Standard operating procedures for efficient management of small ruminant farms

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Abstract

Success in dairy sheep and goat farming depends largely on efficient management of available resources and expertise of farmers. Both, combined with the low level of implementing innovation at farm level dictate animal productivity and farm profitability. The objective was to develop farmer-friendly standard operating procedures (SOPs) for training employees as well as recording protocols to cater the needs of efficient farm management. Initially, a comprehensive review of existing guidelines and relative research studies regarding farm management practices was performed. In particular, milk production recording and udder morphology assessment guidelines of the International Committee of Animal Recording (ICAR) and protocols for Animal Welfare Indicators (AWIN) were examined.

Refereed publications about reproduction technologies, newborn management, nutritional management, milking procedures, milking parlor critical points, and biosecurity measures were studied. Decision support tools for farm management and economic performance assessment were also explored. Based on the above, detailed SOPs, tailored for dairy farms, were developed. Each SOP was divided in subsections detailing objectives, step-by-step procedures, and required equipment/technologies. Specifically, SOPS for reproduction management focused on artificial insemination and natural mating, pregnancy diagnosis, and lambing/kidding management.

SOPs for newborn lambs/kids focused on colostrum quality and storage, artificial rearing, and prevention of diarrhea incidents. SOPs for nutritional management included guidelines for meeting energy and protein requirements of each animal category according to their physiological and production stage, and sample collection of feeds for chemical analysis. Milking parlor and milking procedure guidelines focused on maintenance, cleaning, and education of milkers on milking practices. SOPs for animal health and welfare included vaccination protocols, and practical welfare indicators (body condition score, water availability, fleece cleanliness panting, stocking density, hoof overgrowth, body and skin lesions, lameness, fecal soiling, ocular discharge, mastitis).

SOPs for milk production and udder health detailed procedures for milk yield recording with volumetric milk meters, milk sample collection for chemical analysis as well as udder morphometric measurements. Biosecurity SOPs, focused on internal and external measures for disease prevention and control. Lastly, the applicability and usefulness of existing decision support tools for efficient farm management and economic performance of small ruminant farms was assessed. Next steps include the integration of these protocols in an online interactive platform. The notion is that those

customized SOPs will help farmers become more efficient in managing dairy sheep and goat farms while ensuring animal health and welfare.

Keywords: small ruminants, training, standard operating procedures, recording protocols, production, profitability.
Presented at: ICAR Session 7: "Breeding for agro-ecological transition in sheep and goats"

Introduction

Dairy sheep and goats are primarily reared in Mediterranean countries, having a substantial socio-economic impact. Their milk is mainly processed into cheese products, many of which are Protected Designation of Origin. Moreover, they provide ecosystem services and employment opportunities, especially in mountainous and less-favored areas (Arsenos *et al*., 2021).

However, many sheep and goat farmers do not follow established guidelines and management protocols. Moreover, they have not adopted new technologies, and innovations that could help modernize farm practices (Paraskevopoulou *et al*., 2020). All the above result in low levels of animal productivity, poor animal health and welfare, high production costs, and low farm income. To overcome these challenges education on farm management practices detailing step-by-step procedures is imperative.

The objective here was to develop farmer-friendly standard operating procedures (SOPs) for training employees and recording protocols to cater the needs of efficient farm management.

Reproduction management SOPs

Ten weeks prior to the mating period, males should be assessed to detect issues that could adversely affect reproductive ability. Evaluation includes assessment of body condition score (BCS; 3-4), testicular size (>30 cm and >25 cm in rams and bucks, respectively), genitalia, jaw, teeth, and limbs. Females should be also assessed based on age (first mating at 7-8 months), BCS (2.5-3.5), health, and genetic improvement criteria.

Ideally, artificial insemination (AI) should be performed. AI enhances genetic improvement by increasing selection intensity and genetic evaluation precision. To increase cervical AI success rates the following guidelines (Priskas *et al*., 2022) are suggested:

1. Selection of the best females based on age (first to third lactation period), BCS (2.5-3.5), health, productivity (milk yield and quality), udder morphology, and somatic cell count.
2. Estrus synchronization using intravaginal fluogestone acetate sponges, or CIDR devices and insemination 50-55 hours following their removal.
3. Proper animal handling after AI.

Any animals not artificially inseminated are naturally mated. Hormonal interventions are suggested to increase reproduction and management efficiency. These include estrus synchronization or melatonin implants to accelerate the onset of reproductive activity (1 to 10 and 1 to 25 male to female ratio, respectively). Random mating practices should be avoided, and pedigree records should be kept for purposes of genetic improvement.

Newborn management SOPs

Colostrum is imperative for newborn survival. To guarantee an efficient amount of high-quality colostrum for lambs/kids the following are suggested:

1. Individual housing of ewes/goats with their newborns for 2-4 days following parturition,
2. Assessment of colostrum quality using a digital Brix refractometer,
3. Pasteurization to reduce microbial load,
4. Storage (refrigerator or freezer) to accommodate any future needs,
5. Thawing and warming prior to administration.

Artificial rearing is an important management practice to increase farm profitability. The following guidelines are suggested for efficient implementation:

1. Smooth transition, observation, and assistance of lambs/kids,
2. Use of high-quality milk replacer that should be prepared and administered according to manufacturer's instructions,
3. Provision of a warm and dry environment to avoid hypothermia,
4. Provision of feedstuffs at the age of one week,
5. Weaning at the age of 35-40 days and at a body weight of 15 kg.

Nutritional management SOPs

During the mating period and first month of gestation the nutritional management of the respective lactation stage is followed; flushing is advised to achieve a BCS of 2.5-3.5. During the last month of gestation energy and protein demands increase substantially but feed intake decreases. Therefore, it is suggested to gradually decrease forages and increase concentrates; BCS at this stage should be 3-3.5. During the early stages of lactation, animals are typically fed with 1.5-2 kg of lucerne hay and/or silage, 0.15-0.2 kg of straw and 1-1.5 kg of concentrates offered at least twice daily to avoid ruminal acidosis. In general, feeding of males is designated to cover mainly maintenance requirements. Two months prior to mating period the amount of concentrate should be increased to 1 kg/animal/day to meet energy demands and improve semen quality. Finally, from weaning to five months old, lambs/kids are fed with concentrates and straw ad libitum and 500-600 g of lucerne hay. From the age of five months and until the first mating period, 500-700 g of concentrate feed, 500-600 g of lucerne hay, and straw ad libitum are suggested.

Milking procedure SOPs and milking parlor critical points

Milking procedure includes the following steps:

1. Use of gloves by milkers and frequent disinfection or replacement.
2. Use of discrete measures to indicate animals with mastitis that should be milked separately.
3. Pre-stripping and observation of milk for any signs of mastitis.
4. Attachment of milking units.

5. Cluster removal after vacuum cessation to prevent teat injuries.
6. Post-milking disinfection (post-dipping).

Milking parlor should be cleaned both externally and internally after every milking. External cleaning is performed using high-pressure water. Critical points for efficient internal cleaning include:

1. Water temperature at 70-80° C.
2. Use of alkaline detergents every time.
3. Use of acid detergents once per week if the water is not hard, otherwise 2-3 times per week.
4. Cleaning duration for at least 30 min and 90 min when using only alkaline or both alkaline and acid detergents, respectively.

Vacuum level in the manometer should be checked daily. Moreover, vacuum level, pulsation rate and pulsation ratio in the milking units should be monitored twice per year by authorized technicians using designated equipment. Vacuum level differences between clusters and the vacuum pump should not exceed 2 kPa; such differences have been associated with increased risk for subclinical mastitis and teat-end hyperkeratosis (Vouraki *et al*., 2018). Finally, clusters should be replaced at 2,500-5,000 milkings per milking unit.

Biosecurity, animal health and welfare

External biosecurity aims at reducing the risk of disease introduction to a farm. External biosecurity measures include:

1. Disinfection of vehicles' wheels when entering farm premises.
2. Use of gloves, clean clothing and footwear by all visitors and employees.
3. Low animal purchasing frequency and quarantine for at least three weeks.
4. Handling of dead animals with gloves, and storage in a freezer until disposal, and
5. Vermin control.

Internal biosecurity aims at reducing the spread of a disease within a farm. It is suggested that animals of different age groups are housed separately; younger animals should be visited first since they are more susceptible to infections. Sick animals should be separated from the healthy ones and remain in a hospital pen. Diagnoses, treatments, and deaths should be recorded. Moreover, for efficient cleaning and disinfection the following steps should be followed:

1. Dry cleaning and removal of organic material.
2. Soaking of surfaces with detergents to loosen all remaining organic material.
3. High pressure cleaning with water.
4. Drying to avoid disinfectant dilution.
5. Disinfection and drying.

Vaccinations are suggested for enterotoxemia (ewes/does one month prior to parturition and lambs/kids at the age of three weeks), contagious agalactia (ewes/does two

months prior to parturition and lambs/kids at the age of two months), enzootic abortion (one month prior to first mating) and paratuberculosis (in goat farms where animals have been diagnosed with the disease and at the age of 2-3 weeks to 6 months). Finally, welfare indicators to be routinely assessed include BCS, water availability, fleece cleanliness, panting, stocking density, hoof overgrowth, body and skin lesions, lameness, fecal soiling, ocular discharge, and mastitis. Scoring is performed according to AWIN guidelines (Dwyer *et al*., 2015).

Milk production and udder morphology recording protocols

Milk yield recording is performed using volumetric milk meters. Recording starts after weaning and is performed monthly (five monthly records per milking period are suggested) following the guidelines of International Committee of Animal Recording (ICAR, 2018). Inddividual milk samples should be collected from the milk meters monthly (at least for three months in early lactation) to assess milk quality (fat, protein, lactose, solids-non-fat content). Udder morphology assessment includes morphometric measurements of udder depth, udder attachment, degree of separation of udder halves, and teat placement. Scoring is performed using the nine-point linear scale proposed by Casu *et al*. (2006) and ICAR (2018).

Farm economic performance recording and assessment

Decision support tools can be used to record and evaluate farm economic performance. Specifically, a web-based application has been developed within the ProudFarm project to familiarize farmers with financial management of small ruminant farms and help towards decision making. This app illustrates the expected daily net income against feeding costs. Input data include daily milk production and animal feed intake. Moreover, web applications, such as Happy Goats (https://happygoats.eu/), are available to assess annual farm economic performance in relation to farm management practices. Towards this end, records should be kept and used as input parameters for the following categories:

1. Flock size.
2. Production (milk and meat),
3. Nutritional management and grazing.
4. Income, farm prices, and costs.

Acknowledgements

This work is funded by “Measure 16 ‘Cooperation” in the framework of National Rural Development Programme, and it is co-financed by the European fund for rural development (EAFRD) and national budgets (ProudFarm; Project code M16SYN2-00016).

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