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Sustainability of Small Ruminant Production in Mediterranean Region

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Abstract: The Mediterranean region is characterized by hot and humid summers and, humid and cool winters. Small ruminants (sheep and goats) play a significant economic, social and environmental role providing income and ensuring food for local population. Despite their critical importance, small ruminant's production is threatened by several factor notably climatic, nutritional, healthy and breeding systems. To ensure a sustainability of goat and sheep production, these last decades, several studies have been achieved in order to improve livestock feeding and breeding systems and animal health protection. However, sheep and goat sectors show an important delay. In order to increase the profitability and ensure sustainability of small ruminant production, innovative political, specific managerial strategies and practices have to develop.

Key words: Small ruminant, Mediterranean region, sustainability, strategies.

1. Introduction

The Mediterranean region has a very rich and long history of trade across the Mediterranean Sea in many industries and particularly in animal productions. The Mediterranean animal industries and ruminants in particular, have some common traits such as the importance of pastoral systems, light and young carcass productions, numerous labeled and regional products and the predominance of small versus large ruminants [1]. Moreover, sheep and goats play a crucial role in the farming economy of the Mediterranean basin thanks to their ability to exploit marginal areas, and as well for the limited labor and capital required for their growth. In very difficult and degraded areas, or in harsh climates, this breeding type is the only possible primary activity able to prevent land abandonment [2]. The sustainability of livestock farming systems in relation to climate change, population dynamics, food security and provision of agro-ecosystem services has become a central issue of public and scientific debate [3]. This paper aims to provide information on the state and sustainability of small ruminant production in Mediterranean area).

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2. Presentation of Mediterranean Region

The Mediterranean Basin also known as the Mediterranean region or sometimes Mediterranea is the region of lands located at the intersection of two major landmasses, Eurasia and Africa. Around the Mediterranean Sea, it stretches c.3,800 km east to west from the tip of Portugal to the shores of Lebanon and c.1,000 km north to south from Italy to Morocco and Libya [4, 5]. The climate is characterized by hot-humid summers and humid-cool winters but it can also be notoriously capricious with sudden torrential downpours or bouts of high winds (eg. the Sirocco, the Mistral) occurring at various times of the year. These climatic conditions have a profound influence on the vegetation and wildlife of the region [5]. Moreover, the Mediterranean Region offers an ever changing landscape of high mountains, rocky shores, impenetrable scrub, semi-arid steppes, coastal wetlands, sandy beaches and a myriad island of various shapes and sizes dotted amidst the clear blue sea. Although much of the hotspot was once covered

by a dense cover of forests, the Basin has experienced intensive human development and impact on its ecosystems for at least 8,000 years, significantly longer than any other hotspot. The greatest impacts have been deforestation, habitat fragmentation, intensive grazing and fires, and infrastructure development, especially on the coast, which have distinctly altered the landscape. The agricultural lands, evergreen woodlands and maquis habitats dominating the basin are the result of these disturbances over several millennia [4].

3. Socio-economic Importance of Small Ruminant Production

Small ruminants are important for income generation and security, food supply and for development in rural Mediterranean areas especially in mountainous and marginal regions [6]. Production of small ruminants (sheep and goats) has considerable significant economic, social and environmental value in West Asia, North Africa and South European regions (Spain, France, Italy and Greece) [7, 8]. Sheep and goat productions being frequently the only possible production in less favored areas are often fundamental to maintain social activities and to keep vegetation out fire danger [7]. The animals provide the owners with milk, meat, wool/hair, leather and dung and, in addition, can be used as a source of cash, for transport and as pack animals [9]. In the North African economics, the livestock sector plays an important role especially sheep, goats and cattle which account for 25-80 percent of the value of agriculture output in the region. Moreover, sheep and goats contribute significantly to the livelihoods, self-employment and food security of the rural poor [10]. In mountainous of Mediterranean part of Turkey, goat farming is the most important animal production of people who don't have any other alternative for their subsistence. In addition milk and meat products from goats are very important for population [11].

4. Goat and Sheep Production in Mediterranean Agro-ecosystem

4.1 Relation between Small Ruminant Production and Agro-ecosystem

Livestock have a substantial impact on the world's water, land and biodiversity resources and contribute significantly to climate change. In many situations, livestock are a major source of land based pollution, emitting nutrients and organic matter, pathogens and drug residues into rivers, lakes and coastal seas. Animals and their wastes emit gases, some of which contribute to climate change, as do land-use changes caused by demand for feed-grains and grazing land. The severity of grazing in the European region causes the gradual disappearance of fauna, flora, and entire biotopes, pollution of surface and ground waters, increase in soil salinisation, and soil erosion and, ultimately, intense changes in the landscape. These problems are even more serious in the Mediterranean basin: a number of regions in the Iberian Peninsula are already so degraded as to be included in the world map of deserts [2, 12]. In addition, water availability is becoming a serious constraint to the expansion of agriculture and to meet other growing human needs. Agriculture is the largest user of water, accounting for 70 percent of total freshwater use [12].

4.2 Small Ruminant Production Systems

The main features of sheep and goats production systems relate to the way small ruminants are raised. The major criteria adopted to distinguish the various systems are based on feed resources used and the nature of flock movement during the annual cycle. Small ruminant systems of the Mediterranean basin have considerable economic, social and environmental importance. In the Mediterranean region, these breeding systems are classified as settled, transhumance and nomadic [13].

Nomadic and Transhumant system: In the past, the nomadic and transhumant production systems were

dominant. In summer and autumn, the flocks move to the cultivated areas to graze cereal stubble and the residues of irrigated crops. During the last decades, transhumance is being gradually abandoned. The majority of transhumant flocks were turned into sedentary flocks. In the nomadic system, the flocks migrate annually from the lowland winter ranges to the higher mountain grazing areas in the summer. It is the common system used for small ruminants in the driest areas of North Africa and Near East (NENA) countries [14]. Both nomadic and transhumant systems are characterized by low productivity and high grazing pressure in arid zones [15]. Sheep and goats raised by pastoralists are generally low-producing in terms of milk and offspring but are well-adapted to the climatic conditions and are relatively tolerant of local diseases [9].

Semi-sedentary system: In this system, the flocks are kept in cultivated areas during the winter season. However, in February they must leave the cultivated areas for grazing areas in the steppe to avoid crops' damage. Animals are moved back into cultivated areas immediately after crop harvest to graze cereal stubbles. By the end of summer, the flocks are moved back to their villages.

Sedentary system: In this system, sheep and goat flocks are kept at or close to the village or farm all the year round. The sedentary herding system is dominant among the sheep and goat farming systems. During the day they are grazed either on the common village range or on privately-owned or hired grazing areas; they also have access to stubbles and fallow fields. For the night they return to their sheds in the village or on the farm [16, 17]. These fenced systems of managed fodder area or of semi-natural grazing lands can be found in Turkey, Greece, Sardinia, Tuscany, Lazio and Sicily, but especially in western Spain. Also, animals receive some hand-fed supplements in almost all seasons [16, 18].

Oasis system: The oasis system can allow raising of improved goats thanks to the possibility of producing enough fodder and by-products to feed the animals [19].

Peri-urban system: This system is more common in the peri-urban areas, where hundreds of lambs are confined in a yard or barn for fattening. Traditionally barley is the main diet's ingredient [1].

5. Factors Limiting Small Ruminant Production in Mediterranean Region

In Mediterranean region, small ruminant populations are estimated 40,596,551 goats and 152,069,381 sheep in 2013 according to Faostat. These values account respectively for 4.04% and 12.97% of the world populations. Small ruminant farming systems are characterized by a great diversity, in terms of types of production, breeds (more than 200 breeds), levels of intensification, and are, by the fact, adapted to a wide range of situations. However, and due to the climate conditions, dramatic feed deficits, shortage of drinking water, mismanagement and husbandry, poor control of animal health, weak interaction between researchers, farmers, extension workers and policy makers, poor organization of herders, and unfavorable policies and legislations, the region could not reach its sufficiency on livestock products [10].

5.1 Small ruminants Production and Climate Change

The Mediterranean is one of the most vulnerable European regions to climate change, e.g. in terms of future water shortages, losses of agricultural potential and biome shifts [20]. In fact, climatology characteristics such as ambient temperature and rainfall patterns have great influence on pasture and food resources availability cycle throughout the year, and types of disease and parasite outbreaks among animal populations [21]. Also, the ability of livestock to breed, grow, and lactate to their maximal genetic potential, and their capacity to maintain health is strongly affected by climatic features [22]. The performance, health, and well being of livestock

animals are strongly affected, directly or/and indirectly, by climate change and variability. These impacts are more severe in developing countries and also due to poor access to technologies and financial supports [23].

5.1.1 Impact of Environmental Stress on Small Ruminant Reproduction

High ambient temperatures compromise reproductive efficiency of farm female and male animals [24]. Environmental stresses affect the estrous behavior, embryo production, birth weights of lambs, placental size, and function and fetal growth rate. It can leads to abnormal gametogenesis, folliculogenesis and ovulation, a delayed onset of puberty, large anoestrus periods, change in sexual behaviour, increased embryo and pregnancy loss, low fertility and prolificacy, increased perinatal mortality and morbidity [25-27]. In a study on effect of climate changes on the estrus incidence of goat raised in Mediterranean region of Turkey, the onset of oestrus, which occurred in August in the past, was reported to delay until September due to climate changes. At the periods 26 July-15 September, the estrus densities were reaching to the peak levels when the atmospheric temperatures were decreasing within years.

5.1.2 Impact of Environmental Stress on Small Ruminant Dairy Production

Small ruminants (sheep and goats) are a major component of the dairy sector in the Mediterranean basin [28]. The productive cycle of Mediterranean sheep and goats is very closely linked to the Mediterranean climate. In fact, sheep and goat milk production in the Mediterranean basin is mostly based on pasture utilization and thus follows the pasture availability pattern. This causes a strong seasonal pattern to the amount of milk processed by cheese processes plants, with the peak being in the spring, a marked reduction in early summer and low availability of milk from August to October-November (autumn) [29]. Also a depression of feed intake and reduction of milk production are commonly observed in heat-stressed goats [30].

5.1.3 Impact of Environmental Stress on Pasture Availability

The indirect impacts of climate change on livestock are in reducing water and pasture availability and other feed resources [31]. Fodder resources provide the principal sources of feeds throughout the humid and sub-humid, arid and semi-arid and Mediterranean regions. They include grasses and legumes, and fibrous crop residues (FCR) [32]. Additionally, in the Mediterranean basin, for instance, high temperature and lack of rainfall limit pasture growth in summer. The grazing capacity of mountainous grassland declines significantly during autumn and thus, the animals have to be removed into lowlands where cultivated winter cereals are used for grazing. In general, there is a difficulty in ensuring annual regularity of food supply to small ruminants and this is one of the major constraints for the mainly extensive systems [33].

5.1.4 Impact of Thermal Stress on Small Ruminant Feeding and Growth

The best recognized effect of raised body temperature is an adaptive depression of the metabolic rate associated with reduced appetite [34]. These climatic changes impact animal feeding in two ways: quality and availability of feed-grain, pastures, forage crop and animals feed and water intake. Water, feed and forage are the most important inputs for livestock production. Climate change affects livestock production by altering the quantity and quality of feed available for animals. It is also expected to change the species composition (and hence biodiversity and genetic resources) of grasslands and affect the digestibility and nutritional quality of forage.

When growing animals suffer from heat stress average daily gain is lowered and gross efficiency of converting nutrients to tissue is reduced [35]. In a comparative study between cooled and not-cooled male Assaf lambs growth subjected to heat stress, reported that at an air temperature averaged 35 °C, growth of male Assaf lambs was affected positively

by fan treatment (1,000-1,500 hours during 9 weeks), live weight increased by 15%, and cooled lambs had higher thyroxin levels [11]. Total feed intake of crossbred (75% Alpine and 25% Hair Goat) male kids was affected by ventilation and shower and their interaction effects ($P < 0.05$). More daily gain and final weight were affected by ventilation ($P < 0.05$) and ventilation x shower interaction ($P < 0.01$), as well. Feed intake increased with shower (58 vs. 63 kg/kid, $P < 0.05$) and ventilation application (58 vs. 62 kg/kid, $P < 0.05$), significantly [36].

5.1.5 Impact of Climate Change in Development of Small Ruminant Diseases

The most important environmental factors affecting the pathogens are temperature, humidity and CO_2 level [37]. Biotic stress factors, in particular, gastrointestinal nematodes (helminthes), which have been shown to be very strongly influenced by both the short-term weather and climate through effects on their free-living larval stages on pasture and respiratory diseases are the major disease crisis in small ruminants. Gastrointestinal parasites can cause production losses, increased susceptibility to other diseases and/or pests, and even death [28, 38, 39]. Furthermore changes in temperature and precipitation regimes may result in spread of disease and parasites or produce high incidence of diseases and mortality with concomitant decrease small ruminant's productivity [40]. More seasonal rates of ovine parasitic gastroenteritis diagnosis suggest that, in line with increases in temperature, fewer larvae of *Teladorsagia* and *Trichostrongylus* species survive the winter and spring at pasture, while the windows of transmission of these species, and of *Haemonchus contortus,* have extended into the autumn. For all species categories significant differences in rates of diagnosis, and in the seasonality of disease, were identified between regions [41].

5.2 Other Factors

Other factors that negatively affect to small ruinants and don't allow the region to reach its sufficiency on livestock products are: mismanagement and husbandry, poor control of animal health, weak interaction between researchers, farmers, extension workers and policy makers, poor organization of herders, and unfavorable policies and legislations [10].

6. Strategies to Promote a Sustainability of Small Ruminant Production in Mediterranean Region

6.1 Utilization of Biotechnology in Small Ruminants Production

Significant progress in research was achieved during recent years with small ruminants, particularly in the field of biotechnology. Indeed, the biotechnologies associated with reproduction (e.g. in vitro fertilisation, in vitro embryo growth and the transfer) are considered highly promising for the future of the small ruminant sector [42, 43]. In addition, identification of genetic mechanisms explaining the polymorphism of certain characters, e.g. alpha-s1 casein content of goat milk can have interesting consequences in future selection programs. However, there are still large discrepancies between the availability of scientific knowledge and its application in sheep and goat husbandry in most production areas. Consequently, a strong effort has to be made to improve research efficiency and particularly technology transfer. Due to the high research costs, the organization of regional research and development networks should allow, in the end, the best results [42].

6.2 Feeding Improvement Strategies for Sustainability of Small Ruminant Production

Nutrition is one of the most important environmental factors contributing to unsatisfactory reproductive outputs. Under semi-extensive systems, additional feed (like secondary cereal grains) provided at critical physiological stages (usually corresponding to mating seasons or end of pregnancy and suckling

stages); although not quantitatively important, can have a major impact on the productivity of the flocks when the animals are experiencing drought periods and their body condition is deteriorated. Decades of research on nutrition-reproduction interactions have led to the development of "focus feeding", the success of which depends on the timing and quality of the dietary stimulus as well as the metabolic history of the animals (particularly "metabolic memory"). Focus feeding is already being used to boost sperm production, increase ovulation rate and improve offspring survival [25, 44]. Carrying out a study on reproductive response of Barbarine ewes to supplementation with alternative feed prior to and during mating under semi-arid extensive conditions in semi-arid region with Mediterranean type climate (Tunisia) found that indicated that short-term nutritional supply with cactus cladodes favours follicle development and preserved ovulation rate in sheep in comparison to other conventional sources of supplement [25]. It also improved fertility when used to supplement animals over a longer period of time. They concluded that cactus cladodes may be considered as a less-expensive alternative to conventional concentrate supplements for increasing the reproductive efficiency in semi arid regions without the use of exogenous hormones. In addition, the key factors for improving milk production are provide adequate feeding, satisfactory milk prices for the farmers and efficient supporting services [45]. For the production of adequate, quality roughage, arable land should be utilized in the best way possible. Technical principles need to be applied for the sustainable use of rangelands.

6.3 Protection of Animal Health

In small ruminants farming systems, chemoprophylaxis has been widely used as the main strategy to control parasitic diseases. Frequent use of suppressive or therapeutic anthelminthic drugs is no longer considered sustainable [43]. However, methods of protection of animals from epizootic diseases and zoonoses need to be further improved. This includes development of cheap and efficient methods of animal identification, registration and control of movements, new biological products and means of immunization as well as development of production technologies, which would incorporate sanitary and preventive measures in daily operations. In the globalised world, the highest level of protection could be guaranteed only by the simultaneous and harmonized policies and practices in all parts of the world. However, more efficient regional cooperation in research and in the implementation of measures could be the great step towards safeguarding and protecting animal industry in the Mediterranean [46].

7. Conclusion

Small ruminant have important economical, social and environmental value for autochthon population living in rural Mediterranean areas especially in mountainous and marginal regions. However, goat and sheep contribute to degradation of climate causing climate change associated with increasing of ambient temperature. Theses climatic changes are one of most important factor affecting small ruminant. Decade's studies have enabled to develop strategies to reduce waste from animal husbandry activities and the negative impact of animal husbandry on environment. To become more efficient, research using more specific methods directed to the reality of small ruminant production will be helpful.

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