

# Administration of Vaccines in Dairy Sheep and Goat Farms: Patterns of Vaccination, Associations with Health and Production Parameters, Predictors

Daphne T. Lianou, Charalambia K. Michael, Efthymia Petinaki,  
Vasia S. Mavrogianni and George C. Fthenakis

**Table S1.** Details of variables ( $n = 48$ ) collected during interview of farmers by means of a structured questionnaire and used for the assessment of patterns of vaccinations in 444 small ruminant farms during a countrywide investigation in Greece.

---

Management system applied in the farm (description according to EFSA classification <sup>1</sup> )
Total surface of land available to animals for grazing (acres)
Material of the floor of the barn (soil / other)
Availability of straw bedding (yes / no)
Type of milking mode (hand-milking / machine-milking)
No. of female animals in the farm (no.)
Breed of animals in the farm (description)
Average age of culling female animals (years)
Month of the start of the lambing / kidding season (description)
Total milk quantity per ewe / doe obtained during the preceding milking period (litres)
Total number of lambs / kids born during the preceding lambing / kidding season (no.)
Total number of lambs / kids sold during the preceding lambing / kidding season (no.)
Total number of adult animals that died during the preceding production year (no.)
Collaboration with a veterinarian (yes / no)
Age of newborns when taken away from dam (days)
Application of teat disinfection after milking (yes / no)
Use of laboratory diagnostic examinations in samples of milk (yes / no)
Administration of 'dry-ewe' treatment at the end of the lactation period (yes / no)
Duration of dry-period (months)
Daily number of milking sessions (no.)
Vaccination against brucellosis (yes / no)
Immunological product used for vaccination against brucellosis and vaccination regime applied (description)
Vaccination against chlamydial abortion (yes / no)
Immunological product used for vaccination against chlamydial abortion and vaccination regime applied (description)
Vaccination against clostridial infections (yes / no)
Immunological product used for vaccination against clostridial infections and vaccination regime applied (description)
Vaccination against contagious agalactia (yes / no)
Immunological product used for vaccination against contagious agalactia and vaccination regime applied (description)
Vaccination against contagious ecthyma (yes / no)

Immunological product used for vaccination against contagious ecthyma and vaccination regime applied (description)  
 Vaccination against foot-rot (yes / no)  
 Immunological product used for vaccination against foot-rot and vaccination regime applied (description)  
 Vaccination against paratuberculosis (yes / no)  
 Immunological product used for vaccination against paratuberculosis and vaccination regime applied (description)  
 Vaccination against pneumonia (yes / no)  
 Immunological product used for vaccination against pneumonia and vaccination regime applied (description)  
 Vaccination against staphylococcal mastitis (yes / no)  
 Immunological product used for vaccination against staphylococcal mastitis and vaccination regime applied (description)  
 Vaccination against *Toxoplasma gondii* abortion (yes / no)  
 Immunological product used for vaccination against *T. gondii* abortion and vaccination regime applied (description)  
 Routine administration of antibiotics to newborns (yes / no)  
 Age of farmer (years)  
 Length of previous animal farming experience (years)  
 Farmer's general education (description)  
 Farmer's professional involvement in farming (full-time / part-time)  
 Daily period spent by farmer at the farm (hours)  
 Family tradition in farming (yes / no)  
 Presence of working staff in the farm (yes/no)

---

<sup>1</sup> management system classified as intensive, semi-intensive, semi-extensive, extensive (European Food Safety Authority. Scientific opinion on the welfare risks related to the farming of sheep for wool, meat and milk production. *EFSA J.* **2014**, *12*, 3933–4060.).

12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35

36 **Table S2.** Details of multivariable models ( $n = 16$ ) employed for the evaluation for potential associations with optional  
37 vaccinations in 325 sheep flocks and 119 goat herds in Greece.

Outcome	Variables ( $n$ )		
	assessed in uni- variable analyses	offered to the multi- variable models	required in the final models
Vaccination against chlamydial abortion - sheep	16	9	(a) Age of newborns when taken away from dam, (b) Daily number of milking sessions, (c) Age of farmers, (d) Presence of working staff in the farm
Vaccination against chlamydial abortion - goats	16	7	(a) Breed of animals in the farm, (b) Average age of culling female animals, (c) Age of newborns when taken away from dam, (d) Daily number of milking sessions, (e) Daily period spent by farmer at the farm
Vaccination against clostridial infections – sheep	19	6	(a) Management system applied in the farm, (b) Age of farmers, (c) Family tradition in farming
Vaccination against clostridial infections - goats	19	4	(a) Routine administration of antibiotics to newborns, (b) Family tradition in farming
Vaccination against contagious agalactia -sheep	21	16	(a) Management system applied in the farm, (b) Collaboration with a veterinarian, (c) Age of newborns when taken away from dam, (d) Use of laboratory diagnostic examinations in samples of milk, (e) Administration of ‘dry-ewe’ treatment at the end of the lactation period, (f) Duration of dry-period
Vaccination against contagious agalactia - goats	21	17	(a) Type of milking mode, (b) Breed of animals in the farm, (c) Collaboration with a veterinarian, (d) Use of laboratory diagnostic examinations in samples of milk, (e) Administration of ‘dry-ewe’ treatment at the end of the lactation period, (f) Daily number of milking sessions, (g) Farmer’s general education, (h) Farmer’s professional involvement in farming

Vaccination against contagious ecthyma - sheep	15	6	(a) No. of female animals in the farm, (b) Average age of culling female animals, (c) Farmer's general education, (d) Daily period spent by farmer at the farm, (e) Presence of working staff in the farm
Vaccination against contagious ecthyma - goats	15	4	(a) Farmer's general education, (b) Daily period spent by farmer at the farm, (c) Presence of working staff in the farm
Vaccination against footrot - sheep	19	3	(a) Farmer's professional involvement in farming, (b) Daily period spent by farmer at the farm
Vaccination against paratuberculosis - sheep	19	6	(a) Type of milking mode, (b) Average age of culling female animals, (c) Month of the start of the lambing season
Vaccination against paratuberculosis - goats	19	6	(a) Material of the floor of the barn, (b) No. of female animals in the farm
Vaccination against pneumonia - sheep	18	5	(a) Total surface of land available to animals for grazing, (b) Month of the start of the lambing season, (c) Routine administration of antibiotics to newborns, (d) Daily period spent by farmer at the farm
Vaccination against pneumonia - goats	18	2	(a) Presence of working staff in the farm
Vaccination against staphylococcal mastitis - sheep	21	14	(a) Management system applied in the farm, (b) Collaboration with a veterinarian, (c) Use of laboratory diagnostic examinations in samples of milk, (d) Administration of 'dry-ewe' treatment at the end of the lactation period, (e) Farmer's professional involvement in farming
Vaccination against staphylococcal mastitis - goats	21	11	(a) Type of milking mode, (b) Age of newborns when taken away from dam, (c) Daily number of milking sessions, (d) Daily period spent by farmer at the farm

			(a) Management system applied in the farm, (b) Collaboration with a veterinarian, (c) Age of newborns when taken away from dam, (d) Routine administration of antibiotics to newborns, (e) Daily number of milking sessions, (f) Use of laboratory diagnostic examinations in samples of milk, (g) Administration of 'dry-ewe' treatment at the end of the lactation period, (h) Age of farmers
Total number of optional vaccines administered - sheep	19	14	
			(a) Type of milking mode, (b) Breed of animals in the farm, (c) Daily number of milking sessions, (d) Use of laboratory diagnostic examinations in samples of milk, (e) Administration of 'dry-ewe' treatment at the end of the lactation period, (f) Daily period spent by farmer at the farm
Total number of optional vaccines administered - goat	16	10	

38  
39  
40  
41  
42

43 **Table S3.** Frequency of usage of specific immunological products for optional vaccinations in 325 sheep flocks and 119 goat  
44 herds in Greece.

<b>Vaccinations against chlamydial abortion</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 101) <sup>1</sup>	Goat herds ( <i>n</i> = 31)
Enzovax	98 (97.0%) <sup>2</sup>	29 (93.5%)
Inmeva	1 (1.0%)	1 (3.2%)
Ovax	2 (2.0%)	1 (3.2%)
<b>Vaccinations against clostridial infections</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 295)	Goat herds ( <i>n</i> = 108)
Anero	6 (2.0%)	9 (8.3%)
Bravoxin	64 (21.7%)	32 (29.6%)
Covexin 8A	90 (30.5%)	37 (34.3%)
Covexin 10	1 (0.3%)	0 (0.0%)
Cubolac	3 (1.0%)	0 (0.0%)
Dialuene P	126 (42.7%)	32 (29.6%)
Panclostil	16 (5.4%)	9 (8.3%)
Toxipra	67 (22.7%)	29 (26.9%)
<b>Vaccinations against contagious agalactia</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 144)	Goat herds ( <i>n</i> = 52)
Agalax	120 (83.3%)	39 (75.0%)
Galazel	32 (22.2%)	14 (26.9%)
<b>Vaccinations against contagious ecthyma</b>		
Farmers who provided the information		
	Sheep flocks ( <i>n</i> = 0)	Goat herds ( <i>n</i> = 0)
<b>Vaccinations against foot-rot</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 4)	Goat herds ( <i>n</i> = 0)
Footvax	4 (100.0%)	
<b>Vaccinations against paratuberculosis</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 3)	Goat herds ( <i>n</i> = 26)
Gudair	3 (100.0%)	26 (100.0%)
<b>Vaccinations against pneumonia</b>		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 139)	Goat herds ( <i>n</i> = 39)
Dialuene P	126 (90.6%)	33 (84.6%)
Ovipast	16 (11.5%)	8 (20.5%)

Vaccinations against staphylococcal mastitis		
Farmers who provided the information		
Vaccine used <sup>3</sup>	Sheep flocks ( <i>n</i> = 124)	Goat herds ( <i>n</i> = 34)
Mastivet	14 (11.3%)	3 (8.8%)
Ovax	21 (16.9%)	6 (17.6%)
Startvac	9 (7.3%)	1 (2.9%)
Vimco	81 (65.3%)	25 (73.5%)
Vaccinations against <i>T. gondii</i> abortion		
Farmers who provided the information		
	Sheep flocks ( <i>n</i> = 0)	Goat herds ( <i>n</i> = 0)

<sup>1</sup> number of sheep flocks or goat herds in which specific products used for vaccinations were reported.

<sup>2</sup> number of farms (proportion).

<sup>3</sup> all product names listed are ®.

53 **Table S4.** Association between the total number of optional vaccinations performed in a farm and the average yearly milk  
54 production, as found in 444 small ruminant farms in Greece.

Number of vaccines administered							
	0 ( <i>n</i> = 4 <sup>1</sup> )	1 ( <i>n</i> = 18)	2 ( <i>n</i> = 57)	3 ( <i>n</i> = 121)	4 ( <i>n</i> = 111)	5 ( <i>n</i> = 77)	6 ( <i>n</i> = 47)
Average milk							
production	62.0 ± 5.5	112.9 ± 15.0	181.7 ± 10.4	190.0 ± 9.4	221.3 ± 9.0	219.8 ± 8.7	256.8 ± 13.6
(L)							

55 <sup>1</sup> number of farms, in which respective number of vaccinations were performed.

56  
57  
58  
59

60 **Table S5.** Results of univariable analysis for associations with optional vaccination against chlamydial abortion in 325 sheep flocks and 119 goat herds in Greece.

61

(a) Sheep flocks

Vaccination performed ( <i>n</i> = 130)				Vaccination not performed ( <i>n</i> = 195)				<i>p</i>
Management system applied in the farm								
Intensive 24	Semi-intensive 66	Semi-extensive 35	Extensive 5	Intensive 20	Semi-intensive 74	Semi-extensive 81	Extensive 20	0.001
No. of ewes in the flock								
≤ 165 ewes 28	166-330 ewes 46	331-500 ewes 30	> 500 ewes 26	≤ 165 ewes 60	166-330 ewes 74	331-500 ewes 36	> 500 ewes 25	0.11
Breed of animals								
Crossbreeds 17	Imported breeds 61	Local breeds 52		Crossbreeds 26	Imported breeds 78	Local breeds 91		0.43
Milking mode in flock								
Machine-milking 118		Hand-milking 12		Machine-milking 137		Hand-milking 58		< 0.0001
Average age of culling ewes								
≤ 6.5 years 104		> 6.5 years 26		≤ 6.5 years 138		> 6.5 years 57		0.06
Start of lambing period								
All year 7	Autumn 106	Winter 15	Spring - Summer 2	All year 11	Autumn 139	Winter 40	Spring - Summer 5	0.16
Collaboration with a veterinarian								
Yes 117		No 13		Yes 166		No 29		0.20
Age of newborns taken away from dam								
≤ 40 days 63	41 – 60 days 61	≥ 61 days 6		≤ 40 days 54	41 – 60 days 111	≥ 61 days 30		< 0.0001
Number of daily milking sessions								
One 0	Two 92	Three 38		One 1	Two 172	Three 22		0.0002
Age of the farmer								
Up to 50 years 91		Over 50 years 39		Up to 50 years 106		Over 50 years 89		0.005

Length of previous animal farming experience of the farmer						0.23
≤ 5 years		> 5 years				
34		96		40155		
Education of the farmer						0.75
Primary education		Secondary or post-secondary education		Tertiary education		
25		87		183213825		
Professional involvement in farming						0.76
Full-time		Part-time		Full-time		
116		14		17619		
Daily period at the farm						0.38
≤ 8 hours		> 8 hours		≤ 8 hours		
36		94		63132		
Family tradition in farming						0.69
Yes		No		Yes		
112		18		17124		
Presence of working staff in the flock						0.002
Yes		No		Yes		
63		67		60135		

62

(b) Goat herds

Vaccination performed ( <i>n</i> = 39)				Vaccination not performed ( <i>n</i> = 80)				<i>p</i>
Management system applied in the farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	0.39
2	12	21	4	7	17	40	16	
No. of does in the herd								
≤ 165 does	166-330 does	331-500 does	> 500 does	≤ 165 does	166-330 does	331-500 does	> 500 does	0.34
18	11	7	3	38	26	6	10	
Breed of animals								
Crossbreeds	Imported breeds	Local breeds	Crossbreeds	Imported breeds	Local breeds			0.013
7	21	11	11	24	45			
Milking mode in herd								
Machine-milking		Hand-milking	Machine-milking		Hand-milking			0.09
26		13	40		40			

Average age of culling does							
≤ 6.5 years		> 6.5 years		≤ 6.5 years		> 6.5 years	
26		13		24		56	
0.0001							
Start of kidding period							
All year	Autumn	Winter	Spring - Summer	All year	Autumn	Winter	Spring - Summer
3	23	12	1	5	40	32	3
0.75							
Collaboration with a veterinarian							
Yes		No		Yes		No	
36		3		65		15	
0.11							
Age of newborns taken away from dam							
≤ 40 days		41 – 60 days		≤ 40 days		41 – 60 days	
15		12		11		32	
0.009							
Number of daily milking sessions							
One		Two		One		Two	
1		32		3		76	
0.009							
Age of the farmer							
Up to 50 years		Over 50 years		Up to 50 years		Over 50 years	
26		13		47		33	
0.41							
Length of previous animal farming experience of the farmer							
≤ 5 years		> 5 years		≤ 5 years		> 5 years	
9		30		15		65	
0.58							
Education of the farmer							
Primary education	Secondary or post-secondary education		Tertiary education	Primary education	Secondary or post-secondary education		Tertiary education
4	30		5	16	59		5
0.24							
Professional involvement in farming							
Full-time		Part-time		Full-time		Part-time	
36		3		69		11	
0.34							
Daily period at the farm							
≤ 8 hours		> 8 hours		≤ 8 hours		> 8 hours	
5		34		23		57	
0.05							
Family tradition in farming							
Yes		No		Yes		No	
33		6		70		10	
0.67							

63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94

Presence of working staff in the flock				
Yes	No	Yes	No	
11	28	23	57	0.95

95 **Table S6.** Results of univariable analysis for associations with optional vaccination against clostridial infections in 325 sheep flocks and 119 goat herds in Greece.

96

(a) Sheep flocks

Vaccination performed ( <i>n</i> = 316)				Vaccination not performed ( <i>n</i> = 9)				<i>p</i>
Management system applied in the farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	0.016
44	138	112	22	0	2	4	3	
No. of ewes in the flock								
≤ 165 ewes	166-330 ewes	331-500 ewes	> 500 ewes	≤ 165 ewes	166-330 ewes	331-500 ewes	> 500 ewes	0.95
86	116	64	50	2	4	2	1	
Breed of animals								
Crossbreeds	Imported breeds	Local breeds	Crossbreeds	Imported breeds	Local breeds			0.15
41	138	137	2	1	6			
Total land available for grazing (acres per animal)								
≤ 0.50	0.51 – 2.00	≥ 2.00	≤ 0.50	0.51 – 2.00	≥ 2.00			0.63
116	126	74	2	4	3			
Use of straw as bedding material								
Yes	No	Yes	No					0.21
262	54	6	3					
Milking mode in flock								
Machine-milking	Hand-milking	Machine-milking	Hand-milking					0.38
249	67	6	3					
Average age of culling ewes								
≤ 6.5 years	> 6.5 years	≤ 6.5 years	> 6.5 years					0.82
235	81	7	2					
Start of lambing period								
All year	Autumn	Winter	Spring - Summer	All year	Autumn	Winter	Spring - Summer	0.77
18	237	54	7	0	8	1	0	
Collaboration with a veterinarian								
Yes	No	Yes	No					0.06
277	39	6	3					
Age of newborns taken away from dam								
≤ 40 days	41 – 60 days	≥ 61 days	≤ 40 days	41 – 60 days	≥ 61 days			0.004
114	170	32	3	2	4			

<b>Routine administration of antibiotics to newborns</b>					
Yes	No	Yes	No		
68	248	2	7		0.96
<b>Number of daily milking sessions</b>					
One	Two	Three	One	Two	Three
1	255	60	0	9	0
					0.34
<b>Age of the farmer</b>					
Up to 50 years	Over 50 years	Up to 50 years	Over 50 years		
195	121	2	7		0.017
<b>Length of previous animal farming experience of the farmer</b>					
≤ 5 years	> 5 years	≤ 5 years	> 5 years		
73	243	1	8		0.40
<b>Education of the farmer</b>					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
57	217	42	0	8	1
					0.34
<b>Professional involvement in farming</b>					
Full-time	Part-time	Full-time	Part-time		
284	32	8	1		0.92
<b>Daily period at the farm</b>					
≤ 8 hours	> 8 hours	≤ 8 hours	> 8 hours		
95	221	4	5		0.36
<b>Family tradition in farming</b>					
Yes	No	Yes	No		
277	39	6	3		0.06
<b>Presence of working staff in the flock</b>					
Yes	No	Yes	No		
120	196	3	6		0.78

97

98

99

Vaccination performed ( <i>n</i> = 118)				Vaccination not performed ( <i>n</i> = 1)				<i>p</i>
Management system applied in the farm								
Intensive 9	Semi-intensive 29	Semi-extensive 60	Extensive 20	Intensive 0	Semi-intensive 0	Semi-extensive 1	Extensive 0	0.81
No. of does in the herd								
≤ 165 does 56	166-330 does 36	331-500 does 13	> 500 does 13	≤ 165 does 0	166-330 does 1	331-500 does 0	> 500 does 0	0.53
Breed of animals								
Crossbreeds 18	Imported breeds 45	Local breeds 55	Crossbreeds 0	Imported breeds 0	Local breeds 1			0.57
Total land available for grazing (acres per animal)								
≤ 0.50 17	0.51 – 2.00 31	≥ 2.00 70	≤ 0.50 0	0.51 – 2.00 0	≥ 2.00 1			0.37
Use of straw as bedding material								
Yes 75	No 43	Yes 1	No 0					0.45
Milking mode in herd								
Machine-milking 65	Hand-milking 53	Machine-milking 1	Hand-milking 0					0.37
Average age of culling does								
≤ 6.5 years 49	> 6.5 years 69	≤ 6.5 years 1	> 6.5 years 0					0.24
Start of kidding period								
All year 8	Autumn 62	Winter 44	Spring - Summer 4	All year 0	Autumn 1	Winter 0	Spring - Summer 0	0.83
Collaboration with a veterinarian								
Yes 100	No 18	Yes 1	No 0					0.67
Age of newborns taken away from dam								
≤ 40 days 25	41 – 60 days 44	≥ 61 days 49	≤ 40 days 1	41 – 60 days 0	≥ 61 days 0			0.16
Routine administration of antibiotics to newborns								
Yes 29	No 89	Yes 1	No 0					0.08

Number of daily milking sessions					
One	Two	Three	One	Two	Three
4	107	7	0	1	0
0.95					
Age of the farmer					
Up to 50 years		Over 50 years	Up to 50 years		Over 50 years
72		46	1		0
0.43					
Length of previous animal farming experience of the farmer					
≤ 5 years		> 5 years	≤ 5 years		> 5 years
24		94	0		1
0.61					
Education of the farmer					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
20	88	10	0	1	0
0.84					
Professional involvement in farming					
Full-time		Part-time	Full-time		Part-time
104		14	1		0
0.71					
Daily period at the farm					
≤ 8 hours		> 8 hours	≤ 8 hours		> 8 hours
27		91	1		0
0.07					
Family tradition in farming					
Yes		No	Yes		No
103		15	0		1
0.011					
Presence of working staff in the flock					
Yes		No	Yes		No
34		84	0		1
0.53					

101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111

112 **Table S7.** Results of univariable analysis for associations with optional vaccination against contagious agalactia in 325 sheep flocks and 119 goat herds in Greece.

113

(a) Sheep flocks

Vaccination performed ( <i>n</i> = 186)				Vaccination not performed ( <i>n</i> = 139)				<i>p</i>
Management system applied in the farm								
Intensive 36	Semi-intensive 89	Semi-extensive 58	Extensive 3	Intensive 8	Semi-intensive 51	Semi-extensive 58	Extensive 22	< 0.0001
No. of ewes in the flock								
≤ 165 ewes 45	166-330 ewes 72	331-500 ewes 38	> 500 ewes 31	≤ 165 ewes 43	166-330 ewes 48	331-500 ewes 28	> 500 ewes 20	0.58
Breed of animals								
Crossbreeds 23	Imported breeds 94	Local breeds 69	Crossbreeds 20	Imported breeds 44	Local breeds 75			0.002
Total land available for grazing (acres per animal)								
≤ 0.50 80	0.51 – 2.00 69	≥ 2.00 37	≤ 0.50 38	0.51 – 2.00 61	≥ 2.00 40			0.011
Milking mode in flock								
Machine-milking 163	Hand-milking 23	Machine-milking 92	Hand-milking 47					< 0.0001
Average age of culling ewes								
≤ 6.5 years 146	> 6.5 years 40	≤ 6.5 years 96	> 6.5 years 43					0.05
Start of lambing period								
All year 11	Autumn 141	Winter 30	Spring – Summer 4	All year 7	Autumn 104	Winter 25	Spring - Summer 3	0.96
Collaboration with a veterinarian								
Yes 173	No 13	Yes 110	No 29					0.0002
Age of newborns taken away from dam								
≤ 40 days 79	41 – 60 days 97	≥ 61 days 10	≤ 40 days 38	41 – 60 days 75	≥ 61 days 26			0.0001
Number of daily milking sessions								
One 0	Two 145	Three 41	One 1	Two 119	Three 19			0.08

<b>Use of laboratory diagnostic examinations in samples of milk</b>					
Yes	No	Yes	No		
52	134	18	121		0.001
<b>Application of teat disinfection during milking</b>					
Yes	No	Yes	No		
33	153	19	120		0.32
<b>Application of 'dry-period treatment'</b>					
Yes	No	Yes	No		
40	146	13	126		0.003
<b>Duration of dry-period (months)</b>					
≤ 2	> 2	≤ 2	> 2		
77	109	30	109		0.0002
<b>Age of the farmer</b>					
Up to 50 years	Over 50 years	Up to 50 years	Over 50 years		
132	54	65	74		< 0.0001
<b>Length of previous animal farming experience of the farmer</b>					
≤ 5 years	> 5 years	≤ 5 years	> 5 years		
52	134	22	117		0.01
<b>Education of the farmer</b>					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
34	129	23	23	96	20
					0.83
<b>Professional involvement in farming</b>					
Full-time	Part-time	Full-time	Part-time		
164	22	128	11		0.25
<b>Daily period at the farm</b>					
≤ 8 hours	> 8 hours	≤ 8 hours	> 8 hours		
62	124	37	102		0.19
<b>Family tradition in farming</b>					
Yes	No	Yes	No		
156	30	127	12		0.046
<b>Presence of working staff in the flock</b>					
Yes	No	Yes	No		
83	103	41	98		0.005

Vaccination performed ( <i>n</i> = 65)				Vaccination not performed ( <i>n</i> = 54)				<i>p</i>
Management system applied in the farm								
Intensive 7	Semi-intensive 17	Semi-extensive 33	Extensive 8	Intensive 2	Semi-intensive 12	Semi-extensive 28	Extensive 12	0.28
No. of does in the herd								
≤ 165 ewes 32	166-330 ewes 20	331-500 ewes 7	> 500 ewes 6	≤ 165 ewes 24	166-330 ewes 17	331-500 ewes 6	> 500 ewes 7	0.91
Breed of animals								
Crossbreeds 14	Imported breeds 29	Local breeds 22		Crossbreeds 4	Imported breeds 16	Local breeds 34		0.004
Total land available for grazing (acres per animal)								
≤ 0.50 12	0.51 – 2.00 14	≥ 2.00 39		≤ 0.50 5	0.51 – 2.00 17	≥ 2.00 32		0.24
Milking mode in herd								
Machine-milking 44		Hand-milking 21		Machine-milking 22		Hand-milking 32		0.003
Average age of culling does								
≤ 6.5 years 33		> 6.5 years 32		≤ 6.5 years 17		> 6.5 years 37		0.034
Start of kidding period								
All year 7	Autumn 31	Winter 24	Spring - Summer 3	All year 1	Autumn 32	Winter 20	Spring - Summer 1	0.18
Collaboration with a veterinarian								
Yes 62		No 3		Yes 40		No 14		0.0009
Age of newborns taken away from dam								
≤ 40 days 19	41 – 60 days 22	≥ 61 days 24		≤ 40 days 7	41 – 60 days 22	≥ 61 days 25		0.10
Number of daily milking sessions								
One 1	Two 58	Three 6		One 3	Two 50	Three 1		0.12
Use of laboratory diagnostic examinations in samples of milk								
Yes 22		No 43		Yes 3		No 51		0.0002

<b>Application of teat disinfection during milking</b>					
Yes	No	Yes	No		
11	54	1	53		0.007
<b>Application of 'dry-period treatment'</b>					
Yes	No	Yes	No		
14	51	1	53		0.001
<b>Duration of dry-period (months)</b>					
≤ 2	> 2	≤ 2	> 2		
20	45	19	35		0.61
<b>Age of the farmer</b>					
Up to 50 years	Over 50 years	Up to 50 years	Over 50 years		
44	21	29	25		0.12
<b>Length of previous animal farming experience of the farmer</b>					
≤ 5 years	> 5 years	≤ 5 years	> 5 years		
18	47	6	48		0.025
<b>Education of the farmer</b>					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
10	51	4	10	35	9
					0.14
<b>Professional involvement in farming</b>					
Full-time	Part-time	Full-time	Part-time		
54	11	51	3		0.06
<b>Daily period at the farm</b>					
≤ 8 hours	> 8 hours	≤ 8 hours	> 8 hours		
19	46	9	45		0.11
<b>Family tradition in farming</b>					
Yes	No	Yes	No		
52	13	51	3		0.021
<b>Presence of working staff in the flock</b>					
Yes	No	Yes	No		
22	43	12	42		0.16

115  
116  
117  
118

119 **Table S8.** Results of univariable analysis for associations with optional vaccination against contagious ecthyma in 325 sheep flocks and 119 goat herds in Greece.

120 (a) Sheep flocks

Vaccination performed (n = 3)				Vaccination not performed (n = 322)				p
Management system applied in the farm								
Intensive 1	Semi-intensive 1	Semi-extensive 1	Extensive 0	Intensive 43	Semi-intensive 139	Semi-extensive 115	Extensive 25	0.76
No. of ewes in the flock								
≤ 165 ewes 0	166-330 ewes 1	331-500 ewes 0	> 500 ewes 2	≤ 165 ewes 88	166-330 ewes 119	331-500 ewes 66	> 500 ewes 49	0.09
Breed of animals								
Crossbreeds 0	Imported breeds 3	Local breeds 0	Crossbreeds 43	Imported breeds 136	Local breeds 143			0.13
Milking mode in flock								
Machine-milking 3	Hand-milking 0	Machine-milking 252	Hand-milking 70					0.36
Average age of culling ewes								
≤ 6.5 years 1	> 6.5 years 2	≤ 6.5 years 241	> 6.5 years 81					0.10
Start of lambing period								
All year 0	Autumn 3	Winter 0	Spring - Summer 0	All year 18	Autumn 242	Winter 55	Spring - Summer 7	
Collaboration with a veterinarian								
Yes 3	No 0	Yes 280	No 42					0.50
Age of newborns taken away from dam								
≤ 40 days 2	41 – 60 days 1	≥ 61 days 0	≤ 40 days 115	41 – 60 days 171	≥ 61 days 36			0.51
Age of the farmer								
Up to 50 years 2	Over 50 years 1	Up to 50 years 195	Over 50 years 127					0.83
Length of previous animal farming experience of the farmer								
≤ 5 years 1	> 5 years 2	≤ 5 years 73	> 5 years 249					0.66

Education of the farmer						
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education	
2	1	0	55	224	43	0.08
Professional involvement in farming						
Full-time		Part-time	Full-time		Part-time	
3		0	289		33	0.56
Daily period at the farm						
≤ 8 hours		> 8 hours	≤ 8 hours		> 8 hours	
2		1	97		225	0.17
Family tradition in farming						
Yes		No	Yes		No	
2		1	281		41	0.29
Presence of working staff in the flock						
Yes		No	Yes		No	
3		0	120		202	0.026

## (b) Goat herds

Vaccination performed ( <i>n</i> = 1)				Vaccination not performed ( <i>n</i> = 118)				<i>p</i>
Management system applied in the farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	0.81
0	0	1	0	9	29	60	20	
No. of does in the herd								
≤ 165 ewes	166-330 ewes	331-500 ewes	> 500 ewes	≤ 165 ewes	166-330 ewes	331-500 ewes	> 500 ewes	0.77
1	0	0	0	55	37	13	13	
Breed of animals								
Crossbreeds	Imported breeds	Local breeds		Crossbreeds	Imported breeds	Local breeds		0.06
1	0	0		17	45	56		
Milking mode in herd								
Machine-milking		Hand-milking		Machine-milking		Hand-milking		0.37
1		0		65		53		
Average age of culling does								
≤ 6.5 years		> 6.5 years		≤ 6.5 years		> 6.5 years		0.39
0		1		50		68		

Start of kidding period								
All year 0	Autumn 1	Winter 0	Spring - Summer 0	All year 8	Autumn 62	Winter 44	Spring - Summer 4	0.83
Collaboration with a veterinarian								
Yes 1		No 0		Yes 100		No 18		0.67
Age of newborns taken away from dam								
≤ 40 days 0	41 – 60 days 1	≥ 61 days 0		≤ 40 days 26	41 – 60 days 43	≥ 61 days 49		0.42
Age of the farmer								
Up to 50 years 0		Over 50 years 1		Up to 50 years 73		Over 50 years 45		0.21
Length of previous animal farming experience of the farmer								
≤ 5 years 0		> 5 years 1		≤ 5 years 24		> 5 years 94		0.61
Education of the farmer								
Primary education 1	Secondary or post-secondary education 0	Tertiary education 0		Primary education 19	Secondary or post-secondary education 89	Tertiary education 10		0.08
Professional involvement in farming								
Full-time 1		Part-time 0		Full-time 105		Part-time 13		0.73
Daily period at the farm								
≤ 8 hours 1		> 8 hours 0		≤ 8 hours 27		> 8 hours 91		0.07
Family tradition in farming								
Yes 1		No 0		Yes 102		No 16		0.69
Presence of working staff in the flock								
Yes 1		No 0		Yes 33		No 85		0.11

122  
123  
124  
125

**Table S9.** Results of univariable analysis for associations with optional vaccination against foot-rot in 325 sheep flocks in Greece.

Vaccination performed ( <i>n</i> = 5)				Vaccination not performed ( <i>n</i> = 320)				<i>p</i>
Management system applied in the farm								
Intensive 2	Semi-intensive 2	Semi-extensive 1	Extensive 0	Intensive 42	Semi-intensive 138	Semi-extensive 115	Extensive 25	0.34
No. of ewes in the flock								
≤ 165 ewes 1	166-330 ewes 2	331-500 ewes 1	> 500 ewes 1	≤ 165 ewes 87	166-330 ewes 118	331-500 ewes 65	> 500 ewes 50	0.98
Breed of animals								
Crossbreeds 0	Imported breeds 4	Local breeds 1	Crossbreeds 43	Imported breeds 135	Local breeds 142			0.23
Total land available for grazing (acres per animal)								
≤ 0.50 3	0.51 – 2.00 1	≥ 2.00 1	≤ 0.50 115	0.51 – 2.00 129	≥ 2.00 76			0.24
Material of the floor of the barn								
Soil 5	Other 0		Soil 285	Other 35				0.43
Use of straw as bedding material								
Yes 4	No 1		Yes 264	No 56				0.88
Milking mode in flock								
Machine-milking 5	Hand-milking 0		Machine-milking 250	Hand-milking 70				0.24
Average age of culling ewes								
≤ 6.5 years 5	> 6.5 years 0		≤ 6.5 years 237	> 6.5 years 83				0.19
Start of lambing period								
All year 0	Autumn 5	Winter 0	Spring - Summer 0	All year 18	Autumn 240	Winter 55	Spring - Summer 7	0.65
Collaboration with a veterinarian								
Yes 4	No 1		Yes 279	No 41				0.63
Age of newborns taken away from dam								
≤ 40 days 2	41 – 60 days 2	≥ 61 days 1	≤ 40 days 115	41 – 60 days 170	≥ 61 days 35			0.76

Number of daily milking sessions					
One 0	Two 4	Three 1	One 1	Two 260	Three 59
0.99					
Age of the farmer					
Up to 50 years 3	Over 50 years 2		Up to 50 years 194	Over 50 years 126	
0.98					
Length of previous animal farming experience of the farmer					
≤ 5 years 0	> 5 years 5		≤ 5 years 74	> 5 years 246	
0.22					
Education of the farmer					
Primary education 0	Secondary or post-secondary education 2	Tertiary education 3	Primary education 57	Secondary or post-secondary education 223	Tertiary education 40
0.007					
Professional involvement in farming					
Full-time 5	Part-time 0		Full-time 287	Part-time 33	
0.45					
Daily period at the farm					
≤ 8 hours 3	> 8 hours 2		≤ 8 hours 96	> 8 hours 224	
0.15					
Family tradition in farming					
Yes 4	No 1		Yes 279	No 41	
0.63					
Presence of working staff in the flock					
Yes 2	No 3		Yes 121	No 199	
0.92					

127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137

138 **Table S10.** Results of univariable analysis for associations with optional vaccination against paratuberculosis in 325 sheep flocks and 119 goat herds in Greece.

139 (a) Sheep flocks

Vaccination performed ( <i>n</i> = 11)				Vaccination not performed ( <i>n</i> = 314)				<i>p</i>
Management system applied in the farm								
Intensive 1	Semi-intensive 4	Semi-extensive 6	Extensive 0	Intensive 43	Semi-intensive 136	Semi-extensive 110	Extensive 25	0.51
No. of ewes in the flock								
≤ 165 ewes 3	166-330 ewes 5	331-500 ewes 2	> 500 ewes 1	≤ 165 ewes 86	166-330 ewes 114	331-500 ewes 64	> 500 ewes 50	0.90
Breed of animals								
Crossbreeds 0	Imported breeds 5	Local breeds 6	Crossbreeds 43	Imported breeds 134	Local breeds 137			0.40
Total land available for grazing (acres per animal)								
≤ 0.50 2	0.51 – 2.00 6	≥ 2.00 3	≤ 0.50 116	0.51 – 2.00 124	≥ 2.00 74			0.43
Material of the floor of the barn								
Soil 11		Other 0	Soil 281		Other 33			0.43
Use of straw as bedding material								
Yes 10		No 1	Yes 258		No 56			0.45
Milking mode in flock								
Machine-milking 10		Hand-milking 1	Machine-milking 176		Hand-milking 138			0.022
Average age of culling ewes								
≤ 6.5 years 6		> 6.5 years 5	≤ 6.5 years 236		> 6.5 years 78			0.12
Start of lambing period								
All year 0	Autumn 6	Winter 5	Spring - Summer 0	All year 18	Autumn 239	Winter 50	Spring - Summer 7	0.07
Collaboration with a veterinarian								
Yes 9		No 2	Yes 274		No 40			0.60

Age of newborns taken away from dam						0.13
≤ 40 days 2	41 – 60 days 9	≥ 61 days 0	≤ 40 days 115	41 – 60 days 163	≥ 61 days 36	
Number of daily milking sessions						0.74
One 0	Two 8	Three 3	One 1	Two 256	Three 57	
Age of the farmer						0.40
Up to 50 years 8		Over 50 years 3	Up to 50 years 189		Over 50 years 125	
Length of previous animal farming experience of the farmer						0.27
≤ 5 years 1		> 5 years 10	≤ 5 years 73		> 5 years 241	
Education of the farmer						0.88
Primary education 2	Secondary or post-secondary education 7	Tertiary education 2	Primary education 55	Secondary or post-secondary education 218	Tertiary education 41	
Professional involvement in farming						0.91
Full-time 10		Part-time 1	Full-time 282		Part-time 32	
Daily period at the farm						0.82
≤ 8 hours 3		> 8 hours 8	≤ 8 hours 96		> 8 hours 218	
Family tradition in farming						0.19
Yes 11		No 0	Yes 272		No 42	
Presence of working staff in the flock						0.021
Yes 3		No 8	Yes 194		No 120	

140

(b) Goat herds

Vaccination performed (n = 31)			Vaccination not performed (n = 88)				p
Management system applied in the farm							
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive
2	9	13	7	7	20	48	13
							0.58

No. of does in the herd								0.015
≤ 165 does 8	166-330 does 11	331-500 does 5	> 500 does 7	≤ 165 does 48	166-330 does 26	331-500 does 8	> 500 does 6	
Breed of animals								0.92
Crossbreeds 4	Imported breeds 12	Local breeds 15	Crossbreeds 14	Imported breeds 33	Local breeds 41			
Total land available for grazing (acres per animal)								0.17
≤ 0.50 4	0.51 – 2.00 12	≥ 2.00 15	≤ 0.50 13	0.51 – 2.00 19	≥ 2.00 56			
Material of the floor of the barn								0.13
Soil 25	Other 6		Soil 80	Other 8				
Use of straw as bedding material								0.73
Yes 19	No 12		Yes 57	No 31				
Milking mode in herd								0.45
Machine-milking 19	Hand-milking 12		Machine-milking 47	Hand-milking 41				
Average age of culling does								0.99
≤ 6.5 years 13	> 6.5 years 18		≤ 6.5 years 37	> 6.5 years 51				
Start of kidding period								0.74
All year 2	Autumn 14	Winter 14	Spring - Summer 1	All year 6	Autumn 49	Winter 30	Spring - Summer 3	
Collaboration with a veterinarian								0.14
Yes 26	No 5		Yes 62	No 26				
Age of newborns taken away from dam								0.53
≤ 40 days 7	41 – 60 days 9	≥ 61 days 15	≤ 40 days 19	41 – 60 days 35	≥ 61 days 34			
Number of daily milking sessions								0.12
One 0	Two 31	Three 0	One 4	Two 77	Three 7			

Age of the farmer					
Up to 50 years		Over 50 years	Up to 50 years	Over 50 years	
21		10	52	36	0.38
Length of previous animal farming experience of the farmer					
≤ 5 years		> 5 years	≤ 5 years	> 5 years	
5		26	19	69	0.51
Education of the farmer					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
4	24	3	16	65	7
					0.78
Professional involvement in farming					
Full-time		Part-time	Full-time	Part-time	
26		5	79	9	0.38
Daily period at the farm					
≤ 8 hours		> 8 hours	≤ 8 hours	> 8 hours	
5		26	23	65	0.26
Family tradition in farming					
Yes		No	Yes	No	
29		2	74	14	0.18
Presence of working staff in the flock					
Yes		No	Yes	No	
10		21	24	64	0.60

141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153

154 **Table S11.** Results of univariable analysis for associations with optional vaccination against pneumonia in 325 sheep flocks and 119 goat herds in Greece.

155 (a) Sheep flocks

Vaccination performed ( <i>n</i> = 144)				Vaccination not performed ( <i>n</i> = 181)				<i>p</i>
Management system applied in the farm								
Intensive 23	Semi-intensive 59	Semi-extensive 54	Extensive 8	Intensive 21	Semi-intensive 81	Semi-extensive 62	Extensive 17	0.37
No. of ewes in the flock								
≤ 165 ewes 36	166-330 ewes 54	331-500 ewes 26	> 500 ewes 28	≤ 165 ewes 52	166-330 ewes 66	331-500 ewes 40	> 500 ewes 23	0.33
Breed of animals								
Crossbreeds 19	Imported breeds 64	Local breeds 61	Crossbreeds 24	Imported breeds 75	Local breeds 82			0.85
Total land available for grazing (acres per animal)								
≤ 0.50 51	0.51 – 2.00 69	≥ 2.00 24	≤ 0.50 67	0.51 – 2.00 61	≥ 2.00 53			0.009
Milking mode in flock								
Machine-milking 116	Hand-milking 28	Machine-milking 139	Hand-milking 42					0.41
Average age of culling ewes								
≤ 6.5 years 112	> 6.5 years 32	≤ 6.5 years 130	> 6.5 years 51					0.22
Start of lambing period								
All year 7	Autumn 107	Winter 24	Spring - Summer 6	All year 11	Autumn 138	Winter 31	Spring - Summer 1	0.16
Collaboration with a veterinarian								
Yes 129	No 15	Yes 154	No 27					0.23
Age of newborns taken away from dam								
≤ 40 days 57	41 – 60 days 73	≥ 61 days 14	≤ 40 days 60	41 – 60 days 99	≥ 61 days 22			0.45
Routine administration of antibiotics to newborns								
Yes 41	No 103	Yes 29	No 152					0.007

Number of daily milking sessions						0.15
One 1	Two 111	Three 32	One 0	Two 153	Three 28	
Age of the farmer						0.95
Up to 50 years 87		Over 50 years 57	Up to 50 years 110		Over 50 years 71	
Length of previous animal farming experience of the farmer						0.63
≤ 5 years 31		> 5 years 113	≤ 5 years 43		> 5 years 138	
Education of the farmer						0.77
Primary education 26	Secondary or post-secondary education 97	Tertiary education 21	Primary education 31	Secondary or post-secondary education 128	Tertiary education 22	
Professional involvement in farming						0.89
Full-time 129		Part-time 15	Full-time 163		Part-time 18	
Daily period at the farm						0.017
≤ 8 hours 34		> 8 hours 110	≤ 8 hours 65		> 8 hours 116	
Family tradition in farming						0.90
Yes 125		No 19	Yes 158		No 23	
Presence of working staff in the flock						0.30
Yes 59		No 85	Yes 64		No 117	

156

(b) Goat herds

Vaccination performed ( <i>n</i> = 39)			Vaccination not performed ( <i>n</i> = 80)				<i>p</i>	
Management system applied in the farm								
Intensive 4	Semi-intensive 8	Semi-extensive 21	Extensive 6	Intensive 5	Semi-intensive 21	Semi-extensive 40	Extensive 14	0.78
No. of does in the herd								
≤ 165 does 17	166-330 does 13	331-500 does 8	> 500 does 1	≤ 165 does 39	166-330 does 24	331-500 does 5	> 500 does 12	0.032

Breed of animals							
Crossbreeds	Imported breeds	Local breeds	Crossbreeds	Imported breeds	Local breeds		
5	17	17	13	28	39		0.65
Total land available for grazing (acres per animal)							
≤ 0.50	0.51 – 2.00	≥ 2.00	≤ 0.50	0.51 – 2.00	≥ 2.00		
7	9	23	10	22	48		0.69
Milking mode in herd							
Machine-milking		Hand-milking	Machine-milking		Hand-milking		
22		17	44		36		0.88
Average age of culling does							
≤ 6.5 years		> 6.5 years	≤ 6.5 years		> 6.5 years		
16		23	34		46		0.88
Start of kidding period							
All year	Autumn	Winter	Spring - Summer	All year	Autumn	Winter	Spring - Summer
3	20	14	2	5	43	30	2
							0.88
Collaboration with a veterinarian							
Yes		No	Yes		No		
33		6	68		12		0.96
Age of newborns taken away from dam							
≤ 40 days	41 – 60 days	≥ 61 days	≤ 40 days	41 – 60 days	≥ 61 days		
7	15	17	19	29	32		0.77
Routine administration of antibiotics to newborns							
Yes		No	Yes		No		
8		31	22		58		0.41
Number of daily milking sessions							
One	Two	Three	One	Two	Three		
2	34	3	2	74	4		0.62
Age of the farmer							
Up to 50 years		Over 50 years	Up to 50 years		Over 50 years		
23		16	50		30		0.71
Length of previous animal farming experience of the farmer							
≤ 5 years		> 5 years	≤ 5 years		> 5 years		
6		33	18		52		0.21

Education of the farmer					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
5	32	2	15	57	8
0.43					
Professional involvement in farming					
Full-time		Part-time	Full-time	Part-time	
34		5	71	9	
0.80					
Daily period at the farm					
≤ 8 hours		> 8 hours	≤ 8 hours	> 8 hours	
7		32	21	59	
0.32					
Family tradition in farming					
Yes		No	Yes	No	
36		3	67	13	
0.21					
Presence of working staff in the flock					
Yes		No	Yes	No	
15		24	19	61	
0.10					

157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175

176 **Table S12.** Results of univariable analysis for associations with optional vaccination against staphylococcal mastitis in 325 sheep flocks and 119 goat herds in Greece.

177 (a) Sheep flocks

Vaccination performed ( <i>n</i> = 126)				Vaccination not performed ( <i>n</i> = 199)				<i>p</i>
Management system applied in the farm								
Intensive 20	Semi-intensive 66	Semi-extensive 36	Extensive 4	Intensive 24	Semi-intensive 74	Semi-extensive 80	Extensive 21	0.004
No. of ewes in the flock								
≤ 165 ewes 39	166-330 ewes 48	331-500 ewes 24	> 500 ewes 15	≤ 165 ewes 49	166-330 ewes 72	331-500 ewes 42	> 500 ewes 36	0.35
Breed of animals								
Crossbreeds 15	Imported breeds 66	Local breeds 45	Crossbreeds 28	Imported breeds 73	Local breeds 98			0.019
Total land available for grazing (acres per animal)								
≤ 0.50 52	0.51 – 2.00 50	≥ 2.00 24	≤ 0.50 66	0.51 – 2.00 80	≥ 2.00 53			0.19
Milking mode in flock								
Machine-milking 109	Hand-milking 17	Machine-milking 146	Hand-milking 53					0.005
Average age of culling ewes								
≤ 6.5 years 100	> 6.5 years 26	≤ 6.5 years 142	> 6.5 years 57					0.11
Start of lambing period								
All year 6	Autumn 102	Winter 14	Spring - Summer 4	All year 12	Autumn 143	Winter 41	Spring - Summer 3	0.10
Collaboration with a veterinarian								
Yes 119	No 7	Yes 164	No 35					0.009
Age of newborns taken away from dam								
≤ 40 days 51	41 – 60 days 68	≥ 61 days 7	≤ 40 days 66	41 – 60 days 104	≥ 61 days 29			0.033
Number of daily milking sessions								
One 0	Two 95	Three 31	One 1	Two 169	Three 29			0.06

<b>Use of laboratory diagnostic examinations in samples of milk</b>					
Yes	No	Yes	No		
39	87	31	168		0.001
<b>Application of teat disinfection during milking</b>					
Yes	No	Yes	No		
27	99	25	174		0.033
<b>Application of 'dry-period treatment'</b>					
Yes	No	Yes	No		
30	96	23	176		0.004
<b>Duration of dry-period (months)</b>					
≤ 2	> 2	≤ 2	> 2		
48	78	59	140		0.11
<b>Age of the farmer</b>					
Up to 50 years	Over 50 years	Up to 50 years	Over 50 years		
85	41	112	87		0.044
<b>Length of previous animal farming experience of the farmer</b>					
≤ 5 years	> 5 years	≤ 5 years	> 5 years		
37	89	37	162		0.024
<b>Education of the farmer</b>					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
25	83	18	32	142	25
					0.57
<b>Professional involvement in farming</b>					
Full-time	Part-time	Full-time	Part-time		
109	17	183	16		0.11
<b>Daily period at the farm</b>					
≤ 8 hours	> 8 hours	≤ 8 hours	> 8 hours		
38	88	61	138		0.92
<b>Family tradition in farming</b>					
Yes	No	Yes	No		
110	16	173	26		0.92
<b>Presence of working staff in the flock</b>					
Yes	No	Yes	No		
52	74	71	128		0.31

Vaccination performed ( <i>n</i> = 34)				Vaccination not performed ( <i>n</i> = 85)				<i>p</i>
Management system applied in the farm								
Intensive 2	Semi-intensive 13	Semi-extensive 19	Extensive 0	Intensive 7	Semi-intensive 16	Semi-extensive 42	Extensive 20	0.007
No. of does in the herd								
≤ 165 ewes 17	166-330 ewes 11	331-500 ewes 5	> 500 ewes 1	≤ 165 ewes 39	166-330 ewes 26	331-500 ewes 8	> 500 ewes 12	0.32
Breed of animals								
Crossbreeds 6	Imported breeds 17	Local breeds 11	Crossbreeds 12	Imported breeds 28	Local breeds 45			0.12
Total land available for grazing (acres per animal)								
≤ 0.50 5	0.51 – 2.00 8	≥ 2.00 21	≤ 0.50 12	0.51 – 2.00 23	≥ 2.00 50			0.92
Milking mode in herd								
Machine-milking 27	Hand-milking 7	Machine-milking 39	Hand-milking 46					0.0009
Average age of culling does								
≤ 6.5 years 18	> 6.5 years 16	≤ 6.5 years 32	> 6.5 years 53					0.13
Start of kidding period								
All year 3	Autumn 20	Winter 10	Spring - Summer 1	All year 5	Autumn 43	Winter 34	Spring - Summer 3	0.71
Collaboration with a veterinarian								
Yes 31	No 3	Yes 70	No 15					0.22
Age of newborns taken away from dam								
≤ 40 days 12	41 – 60 days 14	≥ 61 days 8	≤ 40 days 14	41 – 60 days 30	≥ 61 days 41			0.021
Number of daily milking sessions								
One 0	Two 29	Three 5	One 4	Two 79	Three 2			0.018
Use of laboratory diagnostic examinations in samples of milk								
Yes 24	No 10	Yes 70	No 15					0.15

<b>Application of teat disinfection during milking</b>					
Yes	No	Yes	No		
7	27	5	80		0.017
<b>Application of 'dry-period treatment'</b>					
Yes	No	Yes	No		
8	26	7	78		0.023
<b>Duration of dry-period (months)</b>					
≤ 2	> 2	≤ 2	> 2		
11	23	28	57		0.95
<b>Age of the farmer</b>					
Up to 50 years	Over 50 years	Up to 50 years	Over 50 years		
23	11	50	35		0.37
<b>Length of previous animal farming experience of the farmer</b>					
≤ 5 years	> 5 years	≤ 5 years	> 5 years		
7	27	17	68		0.94
<b>Education of the farmer</b>					
Primary education	Secondary or post-secondary education	Tertiary education	Primary education	Secondary or post-secondary education	Tertiary education
4	27	3	16	62	7
					0.65
<b>Professional involvement in farming</b>					
Full-time	Part-time	Full-time	Part-time		
30	4	75	10		1.00
<b>Daily period at the farm</b>					
≤ 8 hours	> 8 hours	≤ 8 hours	> 8 hours		
5	29	23	62		0.15
<b>Family tradition in farming</b>					
Yes	No	Yes	No		
29	5	74	11		0.80
<b>Presence of working staff in the flock</b>					
Yes	No	Yes	No		
13	21	21	64		0.14

179  
180  
181  
182

183 **Table S13.** Results of univariable analysis for associations with total number of optional vaccinations in 325 sheep flocks and 119 goat herds in Greece.

184

(a) Sheep flocks				<i>p</i>
Management system applied in the farm				
Intensive 3.43 ± 0.17	Semi-intensive 3.04 ± 0.10	Semi-extensive 2.62 ± 0.12	Extensive 1.72 ± 0.26	< 0.0001
No. of ewes in the flock <i>r</i> = 0.055				0.16
Total land available for grazing (acres per animal) <i>r</i> = -0.097				0.04
Milking mode in flock				
Machine-milking 3.04 ± 0.08		Hand-milking 2.14 ± 0.15		< 0.0001
Average age of culling ewes <i>r</i> = -0.162				0.002
Start of lambing period				
All year 2.72 ± 0.29	Autumn 2.90 ± 0.08	Winter 2.58 ± 0.19	Spring - Summer 3.28 ± 0.42	0.32
Collaboration with a veterinarian				
Yes 2.94 ± 0.08		No 2.17 ± 0.19		0.0004
Age of newborns taken away from dam <i>r</i> = -0.281				< 0.0001
Routine administration of antibiotics to newborns				
Yes 3.33 ± 0.14		No 2.71 ± 0.08		0.0005
Number of daily milking sessions <i>r</i> = -0.214				< 0.0001
Use of laboratory diagnostic examinations in samples of milk				
Yes 3.43 ± 0.16		No 2.68 ± 0.08		< 0.0001
Application of 'dry-period treatment'				
Yes 3.33 ± 0.18		No 2.71 ± 0.08		0.0005

<b>Duration of dry-period (months)</b>			
$r = -0.176$			0.007
<b>Age of the farmer</b>			
$r = -0.250$			0.007
<b>Education of the farmer</b>			
Primary education	Secondary or post-secondary education	Tertiary education	
3.02 ± 0.08	2.77 ± 0.07	2.98 ± 0.22	0.36
<b>Professional involvement in farming</b>			
Full-time	Part-time		
2.82 ± 0.16	3.06 ± 0.21		0.32
<b>Daily period at the farm</b>			
$r = -0.002$			0.49
<b>Family tradition in farming</b>			
Yes	No		
2.83 ± 0.08	2.95 ± 0.22		0.57
<b>Presence of working staff in the flock</b>			
Yes	No		
3.13 ± 0.11	2.67 ± 0.09		0.002
(b) Goat herds			
			<i>p</i>
<b>No. of does in the herd</b>			
$r = 0.090$			0.49
<b>Breed of animals</b>			
Crossbreeds	Imported breeds	Local breeds	
3.11 ± 0.29	3.13 ± 0.20	2.36 ± 0.18	0.008
<b>Material of the floor of the barn</b>			
Soil	Other		
2.76 ± 0.13	2.80 ± 0.39		0.93
<b>Milking mode in flock</b>			
Machine-milking	Hand-milking		
3.09 ± 0.16	2.36 ± 0.18		0.003
<b>Average age of culling ewes</b>			
$r = 0.199$			0.015

<b>Collaboration with a veterinarian</b>			
Yes		No	
2.87 ± 0.14		2.17 ± 0.23	0.043
<b>Age of newborns taken away from dam</b>			
$r = -0.174$			0.029
<b>Routine administration of antibiotics to newborns</b>			
Yes		No	
2.80 ± 0.23		2.75 ± 0.15	0.87
<b>Number of daily milking sessions</b>			
$r = 0.219$			0.008
<b>Use of laboratory diagnostic examinations in samples of milk</b>			
Yes		No	
3.48 ± 0.27		2.57 ± 0.14	0.003
<b>Application of 'dry-period treatment'</b>			
Yes		No	
3.67 ± 0.30		2.63 ± 0.26	0.006
<b>Education of the farmer</b>			
Primary education	Secondary or post-secondary education	Tertiary education	
2.40 ± 0.32	2.84 ± 0.34	2.80 ± 0.44	0.42
<b>Professional involvement in farming</b>			
Full-time		Part-time	
2.73 ± 0.14		3.00 ± 0.30	0.49
<b>Daily period at the farm</b>			
$r = 0.093$			0.16
<b>Family tradition in farming</b>			
Yes		No	
2.77 ± 0.13		2.75 ± 0.13	0.96
<b>Presence of working staff in the flock</b>			
Yes		No	
3.12 ± 0.25		2.62 ± 0.14	0.07

186  
187  
188  
189