ECONOMICS OF SHEEP FARMING IN GREECE

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ABSTRACT

This paper presents a technical and economic comparison of four groups of 15 sheep breeds based on average milk and lamb production per ewe per year of each group. Certain physical data (e.g. milk production and lambs weaned) derive from the various Centers of Genetic Improvement of Animals in Greece, while the remaining physical and economic data are collected from 70 sheep farms (10,554 ewes) by using records and accounts. The comparative economic analysis of the four groups of sheep breeds showed that the ewes of group I (236 kg of milk production and 1.64 lambs weaned per ewe per year) achieve high profit (8,981 drs./ewe) and high farm income (36,067 drs./ewe). On the contrary, the result of rearing the ewes of group IV (48 kg of milk production and 1.10 lambs weaned per ewe per year) is negative (loss 4,008 drs/ewe) or very low positive (farm income 9,484 drs/ewe). The comparative analysis of the four groups of sheep breeds, including subsidies, shows an increase in the farm income of 21, 27 and 37% respectively for groups I, II and III, and 92% for group IV. Finally, the productivity analysis of the farm resources used in sheep farming shows the need for better organization of the labour, for better use of the pasture available and for using more quantities of silage instead of concentrates. From the above it is concluded that not only the viability but also the competitiveness of the ewes of groups I and II is insured. On the contrary, the viability of the ewes of group III and much more of group IV, which are situated in mountainous and less developed regions, is mainly achieved with the continuation of subsidies and the use of low cost pasture.

RÉSUMÉ

Ce travail présente une comparaison technique et économique de quatre groupes de 15 races de moutons se basant sur la production moyenne de lait et d'agneaux par brebis par an de chaque groupe. Certaines données physiques (par exemple la production de lait et d'agneaux sevrés) proviennent de différents Centres d'Amélioration Génétique Animale en Grèce, tandis que les autres données physiques et économiques sont collectées à partir de 70 exploitations ovines (10.554 brebis) utilisant les archives et les comptes. L'analyse économique comparative des quatre groupes de races de mouton a montré que les brebis du groupe I (236 kg de production de lait et 1,64 agneaux sevrés par brebis par an) réalise un profit élevé (8.981 drs./brebis) et un revenu de l'exploitation élevé (36.067 drs./brebis). Au contraire, le résultat de l'élevage des brebis du groupe IV (48 kg de production de lait et 1,19 agneaux sevrés par brebis par an) est négatif (perte de 4.008 drs/brebis) ou très faiblement positif (revenu de l'exploitation 9.484 drs/brebis). L'analyse comparative des quatre groupes de races ovines, y compris les subventions, montre une augmentation du revenu de l'exploitation de 21,27 et 37% respectivement pour les groupes I, II et III, et 92% pour le groupe IV. Enfin, l'analyse de productivité des ressources utilisées dans l'exploitation ovine, fait ressortir la nécessité d'une meilleure organisation de la main d'œuvre, une meilleure utilisation du pâturage disponible et l'utilisation de quantités supérieures d'ensilage au lieu des concentrés. Ceci nous mène à conclure que non seulement la viabilité mais la compétitivité aussi des brebis des groupes I et II est assurée. Au contraire, la viabilité des brebis du groupe III et beaucoup plus du groupe IV, qui sont situés dans les régions montagneuses et moins développées, est possible surtout grâce à la continuation des subventions et l'utilisation de pâturage à faible coût.

INTRODUCTION

There is no doubt that sheep farming is the most important of our livestock production and the only one which does not face, at least directly, strong competition from the other countries of the European Union. But this does not mean that its viability and much more its competitiveness are insured. This can be shown from the following comparative economic analysis of four groups of 15 sheep breeds existing in Greece.

The physical and economic data used in this analysis derive from the various Centers of Genetic improvement of Animals and from 70 sheep farms situated all over the country. Milk production and lambs weaned are an average of a period of five years (1995-1999), while the rest of the physical and all of the economic data refer to the year 1999-2000. More specifically, the milk production and the lambs weaned per ewe per year derive from the above mentioned Centers, while the physical and economic data of the 70 sheep farms have been collected using records and accounts. The 70 sheep farms of 15 sheep breeds are divided into four groups based on the average milk production per ewe per year of each group. More specifically, group I includes farms of sheep breeds the ewes of which achieve milk production over 200 kg (average 236 kg). Group II includes farms of sheep breeds the ewes of which achieve milk production between 151 and 200 kg (average 176 kg). The ewes of sheep breeds of group III achieve milk production between 100 and 150 kg (average 121 kg) and those of group IV achieve milk production under 100 kg (average 48 kg). Expressing these groups into production systems, it can roughly be said that sheep breeds of group I represent the intensive production system, sheep breeds of groups II and III the semi-intensive production system and sheep breeds of group IV the extensive production system.

It is believed that this comparative technical and economic analysis can identify the strong and weak points of each group and specifically of each sheep breed, and to lead to the appropriate decision making for sheep farms to become not simply viable but also competitive.

PHISICAL AND ECONOMIC DATA OF THE FOUR GROUPS OF SHEEP FARMS

1. Presentation of physical and economic data referring to livestock, buildings and equipment of sheep farms

Table 1 gives the data needed before starting the analy-

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sis of each sheep farm. These data refer to the value of buildings and equipment, the value of ewes and rams as productive animals and as slaughtered ones, their productive life as well as their body weight and the number of ewes per ram. All these physical and economic data make up the base for estimating the annual expenses (depreciation, mortality, maintenance, insurance, interest) of livestock, buildings and equipment. This table also includes the cost of producing a young ewe until its first mating and the interest rate for long term loans. The data show that there is a great difference between the most productive and the less productive groups of sheep breeds.

Table 1 ***Comparative presentation of physical and economic data referring to livestock, buildings and equipment of sheep farms***

Physical and economic datas of livestock, building and equipment	Groups of sheep breeds per class of milk production per ewe			
	I >200 kg	II 151-200kg	III 100-150kg	IV <100 kg
1. Value of buildings and equipment (drs/ewe)	106,000	83,000	57,000	39,000
2. Value of a ewe as a productive animal (drs)	50,000	42,000	29,000	24,000
3. Value of a ewe as slaughtered (drs)	20,000	18,800	15,000	13,500
4. Value of a ram as a productive animal (drs)	80,000	60,000	40,000	40,000
5. Value of a ram as slaughtered (drs)	28,000	26,000	20,000	20,000
6. Productive life of a ewe in years	5.3	6.0	6.2	6.8
7. Productive life of a ram in years	4.0	4.6	4.8	4.8
8. Body weight of a ewe (kg)	67	50	45	40
9. Body weight of a ram (kg)	90	70	65	60
10. Ewes per ram (no.)	22.9	21.4	20.7	17,1
11. Cost of producing a young ewe of first mating (drs)	31,770	24,100	23,700	18,625
12. Interest rate of long term loans (%)	16	16	16	16

Table 2 ***Comparative presentation of physical and economic data of reproduction and production of sheep.***

Physical and economic data of live reproduction and production of sheep	Groups of sheep breeds per class of milk production per ewe			
	I >200 kg	II 151-200kg	III 100-150kg	IV <100 kg
1. Milk production (kg/ewe/year)	236	176	121	48
2. Milk price (drs/kg)	259	259	259	259
3. Lambs weaned per ewe per year (no.)	1,64	1.33	1.26	1.10
4. Value of a lamb at weaning (drs)	15,550	13,950	13,505	13,200
5. Body weight of a lamb at weaning (kg)	15.00	13.50	13.30	12.75
6. Labour required (hours/ewe/year)	14.0	12.0	10.0	8.5
7. Labour wages (drs/hour)	750	750	750	750
8. Concentrates (kg/ewe/year)	285	220	198	105
9. Alfalfa (kg/ewe/year)	205	127	105	72
10. Silage, straw, etc. (kg/ewe/year)	72	32	26	—
11. Price of concentrates (drs/kg)	64.5	64.5	64.5	64.5
12. Price of alfalfa (drs/kg)	55.1	55.1	55.1	55.1
13. Price of silage, straw, etc. (drs/kg)	26.5	26.5	26.5	—
14. Value of meadow, pasture, etc. (drs/ewe)	2,538	2,234	1,850	900
15. Interest rate of short - term loans (%)	17	17	17	17

2. Presentation of physical and economic data referring to reproduction and production of each group of sheep breeds

Table 2 gives the physical and economic data which can be characterized as the technicoeconomic coefficients on which the analysis of the sheep farms is based. Certain of these data are connected with the estimation of gross return, while others with the corresponding production costs.

The first ones are the milk yield in kg, the number of lambs weaned and their prices. Indeed, the ewes of group I achieve 236 kg of milk and 1.64 lambs, followed by group II (176 kg of milk and 1.33 lambs), group III (121 kg of milk and 1.26 lambs) and group IV (48 kg of milk and 1.10 lambs). Although the milk price is not the same in all regions (irrespective of sheep breeds), however, in this analysis the price is considered to be the same for better comparison. The difference in lamb value depends on their body weight and the time at which they are sold.

The second ones are the labour needed (from 14.0 to 8.5 hours/ewe), the labour wages (750 drs/hour), the feed required (from 285 to 105 kg concentrates and from 277 to 72 kg forages) and the feed price (64.5 drs/kg for concentrates, 55.1 drs/kg for alfalfa and 26.5 drs/kg for silage, straw, etc). The difference in the cost of meadow and pasture (from 2538 to 900 drs/ewe) is based on the requirements of each breed of ewes. This table also gives the interest rate for short term loans.

ECONOMIC ANALYSIS OF THE FOUR GROUPS OF SHEEP FARMS

1. Presentation of returns, costs, profits and incomes per ewe

The contribution of the milk value to the gross return of a ewe increases according to milk yield from 46.1 to 70.6%, while the value of lambs decreases from 53.9 to 29.4% because the milk yield increases more rapidly (491.7%) than the body weight of lambs weaned (75.9%) (**table 3**).

Of the various kinds of expenses the most important

one is feed (from 37.6 to 43.6%), followed by annual expenses of livestock, buildings, equipment etc. (from 35.1 to 42.0%) and labour (from 13.4 to 20.6%). Of special importance is the high participation of the total interest (from 21.5 to 23.9%) to the production costs due to the high interest rate of long and short term loans in Greece. On the other hand, the high participation to the total costs of the fixed costs (75.9-82.5%, average 78.7%) in relation to variable costs (17.5-24.1%, average 21.3%) shows the need for a more intensive operation of this branch of livestock production.

The profitability increases from 3,127 to 8,381 drs/ewe/year by increasing milk production from 121 to 236 kg/ewe/year. On the contrary, the profitability is negative (–4,008 drs/ewe/year) when the milk production per ewe and year is under 100 kg (in this case 48 kg). The profit or loss has positive or negative effect on the farm income (from 36,067 to 9,484 drs/ewe/year) as well as on the return to capital (from 23.8 to 6.9%). The last one compared with average interest rate shows that the capital invested in sheep farming achieves good return when the milk production per ewe is over 120 kg (1.478, 1.367 and 1.317 respectively for I, II and III groups) and very low return when the milk production per ewe is under 100 kg (0.429 for group IV).

Table 3 ***Comparative presentation of returns, costs, profits and incomes per ewe.***

Returns, costs, profits and incomes	Groups of sheep breeds per class of milk production per ewe			
	I >200 kg	II 151-200kg	III 100-150kg	IV <100 kg
I. Gross return (drs/ewe/year)				
1. Value of milk production (%)	70.6	71.1	64.8	46.1
2. Value of lambs at weaning (%)	29.4	28.9	35.2	53.9
Total	**86,626**	**64,138**	**48.355**	**26,952**
II. Production costs (drs/ewe/year)				
1. Labour wages (%)	13.4	15.3	16.6	20.6
2. Feed (%)	43.6	41.3	46.6	37.6
3. Depreciation, mortality, repairs, insurance of livestock, buildings, equipment etc. (%)	19.0	18.1	13.6	17.3
4. Total interest of livestock, buildings, equipment and variable capital	22.0	23.9	21.5	23.0
Veterinery, fuel, water, etc. (%)	2.0	1.4	1.7	1.5
Total	**78,245**	**58,844**	**45,228**	**30,960**
III. Kinds of production costs				
1. Fixed costs (%)	75.9	78.5	78.0	82.5
2. Variable cost (%)	24.1	21.5	22.0	17.5
IV. Profit or loss (drs/ewe)	8,381	5,294	3,127	–4,008
V. Farm income (drs/ewe)	36,067	28,385	20,369	9,484
VI. Return to capital and interest rate				
1. Return to capital (%)	23,8	22.0	21.2	6.9
2. Average interest rate (%)	16.1	16.1	16.1	16.1
3. Return to capital and average interest rate ratio	1.478	1.367	1.317	0.429

2. Presentation of returns, costs and profits per kg of milk and per kg of live weight of lambs weaned

The contribution of the milk value and that of the lamb value to gross return is usually used as a measure for distributing total production costs of a ewe between milk and lamb production. This measure is not realistic because it is affected by the milk and lamb prices which fluctuate from region to region and from farm to farm for the same sheep breed. In other words, by this measure the cost of each product (milk, lambs) depends on its price, which is unrealistic, because in actual practice the production cost of each product is independent of its price. In this paper we use another measure which is based on the direct cost of each product and the allocation of the indirect cost of a ewe between these two products.

This allocation depends on the milk which corresponds to each product converting the increase of live weight of lambs from birth to weaning period in equivalent of milk (**table 4**).

In milk production, gross return per kg is actually the milk price, while the corresponding expenses are actually the production cost per kg.

Of the various kinds of expenses the most important is feed (from 100.6 to 133.0 drs), followed by annual expenses of livestock, buildings, equipment, etc. (from 73.1 to 106.4 drs) and labour (from 36.8 to 67.1 drs). The profit achieved is high for groups I and II (23.3-21.3 drs/kg) and low for group III (4.1 drs/kg), while for group IV it is negative (–39.0 drs/kg).

The milk price and feed cost ratio is very high for all groups of sheep farms (2.37, 2.57, 1.95 and 2.16 respectively) which means that the loss of group IV is due to the high annual expenses of livestock, buildings and equipment in relation to milk production achieved.

In lamb production, the price per kg l.w. fluctuates between 1,015 and 1,036 drs.

The same is true for feed (417.2-442.4 drs).

On the contrary, the annual expenses of livestock, buildings and equipment (279.9-494.1 drs) and labour (98.6-258.3 drs) differ between the four groups of sheep farms.

The very high profit of group III (157.1 drs/kg l.w.) and the very high loss of group IV (152.3 drs/kg l.w.) is due to the very low (279.9 drs/kg l.w.) and the very high (494.1 drs/kg l.w.) annual expenses respectively. The price and feed costs ratio (2.34-2.48) shows that the high profit and the high loss is due to the annual expenses of the livestock, buildings and equipment compared with the total live weight of lambs produced per

Table 4 ***Comparative presentation of returns, costs and profits per kg of milk and per kg of l.w. of lambs at weaning.***

Returns, costs and profits or loss		Groups of sheep breeds per class of milk production per ewe			
		I >200 kg	II 151-200kg	III 100-150kg	IV <100 kg
A. Milk production					
I. Gross return	(drs/kg)	259.0	259.0	259.0	259.0
II. Production costs					
1. Labour wages	(drs/kg)	34.7	39.7	42.9	62.4
2. Feed	("/")	102.9	95.6	125.9	112.3
3. Depreciation mortality, repairs insurance and interest of livestock, buildings and equipment and interest of variable capital	("/")	43.3	46.4	35.4	46.8
4. Veterinery, fuel, water, etc.	("/")	4.7	3.3	4.3	4.5
Total		**235.7**	**237.7**	**254.9**	**298.0**
III. Profit or loss	(drs/kg)	37.0	43.2	−1.0	−19.8
IV. Milk price and feed costs ratio		2.37	2.57	1.95	2.16
B. Lamb production					
I. Gross return	(drs/kg l.w.)	1,036.7	1,033.4	1,015.4	1,035.3
II. Production costs					
1. Labour wages	("/")	98.6	118.0	140.4	258.3
2. Feed	("/")	435.8	442.4	423.7	417.2
3. Depreciation, mortality, repairs, insurance and interest of livestock, buildings and equipment and interest of variable capital	("/")	366.3	373.5	279.9	494.1
4. Veterinary, fuel, water, etc.	("/")	18.5	13.3	14.3	18.0
Total		**919.2**	**947.2**	**858.3**	**1187.6**
III. Profit or loss	(drs/kg l.w.)	117.5	86.2	157.1	−152.3
IV. Lamb price and feed costs ratio		2.38	2.34	2.40	2.48

ewe per year (from 24.6 to 14.0 kg l.w.).

3. Presentation of returns, costs, profits and incomes including subsidies

In table 3 we see that the gross return of a ewe covers its production costs and achieves profits in all groups of sheep farms except group IV. In **table 5** the gross return of a ewe includes subsides which contribute to its total amount from 8.0 to 24.5% as the milk production decreases. This is due to the great difference of the gross return with and without subsides rather than to the subsides themselves received by sheep farmers of each group of sheep breeds. The subsides are of great significance for all groups of sheep breeds but much more for group IV since the loss (4,008 drs/ewe) becomes profit (4,719 drs/ewe).

Comparing farm income between tables 5 and 3 we see the big effect subsidies have not only on the viability but also on the competitiveness of sheep farming in Greece irrespective of sheep breed. Indeed, the farm income increases from 20.9 to 92,0% depending on sheep breed. The improvement of farm income in group III and much more in group IV, which are situated in the mountainous and less developed areas, is of great importance for the keeping of this production system of sheep farms.

4. Probabilities of achieving gross return estimated and decision making

From the total number of 10,554 ewes studied, the 10.6% achieve milk yield under 100 kg, the 50.1% between 100 and 150 kg, the 17.3% between 151 and 200 kg and the 22.0% over 200 kg (**table 6**). This table also gives the fluctuation of milk price in each class of milk production, the probability of achieving this price, the gross return corresponding to this yield and price, and the contribution of each class of milk production to the gross return achieved in actual practice (table 6). By using decision tree analysis in average sheep farming we see that the gross return achieved in actual practice is 5.8% lower than that estimated by multiplying milk production with milk price without taking into account the fluctuation of the milk yield and its price. So by using decision tree analysis we can estimate the probability of achieving each amount of gross return and make the appropriate decision.

Productivity analysis of sheep farms

The productivity of the factors used in milk and lamb production and that of the two main kinds of feed (concentrates and forages) are of special importance from an economic point of view because they may lead to the solution of some problems in sheep farming. These problems refer: a) to the contribution of each production factor to the gross return achieved, b) to the marginal productivity of the resources used in relation to their opportunity costs, and c) to the marginal rate of substitution of concentrates by forages and vice versa

Table 5 ***Comparative presentation of returns, costs profits and incomes including subsidies.***

Returns, costs, profits and incomes		Groups of sheep breeds per class of milk production per ewe			
		I >200 kg	II 151-200kg	III 100-150kg	IV <100 kg
I. Gross return					
1. Value of milk and lamb	(%)	92.0	89.2	86.5	75.5
2. Subsidies	(%)	8.0	10.8	13.5	24.5
Total (drs/ewe/year)		**94,162**	**71,867**	**55,884**	**35,679**
II. Production costs	(«/»)	78,245	58,844	45,228	30,960
III. Profit	(«/»)	15,917	13,023	10,656	4,719
IV. Farm income	(«/»)	43,603	36,114	27,898	18,211

Table 6 ***Milk yield, milk price and gross return per ewe with and without probability of achieving them and decision making.***

Average yield in kg per ewe per class of milk production	Number of ewes and % per class of milk production	Milk price (drs/kg)	Probability of achieving each milk price per class of milk production	Gross return from each class of milk production and the corresponding prices without probability (drs/ewe)	Probability of achieving gross return of each class of milk production and the corresponding prices per ewe	Participation of gross return of each class of milk production and the corresponding price to total gross return
< 100	1,118	250	55.5%	12,000	5.9	708
< (48)	(10.6%)	280	44.5%	13,440	4.7	632
		225	3.6%	27,225	1.8	490
100-150	5,288	230	46.8%	28,830	23.5	6,540
(121)	(50.1%)	237	44.8	28,677	22.5	6,452
		265	4.8%	32,065	2.4	770
151-200	1,826	250	29.9%	44,000	5.2	2,288
(176)	(17.3%)	278	58.0%	48,928	10.0	4,893
		280	12.1%	49,280	2.1	1,034
> 200	2322	237	66.5%	55,932	14.6	8,166
> 236	(22.0%)	265	13.8%	62,540	3.0	1,876
		276	19.7%	65,136	4.3	2,801
Numbers of ewes 10,554				38,921	100.0	36,650

for achieving the same milk and lamb production at the lowest feeding costs. The data used were analysed by applying the well known Cobb-Douglas production function of which the general equation is:

$$Y = \alpha X_1^{b_1} X_2^{b_2} X_3^{b_3} \ldots\ldots X_v^{b_v}$$

1. Marginal value products of resources used and their opportunity costs

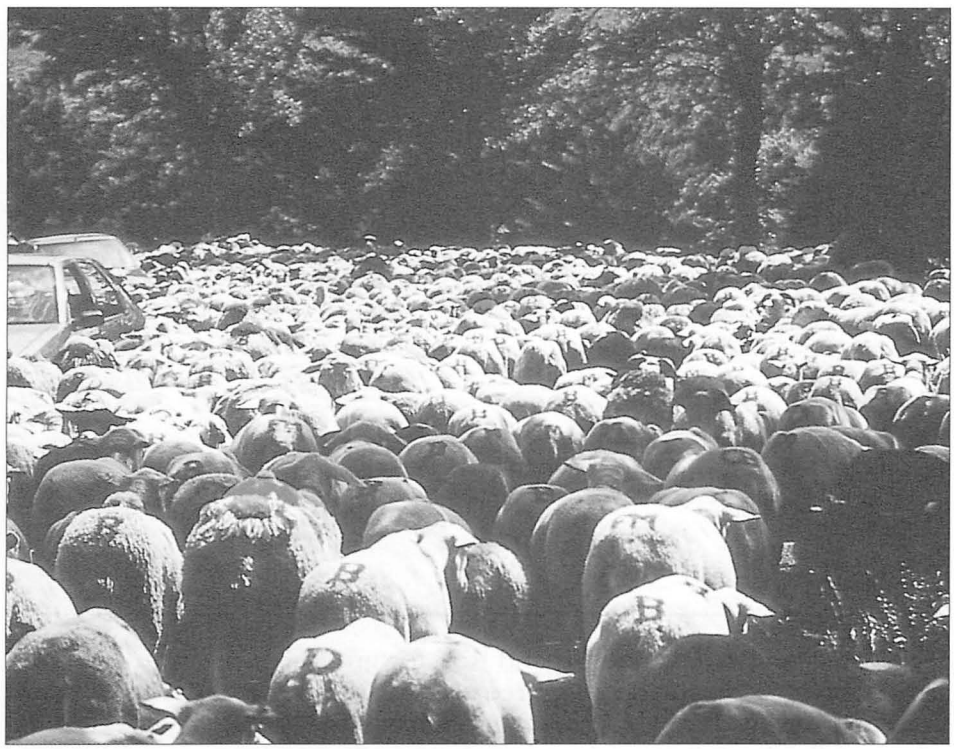
The four farm resources included in the given production function are: a) Ewes (depreciation and mortality of ewes and rams in drs/ewe) b) Labour wages in drs/hour, c) Feed in drs/drs, and d) Buildings and equipment (depreciation, insurance and maintenance in drs/ewe). The gross return achieved is also expressed in drs/ewe. The data were analyzed as a whole and not by groups of breeds because in actual practice the analysis of a small number of data by using this production function is unfavorably affected and usually leads to unrealistic solutions.

The sum of production elasticities (0.900) shows that there is a rather decreasing ratio between input and output, namely when the former is doubled the latter is less than doubled. On the other hand, the coefficient of multiple determination (0.943) shows that the variations in the gross return achieved depend, by 94.3%, on the variations of the above mentioned four farm resources used (**table 7**).

The marginal value product of ewes is higher (10,343 drs/ewe) than their opportunity costs (7,761 drs/ewe), as can be seen by comparing marginal return to opportunity cost ratio (1.333). This means that it is profitable to keep ewes of high potential milk and lamb production because their productivity covers their opportunity costs.

Table 7 ***Marginal productivity analysis of resources used in sheep farming.***

Number of sheep farms		70
Period in years 1999-2000		1
Y= Gross return		
X_1= Ewes		b_1= 0.184
X_2= Labour		b_2=0.135
X_3= Feed		b_3=0.258
X_4= Buidlings and equipment		b_4=0.323
	Sum of b's	**0.900**
α		3.489
R		0.971
R^2		0.943
Marginal value products		
Ewes (drs/ewe including value of ram)		10,349
Labour (drs/hour)		650
Feed (drs/drs)		0.553
Buildings and equipment (drs/ewe)		18,167
Opportunity costs		
Ewes (drs/ewe including value of ram)		7,761
Labour (drs/hour)		750
Feed (drs/drs)		1.085
Buildings and equipment (drs/ewe)		8,231
Marginal return to opportunity cost ratio		
Ewes		1.333
Labour		0.867
Feed		0.510
Buildings and equipment		2.207
Probability level for t's 0.5 > P > 0.001		



The marginal value product of labour, amounting to 650 drs per hour, is lower than labour wages (750 drs/hour), as it is shown by its ratio to opportunity costs (0.867).

The low marginal productivity of labour is due on the one hand to the fact that labour is not organised efficiently in sheep farming and on the other to the fact that labour is used in large quantities compared with those of the other three resources. In Greece, the labour used in sheep farming and generally in livestock farming is mainly based on foreign workers of whom the productivity is low.

The marginal value product of feed, amounting to 0.553 drs/drs, is lower than its opportunity costs estimated at 1.085 drs/drs.

This is confirmed by comparing marginal return to opportunity costs ratio (0.510). This means that ewes yielding 136.4 kg of milk and 1.287 lambs per ewe per year can profitably utilize feed of lesser quantity or cheeper cost than that used. However, the feed needed for achieving maximum total profit depends on the capacity of each group of breed, on the price or costs of producing feedingstuffs and on the milk and lamb price.

The marginal value product of buildings and equipment, amounting to 18,167 drs/ewe, is greater than their opportunity costs (8,231 drs/ewe) as the marginal return to opportunity costs ratio (2.207) shows.

From the above it can be seen that maximum total profits may be achieved by decreasing feed at the level which the cost of the last unit of feed supplied (marginal cost) is equal to the value of the additional amount of milk produced (marginal value product) with the same level of labour, buildings and equipment used.

The reliability of marginal productivity of farm resources is confirmed by the fact that the majority of production elasticities were found statistically significant at the 0.001 and 0.5 per cent level of probability.

2. *Marginal value products of concentrates and forages and marginal rate of substitution between them for achieving least cost ration*

The feed supplied is divided into two main kinds i.e. concentrates and forages. Both kinds of feed are given in drs. because meadow and much more pasture is grazing and for this reason it is very difficult to estimate the actual amount produced. The marginal value product of concentrates, amounting to 1.035 drs/drs, is lower than that of forages, amounting to 1.617 drs/drs. The fact that the marginal value product of forages is higher than that of concentrates leads to an increase of the former and to a decrease of the latter for achieving a more economical ration. Indeed, the existing combination of these two kinds of feed in the actual ration is not the most profitable one, since it does not lead to a least cost ration for producing the same amount of milk and number of lambs. This is achieved by estimating the marginal rate of substitution of concentrates by forages.

The general equation of the marginal rate of substitution is:

$$d X_1 / d X_2 = b_2 X_1 / b_2 X_2$$

which shows the amount saved of feed X1 by supplying one additional unit of feed X_2 for producing the same amount of milk and number of lambs. The marginal rate of substitution leads to a decrease in the total feeding costs per ewe. However, the least cost ration is achieved up to the point where this rate of substitution becomes 1 drs/drs. This is true because the marginal rate of substitution decreases progressively when feed X_1 decreases and feed X_2 increases. The total cost of feed X_1 which corresponds to a certain total cost of feed X_2 is estimated by the following equation:

$$X_1 = \left[\frac{Y}{\alpha X_2^{b2}} \right]^{1/b_1}$$

From the above it can be seen that the marginal rate of substitution becomes 1 drs/drs when 11,175 drs of concentrates and 13,516 drs. of forages are the total cost of feeding for a ewe producing 136.4 kg of milk and 1.287 lambs.
At this level of milk and lambs production and feedingstuffs, the lowest possible feeding cost is achieved, namely 24,691 drs/ewe instead of 26,222 drs/ewe, or 5.8% lower (**table 8**).
The reliability of the marginal productivity of concentrates and forages is confirmed by the fact that production elasticities were found statistically significant at the 0.001 per cent level of probability.
From the above we can see the great significance of the forages and especially meadow and pasture for decreasing the feeding costs of ewes. More specifically, the meadow is connected with sheep breeds of high milk and lamb production, while the pasture with sheep breeds situated in mountainous and less developed areas.

Table 8 ***Marginal rate of substitution between concentrates and forages for producing the same quantity of milk (136.4 kg/ewe) and the same number of lambs weaned (1.287/ewe).***

Concentrates in drs/ewe	Forages in drs/ewe	Average marginal rate of substitution concentrates by forages	Total cost of feeding in drs/ewe
14,778	11,444	1,562	26,222
13,190	11,788	1,353	24,978
12,760	12,115	1,274	24,875
12,355	12,443	1,201	24,798
11,973	12,770	1,134	24,743
11,612	13,098	1,065	24,710
11,270	13,425	1,015	24,695
11,175	13,516	1,000	24,691

Conclusions

This paper presents a technical and economic comparison of four groups of 15 sheep breeds based on average milk and lamb production per ewe per year of each group.
This analysis showed that the ewes of group I (236 kg of milk and 1.64 lambs weaned) achieve high profits (8,981 drs/ewe) and high farm income (36,067 drs/ewe), followed by the ewes of group II (176 kg milk and 1.33 lambs weaned), which achieve good profit (5,294 drs/ewe) and good farm income (28,385 drs/ewe), and the ewes of group III (121 kg of milk and 1.26 lambs weaned) which achieve lower profit (3,127 drs/ewe) and lower farm income (20,369 drs/ewe).
On the contrary, the result of rearing the ewes of group IV (48 kg milk and 1.10 lambs weaned) is negative (loss 4,008 drs/ewe) or very low positive (farm income 9,486 drs/ewe). The profit or loss affects prositively or negatively the return to capital invested in sheep farming in relation to interest rate (23.8, 22.0 and 21.2% instead of 16.1% for groups I, II and III, and 6.9% instead of 16.1% for group IV). The fact that the 75.9-82.5% of the total production cost of a ewe is fixed leads to the need for this branch of livestock production to operate more intensively.
The comparative analysis of the four groups of sheep breeds, including subsidies, showed increase of the farm income by 21, 27 and 37% respecitvely for groups I, II and III, and 92% for group IV.
The decision tree analysis showed that the gross return achieved in actual practice is 5.8% lower than that estimated by multiplying milk production and its price without probability.
Finally, the productivity analysis of the farm resources used in sheep farming shows the need for better organizaiton of the labour, for better use of the pasture available and for using more quantities of silage instead of concentrates.
From the above it is concluded that not only the viability but also the competitiveness of the ewes of groups I and II is insured.
On the contrary, the viability of the ewes of group III and much more of group IV, which are situated in mountainous and less developed regions, is achieved mainly with the continuation of subsidies and the use of low cost pasture. ●

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