

Article

Farmers Profile and Characterization of Sheep and Goat Dairy Chain in Northwestern Greece

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Abstract: The aim of the present study, conducted under the ERA-NET ARIMNet2 Project (Agricultural Research in the Mediterranean Network), was to analyze the sheep and goat dairy sector and assess the quality and safety of milk at various stages of the dairy supply chain. The study took place in the north-west part of Greece; 52 farms, one milk collection center, and eight dairy processing companies participated. The results revealed that all farms had access to water and electricity, the majority of them had a license to operate, used non-organic milk, and employed family members. The price of milk was fairly unstable throughout the year. Two major dairy companies produced all year round while others seasonally. Products were sold in retail, wholesale, company-owned stores, and even by door-to-door delivery service. The analyzed milk samples were of good quality and safety. The strengths, weaknesses, opportunities, and threats (SWOT) analysis revealed the farmers' determination to continue working in the sector despite milk prices and problems due to the shortage of cash. Local sheep and goat breeds may further be used due to the fact of their good adaptation to the environmental conditions. The future of the Greek dairy chain is promising despite high competition within and outside of the European Union.

Keywords: dairy chain; sheep; goat; milk; quality; safety; SWOT; Greece



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1. Introduction

Sheep and goat farming plays an important economic, environmental, and social role in Mediterranean countries. In Greece, this sector can be regarded as an agricultural activity that provides a strong connection to rural, mountainous, arid, semi-mountainous, and semi-arid areas. Greece among other countries is characterized with a high proportion of mountainous areas; thus, a high percentage of the utilized agricultural area is designated as less favored areas (LFAs) [1]. The sheep milk that is produced in Greece is mainly used for cheese manufacturing, while the goat milk, generally, is used as a supplement to sheep for the production of protected designation of origin (PDO) cheeses, such as feta, or other traditional cheeses. Therefore, the quality of sheep and goat milk in terms of both nutritional properties and hygienic features can play an important role in payment schemes as well as in milk processing and the maturing profile of cheese [2,3]. Milk quality is affected by several parameters including but not limited to lactation stage, animal health, feeding practices, milking practices, hygiene of farms, and milk transportation [4–7].

The Epirus region of Greece has many mountainous and disadvantageous areas and belongs to LFAs [8] as defined in Council Directive 75/268/EEC which was repealed and

replaced by 950/97, 1257/1999, 1698/2005, and 1305/2013. In the EU, regulation (EU) No 1305/2013 [9] is currently in force. Sheep and goat farming of pastoral farmers in the mountainous areas of the Epirus region has been described in Reference [10]. However, data on farmers, milk collection centers, and dairy processors in that area are scarce. The present study was conducted under the ERA-NET ARIMNet2 (Agricultural Research in the Mediterranean Network) young Researcher 2017 project, funded by the 7th Framework program, European Union, and is entitled “Characterization of Dairy Chain in Mediterranean Countries and Adoption of Optimum Technologies to Improve Dairy Value Chain” (CDCMCT). The countries participating in the project are Algeria, France, Egypt, Greece, and Spain.

The aim of the present work was (a) to describe the sheep and goat dairy sector in north-western Greece (regional unit Ioannina) by collecting data from farmers, milk collection centers, and dairy processors and (b) to assess the milk quality and safety from farm-to-industry in order to examine the effect of farm/industry practices and transportation on the resultant milk quality and safety. Moreover, a strengths, weaknesses, opportunities and threats (SWOT) analysis was applied as a valuable adjunct to experimental research to organize and analyze the data. This information could be used in order to identify if there were gaps that constrain the milk supply.

2. Materials and Methods

2.1. Description of the Study Area

The study of the sheep and goat sector was conducted in the region of Epirus and more specifically in the regional unit of Ioannina. Ioannina city is the capital of Epirus, Greece. The regional unit of Ioannina had 203,237 sheep heads and 55,420 goat heads in 2017, while in 2012, there were 252,027 and 74,701 heads, respectively. Regarding milk production, in 2017, 16,930 tons of sheep milk and 4852 tons of goat milk were produced in contrast to 28,137 tons and 7933 tons of sheep and goat milk, respectively, produced in 2012 [11].

2.2. Questionnaire Survey

The survey was conducted among 52 farms, 1 milk collection center, and 8 dairy processing companies. Dairy farmers were identified with the collaboration of a local rural association in the region of Ioannina. The main criteria for farmer inclusion in the survey was his willingness to participate in the survey. Milk processing companies were traced with the help of ELGO-DIMITRA (former Hellenic Agricultural Organization-DEMETER). Initially, the questionnaires were evaluated by researchers or academic staff familiar with this type of research, thus their suggestions and comments were taken into consideration. The questionnaire was answered by 52 farmers. One farmer has been working on a farm that belonged to a public research organization; thus, his profile was eliminated and not included in the present survey. Therefore, the data from 51 farmers were used to analyze their profiles. Out of the 52 participating farms, there were 45 farms that raised sheep and 22 goats. Those farms that possessed sheep answered additional detailed questions on sheep production and sheep milk price. Similarly, the farms that possessed only goats answered additional detailed questions on production and milk price.

2.3. Milk Collection and Analyses

A number of selected analyses were conducted in order to examine the milk quality and safety of the dairy value chain. Milk samples were collected and tracked at the farm and industry levels during winter and spring 2019. Milk samples were collected from a subset of the survey participants. Samples were collected at the farm level from sheep farms and goat farms and at the industry level. A total of 68 milk samples were collected 34 samples at the farm level (27 sheep plus 7 goats' milk) and 34 at industry level. Every sheep and goat milk sample could be traced back to where it came from. In detail, milk samples were collected at the farm and a respective sample was collected at the milk collection

center or industry when milk arrived, i.e., the same or the following day (depending on the industry's scheduled program).

During transportation to the laboratory, samples were kept at 2–4 °C. For the microbiological analysis, samples were preserved with sodium azide (0.02%; Merck, Darmstadt, Germany). Milk samples were analyzed for the total viable counts and for the physico-chemical parameters. In detail, the milk was analyzed for fat, protein, lactose, total solid (TS), solids-not-fat, freezing-point depression, and somatic cell counts (SCCs) by MilkoScan, model 6000 (Foss Electric, Hillerød, Denmark) using established methods [12–14]. Milk pH was measured directly with a pH meter (Micro pH 2002; Crison, Barcelona, Spain). Microbiological evaluation was carried out by assessing the total viable counts (TVCs) using the BactoScan FC (Foss Electric) using standard methods [15,16]. For the adulteration of sheep with goat milk, a commercial test (Rapid Test Goat, ProGnosis BioTech Ltd., Larissa, Greece) was used. The detection of antibiotic residues in milk was qualitatively examined using the commercial test Eclipse 3G Milk Antibiotics Test (ZeuLab S.L., Zaragosa, Spain).

2.4. Statistical Analysis

The statistical analysis of the survey questionnaires was performed using the Statgraphics Plus software for Windows v.5.2 (Manugistics Inc., Rockville, MD, USA). Categorical variables were presented as absolute (n) and relative frequencies (%) and associations between them were tested with the chi-squared test. Continuous variables were presented as mean values $\pm$ standard errors (mean $\pm$ SE). Associations between continuous variables and qualitative characteristics derived from the questionnaire were tested through one-way analysis of variance or Student's t -test for independent samples. All examined milk parameters were subjected to one-way analysis of variance, Student's t -test and/or General Linear Model (GLM) analysis, where appropriate, by using the Statgraphics Plus for Windows version 5.2 (1995, Manugistics, Inc., Rockville, MD, 20852, USA), in order to find differences from farm-level to industry/milk collection center-level. Results were considered as statistically significant when $p \leq 0.05$.

3. Results and Discussion

The profile of the 52 farms, the milk collection center, and the eight dairy processing companies present in the area are described in Section 3.1, Section 3.2, and Section 3.3, respectively, (Tables 1–3). The results of the analyzed milk samples collected at the farm and industry levels are presented in Section 3.4. (Tables 4 and 5). Finally, a SWOT analysis is presented in Section 3.5.

3.1. Characteristics of Farms and Farmers in the Regional Unit of Ioannina

In Table 1, the descriptive characteristics of farms are presented. All examined farms (52 out of 52) had access to water and electricity. The majority of sheep and goat farms (67.31%, 35/52) had a license to operate and almost half of them (55.77%, 29/52) had three-phase electrical power. A high percentage (65.38%, 34/52) of the land area of farms was owned and not rented. Most of the farms (63.46%, 33/52) were registered as conventional farms. The cost of animal feed was less than 10,000 euros per year for the 42.31% of farms (mean $\pm$ SE, 6568.18 $\pm$ 596.9 €) and between 10,000 and 30,000 euros per year (mean $\pm$ SE, 20,590.90 $\pm$ 1088.40) for the 42.31% of farms. The cost for the veterinary services, annually, was less than 2000 euros (1163.89 $\pm$ 87.82 €) for 69.23% of the farms. In an emergency case, 86.54% of the farmers were addressed to the veterinarian; mastitis in animals was discovered by 73.08% of the farmers and all the farmers (100%) discarded the milk from animals in therapy from mastitis. Most of the farms (76.92%) had both breed and dairy animals selling both milk and meat products. The production system was transhumance in 32.69% of farms. During the summer, the animals grazed (67.31%) the land around the farm and in case of transhumance moved to mountain pastures. During the winter, in the majority of farms (71.15%), the animals were housed, and supplementary purchased feedstuff were provided when the weather conditions were severe, not allowing

grazing in the outside. Almost half of the farms (53.85%) were equipped with milking systems. A total of 61.54% of the farms were milking the animals twice a day in line with other studies [17]. The milk in all farms (100%) was stored in milk tanks under refrigeration, which are usually provided by the dairy company. In addition, the results of the present study showed that the number of sheep was independent from the type of milking ($X^2 = 4.94$, $p = 0.55$). Independent from the type of milking was also the number of the goat animals ($X^2 = 4.04$, $p = 0.13$). There was no correlation between the number of sheep animals ($X^2 = 5.91$, $p = 0.74$), the number of goat animals ($X^2 = 4.77$, $p = 0.57$), and the status of the land area (owned, rented, etc.). The number of the sheep ($X^2 = 14.96$, $p = 0.09$) and of goat animals ($X^2 = 8.49$, $p = 0.2$) were independent from the number of family persons involved in the farm.

Table 1. Farm status.

Parameter	Answers	Frequency ¹	Relative Frequency
License	Yes	35	67.31%
	No	10	19.23%
	In process	7	13.46%
Access to water	Yes	52	100%
	No	0	0%
Type of electricity	Mono-phase current	18	34.62%
	Three-phase current	29	55.77%
	Other	5	9.62%
Status of the land	Owned	34	65.38%
	Rented	5	9.62%
	Both (owned and rented)	9	17.31%
	Other	4	7.69%
Number of employees	0	34	65.38%
	1	13	25.00%
	2	3	5.77%
	≥3	2	3.85%
Contact person in case of emergency	Veterinarian	45	86.54%
	Company	2	3.85%
	Other	5	9.62%
Spotting mastitis	Farmer	38	73.08%
	Veterinarian	1	1.92%
	Industry	3	5.77%
	Farmer and Veterinarian	10	19.23%
Fate of mastitis infected milk	Discarded	52	100.00%
	No	0	0.00%
Registration as an organic farm	Yes	19	36.54%
	No	33	63.46%
Management of animals	Breeder-dairy	40	76.92%
	Only dairy	12	23.08%
Feeding of animals during summer	Only grazing	35	67.31%
	Only concentrate/only forage	4	7.69%
	Mixture	13	25.00%
Winter animal feeding	Only grazing	2	3.85%
	Only concentrate/only forage	13	25.00%
	Mixture	37	71.15%

Table 1. Cont.

Parameter	Answers	Frequency ¹	Relative Frequency
Times of daily milking	1	0	0%
	2	32	61.54%
	3	10	19.23%
	In the beginning 3, then 2	10	19.23%
Type of milking	Hand	20	38.46%
	Milking machine	28	53.85%
	Both	4	7.69%
Milk storage	Milk tank	52	100.00%
	Plastic milk containers	0	0.00%
Transhumance practiced	Yes	17	32.69%
	No	35	67.31%
Presence of dairy farm shop	Yes	1	1.92%
	No	51	98.08%
Cost of feedstuff (€ per year)	≤10,000	22	42.31%
	10,001–30,000	22	42.31%
	30,001–99,999	7	13.46%
	≥100,000	1	1.92%
Cost for veterinary services (€ per year)	≤2000	36	69.23%
	2001–4999	7	13.46%
	≥5000	9	17.31%

¹ number of farms (n) = 52.

The farmers' profile is presented in Table 2. The majority of the farmers were men (72.55%, 37/51), married with children (78.42%), and older than 40 years old. Most of them (45.10%) have graduated from a high school, while 35.29% primary school and only 7.84% had a University degree. Furthermore, almost half of the farmers (49.02%) had been trained with seminars (in topics such as animal husbandry and milk technology). Previous studies have shown that the majority of the sheep farmers in Epirus and in Peloponnese (southern part of mainland of Greece) region were men, middle aged who graduated high or primary school [18,19]. In the present study, the majority of the respondents (72.55%, 37/51) lived from farming exclusively as livestock farming was their sole source of income with no other professional activity performed. Members of the family participated in farm activities, most notably 31.37% of the farms occupied one member of their family in the farm activities and 41.18% occupied two (Table 2); while most of the farms (65.38%) hired no employees (Table 1) in order to reduce the expenses of the farm. Similarly, Ion et al. [20] found that more than half of the workers in sheep farms in Romania were family members. Regarding the years practicing the farming, 19.61% were registered as farmers for less than 5 years while 25.49% for more than 30 years (Table 2). Regarding future perspectives, almost half of the farmers (58.82%) replied that they will continue to farm in the following five years. Raising livestock for those farmers was an activity passed from one generation to the next. Also, Pappa et al. [21] reported that young people were moving from urban to rural areas seeking employment. In the present study, the analysis indicated that the age of the farmer was significant factor affecting the perspective to continue being a farmer in the future ($X^2 = 9.639$, $p = 0.02$), but was independent from the training ($X^2 = 2.45$, $p = 0.64$). The age of the farmer was related to education ($X^2 = 23.94$, $p = 0.02$) and as expected, younger farmers had a higher level of education. The statistical analysis of the present study showed that the gender of the farmer was independent from his/her education ($X^2 = 2.04$, $p = 0.56$), and it was also independent from the number of years of being a registered farmer ($X^2 = 3.30$, $p = 0.5$).

Table 2. Farmer's profile.

Parameter	Answers	Frequency ¹	Relative Frequency
Gender	Male	37	72.55%
	Female	14	27.45%
Age	<25	0	0%
	25–30	5	9.80%
	31–40	7	13.73%
	41–50	12	23.53%
	51–60	15	29.41%
	>61	12	23.53%
Education	Primary school	18	35.29%
	High school	23	45.10%
	Technical school	6	11.76%
	University	4	7.84%
Training	Yes	25	49.02%
	No	26	50.98%
Future of farming (perspectives)	Continue being a farmer	30	58.82%
	Stop being a farmer	10	19.61%
	Have not decided yet (do not know)	11	21.57%
Income from other sources	Yes	14	27.45%
	No	37	72.55%
Marital status	Married	41	80.39%
	Single	10	19.61%
Number of children	0	11	21.57%
	1	7	13.73%
	2	18	35.29%
	3	12	23.53%
	4	3	5.88%
Years being a registered farmer	≤5	10	19.61%
	5–10	9	17.65%
	11–20	9	17.65%
	21–29	10	19.61%
	≥30	13	25.49%
Number of family members involved in the farm	1	16	31.37%
	2	21	41.18%
	3	9	17.65%
	≥4	5	9.80%
Where is the milk sold?	One of the private dairy leader companies of Greece	39	75.00%
	One of the biggest private dairy companies inside the regional unity of Ioannina	3	5.77%
	One of the biggest private dairy companies outside of the regional unity of Ioannina	5	9.62%
	A private dairy company producing organic products in the regional unity of Ioannina	3	5.77%
	Other (a cooperative dairy company and a vertically integrated dairy company)	2	3.85%
Absence of fluctuation in milk price received year-round	Yes	9	17.65%
	No	42	82.35%
Payment terms	Cash	2	3.92%
	Cash in advance	0	0%
	Credit	49	96.08%
	Other	0	0%

Table 2. Cont.

Parameter	Answers	Frequency ¹	Relative Frequency
Payment credit time (days)	<30	3	5.88%
	30	5	9.8%
	45–50	6	11.76%
	60	11	21.57%
	90	19	37.25%
	>90	7	13.73%
Collection and reception of milk	In situ by a lorry carrying the milk containers	19	37.25%
	In situ by a tank truck pumping from the milk tanks	26	50.98%
	Farmers deliver by themselves to nearby collection center	6	11.76%
Participation in organized groups/associations	Yes	14	27.45%
	No	37	72.55%

¹ Out of the 52 farmers, one worked in a farm belonging to a public research organization and had to be excluded since they were paid by the State, thus $n = 51$.

Regarding the characteristics of sheep and goats, the data from the present study (Table 3) showed that 45 farms raised sheep (45/52) and 22 (22/52) goats; thus, 15 farms had both sheep and goats. Most of the sheep farms (42.22%, 19/45) had 101–300 sheep (mean $\pm$ standard error, 193 ± 10), although 37.78% (17/45) had less than 100 sheep heads (77 ± 4) and 11.11% (5/45) had more than 500 sheep heads (610 ± 98) (Table 3). Similarly, Bellos [18] reported that farms in Epirus region had on average 167.82 sheep. Generally, the Greek dairy sector consists mainly of small farms [21]. The results of the present study regarding the 22 farms that owned goats showed that 59.09% (13/22) had less than 100 heads (21 ± 2) and 22.73% (5/22) had more than 200 (258 ± 17). The statistical analysis showed that the number of sheep was correlated to the number of employees hired ($X^2 = 28.74$, $p < 0.001$), but this did not apply to the number of goats ($X^2 = 4.04$, $p = 0.13$).

The 82.22% (37/45) of the sheep milk production was less than 50 tons, with a mean production of 28.18 ± 2.39 tons per year, and only 4.44% (2/45) was more than 100 tons per year (125.0 ± 5.0). Most of the sheep milk was seasonally produced 84.44% (37/45) (Table 3). The total goat milk production (100%) was seasonal. Most of the goat milk production (59.09%) was less than 10 tons per year (3.13 ± 0.67), and only 13.64% was more than 30 tons (39.0 ± 4.0) per year.

Mixed breeds were the majority of sheep farms (80%) (Table 3), mainly crosses between different local mountain sheep breeds or in some cases with *Chios*, *Lesvos*, *Karagouniko* or *Frizarta* breeds, in contrast (20%) to flocks with pure bred lines of the local sheep breeds of *Katsika* (*Karamaniko*) and *Kalaritiko*. These breeds are considered endangered, due to the fact of their small population numbers and should be included in situ conservation programs. The main reason for farmers' preferences for these breeds is their adaptation to the environment and production system. Farmers who raise purebred breeds express their strong belief on the breeds' characteristics. In addition, heritage and tradition are considered important factors for choosing purebred breeds [10]. Local types of goats made up 54.55% of the goat animals (Table 3). Regarding the management of farms, goat flocks were raised together with the sheep flocks, generally on the farms.

Sheep and goat milks were sold to industries or small dairy companies. Seventy-five percent of farmers (39/52) in the present study sold the milk at one of the leading privately held leading dairy companies in Greece (Table 2), in accordance with the results presented in Reference [8]; while one farm was using milk to manufacture dairy products (i.e., a vertically integrated farm). The milk from nine farms (17.65%) was sold at the same price all year round in contrast to the general practice of relating milk price to the composition of milk (content of fat and protein) (Table 2). Regarding the sheep milk price, 29.55% of the farms sold it between 0.85 and 0.89 €, 2.27% sold it higher than 1 €, and 4.55% lower than 0.85 € (Table 3). Approximately 42.86% of farms sold goat milk at 0.53–0.55 € and 33.33% sold it 0.48–0.50 € (Table 3). The statistical data revealed that in 2019, the mean

price of sheep milk in Ioannina region was 0.85 euros and in Greece 0.80 euros, while for the goat milk it was 0.51 euros both in Ioannina and in Greece, generally [22]. The mode of payment was credit in the majority of cases (96.08%), and the average days of credit were 90 days for 37.25% farms and 60 days for 21.57%, although farmers would prefer to receive prepayments for the milk production of the year (Table 2). The dairy processing company was collecting the milk from farms with plastic containers at 19 farms (37.25%), with a pump from the milk tank at 26 farms (50.98%), and only six farms (11.76%) transferred it to the nearby milk collection center. Only one farm used its own milk to produce products, whereas the other farmers did not sell commercial dairy products (Table 2).

Table 3. Milk production related descriptors.

Descriptor	Answers	Frequency ¹	Relative Frequency
Number of sheep heads	≤100	17	37.78%
	101–300	19	42.22%
	301–499	4	8.89%
	≥500	5	11.11%
Production of sheep milk (tones per year)	≤50	37	82.22%
	51–99	6	13.33%
	≥100	2	4.44%
Number of goat heads	≤100	13	59.09%
	101–199	4	18.18%
	≥200	5	22.73%
Production of goat milk (tones per year)	≤10	13	59.09%
	11–29	6	27.27%
	≥30	3	13.64%
Price of sheep milk (€) ²	0.85–0.89	13	29.55%
	0.90	10	22.73%
	0.91–0.97	9	20.45%
	0.98–0.99	9	20.45%
	≥1.00	1	2.27%
	<0.85	2	4.55%
Price of goat milk (€) ³	0.48–0.50	7	33.33%
	0.51–0.52	1	4.76%
	0.53–0.55	9	42.86%
	<0.48	3	14.29%
	>0.55	1	4.76%
Period of sheep milk production	Whole year	7	15.56%
	Seasonally	38	84.44%
Period of goat milk production	Whole year	0	0.00%
	Seasonally	22	100.00%
Breed of sheep	Mixed breeds	36	80.00%
	Single breed only	9	20.00%
Breed of goats	Mixed breeds	10	45.45%
	Single breed only	12	54.55%

¹ Out of the 52 examined farms, 45 possessed sheep solely and 22 goats solely, thus, $n = 45$ for sheep farms, $n = 22$ for goat farms. ² $n = 44$, ³ $n = 21$, the vertically integrated dairy company was excluded during analysis of these two price-related questions, since no milk price data were available as the milk was not sold but was used for dairy product manufacture.

3.2. Characteristics of Milk Collection Center in the Regional Unit of Ioannina

Milk collection centers are considered part of the milk supply chain and gather raw milk from farmers. Their activities include quality checking, reducing temperature, and storage of the milk [23]. Only one milk collection center is present in the regional unit of Ioannina and it belongs to one of the biggest dairy companies in Greece. The annual average quantity of sheep and goat milk collected per day was reported to be 15.5 tons and

3.7 tons, respectively. The most distant location from where sheep and goat milks were collected was about 50 km from the collection center. The milk was transported in plastic containers and the duration of the transport was up to 2–3 h. At the milk collection center, the milk was stored for less than 24 h, at a temperature 2–4 °C. Milk samples were analyzed for pH and for the presence of antibiotics. The average number of milk refusals was less than 1 incident per month, and the causes of refusals were miscellaneous including but not limited to low pH, presence of antibiotics or non-filtered milk. The other dairy processing companies participated in this study, directly collect the milk from the farms. The role of the milk collection center was considered important as it provided both a collection point and a place for a preliminary scanning of milk. Milk was scanned and any sample refused was omitted and not mixed with others. The presence of a milk collection center was regarded as a positive step to improve the dairy chain value. Similarly, the role of milk collection centers in assuring safe distribution channels in Turkey has been documented [24,25].

3.3. Characteristics of Dairy Processing Companies in the Regional Unit of Ioannina

Eight dairy processing companies in the regional unit of Ioannina participated in the survey. Six dairy companies were private, one was a foundation, and one was a cooperative. Regarding the size of each company, three out of six private companies were regarded as micro in size with less than 10 employees, two were small in size (11–50 employees), and one was a private dairy processing company that had more than 250 employees and was among the private dairy leader companies of Greece. The dairy companies produced cheese (feta and/or other cheeses) and other dairy products (yoghurt or butter), except one that produced other products than cheeses such as milk, yoghurt, kefir etc. They sold the products in retails and/or own shops, using international, European and/or domestic distribution channels. Some companies utilized the milk to produce specific dairy products. One private dairy company produced organic cheese, another private one produced specialty products, such as low-fat cheeses. The foundation among other cheeses is producing the traditional smoked pasta-filata protected designation of origin (PDO) cheese, named Metsovone. One private company was a vertically integrated one, did not sell the milk, but used it to produce dairy products and other products using milk (such as trahana soup). They were all using sheep and goat milk, except one that utilized only sheep milk. All dairy processing companies were licensed, do not manufacture raw milk products and apply a traceability system. Almost all of them (7/8) adapt environmental policy and Hazard Analysis Critical Control Point (HACCP) system. The majority (6/7) paid farmers with credit. Two companies manufactured dairy products the whole year round while others produced seasonally. It seemed that small businesses were trying to establish a distinctive and unique position when dealing with large multinational companies. They all stated that the production and raw material was the highest cost in agreement with the results of Bourlakis et al. [26].

3.4. Milk Quality and Safety

The microbiological and physicochemical parameters of 27 raw sheep and seven goat milk samples, with the range and standard error of means, are shown in Tables 4 and 5, respectively. There were not detected any residues of antibiotics in milk samples. Given that in Ioannina region, the majority of farmers have mixed flocks of sheep and goats, milk samples were analyzed for adulteration of sheep with goat milk. The results have shown that in one sheep milk sample, goat milk was present. This needs to be further investigated in order to find out if this was a mistake or a possible adulteration.

Table 4. Physicochemical and microbiological characteristics of sheep milk samples.

Parameter ¹	Farm-Level ²	Industry-Level ²	p-Value
pH	6.68 ± 0.01 [6.41–6.79]	6.70 ± 0.01 [6.47–6.79]	0.39
Fat, %	6.15 ± 0.10 [5.07–7.24]	6.31 ± 0.10 [5.31–7.33]	0.25
Protein, %	5.40 ± 0.05 [4.95–6.08]	5.41 ± 0.06 [4.73–5.97]	0.91
Lactose, %	4.72 ± 0.02 [4.44–4.96]	4.74 ± 0.02 [4.37–4.95]	0.60
Solid in non-fat substance, %	10.96 ± 0.05 [10.5–11.61]	10.99 ± 0.07 [9.9–11.53]	0.77
Freezing point depression (°C)	−0.562 ± 0.002 [−0.547–(−0.588)]	−0.566 ± 0.001 [−0.550–(−0.581)]	0.06
Somatic cell counts (SCC), (log cfu/mL)	6.06 ± 0.07 [5.09–6.67]	6.10 ± 0.06 [5.36–6.66]	0.67
Total viable counts (TVC), (log cfu/mL)	5.17 ± 0.11 [4.28–6.23]	5.39 ± 0.10 [4.4–6.23]	0.15

¹ Mean values ± standard error. The minimum and maximum values are reported in the brackets. ² A total of 54 sheep milk samples were collected (27 samples at farm level and 27 at industry level).

Table 5. Physicochemical and microbiological characteristics of goat milk samples.

Parameter ¹	Farm-Level ²	Industry Level ²	p-Value
pH	6.66 ± 0.01 [6.6–6.71]	6.70 ± 0.02 [6.62–6.83]	0.16
Fat, %	5.11 ± 0.25 [4.59–6.47]	5.23 ± 0.31 [4.58–6.95]	0.76
Protein, %	3.45 ± 0.06 [3.18–3.63]	3.41 ± 0.06 [3.19–3.62]	0.76
Lactose, %	4.48 ± 0.07 [4.19–4.72]	4.5 ± 0.09 [4.16–4.95]	0.86
Solid in non- fat substance, %	8.74 ± 0.08 [8.47–9.09]	8.71 ± 0.08 [8.44–9.1]	0.77
Freezing point Depression (°C)	−0.542 ± 0.003 [−0.532–(−0.558)]	−0.549 ± 0.001 [−0.541–(−0.556)]	0.08
Somatic Cell Counts (SCC) (log cfu/mL)	6.01 ± 0.14 [5.48–6.55]	6.00 ± 0.13 [5.46–6.53]	0.96
Total Viable Counts (TVC) (log cfu/mL)	5.20 ± 0.21 [4.41–5.72]	5.33 ± 0.20 [4.49–6.02]	0.64

¹ Mean values ± standard error. The minimum and maximum values are reported in the brackets. ² A total of 14 sheep milk samples were collected (seven samples at farm level and seven at industry level).

Sheep milk is known to be rich in proteins, minerals, and lipids; it contains a high amount of calcium, phosphate, and magnesium, and the lipid part contains high middle-chain fatty acids. Due to its richness, sheep milk can provide high cheese-making yields. Goat milk is considered to have fewer allergens; therefore, it may replace human milk better than cow milk and it is denoted for its composition of fatty acids (it contains more short-chain and middle-chain fatty acids) [27].

In the present study, the major income of farmers' owing from dairy animals was derived from the milk; therefore, factors that reduce milk quantity and quality can cause high economic losses to the farmers. For sheep and goat milk, whose production was primary devoted to the manufacture of dairy products (cheese, yoghurt); its composition is

of special interest, since the payment formulate of the dairy processing companies to the farmers depends on the protein and fat composition of it. The chemical composition of milk is generally affected by many factors such as species, breed, stage of lactation, animal's health and age, feeding regime, and season [28].

For the sheep milk, the accepted limits of the officially Milk Quality Testing of Laboratory of Ioannina, ELGO-DIMITRA are for fat 5–10%, protein 5.2–7%, lactose 4.2–5.3%, solid in non-fat substance 10.3–12.2%, freezing point depression from -0.545 to -0.585 °C and for goat milk fat 3.5–6.3%, protein 3.3–4.3%, lactose 4.10–5.10%, solid in non-fat substance 8.5–9.8%, freezing-point depression from -0.540 to -0.565 °C. As shown in Tables 4 and 5, the physico-chemical parameters of sheep and goat milk samples were, in general, in line with the aforementioned limits; thus, milk from the Ioannina region was of good quality. Moreover, the physico-chemical and microbiological characteristics of sheep and goat raw milk in this study were in accordance with the official results for the Ioannina region for the year 2018 [29] and were in line with other reports on milk quality conducted in nearby regions. Most notably, Bontinis et al. [30] reported that the quality of milk from sheep of Arta breed was good and milk of good quality may positively affect the income of farmers via production of local made cheese products.

Mean TVC for sheep milk in the present study, was in accordance with the results of previous studies [31,32]. Goat milk of this study (5.20–5.33 log cfu/mL) showed lower values of TVCs than those reported (6.05–6.14 log cfu/mL) by Kondyli et al. [32] and (7.55 log cfu/mL) by Morgan et al. [33], suggesting better hygienic conditions than those reported from the latter researchers (such as improved hygienic conditions of milk production and handling, better cooling facilities etc.). The regulation (EC) No 853/2004 [34] specified that raw sheep and goat milk must have $\leq 1,500,000$ cells/mL; therefore, the results of this study met this criterion. Under this scope, high TVC values maybe a result of poor hygiene and management at the farm level and may be related to milk and tank hygiene [35]. Similarly, Soomro et al. [36] reported that the average TVC content was higher in transported tank milk samples as compared to fresh and bulk tank buffalo milk samples. Delays in the transportation of raw milk to the dairy industries without bringing down the temperature at 4–5 °C might have negative impact on the raw milk quality due to the fast proliferation of bacteria load within a short period of time. Moreover, the unhygienic conditions and improper storage conditions at farm may contribute to bacteria proliferation. Additionally, pooling of milk from different farms (suppliers) at the cooling centers may possess a risk factor to the growth and proliferation of the indigenous microflora causing a reduction in milk quality and safety [37]. Lingathurai et al. [38] found that cow milk is easily contaminated after milking and during transportation to the milk collection centers or dairy industry due to the external contamination or increased temperature. In fact, cleanliness of the farm, of the animals, of milking parlors, sealing off of the udders, non-delay in transporting the milk to the tank when hand-milking applied, rapid cooling and refrigeration of the milk at correct temperature, frequent collection of the milk and good hygiene of the milking equipment/milk storage tank were important factors in order to achieve low TVCs like those of the present study.

Bulk milk somatic cell count (SCC) can be used to evaluate the udder health status of a herd. Maintenance of low SCC in milk was necessary, as elevated SCC in milk had an effect on milk composition and subsequent changes in cheese quality. According to our knowledge, the European Union has not adapted an upper SCC limit for sheep and goat milk. In the present study, SCC of sheep milk was 6.06 at farm and 6.10 log cfu/mL at industry and of goat milk 6.01 and 6.00 log cfu/mL, respectively. Similar levels (6.05 log cfu/mL) have been found in previous studies [30,31] for sheep milk. In the present study, lower levels of SCCs for goat milk (6.01–6.00 log cfu/mL) were observed than those reported by Morgan et al. [33], suggesting a better quality of goat milk compared to previous years. According to the propositions made by Leithner et al. [2], sheep and goat milk with >6.54 log SCC/mL should not be accepted for consumption because of the high probability that such milk would contain pathogens and toxins and its poor industrial quality (very low or

complete absence of curdling). Under this context, in cows, SCC can be regarded as a value related to mastitis revealing possible infections by *Staphylococcus aureus* and *Streptococcus agalactiae* [39]. In addition, milk with low bacterial counts and SCC results in higher quality milk products with increased shelf life [40,41].

Although no firm conclusions can be drawn due to the small number of samples, no statistically significant difference was determined to the data collected from the farm and the mcc/industry ($p > 0.05$). Ways of transport of raw sheep and goat milk from farms to the factories, the procedures applied in the farms (i.e., discarding the mastitis infected milk or storage of milk under refrigeration) and inside the factories (such as delivering the milk for processing within the specified time) resulted in good quality milk produced in Ioannina region of Greece.

3.5. SWOT Analysis

The data from the present study demonstrate that the main strengths of the dairy sector were the desire of sheep and goat farmers to continue in the future their existence in the sector (58.82%) together with their willing to be engaged in a process that will allow them to sell their products at a higher prices and the existence of purebred animals of the local sheep (*Katsika* or *Karamaniko* and *Kalaritiko*) and the autochthonous goat breeds (*Capra prisca*) which are well adapted in the mountainous area of Ioannina region. Farmers who raised sheep and goat purebred animals had a strong belief on the breed's special characteristics (both in terms of phenotype and milk quality). Also, the organization of the farms was regarded as good since all (100%) of them had access to water and electricity current. Farmers used good practices in milk handling (such as discarding the milk from animals during therapy of mastitis, milk storing in milk tank and in an emergency case to address the veterinarian).

The existence of a significant number of licensed dairy companies in Ioannina region could play an important role in setting quality standards of the dairy sector (good transportation conditions of the milk). These companies produced a high variety of dairy products of high quality and nutritional value such as cheese under labeling (i.e., PDO), yoghurt as well as specific dairy products (organic cheeses, low fat cheeses etc). There were two of the leading establishments in the dairy industries, located in Ioannina region, which both of them were under private status. The milk from farm to industry was of good quality.

The results of the present study showed that Weakness of the dairy sector were the age of the farmers (visible absence of young people as 0% are under 25 years old and only 9.8% are between 25 and 30 years old) and the low educational level (35.29% graduated primary school while 45.10% high school). The exclusive involvement in livestock farming (72.55% of the farmers did not have other sources for their income) together with the labor and the lack of availability of time for other activities were not appealing to young people neither encouraged them to get involved in livestock farming. The high cost (42.31% of the farmers pay 10,000–30,000 euro per year to buy the animal feeds and 69.23% pay less than 2000 euro per year for veterinary services) of milk production in combination with the low prices of selling the milk to the dairy companies and the high delay time of the payment (60–90 days) were dissuasive factors. Moreover, 96.08% of the farmers in this study were paid on credit and could face liquidity problems. Farmers faced difficulties regarding the weak organization of cooperative strategies to promote their interests, such as ensuring better sales prices, differentiation of prices according to the milk quality, production of animal feed, better market infrastructure, better promotion of sheep and goat milk etc.

All the dairy industries of the present survey reported the high cost of buying the milk (raw material). The fragmentation/dispersion of the farms resulted in high collection and transportation costs that in turn seemed to affect the small dairy companies. The seasonality of selling the sheep and goat dairy products could be another restraint factor. The dairy industries were determining the milk prices while livestock farmers were price takers. Furthermore, there was no price differentiation on milk quality (i.e., if the milk was

organic). Moreover, few traditional sheep and goat farms were organized as vertical farms in the region of Ioannina (only one participated in the present survey).

The opportunities of the sector were that in general, in the region of Ioannina there were farms with flocks with purebred animals of the local sheep breeds of *Katsika* (*Karamaniko*) and *Kalaritiko* and local type of goats, with good adaptation to the environmental conditions of Ioannina area. Traditional dairy products using the milk of these breeds could be produced and promoted.

The region of Ioannina has opportunities for touristic development, due to the advantages of the traditional communities, cultural heritage, and natural beauty areas. There are many sites of nature scenery near Ioannina including the two protected national parks and the villages of Zagori. Therefore, the region of Ioannina is of high touristic interest and there are a lot of traditional and local cheeses produced there. There are a lot of opportunities with significant perspectives, as there is a great preference for traditional cheeses of high quality, allowing their expansion in the market. Improvement of the infrastructures in a mountainous area, supporting activities like agro-tourism, promotion of extensive farming and of traditional and local dairy products could strengthen the dairy sector and distribute added value to the sheep and goat milk products.

The Greek dairy products especially cheeses are still very much preferred for consumption from Greeks as well as from tourists. Also, the market of goat milk is continuously being developed. Moreover, as there is an upward trend of demand for special dairy products (such as functional, organic etc) the dairy companies of the area have the potential and the technological knowledge to manufacture such products.

The threats of sheep and goat dairy sector, generally, were the difficult daily life of farmers especially in the mountains and the import of milk from other countries at a low price. Additionally, there was a high competition of the Greek dairy products with similar products (i.e., yoghurt and feta cheese) produced in other countries inside and outside the European Union.

The results of the present study are in agreement with the findings of Pappa et al. [21], who report that some the prospects of the Greek dairy sector are the production of high-quality dairy products, the production of products well known worldwide like feta cheese or yoghurt, and the strong and competitive dairy industry. Also, they state that some of the constraints include the high age level of the farmers, the structure of the sector with mainly small farms, the lack of liquidity and access to funding, the high production cost, the lack of proper farmers' training and education and the global competition and imitation of characteristic Greek dairy products. Moreover, Aggelopoulos and Arabatzis [42] evaluated the aid Programmes for Young Farmers and concluded that the financial incentives that were given to young people in Greece in order to remain in rural areas improved the financial viability of their agricultural holdings.

4. Conclusions

The present study revealed that all farms in the Ioannina region met the basic requirements for farm operation (water and electricity), the majority of them had a license to operate, used conventional (i.e., non-organic) milk, and employed family members. The collected and analyzed milk samples revealed the good quality and safety of the milk. The farmers' determination to continue working in the sector despite milk prices and liquidity problems is regarded as a major strength of the sector. However, the weakness of the dairy sector was the age of the farmers and their low educational level. Local sheep breeds and types of goats, with good adaptation to the environmental conditions of Ioannina area were regarded as great opportunities. Threats of sheep and goat dairy sector included but were not limited to the difficult daily life of farmers especially in the mountains and the import of milk from other countries at a low price. Hence, the efficiency of sheep and goat farming could be increased by focusing on developing farm market for direct selling and adding value to the production. A parallel involvement of farmers or of the members of their family with off-farm activities (such as developing agro-tourism activities) will

contribute on the improvement of their quality of life and generate additional sources of income. Additionally, efforts should take place by the authorities to improve the educational and professional training of the farmers. In conclusion, the future of Greek dairy chain is promising, given that young farmers would like to continue to be involved in farming practice, despite high competition within and outside the European Union. It is very important to align good incentives among the different stakeholders in the dairy chain and support the sustainability of the sector.

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