on the life production of the ewe. Maiden flocks that grew up in times of severe drought remain less productive than ewes that grew well.

Although the data may not be very useful for between flock comparisons this CCP is so valuable that it should form part of all flock management plans.

4.2.13 CC14-Ram replacement

Application

All but four participants in this project select replacement rams from their own flocks. These replacement rams are mostly bred from sires that were also selected from the flock but stud rams are purchased from time to time and then used to breed flock rams. This CCP was practised in modified form by all participants who breed their own rams. Although the ideal is to record 40 day, 100 day and 300 day weights the practical situation on the farm often dictated otherwise.

Flock managers who have been practising this CCP for a number of years have found that the genetic benefits in respect of fertility, adaptability and resistance to parasites have been remarkable. The cost saving for the purchase of rams has been an additional benefit. It has been noticed that flock managers are far less tolerant of potential culling faults in home-bred rams than in purchased rams.

The Ibis flock has been practising this CCP for more than 10 years and the data and report has been chosen to illustrate the application.

Table 4.2.13. Ram replacement data for the Ibis flock in 2007

Number	Mass 1 23 March 2007	Mass 2 4 Dec 2007	Scrotal mass[a]	Index Mass 1	Index Mass 2	Index Scrotal Mass	Combined Index	Winter differential	Rank	Scrotal mass/Body mass 2	Ave body mass
6.14	36	44	192	106	109	162	**125.7**	3	**1**	4.36	40
6.20	37	44	165	109	109	140	119.0	0	**2**	3.75	40.5
6.2	38	44	153	111	109	129	116.6	-3	**3**	3.48	41
6.37	36	44	155	106	109	131	115.2	3	**4**	3.52	40
6.43	40	49	125	117	121	106	114.8	4	**5**	2.55	44.5
6.15	34	42	165	100	104	140	114.4	4	**6**	3.93	38
6.7	35	44	144	103	109	122	111.2	6	**7**	3.27	39.5
6.18	37	45	128	109	111	108	109.4	3	**8**	2.84	41
6.24	33	47	136	97	116	115	109.4	**20**	**9**	2.89	40
6.16	34	43	140	100	106	118	108.2	7	**10**	3.26	38.5
6.33	38	45	120	111	111	102	108.1	0	**11**	2.67	41.5
6.35	35	43	132	103	106	112	106.9	4	**12**	3.07	39
6.19	35	41	136	103	101	115	106.4	-1	**13**	3.32	38
6.21	36	41	132	106	101	112	106.3	-4	**14**	3.22	38.5
6.36	32	43	140	94	106	118	106.3	13	**15**	3.26	37.5
6.10	35	43	120	103	106	102	103.6	4	**16**	2.79	39
6.42	31	42	132	91	104	112	102.2	13	**17**	3.14	36.5
6.38	32	43	125	94	106	106	102.0	13	**18**	2.91	37.5
6.8	33	37	139	97	92	118	102.0	-5	**19**	3.76	35
6.32	40	46	80	117	114	68	99.6	-3	20	1.74	43
6.34	35	41	110	103	101	93	99.1	-1	21	2.68	38
6.40	34	36	120	100	89	102	96.8	-11	22	3.33	35

Table 4.2.13 (cont.). Ram replacement data for the Ibis flock in 2007

Number	Mass 1 23 Mar	Mass 2 4 Dec	Scrotal mass[a]	Index Mass 1	Index Mass 2	Index Scrotal Mass	Combined Index	Winter differential	Rank	Scrotal mass/Body mass 2	Ave body mass
6.28	28	39	128	82	97	108	95.7	**14**	**23**	3.28	33.5
6.12	32	39	113	94	97	96	95.3	3	24	2.90	35.5
6.39	30	35	125	88	87	106	93.5	-1	25	3.57	32.5
6.25	33	35	113	97	87	96	93.0	-10	26	3.23	34
6.5	32	37	110	94	92	93	92.9	-2	27	2.97	34.5
6.26	35	40	88	103	99	74	92.1	-4	28	2.20	37.5
6.30	34	40	88	100	99	74	91.1	-1	29	2.20	37
6.29	35	42	77	103	104	65	90.6	1	30	1.83	38.5
6.31	30	42	94	88	104	80	90.5	16	31	2.24	36
6.3	32	36	104	94	89	88	90.3	-5	32	2.89	34
6.1	34	32	88	100	79	74	84.5	-21	33	2.75	33
6.23	30	33	94	88	82	80	83.1	-6	34	2.85	31.5
6.11	27	38	88	79	94	74	82.6	15	35	2.32	32.5
6.4	34	35	62	100	87	52	79.6	-13	36	1.77	34.5
6.9	31	30	85	91	74	72	79.0	-17	37	2.83	30.5
6.27	34	35	44	100	87	37	74.5	-13	38	1.26	34.5
6.6	39										
6.13	36										
6.17	34										
6.22	34										
Average	34.09	40.39	118.16					0.66			

[a] Calculation based on the formula described by Van Rooyen (2002)

The 40 day weight was not recorded owing to the illness of the flock manager although it had been recorded in all previous years. The flock experienced poor growth and losses during the winter and spring and it was decided to also calculate a winter index differential (difference in index before and after the winter) so that rams could be identified that grow well during the winter. It will be noted that ram 6.24 moved up the index list by 20 points over the test period whilst ram 6.1 dropped by 21 points. The first spring rains only fell in late November and the test period was extended to allow for the identification of animals that could not cope with the poor nutrition.

Although this CCP cannot be used to make comparisons a number of flock managers indicated that they would prefer to apply the standard measurements more strictly in future and it could be possible to use the data on a wider scale and possibly take part in a central data processing scheme.

4.2.14 CC15-Genital soundness

Application

A standard set of parameters was recorded for the ram flocks and entered in a Microsoft Excel® spread sheet. The mating capacities of the rams were calculated automatically and the age composition of the ram flocks presented as pie graphs. This served as the report to the flock managers.

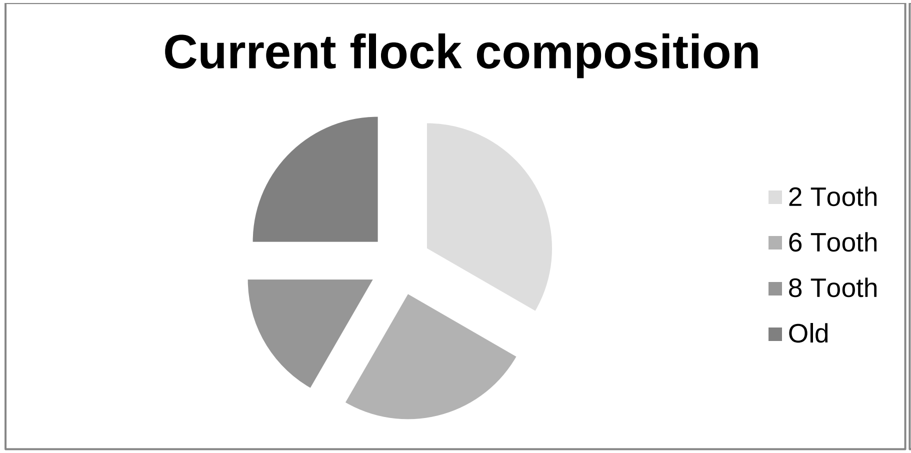
Ram genital soundness examination is an essential CCP in the management of hazards to reproduction in sheep and goats. It should be included in all flock health plans and although the data do not lend itself to between-flock comparisons it is essential for the management of hazards in the flock.

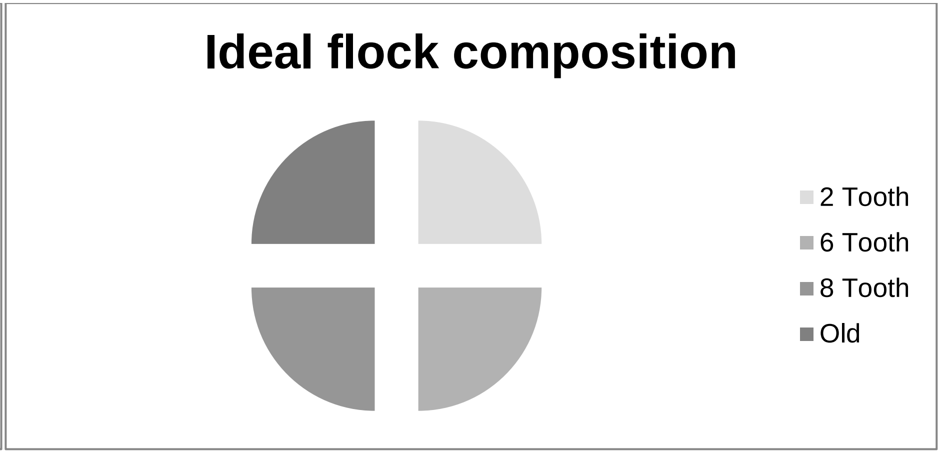
An example of a report of CC15 Genital soundness follows in Table 4.2.14.

Table 4.2.14. Ram Genital soundness examination Ibis flock 2010

Number	Age	Scrotum	Length	Colour	Tone	Cover	Famacha	Pigment	Comment	Density	Motility	Colour	Ram Rated Capacity[a]	Ram Mating Capacity[a]	Cycle
9.32	2 Tooth	33	12	1	3	0	1	10		C	4	C	127	**25**	1
9.25	2 Tooth	30	12	1	4	1	1	10		TC	5	C	107	**43**	1
9.3	2 Tooth	28	11	1	3	0	1	10		C	4	C	85	**17**	1
9.15	2 Tooth	30	10	1	3	1	1	8		TC	5	C	85	**21**	2
6.2	Old	33	12	5	4	0	1	10		TC	5	C	127	**61**	1
7.8	8 Tooth	36	14	5	4	0	1	0		TC	5	C	178	**114**	2
7.19	8 Tooth	38	14	5	4	0	1	10		TC	5	C	197	**126**	1
8.20	6 Tooth	33	12	5	4	0	1	10		TC	5	C	127	**102**	1
8.11	6 Tooth	36	13	1	4	0	1	10	Split 4cm	C	5	C	163	**130**	2
7.5	Old	36	12	5	5	1	1	10		TC	5	C	148	**89**	1
8.5	6 Tooth	38	14	5	4	0	1	10		TC	5	C	197	**158**	1
7.29	Old	34	13	5	4	1	1	10		TC	5	C	147	**71**	1
Total	12								Total in first cycle:			691	Total ewes	**956**	
									Total in 2nd cycle:			266			

	Flock	Ideal
2 Tooth	4	3
6 Tooth	3	3
8 Tooth	2	3
Old	3	3
Total	12	





Comments:

1. No signs of disease or reproductive disorder were noted. The rams were in a good state of nutrition with acceptable body condition scores.

2. The flock composition is acceptable. Five replacement rams will be needed for 2011.

3. The pigment problem has nearly been eradicated and the two rams with poor pigment will again only be used in the second cycle.

4. The ram with the split scrotum has also been allocated to the second mating cycle and it is unlikely that this problem will recur.

[a] Based on calculation described by Van Rooyen (2002)

4.2.15 CC16-Ram recovery

This CCP was originally a response to the observation that rams used in an accelerated lambing system in the Raven flock suffered from prolonged atrophy of the testes. Supplementation with Zn solved the problem. The Stork and Crane flocks noted a similar problem and the CCP was applied in these two flocks by the flock managers.

The results of the application of this CCP are listed in Table 4.2.15 with a sample of five rams from each flock indicating the range of changes to the scrotal circumference which occurred from CC15 to CC16 at two to four weeks after mating. Body weight, condition score, tone and Famacha© score were not recorded. The positive effect of supplementation with Zn (in a mineral lick) can be seen in the difference in the degree of atrophy before and after supplementation.

Table 4.2.15. Results of CC16 Ram recovery data in three flocks indicating changes in scrotal circumference and nutritional management.

			Average scrotal circumference				
Flock	**Year**	**No**	**At CC15 Genital soundness exam**	**At CC16 Ram recovery**	**Average decrease in SC**	**Range**	**Nutrition**
Raven	2008	21	35.7	34.0	1.7	0-4	Mineral lick
Stork	2008	18	34.9	31.1	3.8	1-6	Salt only
Stork	2009	20	35.5	36.7	1.2	0-3	Supplemented Zn
Crane	2009	15	31.1	28.2	2.8	0-5	Salt only
Crane	2011	11	32.7	31.4	1.2	(-1)-4	Supplemented Zn

This CCP should be performed periodically in all flocks to establish the possible problems arising from the nutritional effects on the recovery of testis size after mating. Valuable insights may be gained from correlation of this CCP with BCS in order to possibly identify rams with poor constitution and rams that did not contribute to the mating process.

4.2.17 CC17-Last day of lambing

Three flock managers supplied data for this CCP. In the Ibis and Warbler Flocks no observations were made other than that five and seventeen ewes respectively failed to lamb and form an udder. It is assumed that these ewes were either not really pregnant at scanning or that the conceptus had been lost soon after scanning. The data collected from Hoopoe is summarised in table 4.2.17.

Table 4.2.17. Last day of lambing data for Hoopoe Flock 2009.

STATUS	First flock		Second flock	
AGE	Mature	Maidens	Mature	Maidens
DATE 1ST PRE LAMB	1 Sep	None	None	None
DATE 1ST LAMB	20 Sep	22 Sep	18 Oct	19 Oct
DATE LAST LAMB	10 Oct	10 Oct	8 Nov	8 Nov
EWES STILL IN LAMB	0	0	2	11
EWES DID NOT LAMB	11	5		5
Failed to Form Udder	8	5		3
Formed Udder	3	0		2
Lam suckled	0	0		1
Lochia present	1	0	NS[a]	NS[a]
Fluid in uterus	1	0	NS	NS
Placenta visible	2	0	NS	NS
Dead intact foetus	0	0	NS	NS
Macerated foetus	1	0	NS	NS
Pyometritis	1	0	NS	NS
Recent pregnancy confirmed	5/11	0/5	2/2	3/11
Date scanned	12 Oct	12 Oct		

[a] NS = Not Scanned

The data in table 4.2.17 indicate that a ram returned to the second flock after the end of mating. Eight of the eleven mature ewes examined did not form an udder, possibly indicating an early loss of the foetus. The two cases in which the placentomes were still visible by ultrasound examination were swabbed and in one case a pure culture of *Pasteurella* spp was found.. The case with lochia present was also swabbed and cultured with no result. Five of the eleven ewes had signs of a recent pregnancy.

Ewes that are found to be no longer pregnant at the end of the lambing season can be useful cases to allow making a diagnosis of the cause of foetal losses. It is also important to collect the data as an aid to determining the time at which the foetal losses occur. In many flocks it is impossible to differentiate ewes that did not lamb from those that lost a neonatal lamb. An examination by speculum, ultrasound and an examination of the udder can assist in this process.

Flock managers should be encouraged to collect data on ewes that apparently did not lamb. This CCP will not be part of a core data set for inter flock comparison but will be applied in response to a need to identify the phase at which reproductive failure occurs.

4.2.18 CC18-Body Condition Scoring

The use of body condition scoring could not be established during the period of this study and flock managers indicated that they would require more training before they can use it with confidence. It was used during certain CCP's and found to be especially useful in evaluating nutritional status and in the identification of animals with parasite problems.

4.2.19 CC19-Helminth status

The flock managers showed strong resistance to the application the Targeted Selective Treatment (TST) and relied more on the advice of representatives of drug companies. Many incidents indicating strong anthelmintic resistance by *H. contortus* were experienced during the course of the project but limited resources prevented including this CCP in the flock program.

4.2.20 CC20-Nutritional status

This CCP was not applied during this study.

4.2.21 PC1-4 Process control data

The collection of the data required by the Process control forms: PC 1 – 4. Formed the core of the data used in identifying and evaluating the hazards that may be encountered in a small ruminant flock. The data should be recorded in a computerised database for analysis.

4.3 Flock managers' perceptions.

A questionnaire was designed and tested on five flock managers that were not part of this project.. After alterations the questionnaire was sent to the 25 remaining flock managers. Twelve flock managers responded. Respondents were asked to indicate whether they agree (10) or disagree (1) with the statements. The results of the questionnaire are listed in table 4.3.a and summarised in table 4.3.b.

Table 4.3.a. Response of flock managers to the questionnaire.

	Flock number	**15**	**22**	**1**	**7**	**13**	**18**	**19**	**12**	**23**	**20**	**14**	**5**
1	It will improve my profitability if it is reasonably priced	5	6	6	7	6	6	6	7	5	7	5	7
2	It will assist me in identifying the problem areas	6	7	7	7	6	6	7	7	1	6	6	7
3	It will increase my work load to an unacceptable level	2	4	1	1	1	2	4	2	4	2	3	7
4	It will assist me in my planning and management	4	6	7	7	5	6	7	7	6	7	6	7
5	It must be adapted to my specific needs	6	7	7	5	7	7	7	6	7	6	6	7
6	I can learn from comparisons with other farms	4	5	7	7	6	7	6	7	6	7	5	5
7	I would prefer to keep my production results to myself even if published anonymously	2	1	1	1	1	2	7	2	1	1	2	1
8	A summary of the annual results would be useful for my management	4	4	7	7	6	6	6	7	7	6	6	7
9	I do not need all the services but will make use of some	6	4	7	1	6	5		1	7	6	5	1
10	I do not need any advice with the management of my flock.	2	1	1	1	2	2	1	1	5	2	1	1
11	My greatest problem is predation	6	5	2	3	7	6	7	7	7	7	7	1
12	I cannot improve my management because of labour problems	3	3	1	3	2	1	1	2	5	1	1	3
13	I must have a very simple and uncomplicated system	2	6	7	7	2	5	7	5	7	6	4	7
14	This service must reduce the production risks for my flock	6	7	7	5	7	7	7	7	6	6	7	7
15	I will benefit from a quality control system that can certify my products	4	5	7	6	4	7		7	6	4	5	7

Table 4.3.a. (cont.) Response of flock managers to the questionnaire.

	Flock number	**15**	**22**	**1**	**7**	**13**	**18**	**19**	**12**	**23**	**20**	**14**	**5**
16	I want to be kept informed of potential hazards that may become serious	7	5	7	7	6	7	7	7	6	7	7	7
17	I can benefit from training of my staff	5	7	7	7	6	7	7	7	7	7	5	3
18	I have a problem with wireworms and other parasites	2	4	2	5	5	6	7	6	7	3	3	7
19	I need assistance with collecting and processing the flock results	2	5	3	5	4	7	5	6	2	4	2	7
20	I need to be informed regularly about all aspects relating to animal production	4	5	7	7	6	7	7	7	7	7	7	7
21	My veterinarian does not understand my enterprise	3	1	1	1	2	1	1	2	7	1	4	1
22	I can benefit from forming a study group	4	4	4	5	6	6	5	6	7	6	4	
23	It would be useful to have more complete records of production	5	5	7	7	6	6	5	6	7	7	6	7
24	Financial results for the flock should also be evaluated with production results	4	5	7	7	5	5	7	6	7	7	5	7
25	I have a problem with stock theft	4	1	1	4	3	2	3	5	7	1	1	1

Table 4.3.b. Summary of results of questionnaire.

		Average	Standard deviation	0-3	3-5	6-7	Variance
1	It will improve my profitability if it is reasonably priced	6.08	0.76	0	3	9	0.6
2	It will assist me in identifying the problem areas	6.08	1.61	1	0	11	2.8
3	It will increase my work load to an unacceptable level	2.75	1.69	7	3	1	3.1
4	It will assist me in my planning and management	6.25	0.92	0	2	10	0.9
5	It must be adapted to my specific needs	6.50	0.65	0	1	11	0.5
6	I can learn from comparisons with other farms	6.00	1.00	0	4	8	1.1
7	I would prefer to keep my production results to myself even if published anonymously	1.83	1.62	11	0	1	2.9
8	A summary of the annual results would be useful for my management	6.08	1.04	0	2	10	1.2
9	I do not need all the services but will make use of some	4.45	2.27	3	3	5	5.7
10	I do not need any advice with the management of my flock.	1.67	1.11	11	1	0	1.3
11	My greatest problem is predation	5.42	2.10	2	1	8	4.8
12	I cannot improve my management because of labour problems	2.17	1.21	7	1	0	1.6
13	I must have a very simple and uncomplicated system	5.42	1.80	2	3	7	3.5

Table 4.3.b. (cont.) Summary of results of questionnaire.

		Average	Standard deviation	0-3	3-5	6-7	Variance
14	This service must reduce the production risks for my flock	6.58	0.64	0	1	11	0.4
15	I will benefit from a quality control system that can certify my products	5.64	1.23	0	5	6	1.7
16	I want to be kept informed of potential hazards that may become serious	6.67	0.62	0	1	11	0.4
17	I can benefit from training of my staff	6.25	1.23	0	2	9	1.7
18	I have a problem with wireworms and other parasites	4.75	1.83	2	3	5	3.7
19	I need assistance with collecting and processing the flock results	4.33	1.75	3	5	3	3.3
20	I need to be informed regularly about all aspects relating to animal production	6.50	0.96	0	2	10	1.0
21	My veterinarian does not understand my enterprise	2.08	1.75	9	1	1	3.4
22	I can benefit from forming a study group	5.18	1.03	0	6	5	1.2
23	It would be useful to have more complete records of production	6.17	0.80	0	3	9	0.7
24	Financial results for the flock should also be evaluated with production results	6.00	1.08	0	5	7	1.3
25	I have a problem with stock theft	2.75	1.88	6	3	1	3.8

The results of the survey indicated that there was general acceptance of a HACCP – based management system for the management of reproduction in the small ruminant enterprises by the flock managers that responded to the questionnaire (Questions 1, 2, 4, 8, 10 and 23). Flock managers agreed that the program must be adapted to their individual needs (5), would not be a problem to implement (3, 12) but needed to be simple (13) and many would need assistance (19). Training and information was considered important aspects (6, 16, 17, 20, 22) and there was general consensus that financial results should form part of the program (24) and that comparisons within the group on an anonymous basis is accepted (6, 7). The two responses that showed the least variance were the needs to reduce production risk (14) and to be informed of potential hazards (16). Flock managers differed the most in their response about the range of control points they would implement (9). This correlates with the need to have individually adapted programs (5). Flock managers were not very positive about the benefits of a quality control and certification system (15). Predation proved to be the most important hazard followed by parasites and stock theft (11, 18, 25) all three being highly variable as indicated by a large variance.

4.4 Conclusion

Critical control points one to seventeen were applied to varying degrees on the flocks that formed part of this study. The ease with which data were collected from flocks varied from very good to totally impossible. A number of flock managers withdrew completely but those that remained cooperated very well. Time and financial constraints prevented the full application of the methodology in all flocks.

CHAPTER 5

CONCLUSIONS

5.1 Introduction

The aim of this study was to investigate the use of the HACCP system as a basis for the design of a systematic methodology for the management of reproduction in small ruminants. The principles of HACCP were adapted to the management of flock reproduction and the use of this methodology applied to flocks over a three year period.

The process of reproduction in small ruminants was described in terms of four sub-processes and 33 phases. This was visually represented in Figure 1. The collection of monthly data was standardised in four process control forms that formed the core of the process data. These forms are indispensable in the management of the flock.

The critical control points were described as standard operating procedures where applicable. Data collection was standardised through the use of data collection forms. A generic quality control form was designed to be used at every critical control point. This form proved to be very valuable in ensuring a critical and structured approach to the management of hazards. It assisted in the planning process by ensuring that the necessary changes were made in the flock management program.

The study was not long enough to prove that an improvement in reproductive performance and general sustainability was experienced in the flocks but selected interventions proved that this approach would be successful in reducing production risk and reducing or preventing losses from most hazards.

5.2 Acceptance of the HACCP methodology

The formal survey confirmed the observation that flock managers are willing to accept a more comprehensive and structured approach to the management and especially the record-keeping of their flocks. Although many farmers indicated that the system must be simple and that they will need assistance, they did not consider the additional workload to be a problem in the light of the potential benefits.

The need for a service that is highly personalised poses a possible challenge to the need to have comparable results between flocks. The selection of a core set of records for comparison can however still allow the design of an individualised system. The concept of marketing services to individuals is described in the literature as the "One to One" concept (Peppers & Rogers 1993).

During the course of this study it became clear that a computer-based database would be necessary to manage this program. The One to One marketing concept is an excellent example of such a computer–based system.

5.3 Major challenges in small ruminant production

The major hazard experienced in most flocks appears to be animals that are poorly adapted to their environment including the hazards of predation and parasites. Solving this problem will have to be the main focus of any further activities.

The management factors in the environment need to be standardised to enable breeding animals that are adapted to the environment. Farmers need to be assisted in formalising their flock health and production plans and their breeding objectives

Biosecurity is not a serious concern for most farmers and yet the lack of biosecurity is the most important factor determining the prevalence of disease hazards. The aspect of biosecurity will have to receive more attention in the further development of the methodology.

Record keeping was a serious constraint in the execution of this project. Further development work on this methodology will have to focus on the design of systems that provide much improved client compliance.

5.4 Recommendations

HACCP terminology was used during this study but changes can be made to make it more flock manager friendly. Suitable terms should be found in cooperation with flock managers.

The experiences gained in the design of this methodology should be continued in a longer study to determine the long term effect on the sustainability of the flocks in respect of the five pillars of sustainability namely:

- Reduction of risk
- Financial viability
- Improvement of productivity
- Acceptance by role players

- Preservation of resources.

A further study based on the methodology as described in this study, combined with financial data and training of flock managers and personnel should be undertaken over a minimum period of five years. The entire production process can be included, not only reproduction and this may form the basis of a certification process.

CHAPTER 6

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CHAPTER 7

ADDENDA

Addendum A1 Feed recipes

Mineral lick for small ruminants

Energy lick for small ruminants

Protein lick for small ruminants

Urea based licks for small ruminants

Creep feed for small ruminants

Feedlot rations for small ruminants

Complete feed for lambing pens

Complete feed for ewes carrying triplets, quadruplets and quintuplets

Chocolate (alkali treated) grain for small ruminants

Bloat lick for small ruminants

Phase: feed matrix

Mineral lick for small ruminants

Composition

Ingredients	**Bag size**	**Small mix in kg**	**Bulk mix %**	**Tonne mix in kg**
Salt (sea)	50kg	50kg	48	500kg
Phosphate (P12)	50kg	50kg	48	500kg
Epsom salts ($MgSO_4$)		2 kg	2	10 kg

Recommendations

1. Sheep do not normally require phosphate supplementation for maintenance.
2. Mineral lick should be available when fast growing grass species are main source of nutrition.
3. Epsom salt levels may be increased but could become unpalatable
4. A 50 kg mature sheep ewe requires 1.5g of Phosphate per day for maintenance.
   Grass pastures supply 0.2 to 0.7g/kg (25% Dry matter) of Phosphate.
   Assuming a food intake of 4% of body mass grass would supply 0.4 to 1.4 g of P/day
   an intake of 1.6 g to 18g of mineral lick is needed to supply the deficit.
5. Fast growing and lactating animals may require substantially higher PO^4 intakes.
6. Mg and S are required for viable micro flora populations in the rumen.
7. A 50 kg mature sheep ewe requires 0.9 g of Magnesium per day for maintenance.
   Grass pastures supply 0.5 to 0.9g/kg (25% Dry matter) of Magnesium.
   Assuming a food intake of 4% of body mass grass would supply 0.1 to 0.2 g of Mg/day
   An intake of 50g of mineral lick is needed to supply the deficit at the lower levels. This intake level is not feasible and higher levels of Epsom salts will be required.

Warnings

1. Do not feed to salt-hungry sheep and goats (for example animals from mountain camps).
2. Supply solid rock salt for 7 days to animals that have not had access to salt before supplying this lick.
3. Access to good quality drinking water is a prerequisite for feeding licks containing salt.

Energy lick for small ruminants

Composition

Ingredients	Bag size	Small mix in kg	Bulk mix %	Tonne mix in kg
Maize meal	50 kg	50	76	750
Molasses meal	40 kg	25	8	80
Feed lime	50 kg	.650	1	12.5
Salt	50 kg	10	15	150

Recommendations

1. Salt levels may be increased or decreased to regulate intake
2. Epsom salts ($MgSO_4$) may be added at the rate of 1 to 2 kg per bag of salt.
3. Animals should be fed no more than 270 g per 50 kg animal per day.

Warnings

1. Do not feed to salt-hungry sheep and goats (for example animals from mountain camps).
2. Supply solid rock salt for 7 days to animals that have not had access to salt before supplying this lick.
3. Access to good quality drinking water is a prerequisite for feeding licks containing salt.

Protein lick for small ruminants

Composition

Ingredients	Bag size	Small mix in kg	Bulk mix %	Tonne mix in kg
Maize meal	50 kg	50	40	400
Cotton oilcake meal	50 kg	37.5	35	350
Molasses meal	40 kg	10	8	80
Salt	50 kg	15	15	150
Feed lime	50 kg	1	1	10
Di-calcium phosphate	50 kg	1	1	10

Recommendations

1. Feed maximum 270 g per day to restrict salt to below 40 g for 50 kg ewe
2. Salt levels may be increased or decreased to regulate intake.
3. Epsom salts ($MgSO_4$) may be added at the rate of 1 to 2 kg per bag of salt.

Warnings

1. Do not feed to salt-hungry sheep and goats (for example animals from mountain camps).
2. Supply solid rock salt for 7 days to animals that have not had access to salt before supplying this lick.
3. Access to good quality drinking water is a prerequisite for feeding licks containing salt.

Urea based licks for small ruminants (Crude protein 17-18%)

Composition

Ingredients	Lick with 0% urea	Lick with 1% urea	Lick with 2% urea	Lick with 3% urea	Lick with 4% urea
Maize meal	40	49	58	67	71
Cotton oilcake meal	35	25	15	5	0
Molasses meal	8	8	8	8	8
Salt	15	15	15	15	15
Feed grade urea	0	1	2	3	4
Feed lime	1	1	1	1	1
Dicalcium phosphate	1	1	1	1	1
% natural protein	100	83	67	50	33

Recommendations

1. Feed maximum 270 g per day to restrict salt to below 40 g for 50 kg ewe
2. Salt levels may be increased or decreased to regulate intake
3. Epsom salts ($MgSO_4$) may be added at the rate of 1 to 2 kg per bag of salt.
4. Use the lowest affordable level of urea.

Warnings

1. Do not feed to salt-hungry sheep and goats (for example animals from mountain camps).
2. Supply solid rock salt for 7 days to animals that have not had access to salt before supplying this lick.
3. Access to good quality drinking water is a prerequisite for feeding licks containing salt.
4. Animals need to adapt to urea. Start at 50 g/day and double up every 3 days.
5. Licks containing urea must be protected from rain to prevent urea poisoning by leaching.
6. Urea may depress hormonal activity and butterfat content of sheep milk.

Creep feed for small ruminants

Composition

Ingredients	Bag size	Small mix in kg	Bulk mix %	Tonne mix in kg
Maize meal	50 kg	60	50	500
Lucerne meal		25	21	210
Cotton cake meal	50 kg	10	8	100
Soya cake meal	50 kg	10	8	75
Fish meal	50 kg	3	2	25
Feed lime		12	10	100
Salt	50 kg	1	1	10
Epsom salt		.02		0.5

Recommendations

1. Feed ad libitum in creep feeding pens with adjustable entrances.
2. Feed in close proximity to watering points and ewe lick bins.
3. Creep feed may be medicated to control coccidiosis in lambs.
4. Fish meal may reduce palatability at levels above 3% or if it becomes rancid.

Warnings

1. Lucerne must be of the highest quality possible to prevent premature filling of the rumen.

Feedlot rations for small ruminants

Composition

Ingredients	**Feedlot 1** **%**	**Feedlot 2** **%**	**Feedlot 3** **%**
Maize meal	30	45	60
Lucerne meal	58	44	32
Sunflower cake	10	8	5
Feed lime	1	1	1
Salt	1	1	1
Urea		1	2
Protein content	15	16	18

Recommendations

1. Start with ration 1 for 3 days in the camp. Then move to the feedlot and feed restricted ration 1 plus lucerne hay for 3 days. Then ration 1 ad libitum for 3 days. Progress to ration 2, then 3.

Warnings

1. Feeds containing urea must be protected from rain to prevent urea poisoning by leaching.

Complete feed for lambing pens

Composition

Ingredients	**Bag size**	**Small mix in kg**	**Bulk mix %**	**Tonne mix in kg**
Maize meal	50	50	35	350
Lucerne		70	50	500
Cotton or Sunflower cake meal	50	15	10	100
Molasses	210	7	5	50
Feed lime	50	1.5	1	10

Analysis

Nutrient	**Analysis**
Protein	15.5
Energy (TDN)	66.4%
Energy	10MJ/kg
Ca	1.06%
P	0.28%

Recommendations

1. Ewes should start adapting to the complete feed four weeks before they move to the lambing pens. Start with 200g/day and double-up every 3rd day until they reach the level of intake required in the pens.
2. Ewes carrying singles will need 1.0 to 1.5 kg/day and twins 1.5 to 2.0 kg/day
3. Ewes may consume 2.5 to 3.0% of body weight in late pregnancy and 3.0 to 4.0% in early lactation depending on size, condition and pregnancy status.
4. In ewes carrying multiple lambs the emphasis during pregnancy is on concentrates, during lactation good quality roughage can increase the butterfat content of ewe's milk. Antibiotics and urea can reduce the butterfat content.
5. Magnesium levels may be low, especially where grass is the main source of fodder and supplementation may be beneficial (See mineral lick).

Warnings

1. Hormone disruption has been reported with the use of some sources of molasses.
2. A small number of ewes refuse to eat mixed rations. Separate hay should be available when ewes are in groups.

Complete feed for ewes carrying triplets, quadruplets and quintuplets

Composition

Ingredients	Bag size	Small mix in kg	Bulk mix %	Tonne mix in kg
Maize meal (yellow)	50 kg	75	66.0	650
Full fat soya meal	50 kg	10	9.5	100
Lucerne meal (first grade)		20	19.5	200
Fishmeal	50 kg	3	3.0	25
Brewer's yeast powder		0.5	0.5	5
Salt	50 kg	0.5	0.5	5
Magnesium oxide (MgO)	50 kg	0.5	0.5	5
Trace element premix		0.5	0.5	5

Recommendations

1. Ewes carrying twins triplets and more loose most of their rumen function and should be fed as monogastric animals in the last month of pregnancy. They may suffer from protein wastage of muscle resulting in hernia of the abdomen and tears in pre-pubic tendon.
2. Ewes diagnosed as triplet or more should receive complete feed for lambing pens immediately after scanning. Complete feed for triplet ewes should then be fed *ad libitum* in the last 4 to 6 weeks of gestation.

Warnings

1. Indigestion may occur if no roughage is available. Good quality grass hay in restricted quantities should be fed.
2. Recovery of rumen capacity may take three weeks after lambing. Allow roughage *ad libitum* after lambing.

Chocolate (alkali treated) grain for small ruminants

Composition

Ingredients	Bag size	Small mix in kg	Bulk mix %	Tonne mix in kg
Whole maize	50 kg	70	76.8	750
Water (less if too wet)		6	6.5	65
Salt	50 kg	5	5.5	50
Sunflower cake meal (optional)	50 kg	4	4.5	50
Molasses powder	50 kg	3	3.3	50
CLC lime or cement	50 kg	2	2.2	25
Urea (optional)	50 kg	1	1.1	10
Epsom salt	20/25 kg	100 g	0.1	1
Monensin sodium	25 kg	12 gram		11-22 g/ton

Recommendations

1. Mix small amounts in water, then molasses powder then maize. Spread open to dry. Add cake meal while mix is still moist enough for meal to adhere to maize.
2. Feed 50 g per day for 3 days, then 100 g per day for 3 days then 200 g per day for 3 days. Normally 350 to 500 gram per day is the maximum that is fed.
3. Ewes seldom need more than 100 gram per day for flushing and for winter supplementation.
4. Feed 200 gram every second day. Ensure a wide spread to prevent individuals from over-eating.
5. Salt can be reduced if high levels are fed.
6. Urea may cause problems in pregnant and lactating ewes.
7. Can be spread on bare soil or rocky area. Use feed trough if oil cake is used.

Warnings

1. Monensin may be fatal for horses, milk goats and suckling lambs.
2. Urea may be fatal especially if food gets wet.

Bloat lick for small ruminants

Composition

Ingredients	**Bag size**	**Small mix in kg**	**Bulk mix %**	**Tonne mix in kg**
Maize meal	50 kg	80	45	450
Phosphate (P12)	50 kg	25	15	150
Salt[b]	50 kg	50	30	250
Hypo (Sodium thiosulphate)	5 kg	1.5	1	10
Epsom salt (Magnesium sulphate)	20/25 kg	1.5	1	10
Bloat Guard (Reg G1027)	10 kg	3	2	20
Molasses powder [a]	50 kg	10	6	50

Recommendations

1. [a] Increase molasses powder and/or decrease salt if intake is below 20 grams per day for a 50 kg animal.
2. [b] Increase salt if intake is more than 40 grams per day for a 50 kg animal.
3. Follow normal recommendations for control of bloat:
   - Avoid wilted pastures
   - Feed roughage daily before grazing pastures
   - Place bales of dry roughage around green pastures

Warnings

1. All animals do not consume lick. It may be necessary to dose anti-bloat remedies twice a week up to daily.

A1-10: Phase: feed matrix

No	Phase	Mineral lick	Energy lick	Protein lick	Urea lick	Creep feed	Full feed	Lambing ration	Choc grain	Bloat lick	Lucerne hay
Ewe management cycle											
E1	Selection	●	●	●	●						●
E2	Preparation		●	●					●		
E3	Mating		●	●							●
E4	Pre-placental		●	●							
E5	Early foetal		●	●							
E6	Late gestation			●			●		●		
E7	Peri-partal			●				●	●		
E8	Early lactation			●				●		●	●
E9	Late lactation		●	●						●	●
E10	Weaning	●	●	●	●						
E11	Rest period	●	●	●	●						
E12	Replacement	●	●	●	●						●
Ram management cycle											
R1	Selection	●	●	●	●						●
R2	Preparation (1)	●	●	●				●	●	●	●
R3	Mating		●	●							●
R4	Recovery	●	●	●				●	●	●	●
R5	Rest	●	●	●	●						●
R6	Replacement	●	●	●	●						●
R7	Preparation (2)	●	●	●				●	●	●	●

No	Phase	Mineral lick	Energy lick	Protein lick	Urea lick	Creep feed	Full feed	Lambing ration	Choc grain	Bloat lick	Lucerne hay
Replacement ewe cycle											
F1	Neo-natal							●			
F2	Early suckling			●		●		●		●	●
F3	Suckling/grazing		●	●						●	●
F4	Weaning		●	●						●	●
F5	Post weaning	●	●	●	●				●	●	●
F6	Teething	●	●	●	●				●	●	●
F7	Maturing	●	●	●	●				●	●	●
Replacement ram cycle											
M1	Neo-natal							●			
M2	Early suckling			●		●		●		●	●
M3	Suckling/grazing		●	●						●	●
M4	Weaning		●	●						●	●
M5	Post weaning	●	●	●	●						
M6	Teething	●	●	●	●						
M7	Maturing	●	●	●	●						

Addendum A2 - Reproduction parameters

Reproduction parameters for small ruminant reproduction.

No	Parameter	Unit	CCP	Phase	Parameter definition
1	Ewe replacement	n	CC13	E12	Number of ewes introduced into the breeding flock
2	Ewe replacement percentage	%	CC13	E12	Number of ewes introduced into the breeding flock as a percentage of the total ewe flock
3	Ewe flock composition Two Tooth	%	CC13	E12	Maiden ewes as a percentage of the total ewe flock
4	Ewe flock composition Mature	%	CC13	E12	Mature ewes as a percentage of the total ewe flock
5	Ewe flock composition Six Tooth	%	CC13	E12	Six tooth ewes as a percentage of the total ewe flock
6	Ewe flock composition Full mouth	%	CC13	E12	Full mouth ewes as a percentage of the total ewe flock
7	Ewe flock composition Older	%	CC13	E12	Five year old ewes as a percentage of the total ewe flock
8	Ewe flock composition Worn	%	CC13	E12	Six year old ewes as a percentage of the total ewe flock
9	Pre-flush BCS av.	score	CC3	E2	Average body condition score of ewes at the start of flushing
10	Pre-flush BW av.	kg	CC3	E2	Average body weight of ewes at the start of flushing
10	Flush BCS gain	%	CC3	E2	Increase in body condition score of ewes during flushing as a percentage of the average BCS at the start.

No	Parameter	Unit	CCP	Phase	Parameter definition
11	Flush mass gain	%	CC3	E2	Increase in body weight of ewes during flushing as a percentage of the average BW at the start.
12	Total ewes mated	n	CC6	E3	Total number of ewes joined to the rams
13	Mature ewes mated	n	CC6	E3	Number of mature ewes joined tot the ram
14	Maiden ewes mated	n	CC6	E3	Number of maiden ewes joined to the ram
15	Mature ewes scanned dry	n	CC7	E5/E6	Number of mature ewes diagnosed non-pregnant at scanning
16	Mature ewes scanned single	n	CC7	E5/E6	Number of mature ewes diagnosed pregnant with single fetus at scanning
17	Mature ewes scanned twin	n	CC7	E5/E6	Number of mature ewes diagnosed pregnant with two fetusses at scanning
18	Mature ewes scanned triplet	n	CC7	E5/E6	Number of mature ewes diagnosed pregnant with three fetusses at scanning
19	Mature ewes scanned quadruplet	n	CC7	E5/E6	Number of mature ewes diagnosed pregnant with four fetusses at scanning
20	Mature ewes scanned quintuplet	n	CC7	E5/E6	Number of mature ewes diagnosed pregnant with five fetusses at scanning
21	Maiden ewes scanned dry	n	CC7	E5/E6	Number of maiden ewes diagnosed non-pregnant at scanning

No	Parameter	Unit	CCP	Phase	Parameter definition
22	Maiden ewes scanned single	n	CC7	E5/E6	Number of maiden ewes diagnosed pregnant with single fetus at scanning
23	Maiden ewes scanned twin	n	CC7	E5/E6	Number of maiden ewes diagnosed pregnant with two fetusses at scanning
24	Maiden ewes scanned triplet	n	CC7	E5/E6	Number of maiden ewes diagnosed pregnant with three fetusses at scanning
25	Maiden ewes scanned quadruplet	n	CC7	E5/E6	Number of maiden ewes diagnosed pregnant with four fetusses at scanning
26	Total conception at scanning	%	CC7	E5/E6	Total number of ewes diagnosed pregnant at scanning as a percentage of the total number of ewes mated
27	Mature ewe conception at scanning	%	CC7	E5/E6	Total number of mature ewes diagnosed pregnant at scanning as a percentage of the total number of mature ewes mated
28	Maiden ewe conception at scanning	%	CC7	E5/E6	Total number of maiden ewes diagnosed pregnant at scanning as a percentage of the total number of maiden ewes mated
29	Total scanned lambing	%	CC7	E5/E6	Number of lambs expected as a percentage of the total number of ewes mated
30	Mature ewe scanned lambing	%	CC7	E5/E6	Number of lambs expected by mature ewes as a percentage of the total number of mature ewes mated
31	Maiden ewe scanned lambing	%	CC7	E5/E6	Number of lambs expected by maiden ewes as a

No	Parameter	Unit	CCP	Phase	Parameter definition
					percentage of the total number of maiden ewes mated
32	First cycle conception count	n	CC7	E5/E6	Total number of ewes diagnosed pregnant in the first cycle of mating at scanning
33	Second cycle conception count	n	CC7	E5/E6	Total number of ewes diagnosed pregnant in the second cycle of mating at scanning
34	First cycle conception	%	CC7	E5/E6	Total number of ewes diagnosed pregnant in the first cycle of mating at scanning as a percentage of the total number of ewes diagnosed pregnant
35	Second cycle conception	%	CC7	E5/E6	Total number of ewes diagnosed pregnant in the second cycle of mating at scanning as a percentage of the total number of ewes diagnosed pregnant
36	Twin re-conception percentage	%	CC7	E5/E6	Number of ewes which were scanned pregnant with twins the previous season that were scanned pregnant with twins again
37	Twin maiden 1st conception percentage	%	CC7	E5/E6	Number of maiden ewes that were born as one of a twin that conceived at first mating
38	Twin maiden scanned twin percentage	%	CC7	E5/E6	Number of maiden ewes that were born as one of a twin that conceived a twin at first mating
39	Lambs expected	n	CC7	E5/E6	Total number of lambs predicted by scanning
40	Ewe udder problems at scan	n	CC7	E5/E6	Number of ewes found to have abnormalities of the

No	Parameter	Unit	CCP	Phase	Parameter definition
					udder at scanning
41	Percentage ewe udder problems at scan	%	CC7	E5/E6	Number of ewes found to have abnormalities of the udder at scanning as a percentage of ewes presented for scanning
42	Average BCS at scanning	score	CC7	E5/E6	Average body condition score of ewes at scanning
43	Lambs born	n	CC10	E7	Number of lambs actually born
44	Total after scan abortions	n	CC9&CC17	E5/E6	Number of ewes that were scanned pregnant that did not develop an udder
45	Percentage total after scan abortions	%	CC9&CC17	E5/E6	Number of ewes that were scanned pregnant that did not develop an udder as a percentage of the ewes diagnosed pregnant at scanning
46	Mature after scan abortions	n	CC9&CC17	E5/E6	Number of mature ewes that were scanned pregnant that did not develop an udder
47	Percentage mature after scan abortions	%	CC9&CC17	E5/E6	Number of mature ewes that were scanned pregnant that did not develop an udder as a percentage of the mature ewes diagnosed pregnant at scanning
48	Maiden after scan abortion	n	CC9&CC17	E5/E6	Number of maiden ewes that were scanned pregnant that did not develop an udder
49	Percentage maiden after scan abortions	%	CC9&CC17	E5/E6	Number of maiden ewes that were scanned pregnant that did not develop an udder as a percentage of the

No	Parameter	Unit	CCP	Phase	Parameter definition
					maiden ewes diagnosed pregnant at scanning
50	Lambing BCS av.	Score	CC9&CC17	E6/E7	Average body condition score at lambing of ewes diagnosed pregnant
51	Lambing BCS twin ewes	Score	CC9&CC17	E6/E7	Average body condition score at lambing of ewes diagnosed pregnant with two lambs
52	Lambing BCS single ewes	Score	CC9&CC17	E6/E7	Average body condition score at lambing of ewes diagnosed pregnant with a single lamb
53	Percentage ewes lambing in the first cycle.	%	CC10	E7	Number of ewes laming in the first cycle of lambing as a percentage of all ewes lambing
54	Ewe deaths at birth	n	CC10	E7	Number of ewes dying during partus
55	Percentage ewe deaths at birth	n	CC10	E7	Number of ewes dying during partus as a percentage of all ewes in pregnant flock
56	Percentage ewes peri-partal mortalities	%	CC10	E7	Number of ewes dying as a result of peri-partal conditions related to pregnancy and lactation as a percentage of all ewes in pregnant flock
57	Total ewes developing dystocia	n	CC10	E7	Number of ewes that could not give birth unassisted or had a prolonged birth process
58	Percentage ewes developing dystocia	%	CC10	E7	Number of ewes that could not give birth unassisted or had a prolonged birth process as a percentage of all ewes in pregnant flock

No	Parameter	Unit	CCP	Phase	Parameter definition
59	Mature ewes developing dystocia	n	CC10	E7	Number of mature ewes that could not give birth unassisted or had a prolonged birth process
60	Percentage mature dystocia	%	CC10	E7	Number of mature ewes that could not give birth unassisted or had a prolonged birth process as a percentage of all ewes in pregnant flock
61	Maiden ewes developing dystocia	n	CC10	E7	Number of maiden ewes that could not give birth unassisted or had a prolonged birth process
62	Percentage maiden ewe dystocia	%	CC10	F1&M1	Number of maiden ewes that could not give birth unassisted or had a prolonged birth process as a percentage of all ewes in pregnant flock
63	Lambs counted at 10 days old	n	CC10	F1&M1	Number of lambs that reach the age of 10 days or individual identification.
64	Lamb mortalities < 10days old	n	CC10	F1&M1	Number of lambs that were stillborn or died within the first 10 days of life
65	Lambing % at 10 days old	n	CC11	E8	Number of lambs that reach the age of 10 days as a percentage of ewes mated
66	Lambs marked no.	n	CC11	E8	Number of lambs that reach the age at which tail docking, flock identification and castration takes place.
67	10 to 21 day losses no.	n	CC11	E8	Number of lambs that died after 10 days and before marking
68	Lambing percentage at marking	%	CC12	E10	Number of lambs that reach the age of marking as a

No	Parameter	Unit	CCP	Phase	Parameter definition
					percentage of ewes mated
69	Ewes BCS at weaning av.	score	CC12	E10	Average body condition score of ewes at weaning
70	Lambs weaned no.	n	CC12	E10	Number of lambs weaned
71	Weaning percentage	%	CC12	E10	Number of lambs weaned as a percentage of ewes mated
72	Lambs weaned from mature ewes	n	CC12	E10	Number of lambs weaned from mature ewes
73	Mature weaning percentage	%	CC12	E10	Number of lambs weaned from mature ewes as a percentage of mature ewes mated
74	Lambs weaned to maiden ewes	n	CC12	E10	Number of lambs weaned from maiden ewes
75	Maiden weaning percentage	%	CC12	E10	Number of lambs weaned from maiden ewes as a percentage of maiden ewes mated
76	Marking to weaning losses no	n	CC12	E10	Number of lambs that died after markings and before weaning
77	Weaner mortalities	%	CC12	E10	Number of weaned lambs that die before the age of 12 months as a percentage of lambs weaned
78	Ewe lambs weaned	n	CC12	E10	Number of ewe lambs weaned
79	Percentage ewe lambs weaned	%	CC12	E10	Number of ewe lambs weaned as a percentage of the total number of lambs weaned

No	Parameter	Unit	CCP	Phase	Parameter definition
80	Ram lambs weaned	n	CC12	E10	Number of male lambs weaned
81	Percentage ram lambs weaned	%	CC12	E10	Number of male lambs weaned as a percentage of the total number of lambs weaned
82	Ewe post weaning mortality	n	CC12	E10	Number of weaned ewe lambs that die before the age of 12 months
83	Percentage ewe post weaning mortality	%	CC12	E10	Number of weaned ewe lambs that die before the age of 12 months as a percentage of lambs weaned
84	Ram post weaning mortality	n	CC12	E10	Number of weaned male lambs that die before the age of 12 months
85	Percentage ram post weaning mortality	%	CC13	F6 & M6	Number of weaned male lambs that die before the age of 12 months as a percentage of lambs weaned
86	Post weaning ewe monthly BW change	kg	CC13	F6 & M6	Average change in body weight of ewe lambs per month after weaning
87	Post weaning ram monthly BW change	kg	CC13	F6 & M6	Average change in body weight of eram lambs per month after weaning
88	Yearling ewe mortalities	n	CC13	F6 & M6	Number of ewe lambs that die from 12 months old until after cutting 2 teeth
89	Percentage yearling ewe mortalities	%	CC13	F6 & M6	Number of ewe lambs that die from 12 months old until after cutting 2 teeth as a percentage of ewe lambs weaned after correction for sales

No	Parameter	Unit	CCP	Phase	Parameter definition
90	Yearling ram mortality	n	CC13	F6 & M6	Number of male lambs that die from 12 months old until after cutting 2 teeth
91	Percentage yearling ram mortality	%	CC1	E1	Number of male lambs that die from 12 months old until after cutting 2 teeth as a percentage of male lambs weaned after correction for sales
92	Ewe mortalities p.a.	n	CC1	E1	Number of ewes that die per year
93	Percentage ewe mortalities p. a.	%	CC1	E1	Number of ewes that die per year as a percentage of the number of ewes selected for mating
94	Mature ewe mortalities p.a.	n	CC1	E1	Number of mature ewes that die per year
95	Percentage mature ewe mortalities p.a.	%	CC1	E1	Number of mature ewes that die per year as a percentage of the number of mature ewes selected for mating
96	Maiden ewe mortalities p.a.	n	CC1	E1	Number of maiden ewes that die per year
97	Percentage maiden ewe mortalities p.a.	%	CC2	E6	Number of maiden ewes that die per year as a percentage of the number of maiden ewes selected for mating
98	Ram mortalities p.a.	n	CC2	E6	Number of rams that die per year
99	Percentage ram mortalities p.a.	%	CC2	E6	Number of rams that die per year as a percentage of the number of rams selected for mating

No	Parameter	Unit	CCP	Phase	Parameter definition
100	Lambs born per ewe	ratio	CC10	E7	Number of lambs born divided by the number of ewes mated
101	Lambs born per mature ewe	ratio	CC10	E7	Number of lambs born to mature ewes divided by the number of mature ewes mated
102	Lambs born per maiden ewe	ratio	CC10	E7	Number of lambs born to maiden ewes divided by the number of maiden ewes mated
103	Lambs weaned per ewe	ratio	CC12	E10	Number of lambs weaned divided by the number of ewes mated
104	Lambs weaned per mature ewe	ratio	CC12	E10	Number of lambs weaned from mature ewes divided by the number of mature ewes mated
105	Lambs weaned per maiden ewe	ratio	CC12	E10	Number of lambs weaned from maiden ewes divided by the number of maiden ewes mated
106	30d Re-scan sample abortion rate	%	CC8	E6	Percentage of confirmed pregnant ewes that were not pregnant at re-scan
107	Weaning BW ewes	kg	CC12	E10	Average body weight of ewes at weaning
108	Weaning BW lambs	kg	CC12	F4 & M4	Average body weight of lambs at weaning
109	Weaning BCS ewes	score	CC12	E10	Average body condition score of ewes at weaning
110	Weaning BCS lambs	score	CC12	F4 & M4	Average body condition score of lambs at weaning

No	Parameter	Unit	CCP	Phase	Parameter definition
111	Ram pre-flush BW/BCS av.	kg/score	CC12	F4 & M4	Average body weight and or body condition score of rams at start of preparation phase
112	Ram joining BW/BCS av.	kg/score	CC5	R3	Average body weight and or body condition score of rams at joining
113	Ram flush BW gain	%	CC4	R3	Percentage change of body weight of rams during the preparation phase
114	Ram flush BCS gain	%	CC4	R3	Percentage change of body condition score of rams during the preparation phase
115	Joining Testes Volume/Scrotal Circumference	cm^3/cm	CC4	R3	Calculated testes volume and or scrotal circumference at joining
116	Ram post mating BW/BCS	kg/score	CC6	R4	Average body weight and or body condition score of rams at end of mating
117	Ram BW/BCS change during mating	%	CC6	R4	Percentage change of body weight and or body condition score of rams during the preparation phase
118	Post mating Testes Volume/Scrotal Circumference	cm^3/cm	CC6	R4	Calculated testes volume and or scrotal circumference at end of mating
119	Testes volume/circumference change during mating	%	CC6	R4	Percentage change in calculated testes volume and or scrotal circumference during mating
120	Ram flock composition Two tooth	%	CC15	R1	Two tooth rams as a percentage of the total number of rams joined
121	Ram flock composition Six tooth	%	CC15	R1	Six tooth rams as a percentage of the total number of

No	Parameter	Unit	CCP	Phase	Parameter definition
					rams joined
122	Ram flock composition Full mouth	%	CC15	R1	Full mouth rams as a percentage of the total number of rams joined
123	Ram flock composition Older	%	CC15	R1	Five year old rams as a percentage of the total number of rams joined
124	Ram flock composition Worn	%	CC15	R1	Six year old rams as a percentage of the total number of rams joined
125	Genital soundness RMC av.	n	CC15	R1	Average calculated mating capacity of rams at genital soundness examination
126	Ram post recovery BW/BCS av.	score	CC16	R4	Average body weight and or body condition score of rams at end of the recovery period
127	Ram BCS change during recovery	%	CC16	R4	Percentage change of body weight and or body condition score of rams during the recovery period
128	Post recovery Testes Volume/Circumference	cm^3/cm	CC16	R4	Calculated testes volume and or scrotal circumference at end of the recovery period
129	Testes volume/circumference change during recovery	%	CC16	R4	Percentage change in calculated testes volume and or scrotal circumference during the recovery period

Addendum B – Forms

HAMMER PROCESS CONTROL FORM – STOCK COUNTS									PC1
	AGE	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME									
MATURE RAMS (TOT)									
Mature rams	Worn								
Mature rams	Older								
Mature rams	8 Tooth								
Mature rams	6 Tooth								
YOUNG RAMS	2/4 Tooth								
WEANER RAMS	< 12m								
RAM LAMBS	0 - Wean								
Wethers									
MATURE EWES (TOT)									
Mature ewes	Worn								
Mature ewes	Older								
Mature ewes	8 Tooth								
Mature ewes	6 Tooth								
YOUNG EWES	2/4 Tooth								
WEANER EWES	< 12m								
EWE LAMBS	0 - Wean								
FEEDLOT									
SALE SHEEP									
TOTAL MALE SHEEP									

TOTAL FEMALE									
GRAND TOTAL									
FARM TOTAL									
FLOCK CODE									
FARM CODE									
DATE COUNTED									

HAMMER PROCESS CONTROL FORM – FLOCK TREATMENTS					**PC2**
DATE	DESCRIPTION	FLOCK NAME	TREATMENT CODE	FLOCK CODE	FARM CODE

HAMMER PROCESS CONTROL FORM – INDIVIDUAL EVENT/TREATMENTS					**PC3**
DATE	DESCRIPTION	ANIMAL DESCRIPTION	TREATMENT CODE	FLOCK CODE	FARM CODE

HAMMER PROCESS CONTROL FORM – HAZARD EVENTS					**PC4**
DATE	DESCRIPTION	HAZARD GROUP	HAZARD CODE	FLOCK CODE	FARM CODE

HAMMER CRITICAL CONTROL POINT FORM – EWE SELECTION DATA									CC1
FARM CODE		**Numbers of Ewes Culled**							
FLOCK CODE		Abscess	Blowfly	Cancer	Disease	Locomotion	Teeth	Udder	TOTAL
Mature ewes	Worn								
Mature ewes	Older								
Mature ewes	8 Tooth								
Mature ewes	6 Tooth								
Mature ewes	2/4 Tooth								
	TOTAL								
FARM CODE		**Numbers of Ewes Culled**							
FLOCK CODE		Abscess	Blowfly	Cancer	Disease	Locomotion	Teeth	Udder	TOTAL
Mature ewes	Worn								
Mature ewes	Older								
Mature ewes	8 Tooth								
Mature ewes	6 Tooth								
Mature ewes	2/4 Tooth								
	TOTAL								
FARM CODE		**Numbers of Ewes Culled**							
FLOCK CODE		Abscess	Blowfly	Cancer	Disease	Locomotion	Teeth	Udder	TOTAL
Mature ewes	Worn								
Mature ewes	Older								

Mature ewes	8 Tooth								
Mature ewes	6 Tooth								
Mature ewes	2/4 Tooth								
	TOTAL								

HAMMER CRITICAL CONTROL POINT FORM – RAM SELECTION DATA											**CC2**
Ram number	Age	Abscess	Blowfly	Cancer	Famacha	Feet	Teeth	Scrotum	Body wt	BCS	CULL?
Total 2 Tooth											
Total 6 Tooth											
Total 8 Tooth											
Total older											
TOTAL											
								AVERAGE			

HAMMER CRITICAL CONTROL POINT FORM – EWE PREPARATION DATA								**CC3**
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL/AVERAGE
START FLUSH BCS								
DATE								
SAMPLE WEIGHTS								
DATE 2								
SAMPLE WT 2								
DATE 3								
SAMPLE WT 3								
DATE 4								
SAMPLE WT 4								
AVG WT GAIN								
END FLUSH BCS								
FLUSH CODE								
DATE TEASERS IN								
TEASER COUNT								
Teaser tag no								
Teaser tag no								
Teaser tag no								
Teaser tag no								
CAMP NAME								
FARM CODE								
FLOCK CODE								

HAMMER CRITICAL CONTROL POINT FORM – RAM PREPARATION DATA								**CC4**
	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	TOTAL/AVERAGE
DATE 1								
SAMPLE WT 1								
DATE 2								
SAMPLE WT 2								
DATE 3								
SAMPLE WT 3								
DATE 4								
SAMPLE WT 4								
DATE								
SAMPLE WEIGHTS								
DATE 5								
SAMPLE WT 6								
DATE 7								
SAMPLE WT 7								
DATE 8								
SAMPLE WT 8								
AVG WT GAIN								
END FLUSH BCS								
FLUSH CODE								
CAMP NAME								
FARM CODE								
FLOCK CODE								

HAMMER CRITICAL CONTROL POINT FORM – JOINING DATA									CC5:1
	AGE	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME									
AI date									
Rams in									
MATURE RAMS (TOT)									
Mature rams	Worn								
Mature rams	Older								
Mature rams	8 Tooth								
Mature rams	6 Tooth								
YOUNG RAMS	2/4 Tooth								
WEANER RAMS	< 12m								
RAM LAMBS	0 - Wean								
RAMS TOTAL									
MATURE EWES (TOT)									
Mature ewes	Worn								
Mature ewes	Older								
Mature ewes	8 Tooth								
Mature ewes	6 Tooth								
YOUNG EWES	2/4 Tooth								
WEANER EWES	< 12m								
EWES TOTAL									
EWE :RAM RATIO									

TOTAL RMC									
FLOCK CODE									
FARM CODE									
FARM TOTAL									

HAMMER CRITICAL CONTROL POINT FORM – JOINING DATA													CC5:2	
	FLOCK 1		FLOCK 2		FLOCK 3		FLOCK 4		FLOCK 5		FLOCK 6		FLOCK 7	
RAM	NUMBER	RMC	NUMBER	RMC	NUMBER	RMC	NUMBER	RMC	NUMBER	RMC	NUMBER	RMC	NUMBER	RMC
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
TOTAL														

HAMMER CRITICAL CONTROL POINT FORM – MATING DATA								CC6:1
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
Rams in								
Rams out								
Hazard event 1								
Date start								
Date end								
Hazard event 2								
Date start								
Date end								
Hazard event 3								
Date start								
Date end								
Hazard event 4								
Date start								
Date end								
Hazard event 5								
Date start								
Date end								
Second cycle rams in								
Second cycle rams out								

Third cycle rams in								
Third cycle rams out								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM – MATING DATA											CC6:2
Ram number	Age	Scrotum	Pre-scrot	Decrease	Body Wt	Pre-B Wt	Wt loss	BCS	Tone	FAMACHA	CULL?

HAMMER CRITICAL CONTROL POINT FORM – SCAN DATA								**CC7**
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
Dry								
SINGLES TOTAL								
Singles pre-conceived								
Singles first cycle								
Singles second cycle								
TWINS TOTAL								
Twins pre-conceived								
Twins first cycle								
Twins second cycle								
Triplets								
Quadruplets								
Quintuplets								
TOTAL								
Conception rate								
Lambing %								
Udder damage (n)								
Udder damage %								
Twin re-conception (n)								
Twin re-conception %								
Twin first conception (n)								
Twin first conception %								
Culling recommended								

Pre-conceived date 1								
Pre-conceived date 2								
F.E.C. pregnant								
F.E.C. non-pregnant								
FLOCK CODE								
FARM CODE								
SCAN DATE								

HAMMER CRITICAL CONTROL POINT FORM – RE-SCAN DATA								CC8
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
NON-PREGNANT EWE								
Now dry								
Now single								
Now twin								
Now triplet								
SINGLE EWE								
Now dry								
Now single								
Now twin								
Now triplet								
TWIN EWE								
Now dry								
Now single								
Now twin								
Now triplet								
Total abortions (n)								
Recalculated concept %								
Recalculated lambing %								

FLOCK CODE								
FARM CODE								
RE-SCAN DATE								

HAMMER CRITICAL CONTROL POINT FORM – PREGNANCY MANAGEMENT DATA								CC9
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
STATUS								
AGE								
SCAN DATE								
TWINS SPLIT DATE								
TWIN FEED START								
TWIN FEED LEVEL 2								
TWIN FEED LEVEL 3								
TARGET WT1								
TARGET WT2								
TARGET WT3								
TARGET WT4								
TARGET WT5								
TARGET WT6								
VACCINATION DAT1								
Treatment code								
VACCINATION DAT 2								
Treatment code								
VACCINATION DAT 3								
Treatment code								
DATE 1ST PRE LAMB								
DATE 1ST LAMB								
DATE LAST LAMB								

LAMBS 1^{ST} CYCLE (n)								
LAMBS 1^{ST} CYCLE %								
LAMBS 2^{ND} CYCLE (n)								
LAMBS 2^{ND} CYCLE %								
LAMBS 3^{RD} CYCLE (n)								
LAMBS 3^{RD} CYCLE %								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM – LAMBING DATA								CC10:1
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
STATUS								
AGE								
DATE 1ST PRE LAMB								
DATE 1ST LAMB								
DATE LAST LAMB								
LAMBED 1st CYCLE (n)								
LAMBED 1st CYCLE %								
LAMBED 2nd CYCLE (n)								
LAMBED 2nd CYCLE %								
LAMBED 3rd CYCLE (n)								
LAMBED 3rd CYCLE %								
TOTAL EWES LAMBED								
LAMBS DIED < 10D (n)								
Lamb stuck								
Diseases								
Did not walk								
Did not breathe								
Did not suckle								
Unknown								
DEVIATIONS from SCAN:								
Scanned dry but lambed								
Singles did not lamb								

Single lambed twin								
Twin did not lamb								
Twin lambed single								
Triplet did not lamb								
Triplet lambed twin								
Triplet lambed single								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM –MARKING DATA								**CC11**
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
STATUS								
AGE								
NUMBER of EWES								
RAM LAMBS MARKED								
EWE LAMBS MARKED								
LAMBS DIED >10days								
Disease								
Management								
Genetics								
Functional								
Nutritional								
Predation								
Climatic								
FLOCK CODE								
FARM CODE								
MARKING DATE								

HAMMER CRITICAL CONTROL POINT FORM –WEANING DATA								CC12
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
STATUS								
AGE								
NUMBER of EWES								
LAMBS WEANED								
RAM LAMBS WEANED								
DATE RAMS WEANED								
Losses >marking total								
Disease								
Management								
Genetics								
Functional								
Nutritional								
Predation								
Climatic								
RAM AVE WEAN WT								
EWE LAMBS WEANED								
DATE EWES WEANED								
Losses >marking total								
Disease								
Management								
Genetics								
Functional								

Nutritional								
Predation								
Climatic								
EWE AVE WEAN WT								
ALL AVE WEAN WT								
WEANING DATE ALL								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM –EWE REPLACEMENT DATA								**CC13**
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	AVERAGE
CAMP NAME								
STATUS								
Weaning weight average								
SAMPLE GROUPS AVE:								
Weight at 4 months								
Weight at 5 months								
Weight at 6 months								
Weight at 7 months								
Weight at 8 months								
Weight at 9 months								
Weight at 10 months								
Weight at 11 months								
Weight at 12 months								
Weight at 13 months								
Weight at 14 months								
Weight at 15 months								
Weight at 16 months								
Weight at 17 months								
Weight at 18 months								
COUNT AT WEANING								
COUNT AT YEARLING								
COUNT AT REPLACEM.								
LOSSES < REPLACEM								

Disease								
Management								
Genetics								
Functional								
Nutritional								
Predation								
Climatic								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM –RAM REPLACEMENT DATA									**CC14**
Number	40 day wt	Index	100 day wt	Index	300 day wt	Index	RRC	Index	Comp Index

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HAMMER CRITICAL CONTROL POINT FORM **RAM GENITAL SOUNDNESS DATA**					**CC15**
	-1-	-2-	-3-	-4-	-5-
Tag No					
Case number					
Breed					
Tags					
Chip no					
Tattoo					
Ear notch					
Brands					
Condition 1-5					
Hips √					
Eye pigment 0-10					
Famacha score 1-5					
Age					
Bite					
Parasites					
Colour 0-5					
Cover 0-5					
Tone 1-5					
Scr circumference					
Testes length					
Density					
Motility					
Colour					
Mating dexterity					
Smear box no					
Neutrophils					
Other cells					
Percentage live					
Normal loose heads					
Abnormal heads					
Tail abnormalities					
Teratoid					
Acid fast					
Other					
B. ovis serology					
Abnormalities					
Cert no					

HAMMER CRITICAL CONTROL POINT FORM – RAM RECOVERY DATA											**CC16**
Ram number	Age	Scrotum	Pre-scrot	Decrease	Body Wt	Pre-B Wt	Wt gain	BCS	Tone	FAMACHA	CULL?

HAMMER CRITICAL CONTROL POINT FORM – LAST DAY OF LAMBING DATA								CC17: 1
	FLOCK 1	FLOCK 2	FLOCK 3	FLOCK 4	FLOCK 5	FLOCK 6	FLOCK 7	TOTAL
CAMP NAME								
STATUS								
AGE								
DATE 1ST PRE LAMB								
DATE 1ST LAMB								
DATE LAST LAMB								
EWES STILL IN LAMB								
EWES DID NOT LAMB								
Failed to Form Udder								
Formed Udder								
Lam suckled								
Lochia present								
Fluid in uterus								
Placenta visible								
Dead intact fetus								
Macerated fetus								
Pyometritis								
FLOCK CODE								
FARM CODE								

HAMMER CRITICAL CONTROL POINT FORM – LAST DAY OF LAMBING DATA											**CC17:2**
Tag number	Still in lamb	Did not lamb	Failed to form udder	Formed Udder	Lam suckled	Lochia present	Fluid in uterus	Placenta visible	Dead intact fetus	Macerated fetus	Pyometritis

	HAMMER CRITICAL CONTROL POINT FORM NUTRITIONAL STATUS DATA					CC20-1
		-1-	-2-	-3-	-4-	-5-
Tag No						
Flock code						
Farm code						
Sex/status						
Camp						
Breed						
Protein[d]	Serum					
Ca	Serum					
PO4	Serum					
Mg	Serum					
K	Serum					
Na	Serum					
Cl	Serum					
Cu	Serum					
	Liver					
Zn[b]	Serum					
	Liver					
Se	Blood					
	Liver					
Co	Serum					
	Liver					
Fe	Liver					
I						
Mn	Liver					
Mo	Liver					
Rumen contents						
-pH						
-MBRT[c]						
-Colour						
-Odor						
-Consistency						
Urine						

-pH						
-Ketones						
-SG						

HAMMER **Critical Control Point Generic Questionnaire**		**QQ1**
Client	Critical control point:	
Date	Flock	
Generic hazards		
1	Is there any evidence that diseases could affect flock reproduction?	
2	Is there any evidence that management could affect flock reproduction?	
3	Is there any evidence that genetics could affect flock reproduction?	
4	Is there any evidence of functional (conformation, physiology and behaviour) factors that could affect flock reproduction?	
5	Is there evidence that nutrition could affect flock reproduction?	
6	Is there any evidence that predation could affect reproduction?	
7	Is there any evidence that climate could affect flock reproduction?	

Specific hazards		
8	Diseases:	
9	Management:	
10	Genetics:	
11	Functional:	
12	Nutrition:	
13	Predation:	
14	Climatic:	

Corrective actions		
15	Actions required to reduce disease risk.	
16	Actions required to reduce management risk.	
17	Actions required to reduce genetic risk.	
18	Actions required to reduce functional risk.	
19	Actions required to reduce nutrition risk.	
20	Actions required to reduce predation risk.	
21	Actions required to reduce climatic risk.	

Management		
22	Feedback required?	
23	Insights gained?	
24	Changes to flock health plan?	
25	Changes to data form and questionnaire?	
26	Diary entries required?	
27	Matters to be reported on?	
28	Continuous improvement potential?	