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Prediction of the lactation yield in dairy sheep using a test-day animal model, electronic identification of animals and automated data collection

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SUMMARY - The purpose of the present paper is to present the data collection and selection scheme of the Chios sheep in the Agricultural Research Station of Chalkidiki. Lambs are evaluated on individual weaning weight and on the dam's performance for milk production and litter size. Furthermore, the prospects of electronic identification of animals and automatic collection of data, combined with the possibilities of earlier selection of lambs, are discussed. Finally, the results of the research concerning test-day records and lactation yield prediction are presented.

Key words: Sheep, Chios breed, milk recording, electronic identification, genetic evaluation, animal model.

RESUME - *"Prédiction du rendement par lactation en ovins lait en utilisant un modèle animal basé sur des contrôles journaliers, l'identification électronique des animaux et la collecte automatisée des données". Le but de ce travail est de présenter la collecte de données et le schéma de sélection de la race ovine Chios, qui se trouve à la Station de la Recherche Agronomique de Chalkidiki. Les caractères selon lesquels les agneaux sont évalués concernent la production du lait de la mère, la taille de la portée et le poids individuel au sevrage. En outre, les perspectives pour un système d'identification électronique des animaux et pour une collecte automatisée des données en conjonction avec une sélection plus précoce des agneaux, sont discutées. Finalement, les résultats concernant l'estimation des paramètres génétiques et phénotypiques de la quantité de lait au jour du contrôle et la prédiction de la production laitière sont présentés.*

Mots-clés : *Ovin, race Chios, contrôle laitier, identification électronique, évaluation génétique, modèle animal.*

Introduction

The Agricultural Research Station of Chalkidiki in Greece, was established in 1930 by the Ministry of Agriculture in an attempt to help many sectors of agriculture and livestock development of the region. In recent years, however, the efforts were focused mainly on research and development projects concerning sheep breeding and selection. From 1989 the Station belongs to the Farm Network of the National Agricultural Research Foundation.

Since 1997 - and within the framework of a nation-wide programme for protecting, studying and improving important indigenous sheep breeds - the Station has been assigned the task to investigate the physiological and zootechnical aspects of the Chios and Kymi sheep breeds, originated from the islands of Chios and Euboea, respectively.

The programme aimed at establishing two sizeable closed sheep flocks, of 500 ewes for each corresponding breed, with a rotating inter-family mating system in order to keep inbreeding in low levels. Along with the establishment of the experimental flocks, new buildings, land and water supply arrangements, the introduction of the necessary machinery and updated equipment (milking parlours) were secured to help support the development of the populations study and selection programmes.

Data collection and flock management system

The Station's sheep raising practices and husbandry methods are adapted to a rather large scale and intensive management system, which is not common to small ruminant production on the Greek mainland. The animals are housed in large open-front buildings, except during summer, when they are kept in shaded areas and graze freely on the available poor pastures. Feeding of ewes, lambs and rams is mainly based on concentrates and alfalfa hay and only some secondary grazing. Weaned female lambs are fed *ad libitum* up to the age of six months on grain mixtures and alfalfa hay, after which they are introduced to the standard ewe ration; the requirements of different production levels of lactating ewes are satisfied by group-feeding. Grazing during winter and spring is limited to temporary pastures of barley push, natural vegetation and some light grazing of cereal and alfalfa fields. During summer the ewes graze on stubble and some poor existing vegetation, depending on the prevailing xyrothermic climatic conditions.

For the study of the phenotypic and genetic variation of productive and reproductive traits of the breed, quantitative and qualitative measurements, as well as other observations, have been recorded individually. Data collection follows the different management stages, which are described below:

Milk production

After weaning, ewes are machine-milked twice a day, with an interval of 9-10 hours, until the second half of August; thereafter, milking is limited to once daily, further reduced to once every other day and stopped altogether by the end of September, when lactation ceases naturally. Ewes are milked in a two-compartment parlour of 24 seats. The Fleishmann method is used for the calculation of total milk production. Records of each reproductive period are kept in a data base.

Reproduction

The reproductive period begins on the 20th of May and lasts all summer, till the end of October. Ewes are checked for oestrus by teaser-rams and individually handmade without the use of AI. To avoid inbreeding, a rotational mating plan is applied, according to which the flock is divided into 10 families of 50 ewes and 5 rams each. On the average, the ewes from each family are naturally bred to the rams of another family, according to the rotational mating plan.

Lambings - Suckling

Approximately 45 days before lambing, ewes are group-housed according to the timing of breeding. One week before lambing, they are transferred to individual cells, where they are carefully attended by trained personnel, particularly during parturition and perinatal period. A week after lambing, small groups of 20-25 ewes with their suckling lambs are housed together.

Selection of rams

The final selection of rams is accomplished during shearing. Each year 50 rams, aged 18 months on average, are selected on their dams' milk yield, litter size, body weight (index selection) and body conformation scores.

Weaning - Growth

The suckling period lasts 42 days, after which weaned lambs are classified on the basis of their parental performance, growth rate and phenotype and the final selection is carried out after the completion of their dams' lactation. Based on their indexes the best lambs are kept as replacements and potential breeders. Females are used for reproduction, when they reach the age of 6 months and 60% of the weight of the adult female. The initial number of selected males corresponds to 20-25% of the females which are kept as replacements.

Shearing

Shearing is applied during the months of April and May and it is completed by May 20 th, when the reproductive period starts. During shearing the body and fleece weight are recorded.

A summary of the traits and the data collection is presented in the following table (Table 1).

Table 1. Traits and data collection of the Chios sheep nucleus in Chalkidiki Agricultural Research Station

Reproduction
Mating rates
Oestrus returns
Fertility rates
Lambing rates
Percentage of stillborn lambs
Mortality rates of lambs during the first 48 hours
Mortality rates of lambs during suckling
Growth
Body weight of lambs
{at birth
{at 15, 30, 42, 60, 75, 90 days
{at 4, 5, 6 months
Body weight of ewes
Body weight of ewes
{at mating
{at lambing
{at weaning of lambs
Milk production
Total milk production
Milk production during the first 50 and 100 days
Duration of milking period in days
Average and maximum daily post-weaning milk production
Average number of days between lambing and peak milk production
Fat and protein content

Automation in animal identification and recording

For the management of the flock and the breeding work in the Chios sheep nucleus a software package has been developed utilizing the Microsoft ACCESS 95 database. The package manages the ram, ewe and lamb population of the Station recording details of inventory dynamics, matings,

embryo transfers, pregnancy diagnosis, lambings, abortions, milk production and weights of lambs at birth, weaning and several growth stages. The different reports produced by the software summarize the reproductive and production activities of the flock and provides the relevant data for the estimation of breeding values of the ewes and rams.

Further improvement towards the simplification of management and milk recording will be achieved through automation of the animal identification and transferring the input data directly into the computer system. For this purpose, passive transponders will be used for the identification of the animals and an attempt is planned to interface the electronic identification with different automatic devices as, weighing machine, milk recording and feeding gates (Fig. 1).

Passive transponders use the reader's radio frequency signal as power supply for providing their integrated circuit with the necessary operating power. Either ruminal boli, electronic eartags or injectable transponders will be used as a permanent electronic identification system for the sheep in the Station (Caja *et al.*, 1996a; Caja *et al.*, 1996b).

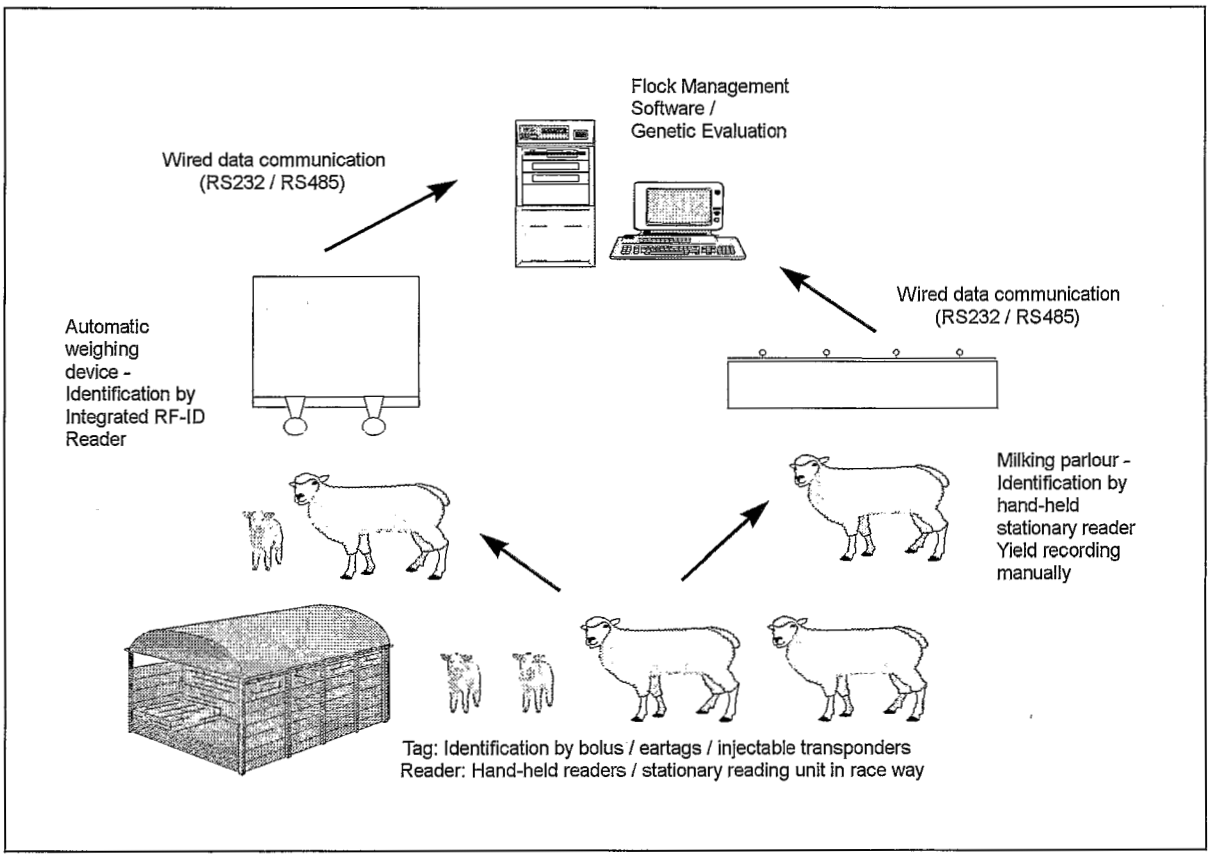

Fig. 1. Automation in animal identification on data collection of the Chios sheep nucleus in Chalkidiki Agricultural Research Station.

Lambs will be tagged at 20 days of age. The entire process of collecting weighing information in conjunction with the genetic evaluation of the lambs and ewes of the Chios breed will be automated combining electronic identification and weighing devices and electronic communication to finally store the collected data on a the Station's computer system. The lambs will be automatically identified during the monthly weighing operations. A fixed antenna realizes the identification of the animals without human intervention and enables the collection of the identities and weights in the electronic case of the weighing machine, which will be interfaced with the Station's computer system (Frappat, 1996).

Static reading of the transponders will be accomplished with a hand-held reader and dynamic reading in moving animals in a race-way using a stationary reading unit and a radio frequency reading system.

The milking and recording of the production will be carried out with manual jars, while hand-held/stationary readers will be used for the recognition of the ewes in the milking parlour. The manually measured milk will be transferred to specific sheets and then to the Station's computer for management and genetic evaluation purposes.

Breeding practices

Selection of female and male lambs is based on individual weaning weight and on dam's performance for milk production and litter size. Information on these traits is combined in a selection index, which phenotypic and genetic parameters for the traits included, are shown in the following table (Table 2).

Table 2. Estimates of heritabilities, genetic and phenotypic correlations among traits used in selection index†

Traits	Commercial milk yield	Litter size	Weaning weight
Commercial milk yield	0.23	0.13	0.05
Litter size	0.08	0.16	-0.39
Weaning weight	0.01	-0.06	0.17

†Genetic correlations above the diagonal, phenotypic correlations below the diagonal

In order to select the lambs early, before the end of lactation period of the ewes, new selection schemes are under development, utilizing BLUP methodology with a test-day animal model. Furthermore, according to the Trus and Buttazzoni (1990) approach, projection of unobserved records and estimation of commercial milk production will be combined in a single procedure in order to make maximum use of the predictability of the lactation curve and to minimize the error of prediction from a sample of daily records.

For the estimation of the genetic parameters for test-day records all lambings of the Chalkidiki Agricultural Research Station of the years 1992-1995 were used. Each female was recorded, after a 42-day suckling period, in 28-day intervals for milk yield.

Only first lactation data were used for variance components estimation with DFREML 2.1 (Meyer, 1993), applying a repeatability animal model (1) which is described as follows:

$$y_{ijklm} = ML_i + MM_j + T_k + a_l + pe_m + e_{ijklm} \quad (1)$$

where,

y_{ijklm} = test-day record from a single standardized 28-day interval
ML_i = month of lambing
MM_j = month of milking
T_k = number of subsequent test-day record
a_l = animal's additive genetic effect
pe_m = effect of permanent environment of the ewe during lactation
e_{ijklm} = residual effect

Estimates of heritabilities are shown in Table 3. The first part of the table presents estimates obtained when only four test-day records were used for each ewe, while for the second part all available test-day records up to seven were used.

Table 3. Estimates of heritability (h^2) and effects of permanent environment (pe) of ewes in first lactation for using a test-day repeatability model

	h^2	pe
1^{st}-4^{th} test-day records milk (g)	0.28	0.39
1^{th}-7^{th} test-day records milk (g)	0.17	0.40

In a second stage, a multitrait animal model (2) was fitted for the estimation of heritabilities of single test-day records and genetic and phenotypic correlations between test-day records and commercial milk yield.

The multitrait model was:

$$y_{ij} = ML_i + a_j + e_{ij} \quad (2)$$

where,

y_{ij} = test-day record from a single standardized 28-day interval (1^{st}, 2^{nd}, 3^{rd}, 4^{th}), or commercial milk yield
ML_i = month of lambing
a_j = animal's additive genetic effect
e_{ij} = residual effect

The parameter estimates from the multitrait analysis are shown in the next table (Table 4).

Table 4. Estimates of heritabilities, genetic and phenotypic correlations using a multitrait animal model

	1^{st} test-day	2^{nd} test-day	3^{rd} test-day	4^{th} test-day	Commercial milk yield
1^{st} test-day	0.26 ± 0.158	0.99	0.98	0.73	0.64
2^{nd} test-day	0.72	0.19 ± 0.129	0.98	0.74	0.72
3^{rd} test-day	0.63	0.75	0.21 ± 0.121	0.78	0.75
4^{th} test-day	0.55	0.56	0.77	0.23 ± 0.121	0.89
Commercial milk yield	0.63	0.71	0.74	0.78	0.16 ± 0.13

Genetic correlations were over 0.9 between the three first test-day records and decreased about 0.7 between the three first and the fourth. Genetic correlations between test-day records and commercial milk yield were about 0.64 for the first test-day record and increased up to 0.89 for the fourth. Phenotypic correlation tended to be smaller than genetic correlations but followed the same trend. These results agree with literature data (Barillet and Boichard, 1994) and they can be used for genetic evaluation purposes.

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