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## Invited review: Current production trends, farm structures, and economics of the dairy sheep and goat sectors

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### ABSTRACT

Dairy small ruminants account for approximately 21% of all sheep and goats in the world, produce around 3.5% of the world's milk, and are mainly located in subtropical-temperate areas of Asia, Europe, and Africa. Dairy sheep are concentrated around the Mediterranean and Black Sea regions, where their dairy products are typical ingredients of the human diet. Dairy goats are concentrated in low-income, food-deficit countries of the Indian subcontinent, where their products are a key food source, but are also present in high-income, technologically developed countries. This review evaluates the status of the dairy sheep and goat sectors in the world, with special focus on the commercially and technically developed industries in France, Greece, Italy, and Spain (FGIS). Dairy small ruminants account for a minor part of the total agricultural output in France, Italy, and Spain (0.9 to 1.8%) and a larger part in Greece (8.8%). In FGIS, the dairy sheep industry is based on local breeds and crossbreeds raised under semi-intensive and intensive systems and is concentrated in a few regions in these countries. Average flock size varies from small to medium (140 to 333 ewes/farm), and milk yield from low to medium (85 to 216 L/ewe), showing substantial room for improvement. Most sheep milk is sold to industries and processed into traditional cheese types, many of which are Protected Denomination of Origin (PDO) cheeses for gourmet and export markets (e.g., Pecorino, Manchego, and Roquefort). By comparing break-even milk price among FGIS countries, we observed the following: (1) most Greek and French dairy sheep farms were

unprofitable, with the exception of the intensive Chios farms of Greece; (2) milk price was aligned with cost of production in Italy; and (3) profitable farms coexisted with unprofitable farms in Spain. In FGIS, dairy goat production is based on local breeds raised under more extensive systems than sheep. Compared with sheep, average dairy goat herds are smaller (36 to 190 does/farm) but milk yield is greater (153 to 589 L/doe), showing room for improvement. Goat milk is mainly processed on-farm into dairy products for national markets, but some PDO goat milk cheeses (e.g., Murcia al Vino) are exported. Processed goat milk is sold for local human consumption or dehydrated for export. Mixed sheep-goat (e.g., Feta) and cow-sheep-goat milk cheeses are common in many countries. Strategies to improve the dairy sheep and goat sectors in these 4 countries are proposed and discussed.

**Key words:** milk, dairy sheep, dairy goat, production system

### INTRODUCTION

There are approximately 2,200 million sheep and goats in the world, and 20.8% are intended for dairy production (Table 1). Despite this large number of animals, sheep and goat milk represented only 1.3 and 1.9%, respectively, of the world's total milk production in 2016 (799 Mt). Cattle (83.1%) and buffaloes (13.1%) are the most important milk producers, and camel milk accounts for only 0.3% of world milk production (FAO-STAT, 2018). Nevertheless, worldwide sheep and goat milk production has more than doubled during the last 50 yr and, if this trend is maintained, it is expected to increase by approximately 2.7 Mt (+26%) and 9.7 Mt (+53%), respectively, by 2030 (Figure 1). Taking into account the total solids content of all products from dairy sheep (i.e., milk, meat, and wool) and dairy goats

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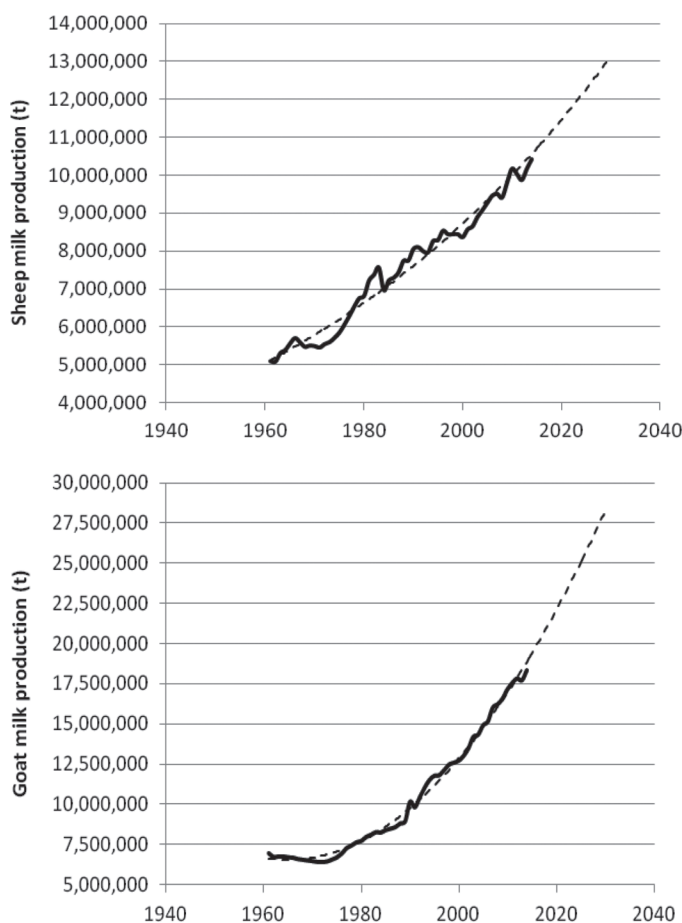
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**Table 1.** World panorama of dairy sheep and goats<sup>1</sup>

| Continent | Total <sup>2</sup> [million head (%)] |             | Dairy [million head (%)] |            | Milk [Mt (%)] |             | Yield <sup>3</sup> [L/head] |       |
|-----------|---------------------------------------|-------------|--------------------------|------------|---------------|-------------|-----------------------------|-------|
|           | Sheep                                 | Goats       | Sheep                    | Goats      | Sheep         | Goats       | Sheep                       | Goats |
| Asia      | 512 (43.6)                            | 556 (55.4)  | 135 (54.0)               | 106 (52.1) | 4.73 (45.6)   | 8.04 (52.7) | 35.1                        | 76.2  |
| Africa    | 352 (30.0)                            | 388 (38.7)  | 79 (31.7)                | 80 (39.6)  | 2.54 (24.5)   | 3.93 (25.7) | 32.2                        | 48.9  |
| Europe    | 131 (11.2)                            | 17 (1.7)    | 33 (13.3)                | 9 (4.3)    | 3.01 (29.0)   | 2.54 (16.6) | 90.8                        | 290.1 |
| America   | 84 (7.1)                              | 38 (3.8)    | 3 (1.1)                  | 8 (4.0)    | 0.09 (0.9)    | 0.75 (4.9)  | 33.0                        | 93.4  |
| Oceania   | 95 (8.1)                              | 4 (0.4)     | <0.1 (0)                 | <0.1 (0)   | <0.01 (0)     | <0.01 (0)   | —                           | —     |
| Total     | 1,173 (100)                           | 1,003 (100) | 250 (100)                | 203 (100)  | 10.37 (100)   | 15.26 (100) | 41.5                        | 75.3  |

<sup>1</sup>Source: FAOSTAT (2018).<sup>2</sup>Total number of sheep and goats (regardless of purpose).<sup>3</sup>The last row for yield is the mean rather than the total.

(i.e., milk and meat, the production of fiber being negligible; FAOSTAT, 2018) worldwide, we estimate that the ratio of milk:meat:wool in dairy sheep is 28:45:27 (38:62 milk:meat, without wool), whereas the milk:meat ratio in dairy goats is 58:42.

**Figure 1.** World sheep and goat milk production trends from 1960 to 2016 (solid line) and forecast to 2030 by using time-series model (dashed line) (FAOSTAT, 2018).

Dairy sheep and goat farms are mainly located in subtropical-temperate areas of Asia, Europe, and Africa. Dairy sheep are concentrated in countries in the Mediterranean and Black Sea regions with relevant Greek or Roman cultural heritage (Caja, 1990), where dairy products are typical ingredients of the human diet. Dairy goats are concentrated in the Indian sub-continent in low-income, food-deficit countries, where their products are a primary food source, but are also present in high-income and technologically developed countries.

Compared with milk of dairy cows, that of small ruminants is generally not consumed directly but is used in the production of niche or ethnic dairy foods, usually used for self-consumption or sold as traditional and high-quality dairy products (e.g., Feta cheese and yogurt) included in the list of key ingredients of the so-called Mediterranean diet (Dennett, 2016).

Given the growing importance of the sheep and goat dairy industry in the world, this paper aims to describe the current production trends, farm structures, and economic results of the dairy sheep and goat sectors, with special attention to the European Mediterranean countries where they are currently most developed (i.e., France, Greece, Italy, and Spain).

## WORLD PANORAMA OF DAIRY SHEEP AND GOATS

### Dairy Sheep

According to FAOSTAT (2018), sheep milk (10.4 Mt) is mainly produced in Asia (45.6%), with remarkable amounts in China and Turkey, followed by Europe (29.0%) and Africa (24.5%; Table 1). Additionally, there is a very small but growing production in the North and South Americas (0.9%) and Oceania (<0.1%).

Most world dairy sheep are raised in an area bounded by the 35°N and 45°N parallels and the 20°W and 50°E meridians. Curiously, new dairy sheep areas are still

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