

**THESIS OF DOCTORAL (Ph.D.)
DISSERTATION**

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EXAMINATION OF DAIRY-PURPOSE LACAUNE AND
LACAUNE F₁ SHEEP

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1. BACKGROUND AND OBJECTIVES

1.1. Objectives

There are several arguments inspiring a change in the current breed structure of the Hungarian Merino breed, which still plays a determining role in our country. The breed which is mostly used for producing slaughter lambs is less and less able to meet the requirements of economic sheep breeding. Except its wool production, it lags behind the wanted levels in every production parameter. Several attempts have already been made to improve the production of this breed, such as importing the French breed, the Lacaune. The main goal was to improve the reproduction rates and milk production, consequently the lamb rearing ability of the Hungarian Merino breed.

The milk production of the Hungarian Merino (20-60 litres) fails to generate the necessary income that would cover the investment costs of mechanical milking in the sheep sector already struggling with financial problems. In order to reach a higher level of milk production, and with it a higher income, crossbreeding with a milking breed which is already well-known in our country seems to be needed.

However, there are problems not only with milk production of the Hungarian Merino, but also with the udder being covered with wool and the heterogeneous size of teats. These traits are disadvantageous not only for milking, but also for lamb rearing.

For my university thesis I have already examined the nucleus stocks of the milking breeds which could be considered for the improvement of the production level of milked populations. In this work production data of three breeds (Milking Tsigai, Milking Lacaune and British Milk Sheep) and the crossbreeds of the two latter with the Hungarian Merino (Hungarian Merino ♀ x Lacaune ♂; Hungarian Merino ♀ x British Milk Sheep ♂) were evaluated based on the official data recorded between the years 2000 and 2006.

This study had been the base of my present experiments, which were carried out on a sheep farm in Hungary, where a Lacaune, and a smaller British Milk Sheep nucleus population was also kept in production beside the Hungarian Merino ewes.

1.2. Objectives

In this study I wanted to examine the effect of crossbreeding of Hungarian Merino ewes with Lacaune and British Milk Sheep rams in order to suggest a possible crossbreeding program for the Hungarian sheep milk producers to improve their production. As part of the produced milk is used by the lambs (until weaning), relationship between the amount of suckled milk and daily weight gain of the lambs was also studied, from which we could deduce the amount of milk suckled.

Although the income from the wool production is not considerable at the moment, I considered the examination of the effect of crossbreeding on the wool quality and the quantity to be important, because of its continuously increasing by-up price.

Considering the points mentioned above, the exact aims of this study were the following:

1. Examination of the effect of crossbreeding on the production parameters of some dairy sheep genotypes.
2. Examination of the effect of the number of milkings per day of different genotypes.
3. Evaluation of the growth rate of the lambs of different genotypes during the suckling period and between weaning and slaughter.
4. Examination of the effect of crossbreeding on the changes in wool quality and quantity.
5. Examination of certain economic parameters in relation to the changes in the production structure and the increase in the product quantity.

2. MATERIAL AND METHODS

2.1. Origin, selection, housing and nutrition of the studied animals

The experiments were carried out on a private sheep farm in the Bács-Kiskun County, where a cross-breeding programme of the Hungarian Merino population – using Lacaune and British Milk Sheep rams – was developed to improve the reproduction and milk production parameters. The following breeds and genotypes were examined:

- Hungarian Merino (*producer population which had been paired only with pedigree rams since 1990*),
- Lacaune (*nucleus population*),
- British Milk Sheep (*nucleus population*),
- Hungarian Merino ♀ x Lacaune ♂ (*Lacaune F₁*),
- Hungarian Merino ♀ x British Milk Sheep ♂ (*British Milk Sheep F₁*),
- British Milk Sheep F₁ ♀ x Lacaune ♂.

Selection of the studied animals:

On this farm the ewes were paired only once a year. The primary goal when choosing the animals was for them to be in the same production cycle. Therefore we selected ewes which had lambed within the previous 3 weeks of the lambing period, together with their lambs. The experiment was conducted with approximately 50 ewes per genotype representing the average age and production level of the whole population on the farm.

Nutrition technology:

The main base for the feed is produced on their own land, but also industrial by-products are used for feeding (wet feed originating from the bioethanol production (CGF) and by-products of the industrial processing of sweet corn (fermented husks).

All the animals had the same feed independently from group and sex. In the summer the energy requirements of the non-lambed ewes and yearlings were supplied mostly by grazing. The milked ewes were also fed fodder (CGF, barley) beside grazing. The fodder was given partly during milking, partly after it, before moving onto the pasture. The ewes whose milk production did not reach the required minimum level were transferred to the yearlings' group and did not get any fodder on top of the grazing. The feeding in winter was mono-dietetic; all the animals were given feed with identical quality and composition. Every morning, during bringing the roughage (alfalfa silage, fermented husks) in, the animals were given fodder (corn, triticale, CGF) on the court. They had ad libitum access to the roughage – mostly alfalfa, rarely grass hay.

Lambs were fed pellet from the 2nd week of age on. It was accessible for them in the so-called „lamb kindergarten”. The „schooling” started on the 3rd-4th week after birth. From then on lambs were separated from the ewes with a fence and they had free access to the pellet and alfalfa hay. The time of weaning coincided with the sale of the lambs.

2.2. Milk examinations

Measurement of the milk production

The individual milk production of the ewes was measured by a Tru-Test device (made in New-Zealand), which made individual sampling possible. This equipment is able to measure up to 3.5 kg. Because the data were obtained in kg, they were converted to litres by using the conversion factor according to the suggestion of the Sheep Performance Examination Codex (2008): $milk (l) = milk (kg) \times 1.036$. The total amount of milk production was estimated from their individual data, measured every 28 days of the examination (3 times / lactation period).

Examination of milk composition

EKOMILK device

The composition of the individual milk samples was determined by an EKOMILK device. This device is an ultrasonic raw milk analyser which can be used for the determination of the fat, fat-free dry matter and protein content of cow and sheep milks and also for the determination of the density, conductivity and freezing point of the milk samples.

Hungarian Dairy Herd Recording Ltd. (Gödöllő)

In 2009 the composition of the milk samples was also examined by the Hungarian Dairy Herd Recording Ltd. in Gödöllő. The fat, protein and lactose content and the somatic cell count of five heads per genotype were determined in the samples. These examinations gave an opportunity to test the accuracy of the EKOMILK device and to collect information about the lactose content of the milk of the different genotypes.

FCM and FPCM milk production

Based on the amount of milk and its fat and protein content, the amount of FCM and FPCM milk was also calculated. The milk production was corrected for 6.5% fat content in the case of FCM and for 6.5% fat and 5.8% protein content in the case of FPCM. For the calculations the following equations – developed by PULINA et al. (1989) – were used:

- FCM milk: milk production /kg/ x (0.37 + 0.097 x fat%),
- FPCM milk: milk production /kg/ x [0.25 + (0.085 x fat%) + (0.035 x protein%)].

Separating into once- and twice-daily milked groups

In 2009 the ewes were milked twice a day for one week after weaning the lambs. After this, based on the individual milk production levels, ewes were separated into two groups. The milk production of both groups (milked once or twice a day) was the same at the time of separating in all of the examined genotypes. Every 28 days (three times in total during the lactation) the individual milk production was measured and the individual samples were collected. The milk samples were analysed with two different methods. Fat, protein and fat-free dry matter content, and freezing point, density and conductivity of the samples were measured by the EKOMILK device on the farm. In the laboratory of the Hungarian Dairy Herd Recording Ltd. in Gödöllő the fat, protein and lactose content of the samples were analysed. Twenty-five ewes were involved per group and genotype. Examinations were made under the same keeping and feeding conditions. Independently from the frequency of the daily milking, ewes were kept in one herd and were sent to the pasture after the morning milking. Before the evening milking they were separated into the two groups (milked once or twice per day).

2.3. Measurement of the weight gain of the lambs

Within 24 hours after birth lambs were weighed and ear-tagged. They were weighed at weaning again, using a HD-300 type scales. The gained data and the sex of the lambs were recorded with the individual number of the ewe. In 2008 and 2010 the weight was measured weekly. The studied animals were kept together with the others under the same conditions, but they were signed with a coloured spray. We examined only the lambs born within the first 3-4 days. These then were taken out of the group for weighing every week on the same day, at the same time (6-7 am). Data were used to calculate the weight gain per week and also for the whole experimental period.

2.4. Wool examinations

The wool was collected individually after shearing. Separated samples were collected from the shoulder and the rump. Samples were sent to the Wool Qualifier Laboratory of the Hungarian Agricultural Authority, where they were analysed according to the Hungarian Standards.

2.5. Data collection, evaluation, statistical methods

Collected data were recorded and systematised with Microsoft Excel (2003) and statistically evaluated by the SAS 9.1 software package.

Data from each parameter were analysed by year and altogether. Extreme values – if it was technically justified – were excluded from the evaluation. The test of normality was also done before the statistical analysis.

As first step descriptive statistics was calculated (average, standard deviation). The effect was analysed by the Multivariate Analysis of Variance. Where it was necessary because of the different number of elements LS Means were calculated.

3. RESULTS AND DISCUSSION

The success of the crossbreeding programme was verified by the increase in the production of Lacaune F₁ confirmed by data.

The milking period became more than 10 days longer, while the daily milk amount increased by 0.5 litre. These facts had positive effects on the lactation yield of Lacaune F₁ herd. However, the milk production of Lacaune F₁ ewes was 8 litres lower than that of the British Milk Sheep F₁ ewes.

Based on the average milk component values in the two studied years, there are no significant differences between the genotypes in protein content (*Lacaune*: 6.46%; *Hungarian Merino*: 6.44%; *Lacaune F₁*: 6.37%; *British Milk Sheep F₁*: 7.17%). However, regarding fat content, Lacaune F₁ differed significantly from other genotypes (*Lacaune*: 8.21%; *Hungarian Merino*: 8.3%; *Lacaune F₁*: 7.83%; *British Milk Sheep F₁*: 8.07%).

The effect of once-daily milking on milk yield and composition in the 4 genotypes was studied. Based on the results the once-daily milking had the biggest negative influence on the milk production of Hungarian Merino ewes, probably because of the small udder-pelvic capacity. The milk production deficit reached 52.7% compared to the twice-daily milked Hungarian Merino herd (*Lacaune*: -34.8%; *Lacaune F₁*: 43.5%; *British Milk Sheep F₁*: 47.1%).

The FCM and FPCM milk yield gives a more accurate idea about the real deficit and makes it possible to compare the breeds in a more reliable way.

The once-daily milking resulted in a decrease both in protein and fat content, where the latter one was more significant, except in British Milk Sheep F₁. The lactose content decreased significantly because of the only one milking, with the exception of the Lacaune F₁ herd, while the conductivity increased significantly in all genotypes. The latter is used to diagnose subclinical mastitis when its value increases. This form of mastitis (without clinical symptoms) has a strong ef-

fect on milk content and on somatic cell count (SCC). The SCC is one of the most important factors of milk quality. The increase of SCC has a negative effect on the effectiveness of cheese making and on product quality. Based on the studies, the SCC of milk from 198 ewes was analysed and correlation analysis was calculated between SCC and conductivity ($r=0.29$; $P<0.0001$).

Although the milk production of purebred Lacaune has not been reached by the two crossbred genotypes used as maternal line, the improvement had a positive effect on the average daily gain of lambs in the suckling period.

The weaning weight corrected to 68 days verified the increase during the lamb rearing period. Important differences were found in the weaning weight of lambs born with an approximately identical weight. The Hungarian Merino and Lacaune F_1 lambs reached 20.6 and 22.6 kg at the age of 68 days. The average weaning weight were 23.4 kg in lambs of Lacaune F_1 ewes, 26.8 kg in lambs of British Milk Sheep ewes and 25.3 kg in the Lacaune breed.

The average net daily gain was calculated cumulative and per week based on the weekly weight data of lambs. The daily gain tendencies greatly varied within each week but they were lower in only lambs.

Independently from litter size and genotype, there was a low on the 3rd-4th week (lowest daily weight gain), probably due to the lambs starting to eat firm forage, as they couldn't suckle throughout the whole day any more.

In the case of cumulative daily weight gain the lambs reached the highest production on the first week (based on the 9 weeks studied), which is followed by a low on the 4th-5th week both in only and twin lambs.

The litter size (except Lacaune) had a seeming effect on the decrease of daily weight gain between the 1st and 4th-5th weeks. The only lambs had twice the amount of daily weight gain decrease than twin lambs (*single: Hungarian Merino: 121.7 g/day; Lacaune: 62.9 g/day; Lacaune F_1 : 96.7 g/day; British Milk Sheep F_1 : 97.6 g/day; British Milk Sheep F_1 x Lacaune: 103.3 g/day; twins: Hungarian Merino: 49.4 g/day; Lacaune: 59.5 g/day; Lacaune F_1 : 40.2 g/day;*

British Milk Sheep F₁: 64.0 g/day; British Milk Sheep F₁ x Lacaune: 44.0 g/day). If these differences were calculated by ewe the differences in daily weight gain were similar.

The net and gross daily weight gain were compared by Paired Samples T-Test using the weekly weight data. Based on the results at 10 weeks, there were significant ($P < 0.001$) differences between the values calculated with the 2 different methods. However, the average difference between these daily weight gain values decreased from 619 g to 50.6 g by the last week.

Concerning wool production the crossbreeding of Hungarian Merino with Lacaune rams had negative effect on the wool quality and quantity. The income from wool had no important effect on the total yearly income from one ewe.

In summary it can be stated that the Lacaune breed had several scientifically proven positive effects on the Merino breed. Based on these results the use of the Lacaune breed can be recommended to increase the production characteristics and income of Hungarian Merino breed.

4. CONCLUSIONS AND RECOMMENDATIONS

Milk production:

The crossbreeding with Lacaune breed had positive effect on Hungarian Merino milk production. The milk yield increased to more than 2.4 times the original amount. The production of female offspring of crossbred Lacaune F₁ and British Milk Sheep rams was higher than that of Lacaune F₁, but the differences were not significant. Beside the milk yield, the milk composition is also important. In protein content the advantage of British Milk Sheep F₁ ewes was noticeable (over than 0.7%), but this value is not significant. In milk fat content Lacaune F₁ ewes had lower value than the parent breeds.

Because of the differences found in milk protein and fat content, it is necessary to calculate and use the FCM and FPCM milk yield, already used in cattle breeding to compare the values more correctly.

The effect of once-daily milking compared to traditional twice-daily milking resulted in a decrease in labour cost, which could mean important saving to the farmers. The once-daily milking could be proposed to the small farms where there was no milking before because the income from milk could increase the income of the sector. The decrease of the number of milking per day had different effect on different genotypes. The least negative effects were found in Lacaune ewes. However, the frequency of milking affected not only the quantity, but also the quality and composition. Therefore the calculation of FCM and FPCM milk yield was justified to allow a more exact comparison. The once or twice daily milking had not effect on protein content, while the once-daily milking had significant negative effect on fat content, except in British Milk Sheep F₁.

The correlation between conductivity and SCC was 0.29%. The diagnosis of SCC and subclinical mastitis form conductivity is a quick and cost efficient

method. Limited differences were observed between the milk composition values measured with EKOMILK device and in the Laboratory in Gödöllő. Therefore it is recommended to use this device on farms, because of the quick analysis and the lack of necessity of milk conservation and transport.

Meat production:

In the herd of the offspring of Hungarian Merino ewes and Lacaune F₁ rams 3 more lambs were born from 100 ewes and 7 more were sold from 100 ewes than in the Hungarian Merino herd.

The Lacaune F₁ and British Milk Sheep F₁ ewes had better milk yield, the daily weight gain and weaning weight correlated to 68 days were higher than in Hungarian Merino.

At weaning the Lacaune F₁ lambs were 2-3 kg heavier, British Milk Sheep lambs had 6-7 kg more weight compared to Hungarian Merino lambs.

The twin lambs showed a range of average daily weight gain measured by week. Similar tendency was observed in only lambs, but the differences were lower.

The lowest average daily weight gain was found in 3-4 week-old lambs in both only animals and twins when the suckling started to be limited.

In the case of cumulative daily weight gain the bottom values were observed on the 4-5th week in both only lambs and twins. The drop in only lambs (except Lacaune) is much bigger compared to the daily weight gain in first week. This value is double than that of twin lambs.

Because of the significant differences until the 10th week between gross and net daily weight gain it would be necessary to publish whether daily weight gain includes the born weight or not.

Wool production:

The crossbreeding of Hungarian Merino and Lacaune or British Milk Sheep had significant negative effect on the wool production. The income loss from this, however, could be counterbalanced by the increased income from selling improved quality and quantity milk and lambs.

Income:

The income of Hungarian Merino, which is still dominant in the Hungarian sheep sector, could be increased by 12-15 thousand HUF if crossbreeding its ewes with milk type rams.

5. NEW SCIENTIFIC RESULTS

1. The reduction of the frequency of daily milking – from two to one – results in a significant (30-50%) decrease in the milk production of the ewes. The rate of decrease depends on the genotype.
2. The reduction of the frequency of daily milking – from two to one – results in a significant (15-20%) decrease in the amount of income per ewe.
3. The amount of produced milk increases when using the Lacaune breed in any blood proportion. Milk contents vary depending on genotype.
4. By using cross-breeding the total income per ewe (lamb + milk + wool) could be increased by 10-80% in the examined conditions.
5. By calculating the FCM and FPCM milk production the differences between the genotypes are more comparable. The use of this calculation method affected the differences between the examined genotypes. This calculation method should be used in the selection of the ewes.
6. The use of the net weight gain is professionally more established in the case of the lambs compared to the use of the gross weight gain.
7. The growth curves of the lambs and their breaking points which could cause an increase or decrease in the production considering the speciality of the milking sheep farms were determined in the different genotypes.

6. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

Books, book chapters

1. GULYÁS, L. – GERGÁTZ, E. – MIHÁLYFI, S. – NÉMETH, A. – NAGY, ZS. (2008): A hazai juhtenyésztés versenyképességének javítása lacaune fajta felhasználásával. 193-218. p. In: KUKOVICS, S. – JÁVOR, A. (szerk.): A juhtenyésztés jelene és jövője az EU-ban. Válogatott tanulmányok. A Magyar Juhtejgazdasági Egyesület és a Debreceni Egyetem Agrár és Műszaki Tudományok Centrumának kiadása. Herceghalom-Debrecen.

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1. NAGY, ZS. – NÉMETH, A. – MIHÁLYFI, S. – TOLDI, GY. – GERGÁTZ, E. – HOLLÓ, I. (2011): The short history of Hungarian sheep breeding and Hungarian merino. Acta Agraria Kaposváriensis. Vol.: 15. No.: 1. 19-26. p.

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1. NAGY, ZS. – TOLDI, GY. – HOLLÓ, I. (2012): Napi egyszeri és kétszeri fejés hatása a juhtej mennyiségére és összetételére. 1. rész. Állattenyésztés és Takarmányozás. Vol.: 61. No.: 2. 51-65. p.
2. NAGY, ZS. – TOLDI, GY. – HOLLÓ, I. (2012): Napi egyszeri és kétszeri fejés hatása a juhtej mennyiségére és összetételére. 2. rész. (*Megjelenés alatt.*)
3. NAGY, ZS. – TOLDI, GY. – SÁFÁR, L. – KUKOVICS, S. (2008): A tejelő cigája versenyképessége hazai tejtermelési és vágóbárány-előállítási feltételek között. Állattenyésztés és Takarmányozás. Vol.: 57. No.: 4. 339-356. p.

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Full papers in proceedings

1. NAGY, ZS. – NÉMETH, A. – MIHÁLYFI, S. – TOLDI, GY. – GERGÁTZ, E. – GULYÁS, L. – HOLLÓ, I. (2010): Effect of dairy sheep breeds to hungarian merino stock. 8th World Merino Conference. Rambouillet. France. CD-kiadvány.
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3. NÉMETH, A. – MIHÁLYFI, S. – NAGY, ZS. – GULYÁS, L. – GERGÁTZ, E. (2008): A lacaune juh hústermelő fajtaváltozatával végzett keresztezések első hazai eredményei. XXXII. Óvári Tudományos Napok. Poszter. ISBN 978-963-9883-05-5, CD-kiadvány.

Presentations

1. NAGY, ZS. – NÉMETH, A. – MIHÁLYFI, S. – GULYÁS, L. – GERGÁTZ, E. (2008): A lacaune fajta 25 éve Magyarország juhtenyésztésében. XXXII. Óvári Tudományos Napok. ISBN 978-963-9883-05-5, CD-kiadvány.

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1. GULYÁS, L. – GERGÁTZ, E. – MIHÁLYFI, S. – NÉMETH, A. – NAGY, ZS. (2008): A hazai juhtenyésztés versenyképességének javítása lacaune fajta felhasználásával. Magyar Mezőgazdaság Melléklete, Magyar Juhászat és Kecsketenyésztés. 17. évf. 2-8. p.
2. NAGY, ZS. – MIHÁLYFI, S. – NAGY, T. – NÉMETH, A. (2008): Juhászokdunk gazdaságosabban. Kistermelők Lapja 52. évf. 7. szám. 16-17. p.

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4. NAGY, ZS. – MIHÁLYFI, S. – NÉMETH, A. – TOLDI, GY. (2009): Figyeljünk a kettőshasznú lacaune juhajtára! I. rész. Magyar Állattenyésztők Lapja. XXXVII. Évfolyam (Új évfolyam: XIV.) 2. szám 18-19. p.
5. NAGY, ZS. – MIHÁLYFI, S. – NÉMETH, A. – TOLDI, GY. (2009): Figyeljünk a kettőshasznú lacaune juhajtára! II. rész. Magyar Állattenyésztők Lapja. XXXVII. Évfolyam (Új évfolyam: XIV.) 3. szám 18-19. p.
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7. TOLDI, GY. – NAGY, ZS. (2007): Lacaune: tej- és hústermelésre. Kistermelők Lapja. 51. évf. 9. szám. 20-21. p.
8. TOLDI, GY. – NAGY, ZS. (2010): Ismerjük meg a hús-lacaune fajtát I. Kistermelők Lapja. 54. évf. 9. szám. 20-21. p.
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