

# Nutritional and Management Strategies to Improve Reproductive Performance in Sheep and Goats: A Review

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**Annotation:** Reproduction represents a major factor influencing productivity and profitability across the sheep and goat industries. Since multiple factors such as nutrition, management, environmental and genetic factors are involved in fertility outcome, unbalanced nutrition and mismanagement are a cause of low ewe conception rate and low progeny survival, which will result in significant economic losses. The review here presents a summary of current information on nutrition-related variables including energy and protein density, vitamins (vitamin A and vitamin E), some antioxidant agents (for example selenium or zinc), fatty acids (i.e., omega-3 and omega-6), and efficient natural phytogetic additives on farm animals reproduction. Management practices covered include flushing, control of the breeding season, nutritional management of the pregnant and lactating ewe, flock health programs, and reproductive technologies like AI. Management and nutritional strategies applied synergistically lead to increased ovulation rate, conception, twinning rate, lactation use efficiency and the productive life of farm flocks of sheep.

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Then, in the main text, we briefly touch on the precision nutrition, biotechnology, and climate-smart farming that comprise potential means for the sheep industry to meet the challenges of climate change and potential feed resource shortage in the future. Together these add on to increased reproductive performance as well as the sustainable in the long run adaptability of production systems for small ruminants to (economic) stresses.

**Keywords:** Sheep; Goats; Nutrition; Management; Selenium; Zinc; Sustainability.

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## Introduction

Reproductive performance enhances the productivity and profit of small ruminants. Main text Hussain et al (2021); Palani, Ameen & Shekhani (2025) Abstract: Sheep and goats are integral component of food and livelihood security of rural population particularly in arid and semi-arid climate contributing significantly towards meat, milk and fiber production.

Reproductive soundness enhances the achievement of desirable lambing and kidding ratios and shorter generation intervals in dairy sheep, and therefore contributes to higher economic returns at the farm level. In contrast, fertility impairment causes economic losses through higher culling rates and reduction in the progeny survival rate as a result of the extended duration of calving intervals.

On the other hand, sheep and goats have limitation in tissue regeneration due to nutritional, environmental and genetic factors. Different forms of malnutrition or under nutrition either in energy and protein or essential micronutrients like selenium & zinc disturb reproductive physiology and thereby lower conceptions rates (Palani et al., 2024a; Palani et al., 2024b). Environmental stressors leading to reproductive performance are described as heat load and oxidative stress, and act through disruption in hormonal regulatory mechanisms and/or through embryonic mortality (Sordillo & Aitken, 2009). Local breeds are generally more resistant than breeds selected in intensive systems (Abecia et al., 2012) but produce less, and genotype/breed differences are also involved.

In addition to the nutrients they offer, the hormones and synchronization methods are the only tools currently available and therefore the two main tools that can be used to enhance reproduction in small ruminants. Vitamin, mineral and EFAs supplementation may also improve oocyte quality, sperm viability and reproductive performance (17–20). I think the least mentioned of the management factors affecting fertility responses to any intervention; control breeding conditions (CBC), flushing and good herd health is probably no less important. Sex steroid status by auction limited blood physiologic and biochemical parameters, and also reproductive performance in Awassi ewes: an endocrine control story for fertility (Alwan et al., 2018a; 2018b).

The current review thereby aims to provide an overview of nutrition and management practices that have been proposed to improve reproductive performance in ewes and does. Emphasis continues on the potential for dietary AOX, minerals and plant-based extractives to express

synergy together with management factors that provide a context to improve reproductive performance for diverse production systems.

### **Nutritional Factors Affecting Reproductive Performance**

Nutrition is the single most important determinant of reproduction performance of sheep and goats. Proper nutrition plays a vital role in folliculogenesis, ovulation, conception and embryo survival. On the other hand, insufficient or imbalance of these nutrients can have deleterious impacts on the reproductive performance resulting in reduced kidding/lambing rate.

### **Role of Energy and Protein in Fertility and Ovulation**

Energy and protein electrolyze the reproduction. Also, protein is an important nutrient that hormones are produced (Diskin & Kenny, 2014) and it representing the energy is conducive restoration of metabolic status in female lambs and facilitates follicle stimulation and ovulation. Conversely, the interruption of anestrus as a result of LH (luteinizing hormone) secretion inhibition through feeding undernutrition and nutritional supplementation through “flushing” strategies (accompanied by increased ovulation rate and litter size of small ruminants as described by Abecia et al., 2012) Conversely, protein plays an important role in gamete production and low dietary protein levels are associated with impaired gametogenesis, while excess dietary protein may also elevate BUN, which negatively impacts embryo survival (Ali et al., 2015).

### **Essential Vitamins and Minerals**

The role of micronutrients as cofactors of enzymatic systems that are directly related to reproduction Selenium (Se) is more than just a block in the building of the enzyme glutathione peroxidase, it is a key protector of spermatozoa and oocyte from oxidative damage. Palani et al. Data coming from (2024a) that boost blood antioxidant status and reproductive performance of supplements in Kurdi sheep. Zinc (Zn) is an essential trace element necessary for testis development, spermatogenesis, and maturation of ovarian follicles. Its deficiency causes low conception rate and abnormal morphology of sperm (Palani et al., 2024b). Vitamin E ( $\alpha$ -tocopherol) enhances immune system activity, the peroxidation of lipids in reproductive organs decreases, and thus, it provides the optimal environment for conception and fetal survival (Chauhan et al., 2014). Oocyte maturation is affected by  $\alpha$ -carotene and vitamin A (Rosenfeld & Roberts, 1999), and it has also been stated that deficiency would affect follicular development at this level (Arechiga et al., 1998) and consequently impair total fertility.

### **Fatty Acids (Omega-3 and Omega-6)**

Fatty acids have been gaining an increasing focus in reproductive physiology. The anti-inflammatory action of Omega-3 (EPA and DHA) extends the oocyte competence and embryo quality and has been correlated with improved folliculation fluid quality (Wathes et al., 2007). Prostaglandins (PGs) are involved in regulating ovulation and luteal activity and are derived from omega-6 fatty acids, especially linoleic acid (LA). Coyne et al. It therefore proposes that given the key roles of Omega-3 and -6 in reproductive performance, the optimal ratio of these two fatty acids would be important in driving increased reproductive performance in terms of higher number of pups and higher pup survival (2019).

### **Natural Feed Additives (Such as Herbs and Antioxidants)**

Several phytonutrients (polyphenols, flavonoids) and essential oils in either crude or purified form found in plant extracts, provide antioxidant and reproductive effects (Table 1). Crocin increased oxidative balance and reproductive performance importance in feed with saffron (*Crocus sativus*) extract in animals Mhamad, Palani, & Al-Zubaidy, 2025 On the other hand, plant extracts such as rosemary and turmeric reduce the oxidative stress in the reproductive tissues and enhance sperm parameters with fertilization and embryo quality as well as development (Surai, 2016). This natural antioxidant might be a more sustainable alternative to synthetic preservatives, plus side advantages of better animal health with improved consumer acceptance of product.

Based on significant data we can conclude that Nutrition plays a very important role on reproductive performance of sheep and goats with special consideration to macronutrients, micronutrients, fatty acids and phyto-genic additives. Provision of Suitable periodical nutritional supplementation according to physiological need will boost fertility, enhance kidding and lambing percentage and promote sustainable small ruminants production.

### **Management Strategies for Reproductive Improvement**

Management is as important as nutrition in affecting sheep and goats productive performances. The maximization of fertility, lambing/kidding, and performance of the entire flock depends on breeding programs, nutritional management of body condition energy balance (BCEB) during critical periods, health care, and reproductive technologies.

### **Breeding Season and Reproductive Programs**

Reproductive activity is affected mainly by photoperiod, and more specifically, sheep and goats are short-day breeders. These have provided an induction of strategic changes in the seasonality of breeding which is an advantage due to the slow cyclic nature of ovulation and synchronization of estrus (Abecia et al., 2012) Hormonal treatments, male exposure (male effect), and nutritional flushing have been effective particularly under conditions of EB and protein pre-mating that favour maximal follicular development and litter size (especially for animals under-fed such as ewes and does) (Diskin & Kenny, 2014). Reproductive cycle manipulation with formal approaches according to co-temporality with feed and total market need

### **Nutritional Requirements During Pregnancy and Lactation**

This is the capacity to accumulate food during pregnancy and nursing — a vital factor of reproductive success. Maternal nutrition is critical to good placental development, growth of the offspring and its post-natal survival (Ali et al., 2015). All of them are at risk of pregnancy toxemia and weak neonates when undernourished in late gestation, whereas the consequences of overnutrition in the same period will be dystocia and metabolic disorders. During lactation, good quality nutrition enables maintenance of the milk yield while aiding in replenishment of body reserves that will be required for the following reproductive cycle. Pregnancy of animals supplemented with antioxidant compounds e.g. selenium and vitamin E enhanced reproductive performance and immunocompetence of offspring (Palani et al., 2024a; Palani et al., 2024b).

### **Flock Health Management**

While nutritional and health factors are widely known as important to reproductive management success, their relative importance is not well characterized. Vaccination against important infectious diseases such as brucellosis and clostridial infections in conjunction with more effective parasite management reduces reproductive wastage while at the same time enhances overall fertility and ameliorates metabolic load. Some of them (Torres-Acosta & Hoste, 2008) are related to low body condition scores and increase the time to return to estrus, which indicate the need for deworming and/or pasture management practices. A healthier flock not merely reduces oxidative stress but additionally lends itself well to nutritional strategies aimed at increasing reproduction.

### **Methods of Making Babies (the Nature Way and the AI Way)**

Natural mating is the dominant breeding system in smallholder systems, but artificial insemination (AI) is increasingly common in commercial businesses. FIT is much faster genomic selection, more targeted breeding programs and lower risk of the transmission of venereal diseases via AI. Nonetheless, its efficiency depends mostly on semen characteristics and the correct estrus detection plus timing of AI (Abecia et al., 2012) Although objective reproductive biotechnologies have increased the efficiency of these reproduction barriers, including ovum pick-up (OPU), in vitro embryo production (IVEP), embryo transfer (ET) and surgically collected semen; the use of this technology in small ruminants have very limited by few farms and experimental.

Reproductive management practices are needed in ewes and does to enhance reproductive efficiency through control of seasonality, flushing, maternal nutrition, flock health and aided reproductive technologies. The provision of these management practices along with judicious supplementation of nutrition is the best way forward for improving the sustainability and fertility of small ruminant production systems.

### **Integrating Nutrition and Management Approaches**

Nonetheless, the optimal method to enhance reproductive performance of sheep and goat is the integration of nutrition and management system. Both mechanisms work to guarantee reproduction without relying on each other; together, however, they have "synergistic" effects, generating an increase in family reproductive success that is greater than that achieved when either mechanism acts in isolation.

### **Nutritional and Management Interfaces**

Management commands how efficient reproduction will be so you ride along and ensure it is efficient, and nutrition is so much of a management decision. Summarizing the findings, Zhang and his colleagues noted that dairy energy and protein alter body condition score, and in turn body condition score impacts estrus expression and ovulation rate. They would necessarily be quite blunt knives if these nutritional strategies were not appropriately integrated with other ewe management components, such as flushing or seasonality controls because they act only to enhance fertility when these factors are also integrated (Abecia et al., 2012). Put another way, the energy coupling and the optimal breeding schedules will force females to mate in the optimal condition metabolo-genetico and timer and hence, in order to maximise the probability of conception and accordingly of the survival of their offspring, feb.

### **Case Studies and Successful Applications**

Findings: Multiple investigations beyond the laboratory emphasise the combination approach. In kurdi sheep selenium and zinc supplementation showed positive effects on antioxidant status as well as repro traits when both elements were given along with good management practices (Palani et al., 2024a; Palani et al., 2024b) Along similar lines, flushing increased ovulation and twinning rates in under-fed ewes (Ali et al., 2015), but there the beneficial effects were magnified with concurrent mineral and vitamin supplementation. The increased kidding percentages along with the reduction in neonatal mortalities in goats had been maintained by there appropriate feeding practice coupled with deworming and vaccination (Torres-Acosta & Hoste, 2008). Our results make clear that there are nutritional inputs that can enhance reproductive performance only if accompanied by appropriate health and breeding management.

### **Reproductive, twinning & lactational effects**

Immediate effects of combined interventions on reproductive biomarkers Good nutrition translates into good follicular dynamics, whilst good management practices ensure fertilization and gestation. This consequently enhances twinning and litter size and hence productivity (Diskin & Kenny, 2014). In addition, the composition of colostrum and the output of milk are positively associated with the nutrition and health condition of the mother during pregnancy, generating direct benefits on the growth and survival of the offspring (Wathes et al., 2007). This not only enhances the sustainable production of livestock, but minimises reproductive wastage, and shortens inter-lambing/kidding intervals but also maximises profit from small Ruminant production systems.

Based on the review presented in this paper, the suggested nutritional and management strategies combined supplement a holistic approach for improving reproductive performance of such small ruminants. Together, they provide metabolic, health and environmental signals to inform both fertility and offspring viability, and thereby also provide strategies for the sustainable production of food animals.

The focus of this review is recent advancements in nutritional concepts, reproductive technology and sustainable production practices and their potential application in the areas of integrated reproductive technologies to enhance the reproductive performance of sheep and goats. Producers will thus require reproductivity to improve, but also to combat climate change and scarcity of key resources, with demand for animal food products only expected to grow.

### **Precision Nutrition Trends and Biotechnological Advancements**

This multi-disciplinary field uses sensor-based technologies and real-time monitoring to deliver feeding agents most effectively and at the individual or group level. This way, the acclimatization of nutrients according to the animal's physiological status eliminates shortage, reduces metabolic pressure and benefits reproduction (González et al., 2018). Less than 1% of artificial insemination with sheep or goats results in live offspring (Fanshi, 2008), and a mean of 82 lambs is produced after embryo transfer from a ewe 6 months later. Further, the greater availability of antioxidants including selenium and vitamin E and protection against reproductive oxidative stress by mycelium nanosupplements and encapsulated delivery systems (Selim et al., 2020).

### **Ensuing Challenges: Environmental Change and Resource Scarcity**

Increasing climatic threats are targeting the reproductive efficiency in small ruminants. Heat stress disrupts the hormonal control of reproduction, which results in decreased conception rates and increased embryonic death (Sordillo & Aitken, 2009). Furthermore, the shortage of low-quality feed in semi-arid and arid regions also creates dietary imbalances which directly influence the fertility capacity of livestock. Also reducing feed intake and affecting metabolic function is the fact that water is also usually restricted here. This highlights the need for adaptation in the future, with some smallholder livestock production systems expected to experience climate change driven productivity reductions of up to 25%. Potential Environmental and Economic Improvements to Livestock Production To overcome these challenges, such a package will be necessary. Nutrition and manage in tandem: Good fertility dividends from antioxidants and good reproduction and herd health practices will last (October, 2023) → Sensor technology sensor and even monitoring fertility criteria of individual feeding → The efficiency is also enhanced to its maximum while minimizing the waste.

Local resources means agro industrial waste/ byproducts Who consumes local feed vs. a big importer. Regional differentiation in cheaper production. Smart Agrarian practices: Routine breeding for heat resistance, well curated & management of common housing, Establish supplementation policies with anti-oxidants & probiotics to circumvent climate change related oxidative stress. As a result, conventional livestock husbandry may aspire to net gains in possible yield and (Palani et al., 2024a; Palani et al., 2024b) sustainability (Palani et al., 2024a; Palani et al., 2024b) for ecoat for all human demand.

### **Conclusion**

The use of a combination of these treatments in conjunction with nutrition and management is supported by evidence as the most effective means of improving reproductive performance in sheep and goats. The another line which more commercially orientated, promotes fertility, twinning, milk production and mammalian survival, which is just a few of the characteristics required to build robust flock genetics. While future challenges like climate change mitigation and feed market competition will continue to exist in the short to medium term, they could be overcome with precision nutrition, smart climate practice, and reproduction biotechnology, all of which together with an assured base of animal health and welfare represent avenues to sustainable and economically sustainable poultry production systems.

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