Reproductive Performance in Sheep under Organic and Conventional Farming Systems

Mariana Luca[1], Andrada Elena Moise[1], Raluca-Anamaria Drideanu[1], Georgiana Magdalena Gheciu Pîrlea[1], Ion Răducuță[1]

[1] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59, Marasti, District 1, Bucharest, Romania

Abstract

Reproductive performance in sheep represents a key element in the efficiency of production systems, being influenced by biological, nutritional, and management factors. This paper analyzes the essential aspects of reproductive performance in sheep under organic and conventional farming systems, with emphasis on fertility, fecundity, conception rate, prolificacy, and the seasonality of reproduction. The specific management and production characteristics of the two systems are examined, as well as the influence of nutrition and animal welfare on the main reproductive indicators. In addition, the comparative analysis of the two systems integrates the constraints and challenges specific to sheep farming under organic conditions, together with their practical implications. Finally, the advantages and limitations of both farming systems are highlighted, underlining the key factors that influence reproductive efficiency and the importance of proper management in improving farm performance.

Keywords: animal welfare, housing conditions, nutrition, prolificacy, seasonality

1. Introduction

Sheep farming represents an important sector of animal husbandry, through its contribution to meat, milk and wool production, as well as through its capacity to efficiently utilize pastures and marginal lands that are difficult to exploit in other forms of agricultural production. Particularly in extensive systems, sheep play an important role in supporting the rural economy and in maintaining production models compatible with the principles of sustainability [1]. At the same time, organic agriculture has developed steadily at the European level, and organic animal production has become a major area of interest for both researchers and consumers. The scientific literature indicates a growing scientific interest in this sector, in the context of concerns regarding environmental protection, animal welfare and the limitation of synthetic input use. However, several studies emphasize that the application of organic farming principles does not automatically guarantee superior performance, as results depend largely on the quality of farm management [2-4]. In sheep farms, reproductive performance is an essential component of economic and biological efficiency, as it directly influences flock fertility, the number of lambs obtained, the replacement rate of animals and the profitability of the holding. Reproductive management is closely related to the organization of the mating period, control of seasonality, body condition of ewes, level of nutrition and general husbandry conditions. Recent studies have shown that reproductive management practices differ between farms and may lead to distinct productive outcomes, while supplementary feeding can positively influence body condition score and the dynamics of reproductive performance. At the same time, reproductive seasonality remains a major

*Corresponding author Andrada Elena Moise andrada-elena.moise@usamv.ro , Raluca-Anamaria Drideanu raluca.drideanu@usamv.ro

biological factor in sheep, being controlled mainly by photoperiodism [5-7].

The comparison between organic and conventional systems is necessary, as there are important management differences between them, with a direct impact on reproduction. In organic systems, certain practices frequently used in conventional farms, such as the use of hormones for reproductive control, are limited or prohibited, which requires the adaptation of reproductive strategies. Nevertheless, the literature shows that good reproductive results can be achieved in organic systems through the use of alternatives compatible with the rules of this production system, such as the proper organization of mating sessions or the use of the ram effect [8, 9]. Animal welfare is also a central aspect in the evaluation of production systems, being frequently associated with health status and reproductive performance. However, the relationship between welfare, stress, housing conditions and reproduction is complex and does not depend exclusively on the type of farming system, but also on the specific way in which management measures are implemented at farm level [4, 10]. In this context, the aim of the present paper is to comparatively analyze, based on the scientific literature, reproductive performance in sheep raised under organic and conventional systems, with emphasis on fertility, fecundity, prolificacy, reproductive seasonality, the influence of nutrition, animal welfare and the main constraints specific to each production system [5-8].

2. Materials and methods

The present paper was carried out based on a bibliographic analysis of the scientific literature concerning reproductive performance in sheep raised under organic and conventional systems.

The aim of the analysis was to highlight the main differences between the two production systems in terms of reproductive indices, with emphasis on fertility, fecundity, conception rate, prolificacy, reproductive seasonality, the influence of nutrition and animal welfare, as well as the specific constraints affecting reproduction in organic systems. The documentation process was conducted by consulting the international databases Scopus, Web of Science and Google Scholar, using keywords relevant to the topic studied, such as: organic sheep farming, conventional sheep farming, reproductive performance in sheep, fertility, fecundity, conception rate, prolificacy, seasonality of reproduction, nutrition, animal welfare and organic livestock production. In addition, combinations of these keywords were used to refine the search results and to identify the most relevant publications for the topic. Scientific articles, review papers and experimental studies relevant to the topic were selected, with particular attention given to recent publications, as well as to certain reference works considered essential for understanding the biological mechanisms and the specific features of reproductive management in sheep. The inclusion criteria were based on scientific relevance, publication in peer-reviewed journals, and direct relation to reproductive performance in sheep under organic or conventional systems. Source selection was based on scientific relevance, the timeliness of the information and their contribution to the comparison between organic and conventional systems. The collected information was analyzed using descriptive and comparative methods, in order to synthesize data from the scientific literature and to highlight the main factors influencing reproductive performance in sheep under the two production systems. Furthermore, the analysis aimed to identify consistent patterns, similarities and differences between studies, as well as potential gaps in the existing literature. The analysis enabled the identification of the specific features of each system, as well as their advantages and limitations from the perspective of reproductive management. This methodological approach made it possible to formulate scientifically grounded conclusions regarding reproductive performance in sheep raised under organic and conventional systems, while also providing an appropriate framework for the comparative interpretation of the results reported in the scientific literature.

3. Results and discussion

3.1. Characteristics of organic and conventional sheep farming systems

Sheep farming systems differ in terms of the level of intensification, the type of resources used and the way management is organized. In general, organic systems rely more on the utilization of pastures and local resources, as well as on the

reduction of external inputs, whereas conventional systems are more frequently oriented towards stricter technical control of feeding, reproduction and animal health. In the scientific literature, small ruminant farming is recognized as an important sector, contributing both to the utilization of marginal lands and to supporting the economic and environmental sustainability of farms [1]. In systems close to the principles of organic agriculture, emphasis is placed on integrating animals into the agroecosystem, using local feed resources and adapting farming practices to natural conditions. These systems aim to reduce dependence on external inputs and to achieve better integration of the ecological and social components of animal production [11]. Data from recent literature show that some conventional sheep farms already present characteristics compatible with the organic model, such as feeding based on local resources, access to pasture and reproduction through natural mating. However, the transition towards a functional organic system may be limited by the low productivity of pastures, the lack of zootechnical records and the insufficient level of technical training regarding the specific requirements of this system [12]. By comparison, the conventional system generally allows more rigorous control of reproductive management. In this respect, the evaluation of males before the mating season, including body condition, reproductive tract assessment and semen quality, represents an important element for the reproductive efficiency of the flock. Thus, the differences between the two systems are not related only to production rules, but also to the intensity of management applied at farm level [1, 13].

In this context, official data at European Union level show that sheep raised under organic systems represented 10.4% of the total sheep population in 2022, confirming the importance of this sector within organic animal production (Figure 1) [14].

These results emphasize that organic sheep farming, although less widespread than conventional systems, plays an increasingly important role in sustainable livestock production and reflects the ongoing transition towards more environmentally friendly agricultural practices.

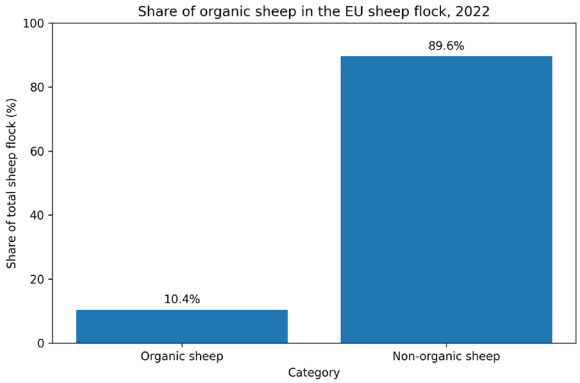

Figure 1. Share of organic sheep in the total sheep flock in the European Union, 2022.

3.2. Fertility, fecundity and conception rate

Fertility, fecundity and conception rate are essential indicators of reproductive performance in sheep, as they directly influence the proportion of females that become pregnant, the efficiency of breeding flock utilization and, consequently, the profitability of the holding. These parameters are determined by the interaction of biological, nutritional, seasonal and management-related factors. Their importance is particularly high in organic systems, where hormonal interventions are limited and reproductive success depends to a greater extent on the organization of mating, estrus detection and the body condition of the animals [15, 16]. A synthesis of the main factors associated with fertility, fecundity and conception rate in sheep, based on the analyzed scientific literature, is presented in Table 1.

The data summarized in Table 1 show that fertility, fecundity and conception rate in sheep are mainly influenced by body condition score, mating weight, level of nutrition, number of lambings and reproductive management. Among these factors, body condition and nutritional status consistently appear as essential elements for achieving favorable reproductive outcomes. Nulliparous females and animals outside the normal breeding season also tend to show weaker reproductive responses. In organic systems, where hormone use is restricted, maintaining adequate body condition and ensuring rigorous organization of mating and estrus detection become decisive factors for obtaining acceptable fertility. The physical condition of females, expressed through body weight and body condition score, has a major influence on fertility and conception ability. An adequate energy status supports reproductive function, whereas insufficient body reserves may

reduce the chances of pregnancy and overall reproductive efficiency. Animals with higher body weight at mating and a better body condition score also tend to show superior reproductive results, highlighting the importance of nutritional preparation before the breeding season [17, 18].

Table 1. Main factors associated with fertility, fecundity and conception rate in sheep, as reported in the literature

Factors evaluated	Main findings	Source
Natural estrus, body condition, lactation status	Acceptable fertility was obtained under natural estrus; better results were associated with lactating ewes and better body condition.	[16]
Body reserves dynamics	Reproductive performance was closely associated with body reserve status.	[17]
Parity, non-breeding season	Nulliparous ewes showed poorer reproductive response and lower fertility than multiparous ewes.	[20]
Liveweight, body condition score	Higher liveweight and better body condition at breeding improved reproductive performance.	[18]
Nutritional flushing	Nutritional supplementation improved body condition and reproductive parameters.	[19]
Mating conditions, management practices	Pregnancy outcomes were influenced by body condition, liveweight and ram percentage.	[21]
Endogenous and exogenous factors	Fertility and conception depend on multiple biological and management-related factors.	[15]

Nutrition plays a direct role in supporting fertility, fecundity and conception rate. Energy and protein supplementation during the period preceding mating may contribute to improving body condition and optimizing reproductive parameters. This aspect is particularly important in the organic system, where forage availability and quality depend largely on season and local resources, and where feeding management must be adapted to support reproduction under the best possible conditions [19]. In addition to nutrition, the physiological category of females and the breeding season significantly influence reproductive outcomes. Outside the breeding season, the response to estrus induction and synchronization may differ between nulliparous and multiparous females, while fertility is generally lower in animals that are less reproductively mature. These differences show that conception rate and reproductive success depend not only on the protocol used, but also on age, number of lambings and the timing of its application [20]. Mating conditions and the organization of the reproductive season may significantly influence the performance achieved on the farm. Mating weight, body condition score and the proportion of rams used within the flock are factors that may modify pregnancy rate and the results of pregnancy diagnosis by ultrasonography. These observations emphasize that reproductive performance is closely related to the quality of management and to the adaptation of technical decisions to the type of animals and to the production system [21]. In organic systems, where hormone use is restricted, strategies based on natural estrus may represent an effective alternative for maintaining satisfactory reproductive results. Artificial insemination at natural estrus may lead to acceptable fertility when supported by good body condition, accurate estrus detection and careful organization of reproduction. Under these conditions, reproductive success depends more on management precision than on pharmacological interventions [16]. Overall, fertility, fecundity and conception rate in sheep are mainly influenced by body condition, level of nutrition, season, number of lambings and mating management. The differences between organic and conventional systems are not determined exclusively by the type of production system, but especially by the degree of control over these factors. In conventional systems, reproduction can be coordinated more easily through technical interventions, whereas in organic systems results depend to a greater extent on adapting management to the biological particularities of the animals [15-17, 21].

3.3. Prolificacy in sheep

Prolificacy is an important indicator of reproductive performance in sheep, expressed as the number of lambs obtained per lambing. This parameter has direct implications for the biological and economic efficiency of the holding, as it influences the total number of offspring obtained during a breeding season and contributes to the profitability of the production system. The value of prolificacy is determined by the interaction of genetic, physiological, nutritional and management-related factors, which explains its variability among breeds, populations and production systems [6, 22]. The variability of prolificacy among breeds, populations and production systems can be explained by the action of several factors, summarized in Table 2.

Table 2. Main factors associated with prolificacy in sheep, as highlighted in the scientific literature

Factor / evaluated aspect	Main findings	Source
Prolific population vs. conventional population	Litter size differs between prolific and conventional populations, being also influenced by parity.	[22]
Genetic parameters of prolificacy	Prolificacy can be improved through targeted genetic selection.	[23]
Candidate loci and regions associated with prolificacy	Loci involved in the expression of prolificacy in sheep have been identified.	[24]
FecB gene	The FecB gene was associated with variation in litter size and with Mendelian inheritance in the analyzed population.	[25]
Nutrition and body condition	Forage supplementation and adequate body condition support the improvement of prolificacy.	[6]
Organic system and natural estrus	Acceptable prolificacy values can be obtained under conditions of appropriate reproductive management.	[16]
Agroecological / low-input systems	Adaptation of breeds to local conditions and efficient use of resources support the expression of reproductive performance.	[11]

The data summarized in Table 2 highlight that prolificacy in sheep is mainly influenced by the genetic background of the population, as well as by body condition, level of nutrition and reproductive management. The differences between prolific and conventional populations confirm the importance of genetic selection in determining the number of lambs obtained per lambing. At the same time, the expression of this genetic potential depends on housing and management conditions and on the preparation of females for reproduction. In organic systems, achieving satisfactory prolificacy values is possible, but it requires careful management of feeding and reproduction. Regarding the number of lambs obtained per lambing, the differences between populations selected for prolificacy and conventional populations are evident. In the prolific population, the mean prolificacy value was 1.56 lambs/lambing, whereas in the conventional population the mean value was 1.07 lambs/lambing [22]. The number of lambs/lambing also varied according to parity, being lower at the first lambing and increasing in subsequent lambings. In the prolific population, the mean increased from 1.43 lambs/lambing at the first lambing to 1.72 lambs/lambing at the fourth lambing, after which it remained at similar values. In the conventional population, the values were lower and relatively constant, ranging between 1.03 and 1.08 lambs/lambing. These results highlight that selection for prolificacy may contribute to increasing the number of offspring obtained per lambing, while lambing order influences the expression of this trait [22]. These differences confirm that prolificacy is a complex trait, influenced by the genetic structure of the population, parity and the selection applied within the flock. In addition, the estimation of genetic parameters for prolificacy supports the possibility of improving this trait through well-oriented selection programs [22, 23]. The role of the genetic factor in determining prolificacy is also supported by the identification of loci and major

genes associated with prolificacy size in sheep. Genomic studies have highlighted the existence of genomic regions involved in prolificacy, while the analysis of Iranian sheep populations showed clear differences between local breeds and highly prolific exotic breeds. In the same direction, the FecB gene was associated with variation in prolificacy size and was shown to follow Mendelian inheritance rules in the analyzed populations, confirming the importance of the genetic basis in the expression of this trait. These results show that differences in prolificacy between flocks cannot be explained only by the production system, but also by the genetic potential of the breeds used [24, 25]. In addition to the genetic component, prolificacy is also influenced by the physical condition of females and by the level of nutrition during the period preceding reproduction. Appropriate body condition and adequate feeding favor the normal functioning of reproductive activity and may support the achievement of a higher number of lambs at lambing. In this respect, forage supplementation before mating has been associated with improved dynamics of reproductive performance, including prolificacy, highlighting the importance of nutritional management in the expression of the reproductive potential of ewes [6]. In organic systems, prolificacy must be analyzed in relation to the specific management features of this type of production. Restrictions on hormone use and the orientation towards reproductive methods closer to the biological rhythm of the animals may limit intensive reproductive control, but they do not exclude the achievement of satisfactory results. Artificial insemination at natural estrus, applied in organic systems, has shown that acceptable prolificacy values can be achieved when animals benefit from good body condition and appropriate reproductive management. At the same time, agroecological and low-input systems emphasize the adaptation of breeds to local conditions, the efficient use of available resources and the maintenance of a balance between production level and system sustainability [11, 16]. The comparison between organic and conventional systems shows that differences in prolificacy do not depend exclusively on the type of production system, but also on how selection, feeding, reproduction and flock health are managed. Conventional systems may allow stricter control of the factors influencing reproduction, but their advantages do not automatically translate into superior prolificacy in all situations. By contrast, in organic systems, obtaining good results depends more on adapting management to available resources, choosing suitable breeds and maintaining optimal body condition in females. Therefore, prolificacy should be interpreted as the result of the interaction between genetic potential and the specific farming conditions [6, 16, 22, 24].

3.4. Reproductive seasonality

Reproductive seasonality is an important aspect of reproductive performance in sheep, as it influences the timing of estrus onset, ovarian activity, conception rate and lambing planning. Sheep are generally considered seasonally polyestrous animals, meaning that they display several estrous cycles during a certain period of the year, followed by a period of reduced or absent reproductive activity. The main environmental factor involved in the regulation of seasonality is photoperiodism, namely the duration of light and darkness throughout the day. Short days favor the secretion of melatonin, a hormone involved in the activation of the hypothalamic-pituitary-gonadal axis and in the resumption of reproductive activity [26, 27]. The estrous cycle in sheep has an average duration of approximately 17 days, although this value may vary depending on breed, age, physiological status, nutrition and season. During the breeding season, ovarian activity is supported by the secretion of GnRH and LH hormones, which are involved in follicular development, ovulation and the expression of estrous behavior. During the period of seasonal anestrus, the secretion of these hormones is reduced, leading to decreased ovarian activity and absence of estrus. Thus, the differences between the breeding season and the anestrus period are closely related to hormonal changes induced by photoperiodism [26]. Melatonin plays a central role in transmitting information regarding day length to the reproductive endocrine system. The secretion of this hormone increases during the night, and seasonal changes in night length influence the resumption or reduction of reproductive activity. In this context, the MTNR1A gene, which encodes the melatonin receptor, is of particular interest, as certain polymorphisms of this gene have been associated with the resumption of reproductive

activity at different times of the year. This shows that reproductive seasonality is determined not only by environmental factors, but also by the genetic background of the animals [27, 28]. Control of the breeding season is important in sheep farms, as it allows the organization of mating, the planning of lambings and the production of lambs during economically advantageous periods. In conventional systems, this control can be achieved through hormonal or technological methods, such as estrus synchronization, stimulation of ovulation, melatonin administration and the use of reproductive protocols during the anestrus period. Through these methods, farmers can reduce the effect of seasonality and achieve better uniformity of lambing groups [29, 30]. An important method for stimulating reproductive activity is represented by the ram effect, which consists of introducing males into groups of females after a period of separation. The presence of rams can stimulate the resumption of sexual activity in ewes, especially during transition periods between anestrus and the breeding season. The efficiency of this method can be improved when rams are sexually stimulated through melatonin treatments or photoperiodic management. This strategy is of practical interest because it may reduce the need for hormonal treatments administered directly to females [30, 31]. In organic systems, control of the breeding season is more limited compared with conventional systems, because the use of hormonal treatments is restricted. For this reason, reproduction relies more on the natural biological rhythm of the animals, the choice of breeds adapted to local conditions, the ram effect and the maintenance of appropriate body condition before mating. In these systems, breeding season management must be adapted to the biological particularities of the species and to the resources available on the farm [27, 28, 31]. By comparison, the conventional system offers more possibilities for controlling the reproductive season through the use of synchronization protocols and hormonal treatments. These methods may contribute to increasing reproductive efficiency, but they involve a higher degree of intervention in reproductive function. In contrast, the organic system emphasizes more natural methods of stimulating reproduction, adaptation of animals to the environment and respect for physiological rhythms. Therefore, reproductive seasonality represents an essential element in planning reproduction in sheep, and its proper management can influence fertility, conception rate and the number of lambs obtained in a production season [26, 29, 30].

3.5. Influence of nutrition on reproductive performance

Nutrition plays an essential role in the expression of reproductive performance in sheep, as it influences body condition, ovarian activity, fertility, maintenance of pregnancy and lamb survival. An adequate intake of energy, protein, minerals and fatty acids contributes to the normal functioning of the hypothalamic-pituitary-gonadal axis, which controls the hormonal secretion involved in reproduction. Under conditions of undernutrition or dietary imbalance, ovarian activity may be reduced, while estrus expression, ovulation and conception rate may be negatively affected [32]. A central element in assessing the relationship between feeding and reproduction is body condition score.

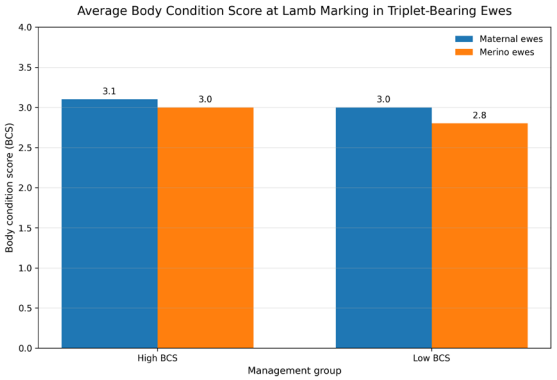

Figure 2. Average Body Condition Score at Lamb Marking in Triplet-Bearing Ewes

This reflects the animal's energy reserves and can be used as a practical indicator for evaluating the preparation of females before mating and during pregnancy. Ewes with appropriate body condition have a greater chance of resuming reproductive activity, maintaining pregnancy and achieving better reproductive results. By contrast, too low a body condition may indicate insufficient reserves to support reproductive function, while excessive body condition may negatively affect metabolism and reproductive efficiency [32, 33]. In this context, the influence of nutritional management on body condition score is highlighted in the graph below, where differences can be observed

between ewes maintained at a high BCS (Body Condition Score) and those maintained at a low BCS, according to genetic type [34]. The graph in figure 2 highlights that maintaining a higher body condition score during pregnancy is reflected in better body condition at the time of lamb marking. This difference is more evident in Merino ewes, suggesting that these animals may be more sensitive to variations in nutritional management. These findings underline the importance of adequate nutritional management during gestation, as body condition score directly influences reproductive outcomes and lamb survival. Therefore, monitoring and maintaining an optimal BCS represents an important measure for supporting reproductive performance and reducing the risks associated with multiple pregnancies. The nutritional level during the reproductive period influences feed intake, body weight, body condition score and reproductive performance. In sheep fed low-quality forage, improving the nutritional level before and during mating may contribute to increasing energy availability and supporting reproductive activity. Thus, feeding during the period preceding mating should not be regarded only as a maintenance measure, but also as a reproductive management strategy, because it influences the ability of females to express estrus, ovulate and support the establishment of pregnancy [35]. Concentrate supplementation before mating and during the first part of pregnancy is a frequently used method for improving body condition and supporting production. The level and composition of concentrates may influence ewe performance through the additional supply of energy and protein, especially when basal forages do not meet the required nutritional needs. This strategy is important during the critical periods of the reproductive cycle, as a well-balanced diet may contribute to supporting fertility and early embryonic development [36].

In addition to energy and protein supplementation, strategic supplementation with certain lipid sources may have effects on fertility. The use of by-pass linseed oil in the diet of Sarda ewes has been analyzed in relation to fertility and milk quality, highlighting the interest in including fatty acid sources in the feeding of females during demanding physiological periods. Fatty acids may influence energy metabolism, ovarian function and the hormonal environment, which is why lipid supplementation must be carefully adapted to the animals' requirements and to the objectives of the farm [37].

Nutrition influences reproductive performance not only until pregnancy is established, but also throughout gestation. Management of body condition score between pregnancy diagnosis and lamb marking has an impact on the survival of ewes carrying multiple pregnancies and their lambs. This aspect is important because reproductive success is not limited to achieving pregnancy, but also includes the female's ability to support fetal development, lambing and offspring survival. Therefore, maintaining adequate body condition during pregnancy is essential for reducing losses and increasing the reproductive efficiency of the flock [34].

The differences between organic and conventional systems are mainly related to the way feed resources are provided and to the flexibility of nutritional interventions. In conventional systems, supplementation can be carried out in a more controlled manner through the use of concentrates, formulated rations and nutritional strategies adapted to production objectives. This allows faster correction of energy or protein deficits and more precise maintenance of body condition score before mating and during pregnancy. By contrast, in organic systems, feeding relies more on pasture, farm-produced forages and resources compliant with organic farming rules, which makes reproductive performance more dependent on pasture quality, forage seasonality and supplementation planning [2-4, 36].

In organic systems, achieving good reproductive performance requires careful feed management, especially during critical periods such as before mating, early pregnancy and late pregnancy. Although intervention possibilities may be more limited than in conventional systems, maintaining optimal body condition and strategically using feed resources can support fertility, ovarian activity and lamb survival. Thus, the differences between organic and conventional systems do not refer only to the type of feed used, but also to the way feeding is planned and adapted to the physiological needs of the animals [32, 35, 36]. Therefore, nutrition represents a major factor in determining reproductive performance in sheep. A balanced ration, maintenance of body condition score and application of supplementation during critical periods may contribute to improving

fertility, ovarian activity, pregnancy maintenance and lamb survival. Conventional systems offer more precise nutritional control, whereas organic systems require more careful planning of available resources and better adaptation to seasonal variations in forage availability [33, 34, 37].

3.6. Animal welfare and its impact on reproduction

Animal welfare represents an important factor in reproductive performance in sheep, as the physiological and behavioral status of females may influence estrus expression, conception rate, pregnancy maintenance and lamb survival. Reproduction is a process sensitive to stress factors, and changes related to the environment, temperature, housing or management may affect hormonal balance and the organism's ability to support reproductive function. In this context, welfare should not be regarded only as the absence of disease, but as a general state in which the animal can adapt to its environment and express normal behaviors [38, 39]. Stress is one of the main factors that can reduce reproductive efficiency in sheep. It may be caused by extreme temperatures, excessive handling, transport, inadequate housing, lack of feed or water and high stocking density. Prolonged activation of stress mechanisms may negatively influence the hypothalamic-pituitary-gonadal axis, which can lead to disturbances of the estrous cycle, reduced fertility, decreased conception rate and increased embryonic or fetal losses [40].

An important type of stress with an impact on reproduction is heat stress. High temperatures may affect feeding behavior, water intake, metabolism and reproductive activity. Under heat stress conditions, the organism directs an important part of its resources towards maintaining body temperature, which may reduce the energy available for reproductive function. Thus, heat stress may negatively influence ovarian activity, estrus expression, fertility and pregnancy development [41, 42]. Housing conditions and farm management play an essential role in supporting welfare and reproductive performance. Shelters must provide sufficient space, adequate ventilation, appropriate temperature, clean bedding and constant access to feed and water. Inadequate conditions may favor the occurrence of stress, disease and physiological imbalances, thereby reducing the chances of achieving good reproductive results. In dairy sheep farms, housing conditions have been associated with the success of artificial insemination, highlighting the link between the housing environment and reproductive indices [43].

Welfare assessment in sheep can be carried out using animal-based indicators, such as body condition, presence of lesions, lameness, fleece condition, behavior, response to humans and signs of disease. These indicators are useful because they reflect how the animal perceives and tolerates environmental and management conditions. Monitoring these aspects allows early identification of problems that may affect flock health and reproduction. Thus, welfare assessment can become a practical tool for preventing decreases in reproductive performance [38].

The impact of welfare on reproductive indices can be observed through its effects on fertility, conception rate, pregnancy maintenance and lamb viability. Ewes kept under good management conditions, with a low level of stress and with the possibility to express normal behaviors, have a better capacity to adapt and support reproductive function. By contrast, chronic stress and poor management conditions may affect endocrine balance and reduce the efficiency of reproductive programs. Therefore, animal welfare has both ethical and productive and economic importance [39, 40].

The differences between organic and conventional systems can be discussed mainly in terms of stress level and management conditions. Regardless of the production system, ewe welfare depends on housing quality, access to feed and water, stocking density, handling practices and the farm's ability to reduce stress factors. Inadequate housing conditions may affect reproductive success, including the results of artificial insemination, while heat stress may negatively influence reproductive activity and the physiological status of ewes. Therefore, the advantage of a system is not determined only by its organic or conventional character, but by the specific quality of management applied on the farm [40-43].

Therefore, animal welfare plays an essential role in maintaining reproductive performance in sheep. Stress, housing conditions, temperature, management and the possibility of expressing normal behaviors may directly or indirectly influence reproductive indices. Reducing stress factors and ensuring appropriate husbandry

conditions represent important measures for improving fertility, conception rate and the reproductive efficiency of the flock [38, 40, 43].

3.7. Constraints and challenges in the reproduction of sheep raised under organic systems

Sheep reproduction in organic systems is influenced by compliance with the principles of organic farming, which limit the use of certain artificial interventions frequently applied in conventional systems. One of the main constraints is the restricted use of hormonal treatments for estrus synchronization and ovulation induction. This reduces the possibility of very precise planning of mating and lambing, which is why reproductive management must be adapted more closely to the natural biological rhythm of the animals and to reproductive seasonality [16, 44].

In the absence of intensive hormonal control, methods based on natural estrus, observation of female behavior and use of the ram effect become important alternatives. Introducing males after a period of separation may stimulate the onset of estrus and contribute to the grouping of lambings; however, the efficiency of this method depends on season, body condition of the ewes, male activity and flock organization. Thus, the organic system requires closer monitoring of the flock and a good understanding of reproductive behavior [16, 45].

Other challenges are related to the seasonal availability of forage, maintenance of adequate body condition and prevention of health problems through appropriate management. Since organic systems rely more on natural resources and on reducing medicinal interventions, reproductive performance depends largely on management quality, adaptation of breeds to local conditions and the farm's ability to prevent nutritional or health imbalances. Therefore, although the organic system may allow less reproductive control than the conventional system, satisfactory results can be achieved when reproduction is planned in accordance with the animals' natural rhythm [16, 44, 45].

4. Conclusions

Reproductive performance in sheep is the result of the interaction between genetic potential, nutritional status, reproductive seasonality, husbandry conditions, animal welfare and the quality of management applied on the farm. The comparison between organic and conventional systems highlights that neither of the two systems automatically guarantees superior reproductive results, as performance is mainly determined by the way in which the biological and technological factors involved in reproduction are controlled.

The conventional system offers a higher level of control over reproduction, through the possibility of more flexible use of hormonal protocols, estrus synchronization, nutritional supplementation and more precise planning of mating and lambing. These advantages may contribute to improving fertility, conception rate and production organization, but they involve a higher degree of intervention in animals and greater dependence on external inputs.

In the organic system, reproduction relies to a greater extent on the natural biological rhythm of ewes, natural estrus, the ram effect, the use of adapted breeds and the maintenance of good body condition. Although restrictions on hormone use may limit control of the reproductive season and lambing planning, reproductive results can be satisfactory when management is well adapted to local conditions. In this system, nutrition, welfare, health prevention and close monitoring of the flock become decisive factors.

In conclusion, the differences between organic and conventional systems should not be interpreted only in terms of production rules, but especially in terms of the quality of management applied. Fertility, prolificacy, conception rate and lamb survival can be improved in both systems by ensuring adequate feeding, reducing stress, maintaining an optimal body condition score and properly organizing the breeding season. Thus, reproductive efficiency in sheep depends on the farmer's ability to adapt management strategies to the biological particularities of the animals and to the resources available on the farm.

References

1. Silva, S. R., Sacarrão-Birrento, L., Almeida, M., Ribeiro, D. M., Guedes, C. M., González Montaña, J. R., Pereira, A. F., Zaralis, K., Geraldo, A., Tzamaloukas, O., Cabrera, M. C., Castro, N., Argüello, A., Hernández-Castellano, L. E., Almeida, A. M., Extensive Sheep and Goat Production: The Role of Novel Technologies towards Sustainability and Animal Welfare, Animals, 2022, 12(7), 885

2. Manuelian, C. L., Penasa, M., da Costa, L., Burbi, S., Righi, F., De Marchi, M., Organic Livestock Production: A Bibliometric Review, Animals, 2020, 10(4), 618
3. Sundrum, A., Organic Livestock Farming: A Critical Review, Livestock Production Science, 2001, 67(3), 207-215
4. von Borell, E., Sørensen, J. T., Organic Livestock Production in Europe: Aims, Rules and Trends with Special Emphasis on Animal Health and Welfare, Livestock Production Science, 2004, 90(1), 3-9
5. Lianou, D. T., Vasileiou, N. G. C., Michael, C. K., Valasi, I., Mavrogianni, V. S., Caroprese, M., Fthenakis, G. C., Patterns of Reproductive Management in Sheep and Goat Farms in Greece, Animals, 2022, 12(24), 3455
6. Nechifor, I., Florea, M. A., Radu-Rusu, R.-M., Pascal, C., Influence of Supplemental Feeding on Body Condition Score and Reproductive Performance Dynamics in Botosani Karakul Sheep, Agriculture, 2022, 12(12), 2006
7. Rosa, H. J. D., Bryant, M. J., Seasonality of Reproduction in Sheep, Small Ruminant Research, 2003, 48(3), 155-171
8. Pellicer-Rubio, M. T., Laignel, G., Thomas, Y., Prache, S., Benoit, M., Tournadre, H., Reproductive Performance in Two Organic Sheep Farming Systems Differing by the Number of Mating Sessions in and out of the Breeding Season, Theriogenology, 2023, 195, 238-248
9. Mayorga, I., Rekik, M., Mara, L., Gallus, M., Ulutaş, Z., Dattena, M., Organic Breeding in Sarda Ewes: Utilization of the Ram Effect in an Artificial Insemination Program, Small Ruminant Research, 2019, 174, 131-134
10. Hansen, I., Behavioural Indicators of Sheep and Goat Welfare in Organic and Conventional Norwegian Farms: A Review, Acta Agriculturae Scandinavica, Section A -Animal Science, 2015, 65(1), 55-61
11. Anim-Jnr, A. S., Sasu, P., Bosch, C., Mabiki, F. P., Frimpong, Y. O., Emmambux, M. N., Greathead, H. M. R., Sustainable Small Ruminant Production in Low- and Middle-Income African Countries: Harnessing the Potential of Agroecology, Sustainability, 2023, 15(21), 15326
12. Hanoglu Oral, H., Yildiz, F., Structural Characteristics of Small Ruminant Production in Mus, Turkiye: A Model for Organic Livestock on the Basis of Sustainability, Sustainability, 2025, 17(7), 3019
13. Maquivar, M. G., Smith, S. M., Busboom, J. R., Reproductive Management of Rams and Ram Lambs during the Pre-Breeding Season in US Sheep Farms, Animals, 2021, 11(9), 2503
14. Eurostat, Developments in organic farming, European Commission,
15. El Amiri, B., Rahim, A., Exploring Endogenous and Exogenous Factors for Successful Artificial Insemination in Sheep: A Global Overview, Veterinary Sciences, 2024, 11(2), 86
16. Palacios, C., Abecia, J. A., Plaza, J., Hidalgo, C., de la Fuente, L. F., Efficiency of Artificial Insemination at Natural Estrus in Organic Churra Ewes, Veterinary Sciences, 2022, 9(7), 370
17. Yagoubi, Y., Smeti, S., Mahouachi, M., Nasraoui, M., Ben Said, S., Mohamed-Brahmi, A., Atti, N., Impact of Body Reserves Dynamic on Productivity and Reproductive Performance in Fat-Tail and Thin-Tail Sheep Breeds over Contrasting Production Cycles, Animals, 2024, 14(6), 891
18. Thompson, A. N., Ferguson, M. B., Kearney, G. A., Kennedy, A. J., Kubeil, L. J., Macleay, C. A., Rosales-Nieto, C. A., Paganoni, B. L., Trompf, J. P., Additive Impacts of Liveweight and Body Condition Score at Breeding on the Reproductive Performance of Merino and Non-Merino Ewe Lambs, Animals, 2024, 14(6), 867
19. Tesfaye, A., Asmare, B., Abiso, T., Wamatu, J., Effect of Nutritional Flushing Using Long-Term Energy and Protein Supplementation on Growth Performance and Reproductive Parameters of Doyogena Ewes in Ethiopia, Veterinary Sciences, 2023, 10(6), 368
20. Santos-Jimenez, Z., Martinez-Ros, P., Encinas, T., Morales-Cruz, J. L., Guerrero-Gallegos, H. Z., Gonzalez-Avalos, R., Gonzalez-Bulnes, A., Guillen-Munoz, J. M., Ovarian Response and Fertility after Short-Term Progestagen/eCG Treatments Are Compromised in Nulliparous Sheep during Non-Breeding Season, Veterinary Sciences, 2022, 9(12), 663
21. Bates, A. L., McGrice, H. A., Fisher, A. D., Hinch, G. N., Kearney, G. A., Lee, C., Refshauge, G., Thompson, A. N., Mating Conditions and Management Practices Influence Pregnancy Scanning Outcomes Differently between Ewe Breeds, Animals, 2022, 12(21), 2908
22. Ziadi, C., Serradilla, J. M., Bedhiaf-Romdhani, S., Molina, A., Genetic Analysis of Litter Size Across Parities in Prolific and Conventional Populations of Tunisian Barbarine Sheep Using a Random Regression Model, Animals, 2025, 15(5), 638
23. Ziadi, C., Bedhiaf-Romdhani, S., Molina, A., Estimation of Genetic Parameters for Litter Size and Growth Traits in a Prolific Line of Tunisian Barbarine Sheep, Ruminants, 2024, 4(2), 256-266
24. Mohammadi, H., Farahani, A. H. K., Moradi, M. H., Moradi-Shahrbabak, H., Gholizadeh, M., Najafi, A., Tolone, M., D'Alessandro, E., Genome-Wide Scan for Selective Sweeps Reveals Novel Loci Associated with Prolificacy in Iranian Sheep Breeds Compared with Highly Prolific Exotic Breeds, Animals, 2024, 14(22), 3245
25. Su, P., Gu, Y., Wang, S., Cao, X., Lv, X., Getachew, T., Li, Y., Song, Z., Yuan, Z., Sun, W.,

FecB Was Associated with Litter Size and Follows Mendel's Laws of Inheritance When It Transited to Next Generation in Suhu Meat Sheep Breeding Population, Genes, 2024, 15(3), 260
26. Kopycińska, K., Wojtulewicz, K., Herman, A. P., Tomaszewska-Zaremba, D., The Effect of Photoperiodic Conditions on GnRH/LH Secretion in Ewes, Animals, 2022, 12(3), 283
27. Mura, M. C., Daga, C., Bodano, S., Luridiana, S., Pazzola, M., Dettori, M. L., Vacca, G. M., Carcangiu, V., Reproductive Resumption in Winter and Spring Related to MTNR1A Gene Polymorphisms in Sarda Sheep, Animals, 2022, 12(21), 2947
28. Arjoune, A., Alsaleh, A. B., Messaoudi, S. A., Chelbi, H., Jelassi, R., Assidi, M., Najar, T., Haddad, B., Sirard, M.-A., Analysis of MTNR1A Genetic Polymorphisms and Their Association with the Reproductive Performance Parameters in Two Mediterranean Sheep Breeds, Animals, 2023, 13(3), 448
29. Takci, A., Dinc, D. A., Stimulation of Estrus and Ovulation by Resynchronization in Kangal Sheep during Early Anestrus, Veterinary Sciences, 2023, 10(8), 499
30. Cosso, G., Luridiana, S., Pulinas, L., Curone, G., Pich, G., Carcangiu, V., Mura, M. C., Melatonin Treatment in Rams and Their Replacement with Novel Treated Rams Advance First Lambing and Increase Fertility in Sarda Ewe Lambs, Animals, 2021, 11(5), 1227
31. Abecia, J. A., Chemineau, P., Gómez, A., Palacios, C., Keller, M., Delgadillo, J. A., Exposure to Photoperiod-Melatonin-Induced, Sexually-Activated Rams after Weaning Advances the Resumption of Sexual Activity in Post-Partum Mediterranean Ewes Lambing in January, Veterinary Sciences, 2017, 4(1), 4
32. Chaves, A. S., Silva, F., Valentim, R., Quintas, H., Body Condition in Small Ruminants-Effects of Nutrition on the Hypothalamic-Pituitary-Gonad Axis and Ovarian Activity That Controls Reproduction, Physiologia, 2024, 4(2), 213-225
33. Luridiana, S., Ouadday, M., Cosso, G., Carcangiu, V., Mura, M. C., Influence of Body Condition Score on Reproductive Recovery in Spring and on Some Hematochemical Parameters in Sarda Breed Sheep, Animals, 2025, 15(3), 372
34. Haslin, E., Allington, T., Blumer, S. E., Boshoff, J., Clarke, B. E., Hancock, S. N., Kearney, G. A., Kenyon, P. R., Krog, J., Kubeil, L. J., Lockwood, A., Refshauge, G., Trompf, J. P., Thompson, A. N., Management of Body Condition Score between Pregnancy Scanning and Lamb Marking Impacts the Survival of Triplet-Bearing Ewes and Their Lambs, Animals, 2023, 13(13), 2057
35. Lourencon, R. V., Patra, A. K., Puchala, R., Dawson, L. J., dos Santos Ribeiro, L. P., Encinas, F., Goetsch, A. L., Effects of Nutritional Plane at Breeding on Feed Intake, Body Weight, Condition Score, Mass Indexes, and Chemical Composition, and Reproductive Performance of Hair Sheep, Animals, 2023, 13(4), 735
36. Belkasmi, F., Patra, A. K., Lourencon, R. V., Puchala, R., Dawson, L. J., dos Santos Ribeiro, L. P., Encinas, F., Goetsch, A. L., Effects of the Level and Composition of Concentrate Supplements before Breeding and in Early Gestation on Production of Different Hair Sheep Breeds, Animals, 2023, 13(5), 814
37. Contreras-Solís, I., Porcu, C., Sotgiu, F. D., Chessa, F., Pasciu, V., Dattena, M., Caredda, M., Abecia, J. A., Molle, G., Berlinguer, F., Effect of Strategic Supplementation of Dietary By-Pass Linseed Oil on Fertility and Milk Quality in Sarda Ewes, Animals, 2023, 13(2), 280
38. Zufferey, R., Minnig, A., Thomann, B., Zwygart, S., Keil, N., Schüpbach, G., Miserez, R., Zanolari, P., Stucki, D., Animal-Based Indicators for On-Farm Welfare Assessment in Sheep, Animals, 2021, 11(10), 2973
39. Muhammad, M., Stokes, J. E., Manning, L., Positive Aspects of Welfare in Sheep: Current Debates and Future Opportunities, Animals, 2022, 12(23), 3265
40. Tüfekci, H., Sejian, V., Stress Factors and Their Effects on Productivity in Sheep, Animals, 2023, 13(17), 2769
41. García-Casillas, A. C., Prado-Rebolledo, O. F., Carrillo-Díaz, M. I., Zepeda-Batista, J. L., Barajas-Saucedo, C. E., Hernández-Rivera, J. A., Reproductive Activity of Socorro Island Merino Ewes and Their Crosses with Pelibuey under Heat Stress Conditions, Animals, 2024, 14(10), 1405
42. Valencia-Franco, E., García y González, E. C., Guevara-Arroyo, A. M., Torres-Agatón, F., Robles-Robles, J. M., Rodríguez-Castillo, J. d. C., Paredes-Alvarado, M., Alaniz-Gutiérrez, L., Ruiz-Ortega, M., Ponce-Covarrubias, J. L., Effect of Heat Stress on Lactating and Non-Lactating Blackbelly Ewes under Tropical Conditions during Summer, Animals, 2024, 14(13), 2003
43. Priskas, S., Valergakis, G., Tsakmakidis, I., Vouraki, S., Papanikolopoulou, V., Theodoridis, A., Arsenos, G., The Role of Housing Conditions on the Success of Artificial Insemination in Intensively Reared Dairy Ewes in Greece, Animals, 2022, 12(19), 2693
44. Zoiopoulos, P., Hadjigeorgiou, I., Critical Overview on Organic Legislation for Animal Production: Towards Conventionalization of the System?, Sustainability, 2013, 5(7), 3077-3094
45. Nassif, C., Mara, L., Chessa, F., Gallus, M., Melis, F., Cossu, I., Ledda, A., Cannas, A., Dattena, M., Natural Reproductive Management in Sarda Sheep: Use of Cryptorchids to Induce a Ram-Effect in Ewes Destined for Artificial Insemination, Animals, 2025, 15(23), 3444