Institute of Animal Science
of Estonian Agricultural University
Estonian Animal Breeding Association
Estonian Animal Breeding Inspectorate

PROCEEDINGS OF THE 7TH BALTIC ANIMAL BREEDING CONFERENCE

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FOREWORD

The annual Baltic Animal Breeding Conference starts its third round. Within seven years, in close co-operation, the three Baltic States have been focusing on finding solutions to several breeding problems of farm animals. We are delighted to see an increasing number of young delegates attending the Conference along with their senior colleagues. International co-operation has become remarkably closer, particularly in the field of conservation of diversity of farm animal genetic resources. Studies on the genetic similarity and diversity of endangered breeds are financially supported by the Nordic countries.

Regarding veterinary medicine, the current situation is rather complicated worldwide, especially in Europe. The outbursts of foot-and-mouth disease and cases of BSE have strongly affected the exchanging of breeding material. Importation of live animals has practically ceased. There is only a chance to exchange semen and embryos between a few countries from time to time. Import of breeding material is of vital importance for each of the Baltic countries, thus we hope the serious diseases will be eradicated and we can proceed with intensive breeding work to enhance the reproductive performance of farm animals.

The present Conference is dedicated to the celebration of the 50th anniversary of the Estonian Agricultural University this year. We are proud of the consistent development of academic educational and research activities. I wish great success to all my colleagues. I am very grateful to the kind supporters of the Conference.

Institute of Animal Science of Estonian Agricultural University
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Prof. Olev Saveli
Chairman of the Organizing Committee

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ANIMAL BREEDING DEVELOPMENT IN LITHUANIA

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Introduction

Animal husbandry, including breeding of cattle, pigs, horses, sheep, goats and other animal species as well as poultry, is the main branch of agriculture in Lithuania. The development of animal breeding has been the most important direction in the Lithuanian animal husbandry for a long time:

- In 1907, Milk recording societies were established;
- In 1924, The Native Cattle Improvement Society and Lithuanian Red Cattle Breeders' Society were established;
- In 1956, the first A.I.- stations were founded;
- In 1958, General animal breeding system for different animal species was established;
- In 1959, Milk recording system was revived;
- In 1978, Computing and information system of cattle selection was founded, and since 1979, all dairy cattle performance and herd-book registrations are stored at the Animal Breeding Information Centre,
- Since 1984, all pig performance testing data are processed at the Animal Breeding Information Centre,
- Since 1993, private animal breeders' associations were re-established instead of Animal Breeding Councils for different animal breeds,
- In 1994 The State Pig Breeding Station with 3 regional departments was founded,
- In 1994, The Livestock Breeding Law of the Republic of Lithuania with its new edition in 1998 was adopted,
- In 1998, The State Livestock Breeding Supervision Service (Inspection) at the Ministry of Agriculture was established instead of The Department of Animal Breeding.

The Animal Breeding System in Lithuania comprises:

- animal breeders,
- enterprises doing service in animal breeding,
- the recognised animal breeding institutions and other animal breeders' associations under co-ordination of The Chamber of Agriculture,
- the State Livestock Breeding Supervision Service at the Ministry of Agriculture.

The State Livestock Breeding Supervision Service at the Ministry of Agriculture is responsible for the control of the Livestock Breeding Law and other legal documents applicable to animal breeding. The control of implementation of the animal breeding programmes, and the optimal distribution and use of government funds to ensure the improvement of all animal breeds and increase of animal production is also under control of The State Livestock Breeding Supervision Service. The Supervision Service has a staff in the central office and animal breeding inspectors in each of the 44 districts. The state control and co-ordination as well as financial support is of greate importance in the animal breeding system until the animal breeders' associations become stronger financially.

Dairy cattle breeding. Dairy farming is the most important enterprise to animal breeders as it gives over 50 per cent of total income in animal husbandry. At the beginning of 2001, there were 861707 cattle head in the country, of which 435,337 were milking cows in the country. Currently the herd size is very small, on the average 2 milking cows. 49.5% of all cows are kept in 1 to 2 cows herds, 30.8% - in the herds of 3 to 5 cows, 9.3% - in the herds of 6 to 40 cows and 10.4% - in the herds of over 40 cows.

Two major cattle breeds maintained in Lithuania are Lithuanian Black-and-White and Lithuanian Red Cattle accounting for 68 and 30 per cent of all cattle, respectively. The imported cattle of German, Danish, Swedish Holstein, Danish Red, Angler, German and Swedish Red-and-White, Finnish Ayrshire and other dairy breeds take the remaining 2 per cent of the total dairy cattle population in Lithuania.

Dairy production of milk-recorded cows is presented in Table 1.

Table 1. Productivity of milk-recorded cows, 1999/2000 recording year

Item	No. of cows	Milk KGs	Fat		Protein	
			%	KGs	%	KGs
All cows	97567	4447	4.36	194	3.26	145
Of which:						
Black-Whites	67235	4551	4.33	197	3.22	146
Reds	30119	4215	4.46	188	3.35	141
Breeding farms	21041	4855	4.37	212	3.24	158
Potential bull-dams	817	7000	4.48	314	3.24	227

In 2000, the number of cows has decreased by 10.3%, however, the milk yield increased by 197 kg, and both fat and protein content increased by 0.10 %. Number of cows decreased due to lower milk market prices in Lithuania and unprofitable fattening of young bulls as well as high costs of heifers rearing for replacement of cows.

Currently only 21 per cent of all cows are under milk recording. The average size of milk-recorded herds is also too small. Only 10% of all milk recorded cows are in the herds of over 40 cows. The situation is result of ruination of many agricultural companies and insufficient support for stimulus of family dairy farming. The major part of milk recording expenses are covered by government subsidies. But this system doesn't stimulate farmers well enough to participate in milk recording. We should have 50% of all cows under milk recording for optimal cattle breeding scheme. 60% of the price for two doses of bull semen used for insemination of milk-recorded cows has been subsidised to encourage cattle breeders to participate in the milk-recording programme. But, this didn't work well. The problem will be solved when the average herd size is increased due to increase of family dairy herd size in Lithuania, because over 80% of all cows in the herds of 5 cows and over size are already milk recorded.

Milk-recording is organized in accordance with the regulations of The International Committee for Animal Recording and carried out by the Animal Production Recording Service (State enterprise GYVULIU PRODUKTYVUMO KONTROLE). Milk is tested for protein, fat and somatic cell count by milk testing laboratory, the State enterprise PIENO TYRIMAI and all data are accumulated and processed at the public institution KAIMO VERSLO IR PLETROS INFORMACIJOS CENTRAS.

The milk-recorded part of population gives a possibility to test about new 50 bulls per year, if all bull semen producing centres would be interested well enough to participate in the bull testing program. Only 35 young bulls, however, were progeny tested last year.

Last 10 years, bulls were selected in three ways:

- young bulls obtained from bull dams in and tested on farms in Lithuania;
- young bulls imported from abroad and tested in Lithuania;
- import of proven bulls.

At present, the last two resources of bulls are terminated under import restrictions, because of BSE and Mouth-and Feet diseases in Europe and Bovine Leucosis in North America. It can continue for two cattle generations or longer time. Much more attention will be paid to bull selection from the best potential bull dams and bull sires.

The number of potential bull dams will increased over 1000. One hundred bull calves at 4 to 6 months of age are purchased to young bull rearing station annually. 60 per cent of the yearling bulls will be selected to A.I. centres for semen production and progeny testing.

There are 53 breeding farms of the first category and 222 breeding herds of the second category. All potential bull-dams are kept in the breeding farms. The farms also are a main resource of heifers for sale. Number of sold heifers dropped from 3636 in 1999 to 1617 heifers in 2000, because of lower subsidy. Therefore, 241 heifers were exported.

Pig breeding. There are one million pigs kept in Lithuania. The major pig breed in our country is Lithuanian White. The Lithuanian White pigs are well suited for industrial crossbreeding as the main maternal breed. Other breeds used for crossbreeding: Swedish, Finnish, Danish, Norwegian and British Yorkshire, Swedish, German, Finnish, Danish, Belgian and Norwegian Landrace as well as German Large White, Pietrain, Hampshire and Duroc.

At the beginning of the year, 77,000 pigs where kept in the 58 nucleus herds.

The selection of pigs aimed at high fertility, good feed intake and fattening, as well as good quality of pork and carcass. Main goals of pig breeding in the nearest future:

- improvement of the Lithuanian White pigs for better fertility, i.e. litter size of main sows should be 11 to 12 piglets;
- meat ratio in carcass 53 to 55 per cent;
- daily gain 780 to 800 g, feed intake 3.2 to 3.4 feed units/ 1kg, fat thickness near the last ribs lower of 18 mm.

Boars and sows are progeny tested for fattening and carcass qualities in The Pig Performance Testing Centre near Baisogala. There are 120 to 150 boars and 400 to 500 sows annually tested in the Centre. According to the results of the Centre, pure-breds of different breeds and some combinations of crossbreeding give a carcass of good quality. Therefore, F_1 crossbred gilts for industrial pig farms are reared at breeding farms too. The crossbred F_1 sows are bred with the boars of specialised meat type breeds under crossbreeding of 2-3 breeds system in the industrial pig farms. So, less imported pigs will be needed.

BIODIVERSITY STUDIES OF BALTIC-NORDIC DOMESTIC ANIMAL GENETIC RESOURCES (ANGR)

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Introduction

The total global biodiversity most likely includes tens of millions of species. But the biological diversity of the planet is rapidly being depleted as a direct or indirect consequence of human actions. An unknown but large number of species are already extinct, while many others have reduced population size that put them to risk (Frankham, 1995).

Mankind uses some 40 species of animals as domestic livestock to meet our needs for food, clothing, power, etc. Within these species, there are in total some 4500 breeds that are referred to as the global animal genetic resources (Barker, 1999).

In recent years, changes in economic climate have promoted the use of breeds suited to intensive production systems, which has led to a few breeds becoming widespread while the breeds that they have replaced have decline in population size. In some cases native populations have been crossbred with imported stock in upgrading programmes (Blott et al., 1998).

Each breed is the product of mutation and genetic drift, as well as separate adaptation and evolution, with differing selection pressures imposed by climate, endemic parasites and diseases, available nutrition and criteria imposed by man. Each breed thus comprises a unique set of genes (Barker, 1999). Native populations may have encompassed genetic variants that would have adaptive advantages under local environmental conditions (Blott et al., 1998).

Domesticated ruminants, such as cattle and sheep, are ecologically and/or economically important farm animals in North Europe with a capability to use grass in nutrition.

The importance of maintenance of domestic animal diversity has been emphasized in several reports (Hall & Bradley, 1995; Kantanen et al., 1999), we can assume that genetic variation of domestic cattle and sheep is declining. To make the current and future progressive improvement of domestic animals populations successful in intensive and extensive circumstances, the genetic variation within domesticated species must be maintained (Oldenbroek, 1999). Both the variation within breeds and the variation between breeds and loss of variation will restrict the options available to meet unpredictable future requirements (Barker, 1999). Species with low genetic variation would be expected to have reduced ability to cope with environmental change during evolution and so have shorter evolutionary lifespans (Frankham, 1995).

However, the dramatic decline in livestock inventories and the economic conditions clearly indicate that there is pressure to increase profitability of livestock farming by replacing less productive breeds with more productive ones. Especially high–input/high–output breeds like the Holstein have already and still are gaining importance in Poland and the Baltics, as well. At the same time, it becomes fashionable to take–up beef farming by importing diverse beef breeds from Western Europe and North America.

Today, in Poland the main cattle breed is the Black&White (Holstein), which represent almost 90% of the national cattle herd, smaller populations being the Red&White, the Polish Red, the Simmental and the Jersey. Only the Polish Red breed has the status of endangered breed.

In Estonia, the main cattle breeds are the Holstein and the Red Cattle with a share of about 70 and 30%, respectively. The Estonian Native cattle has status of endangered breed with a population of about 1000 animals.

In Latvia, the main breed is the Latvian Brown cattle with a share of about 80% of the national cattle herd. Less important breeds are the Black&White (Holstein), the Danish Red and the Angler. The Latvian Blue Cattle has the status of endangered breed.

In Lithuania, there are two main breeds, the Lithuanian Black&White (Holstein) and the Lithuanian Red Cattle comprising respectively some 64 and 36% of the country’s cattle population. The Lithuanian White Back, the Lithuanian Light Gray (Blue) and the old type of the Lithuanian Black&White cattle comprise very small populations and have the status of endangered breed.

The native Baltic sheep breeds: Lithuanian Coarsewooled, Lithuanian Black-face, Estonian Native and Latvian Dark–head, belong to the short-tailed group of sheep and are assumed to be closely related to other short–tailed breeds in North Europe. These sheep breeds are known for hardiness, some grow special wool types and variation in colour is quite common. They are often highly fertile and produce large litters but the body conformation is less compact than of heavy meat type breeds. The market demand for heavy and muscular lamb carcasses with a high lean meat content is unfavourable for the short–tailed breeds in competition with the heavy breeds. Lithuanian Coarsewooled sheep has the status of critical breed.

Until very recently, the many studies of genetic structure have used polymorphism in loci for coat colours, horn types, blood groups, milk and plasma proteins. Since the late 1970s, molecular methods have provided new markers for the study of genetic variation, even to the level of analysis at the DNA sequence itself (Barker et al., 1997). Among these molecular markers, increasing preference is being given to microsatellites. These markers are repetitive elements containing simple sequence motifs, usually dimers or trimers. They appear to be abundant, averaging between 50 000 and 100 000 in mammals, and are evenly distributed throughout the genome. Microsatellites display a high degree of polymorphism, with a mean polymorphism information content of 0.6 (Moazami-Goudarzi et al., 1997).

In addition to microsatellites, analyses of maternally inherited mitochondrial DNA (mtDNA) and paternally inherited Y-chromosomal DNA have proved to be useful tools to assess historical origins and to assess more precisely gene pool development of cattle breeds (Bradley et al., 1996; MacHugh et al., 1997; Mannen et al., 1998). This kind of information has a value when decisions on conservation of unique populations need to be made (May, 1990; Hall & Bradley, 1995).

Analysis of protein polymorphism and mtDNA D–loop sequence has suggested a classification of cattle diversity into two major groups: humpless taurine (*Bos taurus*) and humped zebu (*Bos indicus*). African and European cattle display two different taurine mtDNA sequences. Recently, Japanese and Mongolian indigenous cattle were found to display unique mtDNA diversity. Thus, there are at least four mtDNA lineages in domestic cattle. In domestic sheep were able to find two different mtDNA lineages (European and Asian) by restriction enzyme analysis of mtDNA.

Recent studies on genetic variation indicate a divergence of most of the Nordic indigenous cattle breeds from commercial modern breeds (Kantanen et al., 2000).

The N–EURO–CAD is a collaborative project between the five Nordic countries, the Baltic countries (Estonia, Latvia and Lithuania) and Poland. Data from the microsatellite analysis of the Nordic, Baltic and Polish breeds is collected into a Cattle Diversity (CaDBase) project. The project aims to characterize genetic diversity in European cattle. In addition to autosomal markers, Nordic and Baltic cattle breeds are currently analysed for Y–chromosomal DNA variation in the project funded by Academy of Finland.

Less molecular genetic characterizations has so far been conducted in sheep breeds. The Baltic and Nordic laboratories have started sheep diversity project where 33 sheep breeds or populations of North European origin are analysed for 25 microsatellites and mtDNA sequence diversity. To demonstrate the uniqueness of these sheep breeds and their historical origins, more sheep breeds of Eastern and Western geographic origin should be analysed.

Domesticated animals have had an important association with human movements and studies on origins of cattle and sheep breeds can provide new information on aspects of prehistory of human populations.

The research is focused on collection of blood samples of uncharacterized Baltic and Poland cattle and sheep breeds and their investigation by selected microsatellite markers, investigation of mtDNA sequence variation in cattle and sheep breeds to extent knowledge on distribution of mtDNA lineages of domestic animals, analysis of genetic diversity within a breed and determination of gene frequencies and genetic distances between breeds, to combine these results with other microsatellites, Y-chromosome and mtDNA studies in cattle and sheep to identify genetically unique breeds, generate new information for conservation strategies of cattle and sheep genetic resources for future breeding strategies, and to understand breed histories, and compare the genetic origins of cattle and sheep breeds in the Eurasian continent.

Materials and Methods

Animal samples

Blood/semen samples were collected from 400 unrelated animals belonging to 10 Baltic and Poland cattle breeds and from 116 unrelated animals belonging to 4 Baltic sheep breeds. These breeds are the following:

Breed	No. of females	No. of males	Total
Sheep:			
Lithuanian Coarsewooled	27	3	30
Lithuanian Black–faced	20	10	30
Estonian Native	15	9	24
Latvian Dark–head	26	6	32
Cattle:			
Polish Black & White	30	10	40
Latvian Brown	30	10	40
Latvian Blue	30	10	40
Latvian Danish Red	30	10	40
Estonian Native	30	10	40
Estonian Red	30	10	40
Lithuanian Red	30	10	40
Lithuanian White–Back	30	10	40
Lithuanian Light–Grey	30	10	40
Lithuanian Black & White	30	10	40

Blood was collected into two 10ml vacutainers from each animal. DNA was extracted from 10ml of fresh or frozen blood and 10 ml was kept as a reserve. If collecting of blood samples was not available, the bull's DNA was extracted from semen. Due to the small size of sheep population less than 30 individuals were collected from Estonia.

Laboratory analysis

Microsatellite DNA is analysed in 24 to 40 unrelated individuals per a cattle or sheep breed. The microsatellites have been chosen from the CaDBase recommendation list.

The 20 microsatellite loci studied in cattle breeds are the following: INRA 023, INRA 032, INRA 005, INRA 063, INRA 035, INRA 037, HEL 5, HEL 13, HEL 1, HEL 9, BM 1818, BM 1824, BM 2113, ETH 10, ETH 152, ETH 225, ETH 3, CSSM 66, ILSTS 005, ILSTS 006.

The 25 microsatellite loci studied in sheep breeds are the following: OarFCB 128, OarFCB 304, OarFCB 11, OarFCB 48, OarHH 47, OarHH 64, MCM 527, MAF 65, MAF 48, MAF 36, MAF 214, INRA 023, BM 8125, BM 0757, BM 1818, BM 6526, BM 1314, BM 4621, BM 6506, ILSTS 002, OarCP 38, OarCP 20, OarCP 34, CSSM 31, OarVH 72.

Mitochondrial DNA contains a specific region called the displacement loop. The PCR is used to amplify the D–loop. Six to ten animals per breed are analysed. In bovine mtDNA D–loop sequence (240bp) and in ovine mtDNA D–loop sequence (480bp) variation analysis and a laboratory analysis given by Bradley et al., (1996) are applied.

Sequence variation determined in the present study will be later compared with published sequences of other European cattle and sheep breeds.

Statistical analysis

Microsatellite DNA variation within and between breeds will be assessed as described by MacHugh et al., (1997), Kantanen et al., (2000) and Tapio et al., (2000). Intra– and inter–breed variation based on mtDNA sequences will be estimated as described by Bradley et al., (1996).

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MANAGEMENT OF DOMESTIC ANIMAL GENETIC RESOURCES IN LATVIA

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Introduction

It is significantly important to maintain indigenous breeds and their genes as genetic resource for future selection considering the role of the genetic variation of farm animals' genetic gain. Indigenous breeds adapted to harsh environments, do not demand high input in production and usually they are a part of the culture are neglected for one main reason. A few high productive foreign breeds replaced them. To conserve animals currently are not in interest to farmers is the main target of FAO global strategy.

The first step is to develop and support a country - based infrastructure for the management of animal genetic resources. To implement a part of the first step there was worked out a Conservation Programme for Domestic Animal Genetic Recourses. Five Latvian indigenous breeds were included.

Material and Methods

Countries involved in the Convention of Biological Diversity have sovereignty and responsibility over the recourses they have. Latvia has signed this convention in 1995. Nature Management and Regional Development Ministry has worked out a Nature Management Action Programme to aware the recourses Latvia has and to set several activities to maintain the reasonable utilisation of them.

A specialists` group collaboratoring with the Association of Latvian Animal Breeders worked out a conservation programme in behalf of Ministry of Agriculture of Latvia. There were included breeds of Latvian Brown and Latvian Blue cows, Latvian White pigs, Latvian Dark-head sheep and Latvian Horses. Basic methods for investigation and maintenance of breeds were establishing a database, gene bank forming by storing semen at AI stations, working out a plan for possible complete quantitative, immune-genetic and molecular genetic analysis of the DNA material of them.

Results

Cattle. Historically the most widely reared breed in Latvia is Latvian Brown (79%) since the beginning of 20th century. The next largest breed is black-and-white Holstein-Friesen (14%). There is less than 1% Latvian Blue cattle which has the status of an endangered breed. In fact we can qualify the status of that population as critical-maintained; the amount of active population is Ne=49. The amount of active population of **Latvian Brown** is approximately Ne=536. Taking part in a project of establishing European Red Dairy Breed as a part of Nordic Gene Bank maintains its strong position.

Latvian dairy cattle breeds had been investigated on erythrocyte antigens by different authors: V. Deksne, V. Shimis, L. Lauka, K. Kjaune, R. Beķere etc. They had collaborated with scientists in Baltic countries (Z. Vagonis, L. Vaher) and Russia (A. Mashurov, P. Sorokovoj). There were investigated blood groups for more than 30 years period and made an attempt to find connection between blood groups and productivity and estimated philogenetical relation between different red breeds in Baltic.

Deksne,V. et al.[1] compared the Lithuanian Red (n=1417), Latvian Brown (n=4870), Angler (n=383), Estonian Red (n=2219) and Danish Red (n=1155) cattle breeds by erythrocyte antigens. They found [2] that the smallest difference was between Lithuanian Red and Latvian Brown and between Lithuanian Red and Angler breed (genetic distance D=0.127-0.128), the biggest difference was found between Estonian (D=0.160) and Danish Red (D=0.148) cattle breeds. They suggested that the biggest genetic distance was between Lithuanian and Estonian Red cattle breeds referred to the originality of genetic structure of Estonian Red breed.

If we compare data from severe sources we can see that accent was changed (Table 1) and it pointed out different alleles.

Table 1. The most frequent EAB alleles typical of the Latvian Brown in the different sources

Source		
[4]	[3]	[2]
B_2O_1	B_2O_1	B_2O_1
$B_2O_1Y_2D'$	$B_2O_1Y_2D'$	
$B_2Y_2A'_2 E'_3G'P'Q'Q''$		
B_2P'	B_2P'	
Y_2Y'	Y_2Y'	Y_2Y'
b	b	
	OQJ'K'O'	
	$BY_2A'G'P'Q'G''$	

The frequency of typical Latvian Brown EAB alleles has diminished [3] and the frequency of alleles $B_1P_1Y_2G'$ (typical of Angler breed) and $O_2J'_2K'O'$ (introduced by Holsteins) increased. The frequency of EAB alleles G_2 has increased as well, showing the increase of importance of Holsteins.

The mentioned authors [1] think that rarely find alleles (1% and rare) in Latvian Brown populations are

G_1, K, P_1, P_2, T_1, T_2, I', B', B'', R_2, L' etc.

Frequently find alleles (50% and more) are

B_1, O_1, Y_2, D', G', P', Y', C_1, E.

Like majority of European cattle breeds Latvian Brown [1] has not allele Z'.

There were not found such genetic characteristics of Latvian Blue cattle population.

Pigs. During last decades in Latvia were introduced a number of breeds, such as Deutsche Edelschwein, American Hampshire, Duroc, Large White etc. Basically they were used for crossing and hybridisation purpose. Our native origin swine breed is Latvian White. The Latvian White has taken a leading position among the other breeds although there is a tendency to diminish. It is due to decreasing the total amount of pigs in the country.

Sheep. In Latvia there is reared only one breed of sheep - Latvian Dark-headed. The breed is evolved in Latvia as the base of native sheep strains to improve them with some breeds from Britain as Oxfordshire, Shropshire etc. During the last decades there were used Finnish Landrace, Argentine Corridel, Texel. The active population of Latvian Dark-headed is not large (Table 2) There are worked out activities for its maintaining.

Horses. There is one breed of horses in Latvia with a widespread use - Latvian Horses. The breed was developed from two native horse populations found thorough the territory of Latvia since 5th till 13th century. For improvement were used Zemaitukai Horses from Lithuania, Tori Horses from Estonia, Oldenburger Warmblut, Holsteiner Warmblut, Branderburger Warmblut, and Mecklenburger Warmblut from Germany, Groninger Horses from Netherlands, Anglo-Araber etc. Active population of breed is small and activities for maintenance of breed is extremely indispensable.

In literature sources we could not find useful information about our native pig, sheep and horse population genetics characteristics therefore there were anticipated further activities in our programme. Populations included in the Conservation Programme for Domestic Animal Genetic Resources are in different stages of endangerness. (Table 2)

A very important question for conservation and maintenance the indigenous breeds is to find out advantageous and disadvantageous genes and gene blocks in their genome. In Latvia there is no possibility to use molecular genetics methods in such investigations due to technical matters. In that context we are very thankful to the Nordic countries initiative, especially to Nordic Gene Bank, Norway (Dr. Erling Fimland). During last years there were taken samples from Latvian cow populations (N-EURO-CAD, 2000) and sheep populations (1999).

There will be also analysed a set of approximately 20 microsatellite markers and 40 animals per breed to gather all available information.

Table 2. Characteristics of native farm animals populations in Latvia

Degree of endanger	Breed	Species	Ne [3]	BA [4]
Widespread use				
(1) in crossbreeding	Latvian White	Pigs	-	ABIP [5]
(2) as straightbred in MP [1]	Latvian White	Pigs	154	ABIP
	Latvian Brown	Cows	536	ABIP
Limited use but in WDPS [2]	Latvian Horse	Horses	473	ABIP
	Latvian Dark-headed	Sheep	2157	DBIP [6]
Critical	Latvian Blue	Cows	18	DISPP [7]

Explanation: [1] MP- mainstream production; [2] WDPS - well-defined production system; Ne - amount of active population; [4] - breeding activities; [5] active breed improvement program, [6] - develop breed improvement program; [7] develop in situ preservation program.

Breeds included in the programme are found only in Latvia and not elsewhere. Therefore in situ conservation of their genetic diversity will support all accessible measures - to maintain live animal of small populations, germ plasm (semen and embryo) bank and some gene material (DNA) for future detailed genetic investigation and sustainable use.

Counclusions

1. Latvian indigenous breeds are endangered because they hardly compete with high productive foreign, this reason proves necessity to conserve the indigenous genetic resources.
2. Management of genetic resources is a very essential aspect of the programme. There is necessity to establish National Focal Point and more actively involve Animal Breeders organizations in order to continue more successful implementation of genetic resources conservation programme.

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DEVELOPMENT TENDENCIES OF ANIMAL REARING IN ESTONIA

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Decrease in the total production of animal rearing is greater than in plant production. The number of animals and the output of animal products have declined year by year due to the low purchasing prices, relatively great import capacities, and the influences of the agricultural reform. Within ten years, the number of animals has decreased 65%. The number of sheep and goats has decreased ca 78% (Table 1).

Table 1. The number of cows as of December 31 (by thousands of heads)

	Bovines	Pigs	Sheep and goats	Horses	Poultry
1991	708.3	798.6	142.8	7.8	5538.3
1992	614.6	541.1	124.2	6.6	3418.1
1993	463.2	424.3	83.3	5.2	3226.1
1994	419.5	459.8	61.5	5.0	3129.7
1995	370.4	448.8	49.8	4.6	2911.3
1996	343.0	298.4	39.2	4.2	2324.9
1997	325.6	306.3	35.6	4.2	2602.0
1998	307.5	326.4	30.8	3.9	2635.7
1999	267.3	285.7	30.9	3.9	2461.8
2000	243.8	268.3	31.4	3.6	2529.0

Milk production

Dairy cattle rearing has been the most important sector of agricultural production within the recent decades. Similarly to the general tendencies in agriculture, dairy production has also decreased within the previous ten years. In 1991, there were 109.3 thousand tonnes of milk produced in Estonia, in 2000, the figure had dropped to only 629 thousand tonnes (Table 2). By the year 2000, milk production had decreased 43%. The reason of the decline is the decrease in the number of animals, which has been caused by the steep recession in the purchase capacity of the eastern market and in export capacities.

Since 1994, milk production per cow started to grow again. In 2000, milk production per cow was 12% higher than in 1990.

The number of cows

In 2000, the number of cows in Estonia decreased, compared to that of 1999, by another 7,700 animals, or 5.6%, comprising 130,700 animals as of January 1, 2001 (Figure 1). Since a year ago, there was the drop of almost 13% (1991-2000, 7.5% on the average), then in 2000, relative stabilisation in the number of cows could be observed. The liquidation of the cattle due to the unfavourable production conditions in 1999 has been stopped; stronger and more competitive producers have survived. There is no considerable decline expected in the number of cows within the next few years, rather some increase is assumed. In 2000, 78.8% of cows was under animal recording. The major part in the structure of cattle comprised the Estonian Holstein breed cows – 71.4%, and the percentage of these has compared to the last year increased by 2.6 percentage points. The increase in the number of the Holstein breed cows has been evoked by their greater genetic potential compared to one of those of the Estonian Red and Estonian Native cattle breed cows. The percentage of the Estonian Native cattle breed has also increased from 0.4% to 0.5% and this has been evoked by the government subsidy given to the Native cattle breed cows as an endangered breed. The percentage of the Estonian Red breed cows has decreased to 28.1%, which, compared to the previous year, has dropped by 2.7 percentage points.

Milk production

According to the provisional data, 628,663 tonnes of milk were produced in 2000, which is 0.4% or 2.577 tonnes more than in 1999 (Figure 1). The little increase in milk production was achieved within the last months of the year despite the production being 28,000 tonnes smaller in the first half-year compared to the same period of the previous year. The production of the second half-year exceeded the according value of assets of the previous year already by 30,000 tonnes. There was 408,677 tonnes of milk realised to the milk processing or 1.1% more than in 1999. The amount of milk bought up by the processing industries, i.e. the amounts of the second half-year exceeded the amounts of the same period in 1999. The quality of milk has improved compared to the previous year. In 1999, the elite or higher-grade milk comprised 79.4% of the milk purchased, and in 2000, it was 83.3%. The percentage of grade 1st milk, however, decreased from 16.8% to 14.2%. The fat content of the milk reserved was on the average of 3.9%, or 0.1% percent higher than in 1999.

The increase in the total production of milk while the number of cows has decreased can be explained by the greater average productivity of those remained, which in 2000, reached a record level in Estonia – 4,658 kg, i.e. 478 kg (11.7%) more than in the previous year, and 202 kg more than in the record year of the 1990ies, that is 1998 (Figure 1). This growth in productivity is in many ways explainable by the fact that in most cases the less productive cows were lost in the course of reducing or eliminating cattle during the previous years due to the disadvantageous conditions. At the same time, milk producers have started to pay greater attention to feedstuffs, especially to the production and quality of silo.

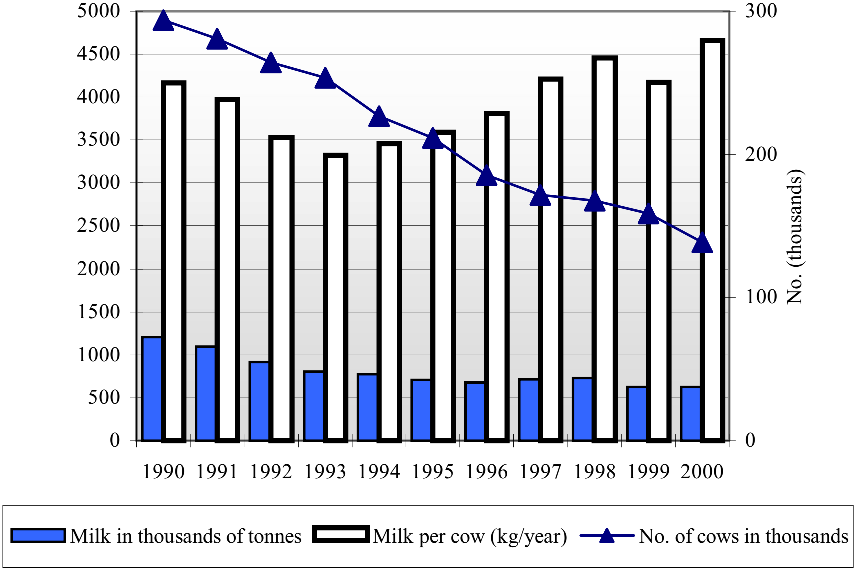

Figure 1. Number of cows and gross production of milk and average milk yield per cow per year

Following the example of the more successful cattle farmers, feedstuffs rations are being more often composed with greater precision; in silos, there are more corn, corn flour, lucerne, and protein cakes used as components, etc.

Buying-in

The purchase prices of milk increased in 2000 compared to the last year by 44%, from the average of 1,884 kr/ton in 1999, to 2.719 kr/ton in 2000. As the main reason for the rise in price, the increase achieved in the Estonian export quota by almost two times as the result of the successful EU accession negotiations and the elimination of the 20% customs tariff within the quota could be emphasised.

Nevertheless, despite the increase in the price of milk, in 2000, most milk producers had no means for current repairs or investments, because the production costs of milk increased considerably due to the increase in the price of several major inputs (e.g. fuel, feedstuffs, electricity). The rise of the USD compared to EURO has been of great influence.

By the end of 2000, 7 milk-processing enterprises possessed the EU euro-certificate, two great cheese producers appeared among others.

There can be one single direction trend noted – the higher the milk yield per cow, the more effective the production economically speaking is. It is clear that milk production can be considered profitable only at over 4,000-4,500 kg production per cow a year and this level has been reached by us by now already.

Subsidies

The trends of the Estonian milk policies in 2000 were reflected by the state's direct aid to dairy cows, which reached 112,402,463 kroons (in 1999, 88,7 million kroons). Subsidies to one cow were 1,065 kroons (in 1999, 872 kroons). In 2000, for the first time, out of the 16 million kroons allocated for the associative enterprises from the state subsidies, the total of 8.7 million kroons were allocated for the dairy sector and the breeding of dairy cattle.

One of the important subsidies for the cattle farmers was also the breeding subsidy. In 2000, our cattle breeding associations and societies received the total of 7.5 million kroons of breeding subsidies. One of the key words in the dairy sector in 2000, was also the school milk, to which legislation and the specific implementation programme were prepared. The goal of the school milk programme was to promote healthy eating habits among school children and develop the habit of dairy products' consumption in children, thus helping the development of local milk production. The programme was implemented in January 2001.

The new key words for the nearest future, that is the year 2001, could be the preparation of the system of milk quotas and the preparation of the implementation of an independent laboratory for assessing the quality of the purchased milk.

Meat production

Meat production is a branch of the traditional agricultural production beside milk and cereal production. In Estonia, mainly pork is produced, which comprised 55% of the meat produced in 2000, the percentages are divided as follows: beef 28%, poultry 16%, and sheep and goat meat 1%. In 1990, the meat production reached 182.5 thousand tonnes. In 2000, only the total of 51,000 tonnes of meat was produced, thus the production has decreased by 72% (Table 2). The decline in the meat production is caused by the disappearance of the demand on the eastern market and the low buying-in prices in the internal market of the past couple of years.

The new food law and the implementing acts of it, including the hygiene requirement rules for fresh meat, enforced on January 1, 2000, influenced both the meat producers and processors.

Table 2. Meat production (in thousands of tonnes)

	Meat production	Beef	Pork	Sheep and goat meat	Poultry
1991	151.8	52.0	75.2	2.2	22.1
1992	107.9	45.4	50.1	1.8	10.3
1993	83.7	42.6	34.7	1.2	5.1
1994	69.4	31.0	30.5	1.3	6.5
1995	67.7	25.8	35.4	0.8	5.6
1996	58.6	22.1	31.7	0.5	4.3
1997	53.4	19.0	29.5	0.5	4.4
1998	60.0	19.3	32.4	0.4	7.9
1999	61.1	21.7	31.3	0.4	7.7
2000	51.0	14.4	28.2	0.4	8.0

Last year, the marking of bovines in accordance with the requirements of the EU was enforced, the marking and registration of pigs and sheep also became obligatory.

Beef

In 2000, the outbursts of foot-and-mouth disease and cases of BSE influenced the beef market of the world. The influence of BSE on the production of beef will probably become more evident in 2001.

The rearing of beef animal breeds is picking up speed and on July 21, 2000, the Estonian Beef Cattle Breeders Association was established, and since 2001, the beef animal recording is conducted.

Beef animal breeding is being dealt within 14 counties, whereas more than 50% of the cattle has been concentrated into Hiiu, Saare, and Lääne counties. There are 76 beef cattle altogether. Over a half of the beef animal breeders are keeping relatively small cattle herds, where there are up to 10 beef animals.

In Estonia, the number of bovines, including cows, has decreased from year to year, as it has in this year as well. In the end of the year 2000, there were 243,800 or almost 10% bovines less than the last year.

Since the production of beef is dependant on the number of milk cows, then in 2000, the beef production decreased to 14,400 tonnes, which is the greatest decline among the branches of meat production.

The purchase prices have remained low during the recent years and this has brought by the little interest in the fattening of animals among the producers. This is why most bull calves are killed younger than 1 month.

Pork

75% of pork comes from production enterprises, where 85% of the total of pigs are kept. Out of the pigs registered with the agricultural animals, the greatest percentage (42%) comprises the purebred Yorkshires, 24% is of Landrace breed and 33% different crossbreeds. In general, within the recent years, it could be noted that the trend of keeping crossbred pigs is accelerating.

As a positive trend, the improvement of the quality of the meat on pigs' carcasses could be pointed out. According to the animal recording, the content of lean meat on the breeding pigs under animal recording is 58%, compared to the 56% five years ago. The average content of lean meat on the fattening pigs realised is at the moment about 56-57%.

In 2000, 28,200 tonnes of pork was produced, which is the most modest result of the last ten years. In comparison with the previous year, the decline was 10%.

If before the end of 1999, the purchase prices of pork increased, then the rise in realisation of pigs in the end of 1999 and beginning of 2000, brought by a certain decline in the purchase prices. In the second half of the year, the buying-in prices rose again and at the moment are thanks to the imported pork's increased price at the price level, which promotes production. Estonia's largest pig reared EKSEKO is at the moment expanding its production. Interest in expanding pork production has been hindered by the feedstuffs prices, which are higher compared to the previous year.

Since July 1, the EU made a commitment to eliminate export subsidies and Estonia has been given a toll free export quota. The influence of these on the foreign trade of pork has so far not been quantitatively important. The termination of the import restrictions did not influence pork export either, because the price of meat had meanwhile increased.

Sheep meat

Sheep rearing in Estonia has during the recent years been influenced by the ewe premium enforced in 1999. Due to the modest offer of lamb on the market and relatively remunerative prices, the interest in sheep rearing is great. The factor slowing down the acceleration of production is that the demand for breeding sheep exceeds offers. The selling opportunities are also limited due to the maedi-visna virus found in Estonian sheep. So far, the producers have found it problematic to market the sheep rearing products. On the initiative of the Estonian

Sheep Breeders society and with the support of associative enterprise, the creation of marketing group and strategies has been started.

Sheep rearing is increasingly being taken up in domestic households. The total number of sheep in Estonia has started to grow. According to ESA, compared to the previous year, there are 500 or 2% more sheep. In the end of the year 2000, the number of sheep reached 31,400.

For meat production, Estonian Blackhead and Estonian Whitehead sheep are grown. At the moment, the Estonian Blackhead dominates, but the percentage of Estonian Whitehead is increasing. In the register of agricultural animals, there were 69% Blackhead and 31% Whitehead sheep. Oxford-Down, Texel, and Dala breeds have been used for the improvement purposes. The production of sheep meat has remained on the level of 1999, which is 400 tonnes. At the moment, there are four bigger slaughterhouses that purchase sheep. The buying-in prices as of the end of the year were 30-35 kr/kg. The price of lamb is of about the same level also in shops and markets. The price of the imported lamb meat, however, is almost by a half higher than the buying up price (60 kr/kg). The interest in lamb meat among the processors and traders is great, because despite our relatively small production, lamb meat is exported at the price level of 92 kr/kg.

Poultry

In 2000, the number of poultry increased in Estonia compared to the last year about 5%. Since in 1999, the number of poultry declined almost 6%, it could be stated that the decline has been stopped by now. In 2000, the number of poultry was on the average level of the recent five years.

In 2000, 8,000 tonnes of poultry meat was produced, whereas almost 75% of the production was covered by Tallegg Ltd. The increase in poultry production compared to 1999, has been 5%. The reason of the rise on the one hand is the decline in the production of the other meats, and on the other hand, the increase there has occurred in the demand for poultry. The percentage of poultry within the total meat production in 2000, was 15.9%. Compared to 1999, it has risen 3.4%, and during the recent five years, 7.5%.

Demand for poultry meat has grown. If in 1995, poultry meat comprised 14.3% of the total of meat consumed, then in 2000, it was already over 20%. There are several reasons for the increase in consumption: the rise in awareness of the characteristics of poultry meat, lower price compared to other meats, and elaborated advertising campaigns.

Although the greatest poultry meat producer in Estonia, Tallegg Ltd, saw the rise of 13% in production last year, there is still room for development, because the self supply level with poultry meat is continuously low, remaining at 35%, which is very little.

Production of eggs

The greatest laying hen grower in Estonia is Tallegg Ltd, where a little over a third of our eggs are produced and marketed. The second greatest egg producer and trader in Estonia is Tamsalu TERKO Ltd with the yearly production of 32 million. In the both poultry production enterprises “health eggs” enriched with omega-3 fatty acids are produced and marketed. There are still other considerable egg producers in Estonia. The Veterinary and Food Board has given the recognition numbers for the marketing of eggs to 15 enterprises and 14 private farms.

The total production of eggs has decreased within the past 5 years, from 326,700 pieces in 1995 to 255,300 pieces in 2000, which means that compared to the year 1999, the decline has been almost 7%. The reason for this is decline in the number of enterprises dealing in poultry production.

The level of laying among hens in Estonia during the recent years has been high. If in 1995, there were on the average 255 eggs laid per hen a year, then in 2000, it was already 301 pieces (Figure 2). The reason for this is the coincidence of several advantageous conditions: feedstuffs of higher quality, better feed conversion rate for the hens, better feeding and keeping conditions, the usage of laying hens of cross breeds of high breeding value, as ISA Brown, Hisex brown and Hisex white.

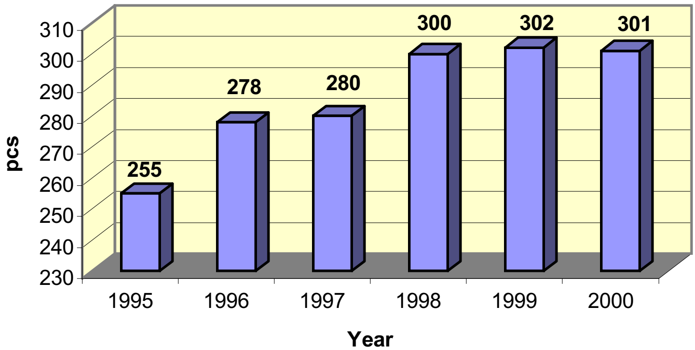

Figure 2. Average number of eggs per hen, pcs

The self-supply with eggs is continuously guaranteed. The consumption of eggs has in the past five years dropped by 30 eggs per person a year.

THE SITUATION IN ANIMAL BREEDING IN LATVIA

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The livestock farming sector in Latvia is functioning and its surveillance and control activities are determined by the Pedigree Law in force since 21 April 1998 amended from 23 December 1998 and 31 March 2000, which provides for the Regulations of the Cabinet of Ministers, addressing specific questions associated with livestock farming. The State Pedigree Inspection carries out functions of control and surveillance determined by the Pedigree Law. The State Breeding Information Data Processing Centre carries out Establishment and keeping of the pedigree information data as well as the animal and herd register keeping.

Livestock farming sector in Latvia ensures herd registration and animal identification. There is a centralized database on the herd and animal registers as well as identification of bovine, porcine, ovine and caprine animals have been carried out in the country. Animals are identified in accordance with the EU requirements, setting up a centralized database. In 2001, the herd and animal registration system will be improved as well as implementation of the identification system for porcine, ovine and caprine will be completed

The Animal Breeders Association of Latvia monitors eight different Animal Breeders Organizations responsible for maintaining herd-books and implementing of breeding programmes.

The State aid is allocated in the form of subsidies in compliance with an annual instruction by the Ministry of Agriculture "On the State Aid for Manufacturing of Products Meeting the EU Quality Requirements".

The major directions of the State aid allocated to animal breeding under the programme are as follows:

- Establishment and keeping of the Animal and Herd Register;
- Animal recording and data processing;
- Rearing breeding animals;
- Marketing of breeding animals and their bio products;
- Imports of breeding material and their bio products.

The situation in dairy sector has been stabilizing during last year. There are several indices confirming it: the average milk yield in 2000 has increased till 4408 kg per cow, the number of small size herds (under 9cows) has decreased for 22 000 during last two years, the quality of produced milk has increased for 10 % comparing to the year 1999. The main targets for the further period are

- To support successful farm management and producing competitive dairy products for domestic and foreign market;
- To improve the structure of dairy farming establishing the milk producers` register in order to implement milk quotation;

- To establish an independent, united milk analysis laboratory to improve the payment system for produced milk and implementation necessary requirements for common market organization.

The Latvian Brown is a base for beef production. The breed is well adapted to the maritime climate and environment and demands medium input management. For improving of beef productivity there are used Hereford, Charolais, Angus and Limousin breeds for crossbreeding of the beef cattle and dairy cows. There are nearly 15 000 beef cattle in Latvia.

Traditionally for Latvia 60% of the total meat consumption constitutes pork that hardly is ensured by Latvian farmers. The total amount of pigs is continuously decreasing during last years. In 2000 there were about 400 000 pigs and 68% of them were in small size farms. The main tasks in pig breeding are early pig weaning, meat quality improvement and renew and maintain a genetic material of pig population. To improve the productivity of fattening pigs there are used breeds of Landrace, Durok, Hempshire,Yorkshire, Pietrene and Latvian White.

The situation in sheep and goat sector is supported by government subsidies since 1996. There are nine nucleus farms with 745 ewes. Although the total number of animals is decreasing there is a tendency to increase the medium herd size. In 1999 there is produced 526 t of lamb. The number of goats is not decreasing due to good demand of goat milk products in domestic market. Yet the sector still needs self-improvement to meet the EU requirements in production of dairy products and milk recording.

There are more than 15700 horses in Latvia. This year the subsidies are paid for using artificial insemination for horses in order to improve faster the population genotype. The horses are exported to the USA, England, Germany, Sweden, Holland, Finland Denmark, Poland, Lithuania, Estonia and etc. Thirty of horses reared in Latvia have participated in the international horse races.

Latvia is one of the European countries where mink is reared and one of the seven states, which has foxes. The fur farming is on the way of stabilization and can offer excellent furs of western breeds for the competitive market. Yet there is a necessity for a computerised high quality breeding work and farmers training to take care of more than 1000 breeding female animals per farm.

EINFÜHRUNG EINES ORGANISIERTEN SCHWEINEZUCHTPROGRAMMS IN ESTLAND

M. Rätsep, Schweinezuchtverband Estland, Tartu*

Einleitung

Im Zeitraum von April 1997 bis Oktober 1999 wurde in Estland ein von der EG unterstütztes *PHARE*-Projekt "Verbesserung der Schweineproduktion in Estland" durchgeführt. Die ausländischen Berater und verantwortlichen Organisationen waren die deutschen Firmen ADT Projekt GmbH, Züchtungszentrale Deutsches Hybridschwein GmbH und DLG Agriservice.

Die Grundaufgaben des Projekts waren am Anfang

a. Effektive Verwendung von Schweinegülle zur Reduzierung der Umweltbelastung
b. Unterstützung der ökologischen und wirtschaftlichen Schweineproduktion in estnischen Betrieben.
c. Verbesserung von Schweinezucht- und Fleischqualität.
d. Verbesserung der Managementsysteme.

Es wurde zur Unterstützung 2 größere Schweinebetriebe ausgewählt, die aus der Sicht des Umweltschutzes strategisch wichtig waren: AG Ekseko in Viljandi Gebiet und Pärnuer Schweinebetrieb.

In ein halbes Jahr hat man in Hauptaufgaben des Projekts Korrektive durchgeführt, weil die beiden Firmen zu diesem Zeitpunkt privatisiert wurden und weil der Pärnuer Schweinebetrieb seine Tätigkeit praktisch beendet hat.

Die neuen Aufgaben wurden so bestimmt, damit sie dem estnischen Staat und der estnischen Schweineproduktion insgesamt nützlich werden könnten:

1. Verbesserung von Schweinezucht- und Fleischqualität
2. Verbesserung der Managementsysteme
3. Verbesserung der Verwendung von Schweinegülle und –Abfall.

Züchtungszentrale Deutsches Hybridschwein GmbH

Der hauptsächliche Partner und Ratgeber in den mit der Schweinezucht und der Zuchtorganisation verbundenen Fragen war während des Projektes Züchtungszentrale Deutsches Hybridschweine GmbH, die der Träger des Bundeshybridzuchtprogramms (BHZP) ist. Das BHZP ist ein Kreuzungszuchtprogramm in Deutschland, das in sich bäuerliche Erzeugergemeinschaften aus ganz Deutschland einigt. 16-20 % der in Deutschland produzierten Schlachtschweine sind genetisch auf das BHZP zurückzuführen. Das BHZP ist Anbieter von Genetik über Zuchtsauen, Zuchteber und Sperma von Vor- und Endstufenebern, seine Produktion erfolgt bei kontrolliertem und definiertem Gesundheitsstatus, es entwickelt und vertreibt spezielle Anwendungssoftware für die Schweinezucht und –Produktion und pflegt eine eigene Zuchtdatenbank, um Zuchtwerte schätzen zu können.

Verbesserung von Schweinezucht- und Fleischqualität

Während des gesamten Projektszeitraum haben die Projektberater aus der Züchtungszentrale Deutsches Hybridschwein sehr intensiv an den mit Zuchtmethodik und Managementsystemen verbundenen Projektaufgaben gearbeitet und komplette Methodik zur Verbesserung des estnischen Zuchtsystems ausgearbeitet.

Die Aufgaben für die Verbesserung der Zucht- und Managementsystems wurden unten folgend:

1. Verbesserung der Zuchtmethoden und – Instrumente
2. Import von Zuchtsperma, Zuchttieren von anderen überlegenen europäischen Zuchtpopulationen
3. Verbesserung der Managementssysteme.

Zu deren Erfüllen wurden folgende Maßnahmen durchgeführt:

- Bestandaufnahme zum vorhandenen Zuchtsystem
- Entwicklung eines Zuchtkonzeptes
- Züchterische Beratung und Schulung von Fachkräften
- Entwicklung und Gestaltung einer modernen Zuchtdatenbank
- Übersetzung und Einführung einer edv-gestützten lokalen Datenerfassung mit Anbindung zur Datenbank und Managementunterstützung für den Betrieb (Sauenplaner)
- Entwicklung und Einführen einer modernen und effektiven Zuchtwertschätzung (BLUP-Methode)

Ausgangssituation und Empfehlungen

In Estland wurde zu dem Zeitpunkt des Projektanfangs hauptsächlich nur Herdbuchzucht getrieben. Die Reinzuchtbetriebe hatten sich in zwei Herdbuchverbänden vereinigt. Es gab hauptsächlich zwei Mutterlinien – Landrasse und Large White. Eine kleine Population gab es auch Hampshire Rasse. Es wurde meistens nur additiv genetischer Effekte genutzt und auf Heterosiseffekte verzichtet. Es gab eine ziemlich ungünstige Zuchtstruktur – viele Zuchtherden, keine überbetriebliche genetische Verknüpfung, geringe Prüfungsintensität und Zeitverzug in der Informationsübermittlung. Künstliche Besamung kam in der Zucht fast gar nicht zum Einsatz. Immer mehr wurde Aufmerksamkeit und ökonomische Bedeutung auf Muskelfleischanteil gekehrt.

In dieser Situation wurde für Estland ein Kreutzungszuchtprogramm empfohlen:

- Strukturverbesserung in der Zuchtstruktur und Organisation

- 3-Linien-Kreutzungsystem
    - Mutterlinien: landesübliche Populationen Landrasse und Large White
    - Vaterlinie: fleischreiche und robuste Population mußte importiert werden (Pietrain)
- Straffung der Zuchtorganisation
- Aufbau der Zuchtpyramide
    - Basiszucht mit 400 Stammsauen
    - Vermehrung mit 3000 Stammsauen
- Moderne Zuchtdatenbank mit lokaler Zuchtdatenerfassung
- Zuchtprogramm mit Leistungsprüfung und konsequenten Selektion
- Stärkere Einbindung der KB in Zucht und Produktion

Verbesserung der Zuchtmethoden und Instrumente

Als eine der wichtigsten Maßnahmen zum Einrichten und zur Verbesserung des Zuchtsystems hat sich in Estland das Verbessern der EDV-Instrumente und Systeme erwiesen. Während zwei Jahren wurde eine moderne und überbetriebliche Zuchtdatenbank auf Oracle-Basis bei dem Leistungs-kontrollzentrum in Tartu geschafft. Es wurde ein Sauenplaner *db-Planer* von der Züchtungszentrale "importiert" und ins Estnische übersetzt, wobei der Sauenplaner eine Anbindung an die Datenbank hat. Für Effektivität bei der Selektion und Ausmerzung der Zuchttiere ist eine überbetriebliche BLUP-Wertschätzung unentbehrlich.

Die Resultaten auf diesem Gebiet sprechen für sich selbst:

- Der estnischsprachige *db-Planer* kommt zur Zeit in 57 Betrieben zum Einsatz.
- Ende September 2000 sind über 20 000 Stammsauen in der zentralen Datenbank erfasst. Davon sind
    - 5340 Landrasse-Sauen
    - 9740 Large White-Sauen
    - 5968 Hybridsauen
- Der Jahresbericht enthält detaillierte Informationen zur Leistung innerhalb der Zucht
- Jede Woche wird allen Zuchttieren sowohl in Betrieben als auch in den KB-Stationen überbetriebliche *BLUP*-Zuchtwerte gerechnet.
- Die Betriebsleiter haben eine zeitgleiche Rückkoppelung betreffs der Zuchtwerten ihrer eigenen Tiere und der Daten der KB-Eber, außerdem über die Jungtiere, die besten Zuchtwerten in Estland haben.

Import von Zuchtsperma und Zuchttieren

Im Rahmen des *PHARE*-Projekts wurden sowohl Zuchtsperma als auch Zuchttiere aus Niederösterreich importiert. Da es in Estland früher eine Vaterrasse fehlte, wurde eine kleine Pietrain-Population (38 Jungsauen, 14 Eber und 95 Spermatuben) zur Vermehrung eingeführt. Außerdem wurde 4 KB-Eber von beiden weißen Rassen und 365 Spermatuben von Landrasse und 410 Spermatuben von Large White importiert.

Verbesserung der Managementsysteme

Darunter muß man in erster Linie eine Übertragung von Know How über eine effektive und moderne Schweinezucht und Produktion verstehen.

Dazu wurden in Estland mehrere Seminare und Workshops über Hybridzuchtsystem, Sauenselektion, Fütterung, Sauenmanagement, beispielweise Feldtagen, wo auf Grund der Sauenplaner-Ausdrucken und –Analysen über die Schweineproduktion diskutiert wurde, durchgeführt. Für die Unterstützung der Entwicklung der Datenbank wurden die Fachleute an dem Leistungskontrollzentrum in Tartu an Ort und Stelle konsultiert und geholfen, ökonomische Parameter für die BLUP-Zuchtwertschätzung auszuarbeiten.

Neben den Seminare und Workshops in Estland hat man auch in Deutschland Ausbildung durchgeführt – Besuche der verschiedenen Schweinezucht- und Produktionsbetriebe. Es wurden estnische Fachleute in einer KB-Station in Deutschland geschult, mehrtägige Kursen auf Gebiet Fütterung, Zucht, Farmmanagement, Datenbank und Zuchtwertschätzung durchgefürt.

Perpektiven und Ausblick

- Die Entwicklung der optimalen Zuchtstrukturen benötigt Zeit. Die Umorganisierung des ganzen Reinzuchtsystems zu einem systematischen Kreuzungszuchtsystem erfordert erhebliche organisatorische Veränderungen. Die Situation ist dermaß verändert, daß es in Estland jetzt einen einheitlichen Schweinezuchtverband gibt, zu dem es mit dem Stand 01. März 2001 55 Mitgliederbetriebe und 29 Mitglieder-Unterstützer gehören. Der Estnische Schweinezuchtverband hat das Kreuzungszuchtprogramm "Marmorfleisch", das zielstrebig Schritt für Schritt eingesetzt wird.
- Lokale Zuchtdatenerfassung und Zuchtdatenbank sind gute Voraussetzungen für die Zuchtwertschätzung, deren Auswirkungen erst langfristig spürbar sind. Heutzutage werden alle in der Datenbank vorhandene Zuchttiere Zuchtwert bekommen. Auf diesem Grund können die Tiere sowohl in den Betrieben als auch in den KB-Stationen

remontiert, verkauft oder ausgemerzt werden.

- Die Kreuzungssauen setzen sich in Estland immer mehr durch. Nach dem Jahresbericht 1999 des Leistungskontrollzentrums in Tartu werden von den Kreutzungssauen etwa 0.5 Ferkel pro Wurf mehr lebend geboren.
- Die Nachfrage nach Pietrain-Endprodukteber nimmt zu. Die Esten haben es ersehen, daß die Endstufeneber Schlachtkörperqualität verbessern.
- Die künstliche Besamung gewinnt in Estland immer mehr an Bedeutung. Im Jahre 2000 konnte der Absatz nahezu vervierfacht werden. Das schafft günstige Voraussetzungen für die genetischen Verbindungen zwischen den Tieren in verschiedenen Betrieben in Estland und gleichzeitig vergrößert die Zuverlässigkeit der BLUP-Zuchtwerte.

Der Kontakt zu den Projektpartnern in der Züchtungszentrale besteht weiterhin. Ebenso wird die Zusammenarbeit zwischen dem Leistungskontrollzentrum und dem Estnischen Schweinezuchtverband immer enger und stärker.

BODY CONFORMATION AND MILK PRODUCTIVITY OF ESTONIAN HOLSTEIN HERDBOOK COWS.

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Introduction

Body conformation of dairy cows has been measured in Estonia from the beginning of collecting herdbook data till today. In addition there have been expeditions where couple hundreds of cows from each breed have been measured occasionally. The first expedition took place in 1910s participated by Russian scientist Liskun and Estonian husbandry classics Mägi, Pool etc. The hedbooks where the measurements of cows were the most important traits were published. On the initiative of A.Pung measurements of cows of three breeds were started after the II World War since 1948…1950. It was repeated each 20 years (Table 1). E.Orgments measured the same cows during three lactations. Those mesasurements show small difference between the main figures.

Table 1. Measurements of black and white cows through times

Authors	A. Pung, 1984		Leping, 1992	E. Orgmets, 1997		
Measurements	1950	1970	1990	1. lact.	2. lact.	3. lact.
Withers height	128.2	128.3	127.6	126.8	130.2	132.7
Chine height	132.2	134.1	129.0	132.5	135.8	136.5
Body debth	69.4	71.4	69.4	65.5	69.1	71.0
Rump width 2	48.6	50.1	46.3	x	x	x
Rump width 3	35.3	37.8	37.9	30.5	37.0	37.8
Body length (stick)	157.4	157.5	154.7	144.7	150.2	152.6
Body length (belt)	173.7	171.3	x	x	x	x
Chest girth	190.4	197.2	196	183.4	191.8	194.9
weight	555	586	x	499.4	574.0	604.0

Significant change can be seen in the withers height, difference in chine height is smaller. Alternate body length and chest girth are dicreased, body debth and rump width have not changed. Weight was established using different methods. Before the weight was based on chest girth and alternate body length, last years the weight and chest girth are taken from the same tapeline.

The first offspring of Grandboy 3299 and Major 3300 was born in 1976. Grandboy became very popular because he had better pedigree than Major and more important was that his conformation was different of black and white Dutch bulls. Next came big bulls with big stature Gabriel 3460, Grenader 3393 and

Gavin 3394 from USA; Elastre 4478 from Canada; Pilot 5700 and Nils 5706 from Germany. The breeding goal was to get dry cows with big framed conformation. The used bulls were significant higher with narrower and deeper body. There was signifant decrease of musculature.

The figures of body measurements presented in Table 1 do not affirm the regular changes during 50 years. Only the height of cows has increased a little. What the reason? There can be several. For example:

*the measurements are taken from the herds with different breeding values

*the single measurements cannot reflect the changes in the type of conformation

*the single measurements have to be correlated to other measurements - to estimate the indexes of conformation

Proceeding from the preceding the aim of the current research was to bring in one more selection criteria to the existing measurements and explain the role of farm, sire and grade of Holstein blood to the cormormation of cows.

Material and Methods

The material of current research is based on data of 707 cows (registered in Estonian Holstein Herdbook during 1996…1998) from six farms. T.Bulitko took 6 measurements and the weight was established by chest girth. The cows were measured from the 2nd lactation. The grade of Holstein blood varied from 0…93,75%. The data were processed by T.Kaart using SAS programme (SAS Inst.Inc., 1991) and general linear model (GLM).

$$\mathbf{y_{ijkl}} = \mu + \mathbf{I_i} + \mathbf{M_j} + \mathbf{HF_k} + \mathbf{e_{ijkl}}, \text{ where}$$

y_{ijkl} - measured trait of offspring k, sire i and farm j;
μ - avergae;
I_i - sire´s i influence (i = 1...97)
M_j - farm j influence (j = 1...6)
HF_k - the grade of Holstein blood of offspring (k = 1...4);
e_{ijkl} - occasional mistake (individuality of the cow).
The connections between the traits were estimated by correlation analyse.

Results

The body measurements of young cows are promising. Chine height promises the 140 cm height to adult cows (table 1). Also 180 cm long body meets the suitable frame. The distance between hips and the rump length were equal. The weight (568,5 kg) established by chest girth was optimal.

Table 1. Influence of sire, farm and grade of Holstein blood to cows´ measurements.

Factor	Average		Farm		Sire		HF-blood	
Measurement	x	s	F	P	F	P	F	P
Chine height	135.9	3.90	3.08	<0.01	2.02	<0.001	35.96	<0.001
Body debth	70.1	3.21	5.40	<0.001	1.46	<0.01	7.71	<0.01
Rump width 2	49.6	3.43	3.15	<0.01	1.88	<0.001	0.36	n.s.
Rump length	49.3	2.97	1.52	n.s.	1.67	<0.001	3.07	n.s.
Alternate body length (belt)	179.7	7.60	6.47	<0.001	3.12	<0.001	5.00	<0.05
Chest girth	191.4	7.50	5.45	<0.001	2.13	<0.001	0.78	n.s.
weight	568.5	69.95	5.56	<0.01	2.09	<0.001	2.12	n.s.

The largest effect to productivity factors had the farm the cow originated from and sire (table 2). The grade of Holstein blood did not have essential influence on productivity.

Table 2. Influence of sire, farm and grade of Holstein blood to milk productivity of cows.

Figure	Factor	1st lact.		2nd lact.		3rd lact.	
		x;F	s;P	x;F	s;P	x;F	s;P
Milk, kg	average	3959	812.6	4559	986.0	4767	939.4
	Farm	7.38	<0.001	10.30	<0.001	6.33	<0.001
	Sire	3.52	<0.001	3.69	<0.001	3.38	<0.001
	HF	1.66	n.s.	3.68	n.s.	0.58	n.s.
Fat, %	average	4.09	0.59	4.11	0.52	4.19	0.58
	Farm	21.18	<0.001	14.29	<0.001	10.32	<0.001
	Sire	2.01	<0.001	1.67	<0.001	2.75	<0.001
	HF	1.17	n.s.	0.36	n.s.	1.20	n.s.
Protein, %	average	3.00	0.18	3.06	0.17	3.04	0.17
	Farm	4.88	<0.001	2.82	<0.05	4.12	<0.01
	Sire	2.13	<0.001	1.67	<0.001	1.77	<0.001
	HF	0.00	n.s.	0.65	n.s.	0.11	n.s.

The cows originated from 6 farms. The analyse improved the big difference between the farms and shows the influence of feeding to the measuremets. Sire´s influence as the second factor is statistically reliable, although the number of sires was big (97). Therefore the selection of breeding bulls is very important. The grade of Holstein blood had no significant influence. Body height, length and depth were influenced by the grade of Holstein blood. Correlation analyse improved the reliable influence of the grade of Holstein blood to chine height (table 3).

Table 3. Correlation between measurements and milk productivity

Measurements	Lact.	Milk, kg	Fat, %	Protein, %	HF-blood
Chine height	1.	0.169***	0.01	-0.04	0.323***
	2.	0.172***	-0.09*	-0.07	0.31***
	3.	0.04	0.01	-0.07	0.32***
Body depth	1.	-0.02	0.01	0.06	0.07
	2.	0.01	-0.04	0.11**	0.06
	3.	0.03	-0.00	0.09*	0.07
Rump width 2	1.	-0.05	0.02	0.07	-0.08
	2.	-0.10*	-0.02	0.07	-0.10*
	3.	-0.09*	0.00	0.11**	-0.10*
Rump length	1.	0.00	0.06	0.06	0.06
	2.	-0.01	0.02	0.05	0.05
	3.	-0.06	0.06	0.09*	0.04
Alternate body l	1.	-0.17***	-0.24***	-0.05	0.02
Length	2.	-0.14***	-0.19***	0.02	0.01
	3.	0.09*	-0.11**	-0.01	0.04
Chest girth	1.	-0.08*	0.11**	0.10**	-0.13***
	2.	-0.05	0.03	0.16***	-0.14***
	3.	-0.05	-0.02	0.14	-0.14***
Weight	1.	-0.07	0.12**	0.11**	-0.11**
	2.	-0.05	0.03	0.17***	-0.12**
	3.	-0.04	-0.01	0.15***	-0.11**

At the same time the chest girth and and weight were in negative correlation with the grade of Holstein blood. We can conclude that wide usage of Holstein bulls increases the height and body debth of the cows but decreases the chest width. It causes the decrease of chest girth and weight.

Milk production was in positive correlation with chine height and in negative correlation with alternate body length. It was interesting that correlation improved through the negative correlation that cows with bigger conformation had higher % of protein and lower % of the grade of Holstein blood. As the variety of the grade of Holstein blood was big we can confirm that the growth of the grade of Holstein blood causes the decrease of protein %.

Discussion

Comparison of the published measurements confirms the consistence of the data of E.Orgmets (1997) collected during the same period. There were some problems with the alternate body length measured with the tapeline (belt) or the stich. The difference between the two measurements was 15…16 cm. To compare with the data of A.Pung (1984) measured with tapeline then the body has become longer. But comparing the data measured with the stick the alternate body length has become shorter. It is probably necessary to implement more thorough measurement of cows to determine the features of conformation and their connection to productivity.

The productivity depended more on farm and sire but the grade of Holstein blood had no importance. The reliable correlation between the grade of Holstein blood and chine height was positive and negative with chest girth and weight. The correlation between body measurements and productivity was weak, only the alternate body length was in negative correlation with productivity and fat%. According to the data of E.Orgmets (1997) the correlation between body measurements and productivity was dense and positive ($P<0,001$). The difference could be caused by the fact that E.Orgmets measured cows on the 2nd …4th month of each lactation, in this research they have been measured once per year from the 2nd lactation. Correlation between the figures of three lactations were studied.

Summary

During 1996-1998 707 cows from 6 farms were registered in the herdbook. The measurements of those cows had no significant difference from the same data earlier. The height and length of cows has increased a little. Measurements and milk productivity were more influenced by farm and sire. Less important was the grade of Holstein blood which according to the statistic analysis was more expressed by the influence of sire factor.

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APPLICATION OF FUZZY LOGIC FOR OESTRUS DETECTION IN DAIRY COWS

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Introduction

In order to realise satisfying fertility performance under conditions of artificial insemination, effective oestrus detection is essential. Due to increased herd sizes and reduced staff per herd, automatic monitoring of cows must be improved. Most investigations are performed under experimental conditions with a limited number of cows and induced oestrus's (ROTH et al., 1987).

In this investigation suitability of activity, milk yield, milk flow rate, and electrical conductivity for automatic oestrus detection in field data was analysed. First purpose was to test several time series methods for application with different traits. Second purpose was to improve the detection results by combination of traits.

Material and Methods

Data collection of 2817 cows, which were milked between February and December 1998, took place on a commercial dairy farm. At each milking activity, milk yield, milk flow rate, and electrical conductivity were recorded. On a daily basis a value was calculated for each trait and each cow. Electrical conductivity and milk flow rate were weighted by milk yield. For oestrus detection time series, consisting out of day of oestrus, 15 days before and 15 days after oestrus, were analysed. The day of oestrus was identified by an insemination followed by a calving after 265 to 295 days. Due to cows without oestrus within observation period and missing values, time series of 836 cows were available for oestrus detection by activity, milk yield, electrical conductivity, and milk flow rate.

Four different time series methods were used for oestrus detection: day-to-day-comparison, moving average (out of 5 or 10 values), exponential smoothing (out of 5 or 10 values) with different α-values and Box-Jenkins three parameter smoothing. If the relative deviation between estimated and measured value exceeded a given threshold, the cow was detected as in oestrus.

Combination of traits was realised by use of fuzzy logic. The fuzzy logic method consists out of three elements: fuzzification, inference and defuzzification (YANG,1998). Relative deviations, calculated by the best suited time series method for each trait were input data for fuzzification. Input values were interpreted linguistically by membership functions and the degree of membership. Thus crisp values were transformed into fuzzy values. An example is shown in figure 1 for the trait activity.

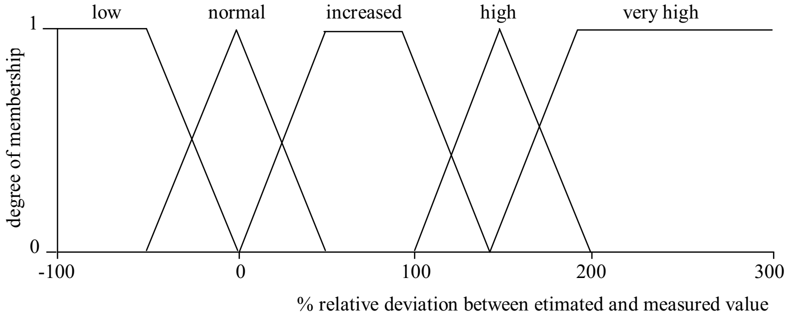

Figure 1: Membership functions for activity

A deviation of 200% between estimated and measured value would result in a degree of membership of 1 for membership function “very high”. For all other membership functions degree of memberships would be 0. Membership functions were built for all input and output variables. The output variable oestrus was expressed by five membership functions. Range of relative deviation depends on the trait.

The fuzzy logic inference includes combination of traits by rules. The rules result from human knowledge and have the form:

if conditions, **then** conclusion.

The conditions are represented by input variables. The conclusion is normally presented by one output variable, in this case the result oestrus or not. An example for combination of activity and milk yield is: if activity is high and milk yield is high decreased, oestrus is possible. Further rules can be seen in table 1.

Table 1: Rules for the fuzzy inference

		milk yield				
		high decreased	decreased	Normal	increased	high increased
activity	low	no oestrus	no oestrus	no oestrus	no oestrus	no oestrus
	normal	possible not	no oestrus	no oestrus	no oestrus	no oestrus
	increased	possible	possible	possible	possible not	possible not
	high	possible yes	possible yes	possible yes	possible	possible
	very high	oestrus	oestrus	oestrus	oestrus	oestrus

Results from fuzzification and inference are transformed back in crisp results by defuzzification. Results of inference present the degrees of membership for the membership functions of the output variable. The marked areas under the membership functions are added. The crisp value for decision is calculated by defuzzification method centre of area. Results of defuzzification higher than 0.5 were treated as oestrus warnings.

Accuracy of time series methods and fuzzy logic method was expressed by:

$$\text{sensitivity} = \frac{\text{detected}}{\text{detected} + \text{not detected}}$$

$$\text{error rate} = \frac{\text{detected but not in oestrus}}{\text{detected} + \text{detected but not in oestrus}}$$

Sensitivity qualifies the amount of detected oestrus's on all oestrus's. Warnings for oestrus on days without oestrus were qualified as error rate.

Results

First results for univariate comparison of methods are presented. In figure 3 sensitivity and error rate for the trait activity can be seen. With increasing threshold value of 40 to 120% sensitivity and error rate decrease.

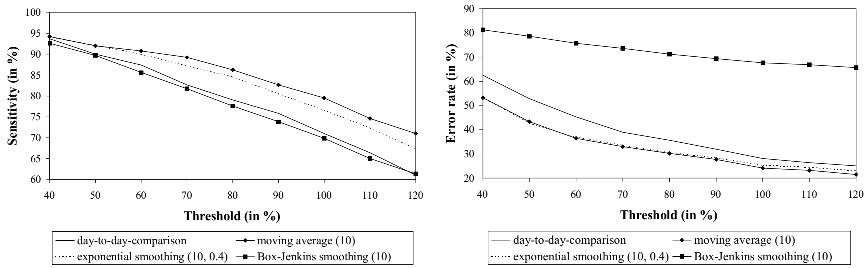

Figure 3: Sensitivity and error rate depending on the threshold and on the forecasting method for the trait activity

Sensitivity ranged between 94.2 and 61%. Independent from threshold value moving average with a history of 10 value gives best results for sensitivity. Error rate ranged between 81.3 and 21.5%. Lowest error rates were found for moving average (62.5 to 21.5%) and exponential smoothing (53.4 to 23.1%).

Results for sensitivity and error rate of other traits are presented in table 2.

Table 2: Sensitivity and error rate depending on the threshold for the traits electrical conductivity, milk flow rate, and milk yield, calculated with the best method

Threshold	Sensitivity			Error rate		
	Electrical conductivity[1)]	Milk flow rate[1)]	Milk yield[2)]	Electrical conductivity[1)]	Milk flow rate[1)]	Milk yield[2)]
2%	99.0%	99.5%	94.4%	96.0%	95.6%	95.6%
6%	90.9%	98.5%	62.3%	95.6%	95.1%	94.0%
10%	52.8%	90.2%	31.6%	94.2%	93.8%	91.7%
14%	16.6%	67.6%	18.9%	92.0%	92.2%	89.0%

1) Exponential smoothing, with a history of 5 values and an α-value of 0.4
2) Day-to-day-comparison

At a threshold value of 6% sensitivity was acceptable high for electrical conductivity and milk flow rate (90.9 and 98.5%). Sensitivity for milk yield was 62.3%. Error rate of all traits was high independent of threshold value.

Sensitivity and error rate of combinations of activity with milk yield, milk flow rate, or electrical conductivity by fuzzy logic are presented in table 3.

Table 3: Results of combined traits by fuzzy logic

Trait 1	Trait 2	Sensitivity	Error rate
Activity	Milk yield	88.1%	37.6%
Activity	Milk flow rate	89.6%	33.4%
Activity	Electrical conductivity	90.2%	37.0%

Results for fuzzy logic depend on the chosen membership functions and on the rules in fuzzy inference. Best results for sensitivity ranged between 88.2 and 90.2%. Error rate was between 33.4 and 37.6%.

Discussion

Best results for oestrus detection by activity were reached with the method moving average. In comparison with results of ROTH (1987) sensitivity was on the same level (80%). Error rate improved but was with 24.1% still high.

The day-to-day-comparison was the best suited method for detection of changes in milk yield due to oestrus. Best results for detection of deviations due to oestrus caused by milk flow rate and electrical conductivity were found with an exponential smoothing. For milk yield, milk flow rate, and electrical conductivity

sensitivity was moderate to satisfying, but error rate was to high. It can be concluded, that these traits are more influenced by other parameters then by oestrus.
Sensitivity and error rate should be improved by combination of activity with milk yield, milk flow rate, and electrical conductivity, respectively. Using fuzzy logic, results for sensitivity were satisfying, with around 90%. Error rate was high (33.4 to 37.6%). Error rate for univariate analysis for activity was 36.4%, when sensitivity was 90.8%. Due to the high error rate in univariate analysis of milk flow rate, milk yield, and electrical conductivity, expected value for additional gain by combining these traits with activity was small.

Conclusion

For different traits different methods of time series analysing are useful for oestrus detection in dairy cows. Acceptable sensitivity can be reached by use of moving average for detection of deviations in activity. The amount of falsely detected oestrus's must be reduced, in order to increase the farmers confidence in the decision system. One possibility for improvement of error rate is combination of traits by fuzzy logic. Milk Yield, milk flow rate, and electrical conductivity are not able to improve error rate in combination with activity.

Further analysis should focus on traits like time since last oestrus. Combining those parameters and activity with fuzzy logic improves accuracy of the decision system.

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GENETIC ANALYSIS AND MILK PRODUCTION OF LITHUANIAN ABORIGINAL CATTLE

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Introduction

Commercial livestock farming is based on highly productive and specialized breeds that become the greatest threat to native breeds, especially through artificial insemination. Although Lithuanian cattle have been intensively improved by crossing with Black-and - White and Red bulls of various breeds, there still remained cattle with qualities and colour characteristic to native populations. Most of such cattle are kept by private holders, who used to pair their own, often native or improved native bulls and select the breeding stock at their own discretion. There was no systematic pure-breeding, thus, both Ash-grey and White-backed cattle vary significantly according to their conformation and productivity traits. The conformation of Ash-grey and White-backed cows is characteristic to that of dairy cattle. Among ash grey cattle there also could be found animals with qualities common to dairy – beef cattle.

Conservation of the indigenous cattle breeds was started with the establishing of preservation herds and pure breeding, organization of milk recording and cryopreservation of semen. There are only a few studies about Lithuanian aboriginal cattle (1, 2, 3, 4) and many aspects need to be studied and analysed.

The purpose of the present study was to analyse the pedigree of aboriginal cows and to determine the influence of the different genotype on milk production of aboriginal cattle.

Material and methods

In 2000-2001, the pedigree and productivity data of 116 Ash-grey and 87 White-backed milk recorded cows were collected and analysed. The groups were compared on the basis of the lactation productivity. The cows were divided into following groups: the cows from bulls with aboriginal or unknown pedigree, the cows from bulls with holstein blood, the cows from bulls with blood infusion from other cultural breeds. Differences between individual production traits were computed using statistical analysis.

Results and discussion

There is very little information about the pedigree of the cows of the aboriginal breeds. The dams of these cows are mostly cows of the aboriginal breeds, and sires are aboriginal or aboriginal improved bulls. As there is more data available regarding the sires of the aboriginal cows, this analysis was based on the pedigree of sires. The analysis indicated that purebred aboriginal bulls were the sires of only 3.7% white-backed cows. The pedigree on the sire side is not known for 67.0% of ash-grey and 34.3% of white-backed cows. However, it is supposed that the sires were most often aboriginal or slightly improved aboriginal bulls with the lowest infusion of blood of foreign breeds. About 16.7% of ash-grey and 36.5% of white–backed cows are the daughters of bulls with ½ to ¾ of Holstein blood. About 3.7% of ash-grey and 12.2% of white-backed cows are the daughters of bulls with ½ to ¾ of Black-and-White Dutch blood and 4.6% of ash-grey and 9.4% of white-backed cows are the daughters of bulls with ½ to ¾ of British friesian blood. We can conclude that there was a certain higher or lower degree of blood infusion from foreign breeds to Lithuanian aboriginal cattle.

Milk recording data (Table 1) indicated that the milk yield of aboriginal cows was not lower than that of the wide-spread cultural breeds in Lithuania. The milk yield of white-backed cows was by 2.9% higher and ash-grey nearly the same as the average of all milk recorded cows in Lithuania. The milk fat content of white-backed cows was by 0.08% and protein content by 0.02% lower, but the yield of fat and protein in the milk was even higher than the average of all recorded cows (it has been compensated by higher milk yield). The milk yield, fat and protein content of white-backed and ash-grey cows were a little lower in comparison with the average of milk-recorded cows on private farms.

Table 1.The average milk productivity of recorded cows

Breed	Number of cows	Milk. kg	Fat		Protein	
			%	kg	%	kg
White-backed	87	4577	4.28	195.7	3.24	148.3
Ash-grey	116	4489	4.32	193.7	3.22	144.7
Lithuanian Black-and-White	64629	4521	4.33	195.7	3.22	145.5
Lithuanian Red	28914	4162	4.45	185.4	3.35	139.4
Total on private farms	62575	4650	4.38	203.6	3.27	152.1
Total	97567	4447	4.36	194.1	3.26	144.8

The analysis of the milk production of cows per lactation (Table 2) indicated that most milk productive were the cows from the sires possessing the blood of Black-and-White Dutch, British Friesian and other foreign breeds. White backed cows of this group produced even by 21.4% ($P<0.005$) more milk than aboriginal cows or cows with unknown pedigree and by 15.5% more milk than cows with Holstein blood. The milk fat content of white-backed cows with Holstein blood was by 0.13% and cows with blood infusion from other cultural breeds by 0.12% higher than cows with blood infusion from other cultural breeds was by 3.2%

higher than aboriginal cows or unknown cows and by 10% (0.10 < P P < 0.05) higher in comparison with cows with Holstein blood.

Table 2. Milk performance of aboriginal cows of different genotypes

Breed	No of cows	Milk, kg	Fat		Protein	
			%	kg	%	kg
Aboriginal cows or cows with unknown pedigree						
Ash-grey	44	4722±100	4.22±0.06	199.9±5.3	3.15±0.03	148.0±3.1
White-backed	14	4342±198	4.12± 0.04	178.2±7.7	3.2±0.03	140.2±5.9
Cows with Holstein blood						
Ash-grey	16	4431±166	4.20±0.26	189.3±7.2	3.27±0.03	145.1±5.8
White-backed	15	4565±237	4.25±0.12	183.7±13.8	3.15±0.03	144.0±7.8
Cows with blood infusion from other cultural breeds						
Ash-grey	12	4875±154	4.32 ±0.5	210.1±7.0	3.29±0.04	159.7±4.7
White-backed	15	5271±173	4.24±0.06	223.5±8.3	3.22±0.03	170.0±6.1

The milk yield of ash-grey cows with Holstein blood was by 6.6% lower than aboriginal cows or cows unknown pedigree (the difference was statistically insignificant) but milk protein content was by 0.12% ($P < 0.005$) higher.

Conclusion

1. It is unanimously agreed that there was a certain higher or lower degree of blood infusion from cultural breeds to Lithuanian aboriginal cattle.
2. The cultural breeds had a positive effect on the milk productivity of Lithuanian aboriginal cattle (especially White-backed).

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EFFECT OF CHANGES IN FEED RATION ON MILK PRODUCTIVITY OF ESTONIAN NATIVE COWS

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Introduction

The owners of Estonian Native cows are aware of the advantages and deficiencies of this breed, whereas other cattle breeders know this breed as local endagered breed with small growth and low milk-producing ability (World...,1995). The low production is often caused by poor feeding-keeping conditions due to which the genetic potential of the Estonian Native breed cannot be fully realized.

Several countries want to preserve their numerically small cattle breeds first of all for the genetic diversity and specific features (Kantanen, 1991; Kantanen 1999), but also for economical-biological, scientific, cultural-historical and ethical reasons (Maijala, 1995; Maijala et al., 1992). In Finland (1978...1987), FABA and ARC carried out the comparison trial with Finnish Ayrshire, Friesian and local Finncattle, keeping the animals in similar conditions and paying a special attention to their longevity (Maijala et al., 1992). The results of the trials are interesting for us due to a close relationship between West-Finnish breed and our Estonian Native breed. It is high time to study the genetic potential for milk productivity of the Estonian Native breed on a large farm and to obtain comparative data.

Material and Methods

Lanksaare farm has become a breeding center of Estonian Native cattle. At present there are 51 dairy cows, whereas last year 23 cows were sold to other farms. The aim of the feeding trial, carried out with Estonian Native cows, was to study the effect of better feeding on milk-productivity. Seven adult cows, who had calved 3 to 6 times by spring-summer period in 2000, were chosen for the trial, because the Native breed is known for its late maturity (Pung, Teinberg, 1982). Regarding the milk yield of the previous lactation, two best cows, two average cows and three poor cows were chosen. The sires of cows were also considered. The chosen cows were the offspring of 5 different sires. The trial cows were compared with 17 cows of the same age in the same cowshed.

The previous lacatation milk production data of 7 cows of the trial group (control 1) and the adult farm-neighbours (n=17), who had calved at the same time as trial cows (control 2), were used for comparison. According to newly formulated feed rations, the trial cows were fed better, starting about one week after calving, when udder swelling had dissapeared. The feed ration consisted of timothy-rich hay, barley- and oat-meal, potatoes and mixed silage (grass, oat, pea), supplemented with purchased concentrates and sunflower cake.

In formulating the feed rations, the previous milk productivity data and body weight of a cow were taken into consideration. It was followed that feed dry matter were not over 4 % from cows` body weight and crude fiber content were over 14 % in dry matter. Particular attention was paid to digestible protein, metabolizable energy as well as to Ca and P requirements. On the basis of the existing feeds, it was difficult to formulate a good feed ration to meet at the same time both energy and digestible protein requirement. Therefore, there was lack of energy as well as digestible protein. At first the cows were not able to consume such amount of feed, but day by day they started to eat faster. The control cows got similar feed, except for concentrates and cakes, but in smaller amounts.

Results and Discussion

Two control groups had similar milk-producing data (Table 1). Daily-milk yields were 13.6 kg and 13.4 kg, respectively, milk-fat yield and milk-protein yield were 1.08 kg and 1.12 kg. The data variation was somewhat (v>24%) bigger than in trial group. Daily milk yield of the trial group was 18.9 kg, and the yield of milk fat and milk protein was 1.53 kg, which is a remarkable result, as far as the Estonian Native cows are concerned.

Table 1. Average daily milk production of cows of trial and control groups

Group		Milk, kg	Fat, %	Protein, %	F+P, kg	SCC	Urea
Trial	x	18.9	4.73	3.43	1.53	587.5	391.0
n = 7	s	4.0	0.56	0.36	0.31	788.5	71.5
	v	21.2	11.9	10.5	20.6	134.2	18.3
Control-1	x	13.6	4.91	3.42	1.08	443.0	282.2
n = 7	s	5.3	1.17	0.56	0.34	491.5	95.7
	v	38.9	23.8	16.4	31.7	110.9	33.9
Control-2	x	13.4	5.03	3.43	1.12	932.2	325.1
n = 17	s	3.4	1.01	0.56	0.28	1438.6	117.9
	v	25.2	20.1	16.3	24.9	154.3	36.3

Protein content of milk was similar in all groups, but fat content was lower in trial group. Higher protein content of feed did not influence the milk dry matter synthesis. The problems may be in energy storing, because the milk urea content in trial group was considerably higher than in control group, and it refers to energy deficiency in rumen digestibility.

The udder health of trial cows was rather poor, but it was better than that of the control-group.. The somatic cell count (SCC) was considerably lower than that of other cows in the same shed. The milk SCC as well as udder health depend mostly on the milker`s working-methods (Kiiman, 1999). On Lanksaare farm the milkers were careless and they were often replaced. Replacement of a milker decreases also the milk yield. Thus, in September, after the replacement of a milker, the milk yield of trial cows decreased by 5.97 kg (2.3....10 kg). Consequently, on Lanksaare farm there is much work to do to achieve SCC limit of 100,000.

Figure 1. Milk production of trial and control group cows depending on lactation month

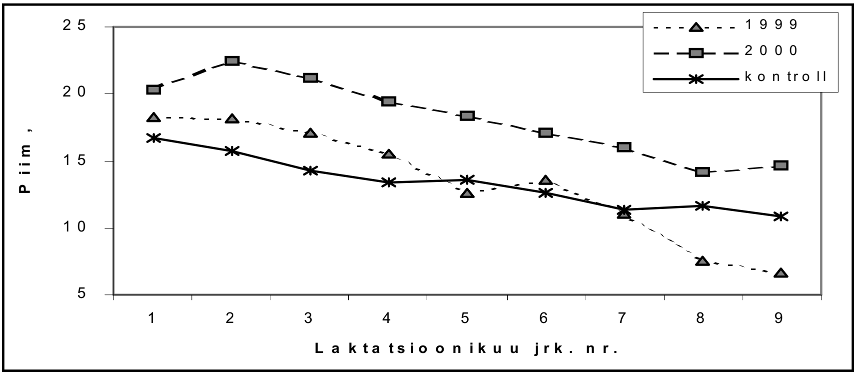
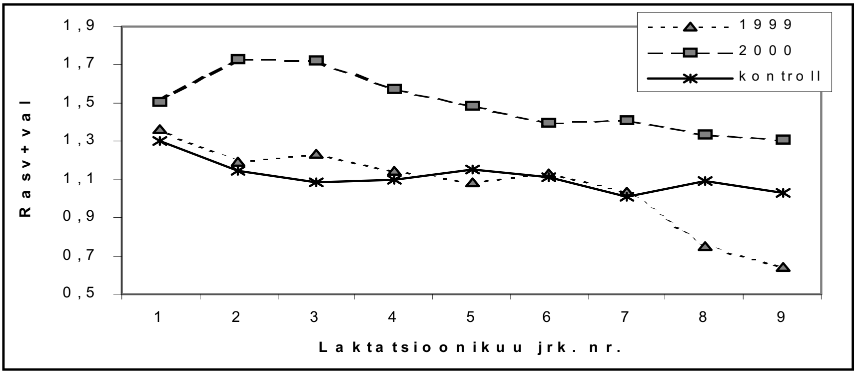


Figure 2. Daily milk fat and protein production depending on lactation month



The data of different lactation-months (Figures 1...3, Table 2) showed that daily milk yield of trial cows was 2.03...5.55 kg higher than in previous lactation, and 3.65...6.94 kg bigger than that of other cows in the same shed.. Taking into account the daily milk fat and milk protein yield, the production of trial cows was 0.144...0.547 kg bigger than in previous lactation, and 0.203...0.640 kg bigger than that of other cows on the same farm. Variation was statistically probable (P<0.05...0.001) during six lactation months.

Figure 3. Milk urea content depending on lactation month

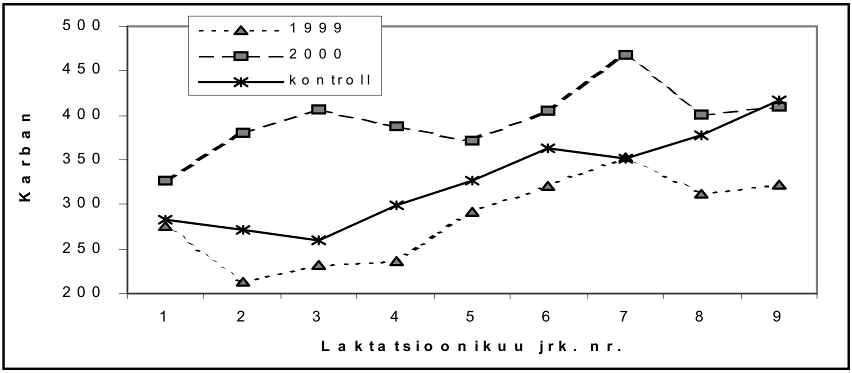


Table 2. Comparison between trial and control group cows

Lact. month	Milk, kg		Fat + Protein, kg		SCC		Urea in milk	
	control							
	1	2	1	2	1	2	1	2
1.	2.03 *	3.65 **	0.144	0.203	220.4 *	107.3	50.4	43.8
2.	4.36 *	6.82 ***	0.547 **	0.581 **	335.0 *	-218.3	167.3 ***	108.7 *
3.	4.07 **	6.94 ***	0.488 ***	0.640 ***	258.9	3.5	174.4 ***	147.1
4.	3.97 *	6.10 ***	0.426 *	0.470 **	18.6	-506.0 *	151.7 **	188.7
5.	5.55 *	4.74 ***	0.366 *	0.333 *	702.8	495.1	70.5	44.9
6.	3.17 *	4.503 **	0.248 **	0.285 *	123.7	-670.9	86.5	41.4

*) *statistical probability*: * P<0.05; ** P<0.01; *** P<0.001.

Urea content of milk increased remarkably, compared with previous lactation, exceeding also the urea data of other cows on the same farm, which refers to energy deficiency in a feed ration.

Milk fat content was nearly on the same level, but in the second half of lactation period the milk-fat content of trial cows was lower than that of control group. Milk protein content of trial cows, however, was higher during the first months of lactation, whereas no difference was observed in the second half of lactation period.Both the milk fat and milk protein content increased during the lactation period.

Conclusion

A feeding trial was carried out on Lanksaare farm to study the reaction of the Estonian Native breed cows to better feeding conditions. Feed rations for trial cows were formulated according to their milk yield. The milk performance data of the trial cows (n = 7) were compared with the relevant data of their previous lactation (control 1), and with the productivity data of the cows of the same cowshed who had calved in the same period (n=17; control 2).

The milk yield of trial cows exceeded significantly, by 2.03...5.55 kg, the daily output of both control groups as well as the daily output of other cows in the shed, by 3.65...6.94 kg, respectively. The milk fat and protein yield of the test cows was by 0.144...0.547 kg higher, compared with the yield of previous lactation, and by 0.203...0.640 kg higher than that of other cows in the same shed. The results could have been even better unless energy deficiency occurred in feeding, and milk SCC exceeded 250,000 cells/ml.

Thus, the Estonian Native cows reacted favourably to better feeding conditions. The results of this study suggest that the milk production potential of the Estonian Native breed cows could be 5000...6000 kg/year, 5.0% fat content, and 3.45% protein conent. Consequently, the Estonian Native breed cattle are worth keeping not only for genetic diversity conservation purposes, but also for their high potential productivity.

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ABOUT METHODS REDUCING SOMATIC CELL COUNT IN MILK

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Introduction

Infection status is the most important factor affecting somatic cell count (SCC) in milk. High milk somatic cell count is almost always the result of infection. Variation in SCC from day to day for healthy cows does results in slightly elevated for some cows but seldom to extremely high levels. Mastitis is the costly disease to animal agriculture. There was found (Heald et al., 1998; Rogers et al., 2000) that 200 000 cells/ml to be the most practical threshold to determine mastitis based on SCC. Milk yield, reproductive performance, and health are important factors that determine profitability of dairy farms.

The success of the modern dairy farm will be dependent on the profitable production of high quality milk. As our dairy herds increase in size, cows' will be milk more frequently by milkers. Dairy cattle breeders are renewing own milking equipment by modern one. In 1996 the standards of International Standard Organisation (ISO) for milking machines and components were revised. A further step in automation was the introduction of automatic cluster remover (ACR). An automatic cluster removal system assists the milker in his job by taking over the removal of the milking cluster from the udder at right moment. Every dairy farm is different by his management methods.

The object of the present study was to investigate what kinds of other methods than treatments are in lowering milk somatic cell count, when there is applied machine milking in dairy farms.

Material and Methods

In the present study 36 milkers working time observations in eight agricultural enterprises were carried out. Nine milkers were worked in milking parlour and 27 milkers were milked with pipeline milking equipment. Monitoring of the working operations of the milkers was carried out. The duration of each element of the working process was recorded. In one enterprise were kept Estonian Red cows, in two enterprises Estonian Holstein and Estonian Red cows and in five agricultural enterprises only Estonian Holstein cows. The data about test-day somatic cell count in 2000 were collected. The milking machines were tested in milking parlours. The analysis of variance with SAS- program was used to find the effects of cow preparing for milking, delay in applying the milking unit to the cow, machine stripping and over-milking and explain their significance on SCC.

Results

Milking procedures should be designed in synergy with cow physiology so as to optimise cow health, milk quality and human health. Researchers (Merril et al., 1987) were found that twelve hours interval is most optimal milking interval with twice daily milking. An optimal milking routine include different working operations: cleaning udders and teats, manual pre-stimulation, fore milking, attaching milking unit to cow, removing milking unit, teat dipping. In our trials the dairy cow groups were large, more than 50 cows milked by one milking operator. From table 1 we can find duration of the basic working operations doing during milking process in seconds.

Table 1. Duration of basic operations doing during milking process in seconds

Item	Mean	Minimum	Maximum
Duration of udder preparation	21.4	8.0	53.0
Delay in application of the milking machine	9.7	0	57.0
Over-milking	29.3	0	157.0
Machine stripping	31.9	0	72.0

One of the important working operations in milking is the efficient pre-milking udder preparation of the cow. In table 1 we see, that some cows' udders were prepared even by 8 seconds. The hormone oxytocin actuates the milk letdown mechanism and that is quite essential that udder preparation time is longer. Essential part of the udder preparation is forestripping, when we can check the foremilk for clinical mastitis. In our trials 24 milkers from 36 done forestripping in milking all the cows.

The milking unit should be applied to the cow as soon as possible. The longer delay in application of the milking unit to the cow was 57 seconds.

The milker should remove the milking machine as soon as milk flow ceases. From these observations appeared, that milkers did not pay necessary attention to watching the milking machines. The maximum over-milking was 157 seconds per cow. It is quite essential that machine stripping will be a short-range. In our trials the machine stripping was 31.9 seconds. Machine stripping should take no more than 15 to 20 seconds.

From the observations appeared, that milkers did not pay enough attention to watching the milking machine. It may result in over-milking. From table 1 we can see, that the maximum over-milking duration was 157 seconds.

It appeared from the analysis of the data that the effect of the udder preparation time was essential to milk somatic cell count ($P<0.01$). In table 2 there is mean milk somatic cell count, when udder preparation time was less than 20 seconds, 20...30 seconds and more than 30 seconds. When the udder preparation was 20...30 seconds, then the milk somatic cell count was essentially lower (324 000/ml) than if the udder preparation was less than 20 seconds. From these data we can conclude that to high producing cows the udder preparation of 20...30 seconds be adequate. Research data (Rasmussen, 1992) demonstrates that optimising udder preparation reduces milking time and improves cow handling efficiency.

Table 2. Effect of the udder preparation time to milk somatic cell count (SCC)

Item	Characteristic	Duration of udder preparation		
		<20 sec	20...30 sec	>30 sec
SCC, 10^3/ml	$\bar{x}$	517	324	291
	s	503	311	297

The next essential procedure is the application of the milking unit to the cow. Milkers lost time between stimulation and actual attachment of the milking unit clusters to the cow.

The milking unit should be applied to the cow as soon as cow preparation is completed (Merrill, 1987). The ideal time is 1.3 minutes (1 min. 18 seconds) with a range of 1...1.5 minutes between the beginning of preparation to the application of the milking machine.

Table 3. Effect of delay in applying the milking unit to milk somatic cell count (SCC)

Item	Characteristic	Application of the milking machine	
		delay	no delay
SCC, 10^3/ml	$\bar{x}$	311	423
	s	303	457

From table 3 we can see that, when there was delay in applying the milking machine, then the milk somatic cell count was higher - 423 000/ml ($P<0.05$). Rasmussen et al. (1992) determined that the range of 1 to 1.5 minutes is accepted as the optimal time from the beginning of udder preparation to the application of the milking machine. Prep lag times of greater than 3 minutes were found to result in more residual milk and lower milk yields regardless of stages of lactation.

The milker should remove the milking machine as soon as milk flow ceases by shutting off the vacuum. Faster milking quarters that milk out one to two minutes before other quarters should be left alone. It is quite essential that the machine stripping will be a short-range.

From the data analysis observed that the machine stripping was essential to milk somatic cell count ($P<0.05$). In table 4 there are mean milk somatic cell counts, when the machine stripping was less than 20 seconds, 20...30 seconds and more than 30 seconds. When the machine stripping was less than 20 seconds, then the milk SCC was 289 000/ml, but when this item was more than 30 seconds the mean milk somatic cell count was 443 000/ml. From these data we can concluded that, when the cows are properly prepared and milked with a good milking system, then the machine stripping should take no more than 15 to 20 seconds.

Table 4. Effect of the machine stripping to milk somatic cell count (SCC)

Item	Characteristic	Machine stripping		
		<20 sec	20...30 sec	>30 sec
SCC, 10^3/ml	$\bar{x}$	289	321	443
	s	297	304	471

One of the long-standing recommendations is adequate watching the milking machine by milking the cow. To empty the udder as completely as possible does not mean that milkers can allow over-milking. The milker should remove the milking unit as soon as milk flow ceases. From table 5 we can see, when milkers did not pay necessary attention to watching milking machine, there was over-milking. In these case the somatic cell count in milk was high - 481 000/ml ($P<0.001$).

Table 5. Effect of the over-milking to milk somatic cell count

Item	Characteristic	Over-milking	
		appeared	not appered
SCC, 10^3/ml	$\bar{x}$	481	214
	s	513	203

Without over-milking the mean milk somatic cell count was remarkably lower 214 000/ml. The over-milking was observed any more in these cases when there were so many milking machines that milker was not able to monitor throughout the entire milking process.

The results of milking machine tests showed, that the basic readings were remained within standards (ISO 6690, 1996) licensed.

Conclusions

In the present research the monitoring of the working process of 36 milkers in eight agricultural enterprises was carried out. The duration of each element of the working process was recorded. Nine milkers worked in milking parlours and 27 milkers with pipeline milking equipment. The milking machines were tested in milking parlours. From data analysis observed that the adequate pre-milking cow preparation for milking was essential to milk somatic cell count (P<0.01). The delay in application of the milking machine was affected milk somatic cell count (P<0.05). From these data observed that milk somatic cell count was 311 000/ml, when there was not delay in applying the milking unit and 423 000/ml, when there was delay. Statistically significant was the effect of machine stripping to milk somatic cell count (P<0.05). It appeared from the observations, that milkers did not pay enough attention to watching the milking machines- result was over-milking. Milk somatic cell count was remarkably lower- 214 000/ml, when over-milking was not observed and higher- 481 000/ml, when there was over-milking in one or more udder quarters (P<0.001). The results of milking machine tests showed, that the basic readings within standards (ISO 6690, 1996) licensed.

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INTERACTION BETWEEN GENOTYPE AND FEEDING-KEEPING CONDITIONS OF ESTONIAN RED COWS

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Introduction

The Danish Red breed has been used to improve the Estonian Red breed of cattle already since the last decade of the 19th century. Majority of the first lines of the Estonian Red herd were established on the basis of the Danish Red bulls and their offspring /1/. Nowadays, 32.7 % of the gene pool of the Estonian Red breed cattle and 33.8 % of semen bank of the breeding co-operative "Estonian Red Herd" originate from the Danish Red breed /2/.

The Danish Red breed is widely known and highly recognized among other breeders of Red cattle as well. Although the above breed has been widely used to improve the Estonian Red breed, not always the expected increase in milk productivity has been obtained. This may be caused by the fact that local feeding-keeping conditions do not meet the needs of the breed improvers.

The objective of the present study was to investigate the changes in relative breeding value (RBV) for milk productivity in different feeding-keeping conditions, depending on the percentage of Danish Red breed genes in genotype. When RBV of the cows of different genotypes, i.e. the RBV of the cows with different percentage of Danish Red genes, changes differently in various keeping conditions, the interaction between genotype and environment takes place. In case of interaction, the productivity characteristics of animals estimated in certain conditions cannot be strictly transformed into other conditions.

Material and Methods

2275 cows from 395 farms were investigated after their 3rd lactation. The number of sires was 172. The classification was based on the share of breeding-component genes in genotype, separated into three following groups: up to 25%, 25...50%, over 50%. The farms are also divided into three groups, according to the production level of a forage cow: up to 3500 kg, 3500...5000 kg and over 5000 kg milk per cow a year. RBV for each cow was calculated on the basis of 3 lactations according to BLUP animal model. RBV is expressed by points, with mean of 100 and SD of 12 points, combining breeding values of milk, fat and protein quantity by relative economic weights of -0.1:1:6 on fixed cow base in 1995. While RBV for milk productivity of cow, calculated according to BLUP animal model, considers in reflecting the animal's genetic variation the environmental effects as well, then RBV cannot be considered as the data indicating strictly the amount of production, but as an estimate given in certain conditions.

Mean RBVs in the groups of different share of breeding-component genes and on the farms with different feeding-keeping conditions were compared using SAS program. The following formula for two-factor analysis of variance, adjusted to the data, was used:

$$y_{ijk} = \mu + A_i + B_j + C_{ij} + e_{ijk},$$

where μ - average RBV of cows, *Ai* - *i* effect of group with Danish Red gene percentage (i = 1, 2, 3), *Bj* – *j* effect of feeding-keeping level (j = 1, 2, 3), *Cij* - total effect of *i* group with Danish Red gene percentage and *j* feeding-keeping level, e_{ijk} – non-described part of studied trait (random error).

To illustrate graphically the differences of means as well as the total effect of the share of Danish Red breed genes and feeding-keeping conditions, the diagrams were drawn using MS Excel on the basis of the results obtained by SAS program.

Results

The results of the analysis indicated that both the percentage of the Danish Red breed genes and feeding-keeping conditions, as well as these two factors together, had a statistically significant effect on RBV for milk (Table 1).

Table 1. Studied factors and significance of their effect

Factor	No. of levels of factor	F statistic	Significance of probability
Percentage of Danish Red breed genes in genotype (DRB%)	3	7.49	p<0.001
Farm's production level (FPL)	3	21.69	p<0.001
DRB % x FLP	9	3.48	p<0.01

As shown in Table 2, by improving feeding-keeping conditions the RBV of different genotypes also increases. Less has increased that of the cows possessing up to 25% Danish Red breed genes – 2.4 and 0.9 points, respectively. Bigger changes in RBV-s, however, were observed in cows possessing 25 to 50% and more than 50% Danish Red breed genes, 2.6 to 6.1 points, respectively, depending on keeping conditions.

With regard to the milk yield of a farm's forage cow or keeping conditions, the RBV of the herds with the production level of less than 3500 kg milk did not increase but even decrease in the result of increasing the share of breed improver's genes in genotype, whereas in the herds with the milk yield from 3500 to 5000 kg per forage cow, a slight increase in RBV was observed –1.5 and 0.3

points, according to the share of genes. A considerable increase in RBV was observed in the herds with the milk yield over 5000 kg per forage cow –3.2 and 1.0 points, according to the percentage of the Danish Red breed genes in genotype.

Table 2. Mean RBVs depending on three different levels of genotype and feeding-keeping conditions

Milk yield of a farm's forage cow	Percentage of Danish Red breed genes in genotype		
	< 25%	25...50%	> 50%
< 3500 kg	93.2	91.0	92.8
3500... 5000 kg	95.6	97.1	97.4
> 5000 kg	96.5	99.7	100.7

Figure 1 illustrates the changes in RBVs of the cows with different genotypes, kept in three different feeding-keeping conditions. Changes in RBVs of the cows of three different genotypes, depending on their keeping conditions, are shown graphically in Figure 2.

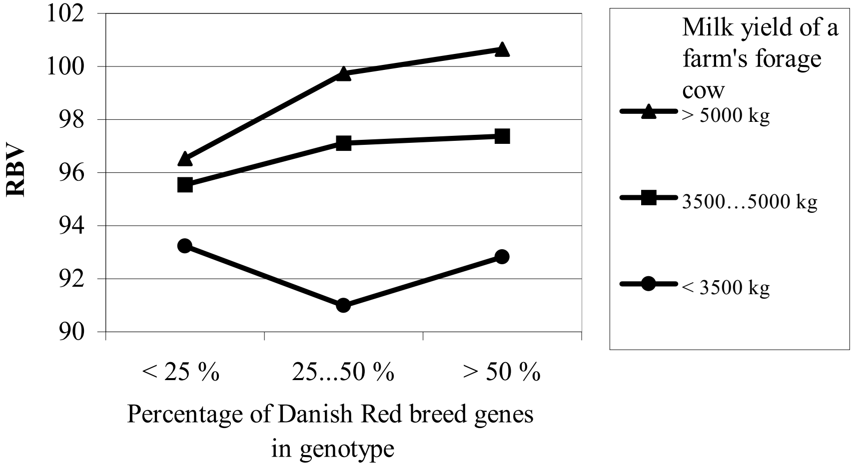

Figure 1. Mean RBVs of cows, kept in three different feeding-keeping conditions, depending on genotype

As indicated in Figure 1, increase in RBV was not observed in case of increasing the share of breed improver's genes in genotype on those farms, where the average yield of forage cow was less than 3500 kg, whereas it even decreased. A slight increase of RBV can be seen on the farms of the production level from 3500 to 5000 kg, and a considerable increase on the farms of the milk yield of more than 5000 kg per forage cow. Figure 2 also demonstrates, that by improving keeping conditions RBV may significantly increase, particularly in case of higher percentage of breed improver's genes.

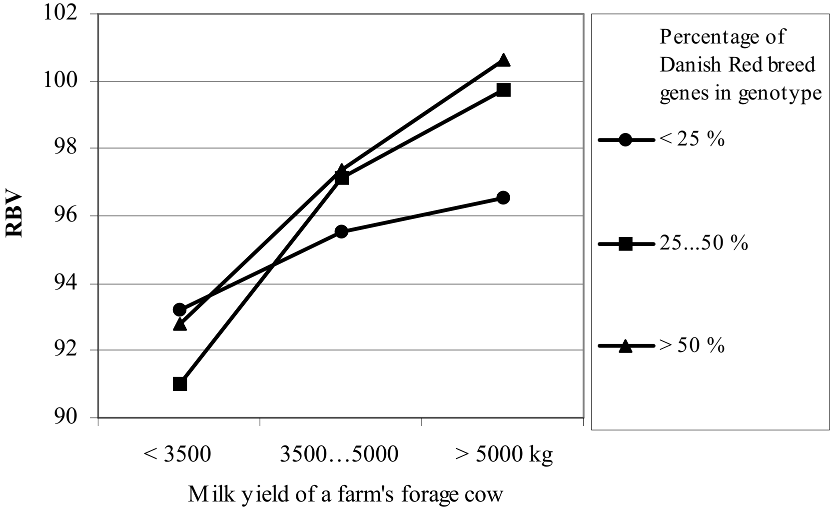

Figure 2. Mean RBVs of cows of three different genotypes, depending on feeding-keeping conditions

On the farms where a forage cow yielded less than 3500 kg milk, the mean RBV-s of the cows of three different genotypes were within the limits of 91.0…93.2, difference of values being 2.2 points. On the farms with the production level from 3500 to 5000 kg per forage cow, the mean RBVs were between 95.6 and 97.4, difference of values 1.8 points. On the farms with the milk yield over 5000 kg per forage cow, the RBV-s were between 96.7 and 100.7, difference of values 4 points. In case of improving the feeding-keeping conditions, the RBV of the cows with lower percentage of Danish Red breed genes increased slowly, compared with that of the cows possessing higher percentage of Danish Red genes.

The studies indicated that relative breeding value for milk (RBV) of the cows of the Estonian Red breed depends statistically significantly on the percentage of

Danish Red genes in genotype, the feeding-keeping conditions as well as the total effect of the share of Danish genes and the feeding-keeping conditions.

Together with each 25% increase in the share of Danish Red genes in the genotype increased also the RBV by 1 point. Each increase in production level of a forage cow of a farm by 1000 kg, from 3500...5500, increased also the RBV by 3 points. The environment-genotype interaction was expressed by the fact that in case of poor feeding-keeping conditions and increasing share of Danish Red genes in genotype the RBV decreased, whereas in favourable conditions it increased. In the earlier studies, other authors /3, 4/ have found similar results, i.e. that the total effect of the breed improver's genotype and the environment of the breed to be improved affects productivity. They have also pointed out that advantages of breeds will usually appear in favourable keeping conditions.

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RELATIONSHIPS BETWEEN ESTIMATED BREEDING VALUE OF MILK PERFORMANCE AND TYPE TRAITS OF ESTONIAN RED CATTLE

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Introduction

In several countries the combined index where both milk performance and type traits are enclosed for estimation of sires is used. The combined index is giving more genetic information than index calculated by milk performance index alone. The milk performance can also be predicted by type scores. W.W Foster et al (1985) found that the cows with better exterior have longer stayability and higher lifetime milk performance. It is very important to improve the udder traits of high yielding cows, which enable longer life and higher milk productivity (M.A.De Lorenzo et al 1982). L.D. van Vleck et al (1980) mentioned the positive relationships between body conformation traits and milk performance (r= 0.18 to 0.29). It means that improvement of type will increase milk production as well. G.W. Rogers et al (1988) reported the highest effect of stature, dairy form and udder traits on milk yield. P.M. Van Raden et al (1990) mentioned that the type scores of daughters are necessary to include into total merit index of sires where each trait is need to be analyzed separately according to their heritability, genetic relationships and economic weights.

P.J. Berger et al (1973) reported the higher response when the selection was carried both by type and milk performance, compared to selection by milk performance only.

The objective of present research was to find out the relationships between the milk yield and type traits of Estonian Red cattle.

Material and Methods

The data of 4998 first lactation Estonian Red cows were obtained from Estonian Animal Recording Centre. The cows were linearly classified from 1996 to 1999.

In addition to the type scores the sires breeding values for milk performance was included in the database. The cows were divided into 8 groups according to their milk production. The least square means (LSM) of general impression, udder, feet and legs as well as final score on different production groups were compared using the following model:

$$Y_{ijklmn} = +A_i+B_J+C_k+D_{l(k)}+E_m+e_{ijklmn}, \text{ where}$$

Y_{ijklmn} – i-th trait

A_i - sire $D_{l(k)}$ - lactation stage(nested within the age at 1st calving)
B_J - herd E_m - milk yield class
C_k - age at 1st calving e_{ijklmn} - residual.

The breeding value of type scores were calculated using BLUP Animal Model:

$$Y_{ijklm} = \mu+A_i+B_J+C_k+D_l+a_m+e_{ijklm}, \text{ where}$$

Y_{ijklmn} – i-th trait score D_l- stage of lactation
μ - overall mean C_k – age at first calving A_i – classifier*year
a_m – additive genetic effect B_J – herd * year fixed effect e_{ijklmn} – residual

The total breeding value for final score (BVF) was calculated according to the percentage of body region scores from the final score. The following model was used:

$$BVF= 100+0.5*(BV_{udder} -100)+0.3*(BV_{general\ impression} -100)+0.2*(BV_{legs}-100).$$

The breeding values for milk performance traits (BVM) of sires were also calculated by BLUP animal model:

$$Y_{ij}=\mu+A_i+a_j+e_{ij}, \text{ where}$$

Y_{ij} – measured yield μ - overall mean A_i – herd*calving year* calving season
a_j – additive genetic effect e_{ij} – residual

The following formula for calculating of sires total merit index (BVT) was used:

$$BVT=100+0.85*(BVM-100)+0.15*(BVF-100), \text{ where}$$

BVM is 85% and BVF is 15% from total merit index (BVT).

The heritability of type scores was found by REML method.

Data was processed using the SAS, Minitab, Excel and PEST programs.

Results

Table 1 shows that the cows with milk production under 3000 kg have significantly lower general impression score than the high-producing cows ($P<0.05$). The average score of general impression of low-producing cows (<3000 kg) was 0.4 points lower than that of the cows with milk production 3000…3500 kg. The average score of legs and feet of high producing cows was significantly better, than that of the cows with lower production.

Table 1. The LSM and differences of general impression (below) and legs and feet score (above) of 1st lactation Estonian Red cows

General impression	Legs and feet	Milk, kg	<3000	3000-3500	3501-4000	4001-4500	4501-5000	5001-5500	5501-6000	>6000
17.9	13.5	<3000		0.1	0.2[a]	0.2	0.3[a]	0.4[b]	0.8[c]	0.7[c]
18.3	13.6	3000-3500	0.4		0.1[a]	0.1	0.2[a]	0.3[b]	0.7[c]	0.6[c]
19.2	13.7	3501-4000	1.3	0.9		0.0	0.1	0.2	0.6[c]	0.5[b]
19.3	13.7	4001-4500	1.4	1.0	0.1		0.1	0.2	0.6[c]	0.5[b]
19.8	13.8	4501-5000	1.9	0.5	0.6	0.5		0.1	0.5[b]	0.4[a]
21.0	13.9	5001-5500	2.1	1.7	0.8	0.7	0.2		0.4	0.3
21.0	14.3	5501-6000	2.1	1.7	0.8	0.7	0.2	0.0		-0.1
21.3	14.2	>6000	2.4	2.0	1.1	1.0	0.5	0.3	0.3	

[a]-P<0.05; [b] -P<0.01; [c]-P<0.001

The milk production is highly related with udder traits. Therefore the better udder of high producing cows was expected (Table 2). When the production increased 500 kg, the udder score increased by 1...2 points respectively.

The udder score of cows producing milk over 6000 kg was 9.4 points higher than that of the cows with milk yield under 3000 kg (Table 2).

Table 2. The LSM and differences of udder (above) and final score (below) of 1[st] lactation Estonian Red cows

Udder	Final score	Milk, kg	<3000	3000-3500	3501-4000	4001-4500	4501-5000	5001-5500	5501-6000	>6000
27.3	58.8	<3000		2.0[c]	4.2[c]	4.4[c]	7.0[c]	8.1[c]	8.5[c]	9.4[c]
29.3	61.2	3000-3500	2.4[c]		2.2[c]	2.4[c]	5.0[c]	6.1[c]	6.5[c]	7.4[c]
31.5	64.4	3501-4000	5.6[c]	3.2[c]		0.2	2.8[c]	3.9[c]	4.3[c]	5.2[c]
31.7	64.7	4001-4500	5.9[c]	3.5[c]	0.3		2.6[c]	3.7[c]	4.1[c]	5.0[c]
34.3	67.9	4501-5000	9.1[c]	6.7[c]	3.5[c]	3.2[c]		1.1	1.5	2.4[b]
35.4	70.2	5001-5500	11.4[c]	9.0[c]	5.8[c]	5.5[c]	2.3[a]		0.4	1.3
35.8	70.9	5501-6000	12.1[c]	9.7[c]	6.5[c]	6.2[c]	3.0[b]	0.7		0.9
36.7	72.4	>6000	13.6[c]	11.2[c]	8.0[c]	7.7[c]	4.5[c]	2.2	1.5	

The final score was also higher in cows with high milk production compared to the lower-producing cows. The average of final score of cows producing milk under 3000 kg had 58.8 points.

The final score increased by 2...3 points per each next group of production.

The cows producing milk over 6000 kg had final score even 13.6 points higher than the cows with milk production under 3000 kg. It can be assumed that high producing cows have significantly better exterior.

The heritability for type traits was ranging from 0.10 to 0.38 (Table 3). Estimates were higher for stature, dairy form, rump angle, chest depth and centre ligament (h^2 = 0.25...0.38). Heritability for other traits was ranging from 0.10 to 0.22.

Table 3. Heritability and relationships between breeding values of daughters type traits and breeding values (BVM) of sires milk production traits

Type traits	h^2	$r_{p\,(BVM)}$	BVM>100	BVM ≤ 100	Difference
Dairy form	0.26	-0.15	98.6	101.4	-2.8c
Stature	0.38	0.42	98.9	92.5	6.4c
Chest depth	0.25	0.37	101.9	94.6	7.4c
Rump angle	0.28	0.35	99.1	91.0	8.1c
Rump width	0.22	0.31	102.4	94.6	7.7c
Rear legs side view	0.36	-0.09	98.9	100.0	-1.2a
Foot angle	0.11	0.22	104.1	100.1	4.0c
Pastern	0.12	0.20	103.4	99.5	3.9c
Fore udder attachment	0.20	0.17	100.1	97.3	2.8c
Udder depth	0.10	0.20	97.3	95.0	2.3c
Rear udder height	0.10	0.32	101.5	94.3	7.2c
Centre ligament	0.27	0.41	105.8	96.4	9.4c
Teat placement	0.12	0.40	102.2	94.0	8.2c
Teat length	0.20	-0.12	98.7	101.2	-2.5c
General impression	0.11	0.38	100.6	93.7	6.8c
Udder	0.12	0.47	99.9	90.3	9.6c
Legs and feet	0.15	0.27	104.2	100.3	4.0c
Final score	0.11	0.49	101.0	93.3	7.6c

Since the type traits inherited, it is necessary to take them into account in evaluation of breeding values of sires. This is confirmed by the correlation analysis between BVM of sires and breeding values of daughters' type traits.

Majority of the type traits of the daughters of sires with higher breeding value were better, compared to the sires with lower breeding value. The stronger correlation between sire's breeding value and body region scores was found (r=0.35...0.49).

According to previous analysis, the differences between daughters' breeding values of type traits and sires with both higher (BMV>100) and lower (BVM$\leq$100) breeding values were compared. The breeding values of most of type traits (except rear legs side view, dairy form and teat length) of daughters of sires with higher BVM were significantly higher than those of the daughters of sires with lower BVM (P<0.001).

Therefore the information of daughters' type should be considered in addition to milk performance for estimation of sires breeding value.

Table 4. Comparison of Estonian Red bulls by production index (BVM), type index (BVF) and combined index (BVT)

Sires name and ID	BVM	Rank	BVF	Rank	BVT	Rank
SYD JASON 42385	130	1	106	4	126	1
METEOR 40249	124	2	98	7	120	4
FYN NOLO 42574	124	3	107	2	122	2
IBERT 40799	123	4	104	5	120	5
JUPI 10145	123	5	107	3	121	3
IBREK 10144	120	6	104	6	118	6
FYN ROSEN 42683	117	7	109	1	116	7
BALIS 17427	112	8	98	8	110	8
ODA CHILE 42622	111	9	96	12	109	10
KELM 17605	111	10	98	9	109	9
DEIMU 17727	109	11	95	13	107	11
IVER 17186	104	12	94	14	102	12
ELRON 17581	101	13	91	16	99	14
AARD 17525	100	14	97	10	100	13
MEZBORN 40217	100	15	91	17	99	15
DZEER 17349	98	16	97	11	98	16
ELAK 17527	96	17	87	20	95	18
ELLET 17686	96	18	91	18	95	17
JAN 17419	93	19	93	15	93	19
ELAV 17295	89	20	88	19	89	20

The total merit index (BVT) of sires was calculated to compare their ranking by both (BVM) and BVT.

It was found that the daughters of sires with higher breeding value of milk performance had also higher breeding value of type (BVF). Greater changes in ranking by total merit index were observed in the sires whose BVT exceeded 120 points. Higher differences were found in of those bulls whose BVM was high, whereas the breeding value of daughters' type was low. The rank of sires with lower BVT changed less.

Conclusions

It can be concluded from the results of previous research:

1. The heritability of type traits of Estonian Red cows was ranging from 0.10 to 0.38, where the estimates were higher for stature, dairy form, rump angle, chest depth and centre ligament (h^2 = 0.25...0.38).
2. The stronger correlation between breeding value of milk production stature, chest depth, rump angle, udder traits, general impression and final score was found (r= 0.35..0.49)
3. The daughters of sires with higher breeding value of milk performance have significantly better type than the daughters' of sires with lower breeding value.
4. It is possible to predict the breeding value of sire by daughters' exterior.
5. It is necessary to calculate the breeding value of sires both by daughters' milk performance and type scores.

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SPERM MORPHOLOGY IN ESTONIAN HOLSTEIN BULLS OF VARIOUS AGES AND GRADE OF HOLSTEIN GENES

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Abstract

The aim of the current study was to determine the influence of the grade of Holstein genes, country of origin and age of the bull on sperm morphology.

The results of the study showed that the increase in the grade of Holstein genes was accompanied by the increase in sperm abnormalities (P<0.0001). The morphological characteristics of semen collected from American Holstein bulls were significantly different from that of bulls of European origin (P<0.0001).

The incidence of sperm abnormalities increased singnificantly in 6-7 years old bulls if compare to 4-5 and 1-3 years old bulls (P<0.0001).

Introduction

Efficiency of milk production does not depend only on high genetic merit of cows but is influenced by many factors including calving interval. The latter definitely depends in part on the quality of frozen semen.

During past few years variety of laboratory methods of testing semen quality have undergone significant improvement and used in combination, enable to prognose the fertility of the bull. Sperm morphology has been shown to be one of the important quality characteristics of bull semen which correlates well with the NRR of the cows (Söderquist, 1991; Barth, 1992; Padrik, 2000a; Padrik, 2000b). Despite of the long period of using the morphological methods there is still much to do to standardize the criteria especially those of sperm head because of the differences between the labs (Boersma *et al*., 2000). Semen quality evaluation using morphological characteristics is quick and perspicuous and fits well to AI station for it´s simplicity and low costs.

The aim of the present study was to determine the influence of the grade of Holstein genes, country of origin and age of the bulls to the morphological quality of semen.

Material and Methods

Altogether 2472 ejaculates from 78 bulls collected during March, 1999 - February, 2001 were studied. Five to eight ejaculates per months from each tested bull and 3-4 ejaculates from the young bulls were collected during that period.

To study the influence of the grade of Holstein genes the bulls were divided into 3 groups according to the grade: 75.00-87.59%; 87.60-93.75%; 93.75% and higher.

Seventy seven bulls were used to study the influence of the country of origin to sperm morphology. They were divided into Estonian, Dutch, German and American groups. The origin means the country from what the bulls or bull dams being pregnant heifers or the embryos were imported to use in the local breeding programme.

Sixty nine bulls divided into 3 groups (1-3; 4-5; 6-7 years old) were studied to determine the influence of age on sperm morphology.

Evalution of sperm morphology was performed as described earlier (Padrik, 2000a). Different morphological abnormalities (Figure 1) were registered in each preparation as a percentage of the total number of counted spermatozoa. Differences between mean values of sperm abnormalities were evaluated using analysis of variance to determine the effect of the grade of Holstein genes, country of origin and age of the bulls.

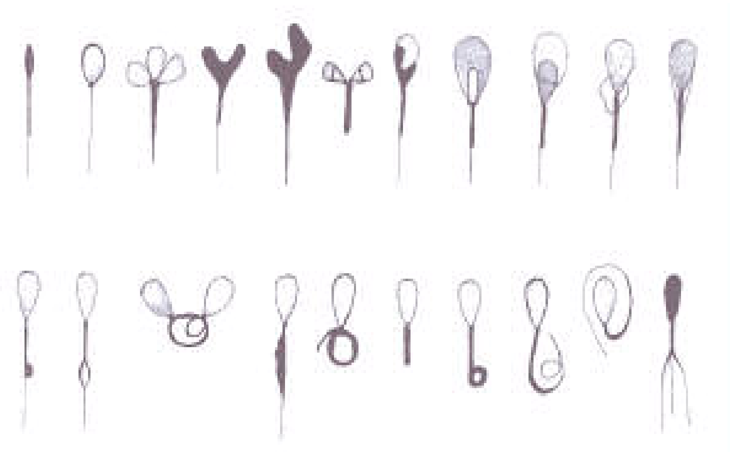

Figure 1. Sperm abnormalities in the semen of Holstein bulls

Results and Discussion

Effect of the grade of Holstein genes on the morphological quality of bull semen.

The results presented in Table 1 showed that there was a significant difference in the incidence of abnormal sperms between the bull groups with the different grade of Holstein genes (P<0.0001). Generally, the increase in the grade of Holstein genes was accompanied by the increase in the incidence of abnormal sperms. The bulls with 87.60-93.75% of Holstein genes had the highest incidence of sperm abnormalities in our study. The significant differences in the incidence of abnormal midpieces, detached heads and abnormal tails were recorded between the groups.

Such differences in sperm morphology dependent on the grade of Holstein genes may be partly caused by inbreeding effect as many of the tested bulls have similar pedigree from the sire side.

Table 1. The incidence of sperm abnormalities depending on the grade of Holstein genes

Sperm abnormalities	Grade of Holstein genes 75.00-87.59%	87.60-93.75 %	≥93.76%
No of bulls	16	14	48
No of ejaculates	397	316	1759
1. Abnormal heads %	2.14	2.83	2.99
2. Detached heads %	2.49*	4.05*	2.40*
3. Abnormal acrosomes %	0.49	0.37	0.50
4. Neck defects %	0.63	0.66	0.67
5.Proximal&distal cytoplasmic droplets %	0.98	1.04	1.14
6.Abnormal midpieces %	2.49**	3.29**	3.39**
7.Abnormal tails %	0.94*	1.05*	0.97*
8.Total abnormalities %	10.16***	13.29***	12.06***

Values in a row with an asterisk are significantly different (* P<0.05; **P<0.001; ***P<0.0001)

The incidence of sperm abnormalities depending on country of origin of the bull.

The American Holstein bulls had significantly more sperm abnormalities than the Dutch, German and Estonian bulls (Table 2, P<0.0001). There was no significant difference (P<0.1) in sperm morphology between the bulls imported from the European countries.

Such a difference in sperm morphology needs further study as the number of American Holstein bulls is small. However, it could be caused by the different breeding goals in each country and attention which was paid to the selection of the breeding bulls according to their semen quality.

Effect of bulls' age on the incidence of sperm abnormalities.

The results of the study demonstrated that the bulls' age had a significant effect on the incidence of sperm abnormalities (Table 3). The gradual increase was clearly determined for the incidence of detached heads, neck defects, proximal and distal cytoplasmic droplets and abnormal midpieces.

Table 2. Relationships between the incidence of the sperm abnomalities and country of origin of a bull

Sperm abnormalities	Country of origin of the bulls Estonia	Holland	Germany	USA
No of bulls	30	23	15	9
No of ejaculates	697	876	476	387
1.Abnormal heads %	2.48	2.80	2.93	3.51
2.Detached heads %	3.20***	2.62***	1.56***	3.06***
3Abnormal acrosomes %	0.44*	0.44*	0.53*	0.62*
4.Neck defects %	0.67	0.66	0.57	0.77
5.Proximal&distal cytoplasmic droplets %	1.13	0.97	1.21	1.21
6.Abnormal midpieces %	3.11**	3.05**	3.79**	3.29**
7.Abnormal tails %	0.88	1.11	1.12	0.65
8.Total abnormalities %	11.91***	11.65***	11.71***	13.11***

Values in a row with an asterisk are significantly different (* $P<0.05$; ** $P<0.001$; *** $P<0.0001$)

Table 3. The incidence of sperm abnormalities depending on the bulls' age

Sperm abnormalities	Age of bulls, year 1-3	4-5	6-7
No of bulls	58	11	9
No of ejaculates	1666	488	326
1.Abnormal heads %	2.82	3.35	2.91
2.Detached heads %	2.14***	3.11***	4.61***
3.Abnormal acrosomes %	0.49	0.48	0.49
4.Neck defects %	0.62**	0.71**	0.82**
5.Proximal&distal cytoplasmic droplets %	1.11*	0.88*	1.39*
6.Abnormal midpieces %	3.10*	3.42*	3.61*
7.Abnormal tails %	0.92	1.09	1.09
8.Total abnormalities %	11.19***	13.04***	14.92***

Values in a row with an asterisk are significantly different (* $P<0.05$; ** $P<0.001$; *** $P<0.0001$)

It is well established that hormones, mainly FSH and testosterone, directly influence the sperm producing function of the testis (Parvinen, 1996). Testosterone is responsible also for the regulation of epididymal function (Vierula, 1996). The deterioration of morphological quality of semen in older bulls can be caused by changed hormonal balance (Foote *et al*., 1976).

Conclusions

Increase in grade of Holstein genes, country of origin and age of the bulls had a significant influence on the morphological quality of bull semen.

The results of our studies suggest to collect the necessary store of semen from AI bulls in young age to prevent a decrease in the morphological quality of semen. Import of genetic material should be accompanied by careful monitoring of semen quality to stabilize the breeding success. Selection of bulls depends most of all on their breeding value but their fertility as very important from the point of view of the efficient reproductive performance of the dairy herd should be considered as well.

Acknowledgements

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ANALYSIS OF FACTORS EFFECTS IN LATVIAN BROWN OF DIFFERENT LACTATION FOR SOMATIC CELL COUNT

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Introduction

Somatic cell count (SCC) has been determined in Latvia since February 1998 for cows, which are in care. SCC is an indicator for mastitis and milk quality. Diseases of udder advantage the decrease of milk yield and below the decrease of profit.

Emanualson et. al. (1998) present very high (r_g=0.85) genetic correlation between SCC and mastitis.

As a measure for statistics and genetic analysis, however, SCC has several deficiencies: its distribution is not normal, and its relationship with milk yield is not linear. For the solution of these problems (DA Y. et. al., 1992) is necessary SCC transformation with $\log_2$:

$$SCS = \log2\ (SCC/100000) + 3,$$

where SCS – Linear Somatic Cell Score.

The SCS has been accepted by the National Co-operative Dairy Herd Improvement (DHI) Program a standard recording scale for SCC.

Materials and Methods

Sample of data for this study were included 396 Latvian brown cows of different lactation, which had lactation during 1998 and 1999.

For analyses SCC was transformed to SCS to achieve normality, and lactation mean of SCS was calculated.

By analogy of Latvian milk standard, SCS can be distributed to the following classes: SCS 1-4 - high quality class; SCS 5 – 1st class milk; SCS 6 – 2nd class milk; 7-10 – classless milk.

For estimation of factors effect there was used sire single trait model.

Sire and environmental effects were analysed severally for SCS of different lactation with the following model:

$$y_{ijk} = \mu + T_i + YS_j + MY_k + e_{ijk}\ , \quad (1)$$

where y_{ijk} – Somatic cell score; μ - general mean; T_i – sire (random factor); YS_j, - year, season interaction (fixed factor); M – milk yield (covariate factor); e_{ijk} – residual.

For evaluation of lactation effects the model was:

$$y_{ijkl} = \mu + T_i + YS_j + L_k + MY_l + e_{ijkl} \,, \qquad (2)$$

where y_{ijk} – Somatic cell score; μ - general mean; T_i – sire (random factor); YS_j, - year, season interaction (fixed factor); L_k - lactation; MY – milk yield (covariate interaction factor); e_{ijk} – residual.

Results

The 3rd and older lactation cows have higher milk productivity level. From these cows have been obtained milk with lower quality class (Table 1) because SCS is higher.

Table 1. Means of milk productivity and SCS traits included in analyses

Lactation	n	Milk yield, kg	Fat yield, kg	Protein yield, kg	SCS	Quality class
1st	177	3956.5±47.88	183.4±2.73	122.0±1.37	4.3±0.14	I
2nd	72	4289.7±73.57	199.5±4.21	135.6±2.39	5.0±0.22	I
3rd	51	4497.3±87.27	214.7±5.15	143.9±2.62	5.8±0.22	II
4th – 8th	96	4436.0±72.99	214.4±3.90	143.6±2.23	6.6±0.15	classless

Data analysis showed that in lack age groups there were animals, which produced milk of higher or lower quality class.

Obviously 46.2% milk produced by first calves corresponded to high quality class (Figure 1). Only 3.1 to 27.7% milk yield produced by older lactating dairy cows was distributed to high quality class. From the total milk yield, the proportion of the 1st class milk produced between lactations was in the range from 11.5 to 22.5%.

In total, the following milk yield was included in high quality and 1st class milk: 61.5% produced by 1st lactation cows, 41.6% by 2nd lactation cows, 35.2% by 3rd lactation cows and 14.6% milk produced by older lactation cows.

The 2nd class milk yield was similar to cows of different age, ranging from 15.6 to 27.8%. The highest classless milk yield was obtained from the 4th and older lactation cows (Fig. 2).

The cows of older age of calving provided higher total milk yields during lactation. However the production of such milk is unprofitable, as it is of poor quality.

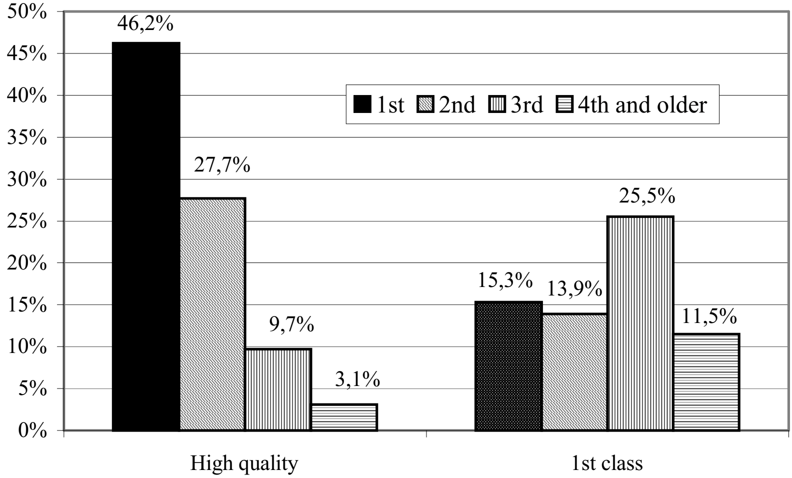

Figure 1. The yield of high quality and 1st class milk produced by dairy cows of different lactation

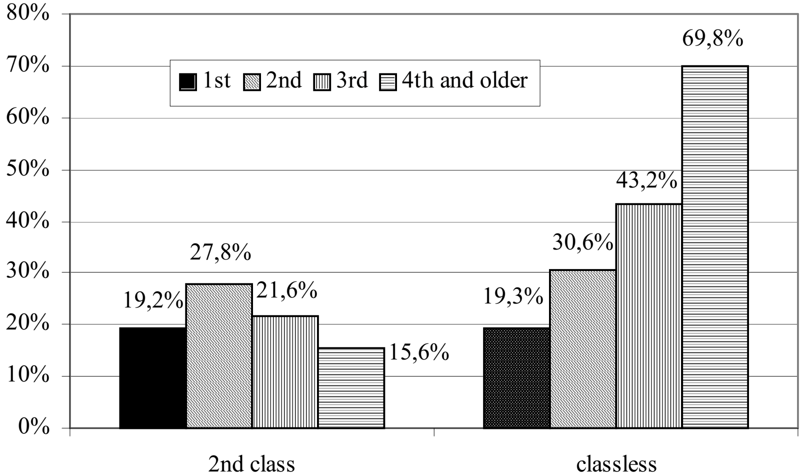

Figure 2. The yield of 2nd class and classless milk produced by dairy cows of different lactation

The main objective was to study the influence of milk yield and other factors effects on the SCS.

The effect of the sire on the somatic cell count of milk was analysed for cows of different lactation. The influence of sire decreased with the increase of age (Table 2).

The SCS was dependent on the year and month environment factor ($p<0.05$).

Table 2. Test of significance for effects of factors on somatic cell score in different lactation

Effects	Significance level			
	1st lactation	2nd lactation	3rd lactation	1st 3rd lactation
Sire	0.365	0.405	0.918	0.965
Year * Month	0.014	0.028	0.025	0.012
Milk Yield	0.719	0.310	0.186	0.490
Lactation	x	x	x	< 0.001

The solution for estimation of factor was similar for all parity and it was not significant. It appears that SCS was not higher for the cows with higher milk yield productivity.

The SCS was dependent on lactation ($p<0.001$) and age of calving. This effect is included in the model (Boettcher et. al., 1992; Schuttz, 1994) for genetic evaluation in several countries.

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GENETIC RESPONSE IN INDIVIDUAL TRAITS AND THEIR ECONOMIC VALUE

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Introduction

Milk components have different price per milk volume, fat and protein yield. This means that the philosophy of using bulls in the herd must consider the fact that some bulls have profitable daughters and some bulls are less profitable. To evaluate the bulls according to their profitability, we have to consider the value of milk components: carrier, fat and protein, the cost of production and the genetic relationship between milk components. Extensive research in many countries has shown that there is a simple way of ranking bulls to provide efficient evaluation to the profitability of bulls and cows on the basis of the economic value of different milk components. The aim of the paper is to reveal some results of breeding for maximum profit of Estonian Holstein.

Material and Methods

Structure of the breeding programme corresponds to the situation of Estonian Holstein population in 1997 based on data of Agricultural Registers' and Information Centre and Animal Breeders' Association of Estonia. Genetic and phenotypic variance-covariance matrices were constructed using parameter estimates from Estonian Holstein population. The economic values for goal traits are presented in Table 3. Most probably these differ from the economic values at the moment as they reflect the lower milk price received by farmers for sales in 1997. Implementation of new economic values for production traits as well as for some functional traits are under consideration.

Selection intensities in 4 pathway were derived according to Falconer and Mackay (1996) and accuracy and generation interval according to Brascamp et al., (1995). Genetic response to selection was derived using Rendel and Robertson (1950) methodology, expected annual responses were derived by selection-index theory (Cunningham, 1969), using Selection Index Program (SIP) (Wagenaar et al., 1995). Selection an index pertaining to aggregate genotype will maximise the monetary returns of selection for milk. Genetic parameters of Estonian Holstein (heritability, phenotypic and genotypic correlations and standard deviations), economic and energetic parameters for deriving economic weights of milk components are published earlier (Pärna, Saveli, 1998; Pärna, 1999). In construction Profit Index methodology of J.Gibson (1995) was used.

Results and Discussion

1. Profit Index

Based on economic value of different milk components (milk carrier, fat and protein yield) and ETA of bulls we have introduced Profit Index. Profit Index gives relative weights of 0.978, 5.051 and 22.48 to milk carrier, fat and protein yield, respectively. Profit Index can be easily calculated for any bull with an official proof and it estimates genetic profitability - the profitability that bull passes on to his daughters due to his genetic excellence.

The pricing system determines the income to the farm. Economic values of the milk components most probably differ at the moment as they reflect the lower price received by farmer sales in 1997. There are changes in management and feed costs also in comparison to 1997, when economic calculations were made. Implementation of new economic values for production traits as well as for some functional traits are under consideration. Due to genetic improvement of the herd, feed and management costs increase. These costs are not the same for different milk components.

Important prerequisite for genetic improvement is genetic variation. If there was not genetic variation, all bulls would have the same genetic value. The range in genetic value between bulls depends on the genetic variation. Genetic progress is the highest in those milk components with the highest levels of genetic variation. As genetic standard deviation for Estonian Holstein fat yield is 12.6 and for protein 10.6, we will increase our emphasis on fat relative to protein, because there is more genetic variation for fat yield than for protein yield. Milk components are genetically dependent of each other. Milk carrier, fat and protein yield are positively related to each other. It means that bulls with high proofs for milk carrier will also tend to have high proofs for fat and protein yield. Those relationships have taken into account in constructing Profit Index.

$$\text{Profit Index} = 0.978\ \text{ETA}_{\text{Carrier}} + 5.051\ \text{ETA}_{\text{Fat}} + 22.48\ \text{ETA}_{\text{Protein}}$$

ETA for carrier, fat and protein are the sire’s proof (1/2 EBV) and the index value is the estimated net profit of the sire’s average daughter each year she is milking in the herd. This value can be used to obtain estimate of the EEK value of specific bull. Profit Index values of some Estonian Holstein bulls (based on data Bulitko, 2000) are given in the Table 1 and 2.

Table 1. Profit Index (PI) and SPAV (RBV for production) of Estonian Holstein bulls in IV 2000

Bull	Herdbook No.	SPAV	Profit Index (EEK/daughter lactation)	Superiority of bull	
				based on SPAV	based on PI
E Lambro ET	5842	145	1746	1	1
BB Jaco ET	5841	141	1582	2	2
Profil ET	5965	130	1186	3	3
H P Jaap	5840	129	1057	4	4
Marbel ET	5000	128	785	5	8
Dr Lutz ET	5844	122	838	6	6
Lamberg ET	5843	120	889	7	5
Nils	5706	118	817	8	7
Maldon	5748	118	730	9	10
Randu	5782	118	479	10	13
Amper	5740	118	691	11	11
Melvin	5712	116	672	12	12
Luksor	5788	113	753	13	9

Table 2. Profit Index (PI) and SPAV (RBV for production) of Estonian Holstein bulls in IV 2000 (import semen)

Bull	Herdbook No.	SPAV	Profit Index (EEK/daughter lactation)	Superiority of bull	
				based on SPAV	based on PI
Glenwood ET	62585	144	1535	1	2
Zebo	62511	141	1646	2	1
Magic ET	62814	140	1441	3	3
Metro ET	62266	131	1422	4	4
Dorado ET	65303	127	1043	5	6
Asterix ET	65690	127	1003	6	7
Magnum	65787	124	1123	7	5

2. Genetic response of milk components

The annual genetic response for individual traits and their economic value are given in Table 3 and annual improvement per year in Estonian Holstein bulls and bull dams in Table 4.

The annual genetic response in protein yield is 1.54 kg, which is about 0.15 genetic standard deviation. The annual genetic response in fat yield is 1.81 kg (0.15 genetic standard deviation) and milk carrier yield 52.6 kg.

Economic value of the response amounts 51.44 EEK per kg milk carrier, 9.14 EEK/kg fat and 34.62 EEK/kg protein, 95.2 EEK/kg in total. Assuming the Estonian Holstein population 105 800 cows, it makes the value of genetic response 10.1 million EEK per year. This value is not discounted.

Using selection index methodology, the consequences of selection following a single round selection were calculated for index including production only: milk carrier, fat and protein yield. Annual returns were calculated as 0.15 standard deviations of the aggregate genotype. This value approximates selection response in typical 4-pathway dairy cattle breeding scheme (Robertson and Rendel, 1950).

Table 3. Genetic response in individual traits and their economic value

Trait	Genetic response / year	Economic value (EEK) / unit expressed	Economic value (EEK) of the response
Milk carrier (kg)	52.6	0.978	51.44
Fat yield (kg)	1.81	5.051	9.14
Protein yield (kg)	1.54	22.480	34.62
Total			95.20

Annual improvement of 96 EEK per year has been achieved in Holstein bulls and 222 EEK in Holstein bull dams. The annual improvement 96 EEK is similar to the Robertson and Rendel (1950) expectation. It is difficult to predict future industry response to selection, however it is anticipated that genetic progress will be maintained at least 0.15 standard deviations per year.

Table 4. Annual improvement per year in Estonian Holstein bulls and bull dams

Trait	Economic value (EEK) / unit expressed	Genetic response / year		Economic value (EEK) of the response	
		bulls	bull dams	bulls	bull dams
Milk carrier (kg)	0.978	53.2	122.9	52.0	120.2
Fat yield (kg)	5.051	1.84	4.2	9.3	21.2
Protein yield (kg)	22.480	1.55	3.6	34.8	80.9
Total				96.1	222.3

Summary

Genetic and phenotypic variance-covariance matrices were constructed using parameter estimates from Estonian Holstein population. The economic values assumed for goal traits were 0.978 EEK/kg for carrier, 5.051 EEK/kg for fat and 22.48 EEK/kg for protein. Most probably these differ from the economic values at the moment as they reflect the lower milk price received by farmers for sales.

Implementation of new economic values for production traits as well as an introduction of economic values for some functional traits are currently under consideration. Using selection index methodology, the consequences of selection following a single round selection were calculated for index including production only: based on milk, fat and protein ETA-a. Annual returns were calculated as 0.15 standard deviations of the aggregate genotype. This value approximates selection response in “typical” four-pathway dairy cattle breeding schemes. Annual improvement of 96 EEK per year has been achieved in Estonian Holstein bulls and 222 EEK in Holstein bull dams. Profit Index is based on ETA-s for milk, fat and protein weighted by their assumed future economic values.

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MILK PRODUCTIVITY OF DUTCH HOLSTEIN COWS IN ESTONIA

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Already for 150 years the breeding of the Estonian Holstein cattle has been related to the Dutch breeding material. Its effect became more significant in the 1960s and 1970s, when the imported material was distributed by the use of AI method. Using of Holstein breeding material accelerated the genetic success in both breeds. Great success was achieved in Holland, where milk productivity exceeded 8,000 kg in 1998 (Dommerholt, 1998). In Estonia as well as in Holland, 9 Dutch Holstein sires were estimated by daughters. The comparison of their daughters in both countries showed a moderate advantage of the Dutch Holsteins (Siiber et al., 2000). Seven young bulls, estimated later in Estonia, were purchased from Holland in 1997. The preliminary estimation proved their high breeding value. The relative breeding value of three bulls exceeded 140 points and they belonged to the list of Interbull TOP100 (Bulitko, 2000).

27 heifers for two enterprises were purchased from Holland in 1997, and 75 heifers for one enterprise in 1998. Regarding the enterprises, the preliminary performance data of the heifers differed considerably. The data of the 1st lactation indicated that in favourable feeding conditions the Dutch Holstein cows exceeded their shedmates, whereas in average conditions the difference was insignificant (Saveli, Pulk, 2000). Within the next year the data of the 2nd and 3rd lactations were obtained. The analysis of these data is the objective of the present study.

Material and Methods

The milk productivity data of the 1st lactation of 92 cows, 2nd lactation of 77 cows and 3rd lactation of 14 cows of the Dutch Holstein breed (HHF), which was compared with the similar data of other cows (EHF) in the same shed (shedmates), were used as study material. The shedmates were the cows, which had started the same lactation in the same year. Data on 305-day lactation yield were obtained from the Agricultural Registers and Information Centre.

For statistical analysis, the mean productivity of calving years by enterprises and lactations were used, whereas statistical significance of differences were estimated by t-test analysis, by which mean standard deviations were used (s_0): milk – 900 kg, milk fat – 50 kg and 0.40%, milk protein - 40 kg and 0.30%.

Results and Discussion

The yields of milk, milk fat and milk protein of Dutch Holstein cows were higher, compared with the similar data of Estonian Holsteins during all three lactations (Table 1). In the 2nd lactation the differences were more significant, compared with the 1st lactation. This might have been caused by adaptation difficulties of the imported cows.

Table 1. Comparison of milk productivity between Dutch (HHF) and Estonian (EHF) Holstein cows

Breed	Lact.	No. cows	Milk, kg	Fat, kg	Fat, %	Protein,kg	Protein,%
HHF	1.	92	6812	286	4.20	211	3.10
EHF	1.	273	6193	265	4.28	195	3.15
			+ 619* **	**+ 21*** **	**-0.08**	**+ 16*** **	**-0.05**
HHF	2.	77	8749	360	4.11	288	3.29
EHF	2.	216	7269	314	4.32	238	3.27
			+1480* **	**+ 46*** **	**-0.21*** **	**+ 50*** **	**+0.02**
HHF	3.	14	8929	374	4.19	302	3.38
EHF	3.	23	8067	333	4.13	270	3.35
			+ 862 **	**+ 41* **	**+0.06**	**+ 32**	**+0.03**

It is somewhat surprising that the milk fat and milk protein content of Dutch Holstein cows did not exceed that of Estonian Holsteins, being occasionally even lower. Moreover, the Dutch Holstein breed has had a leader position among black-and white breeds just for the above qualities. Obviously, the nutrient and energy content of feed ration, offered in Estonia, did not guarantee the full exposition of the high genetic potential of the Dutch Holstein cows.

Major variations were observed by enterprises, as the milk productivity of Dutch Holsteins was compared with that of their shedmates (Table 2). Highly stabile difference by lactations was observed on Soone farm (1219), more significant differences were found on Maasikamäe farm, particularly in the 2nd lactation, when the Dutch Holsteins`milk yield was almost 10,000 kg and the total yield of milk fat and protein was 733 kg. The high level was observed also in the 3rd lactation, which was still lower than in the 2nd lactation. On two farms of Adavere Agro the data of the 1st lactation were virtually identical and the differences between breeds were insignificant. The 2nd lactation was prepared more carefully, also the feed ration was markedly changed.

Remarkable results were obtained in Adavere Agro shed No.2, where milk yield of Dutch Holstein cows was 9,359 kg, and that of Estonian Holsteins was 7,345 kg. Once again it was demonstrated, that balanced feed rations may guarantee high production data on each farm in Estonia.

Table 2. Comparison between imported Dutch Holsteins and their contemporaries in the same shed

Farm"	Breed	Lact.	No cows	Milk, kg	Fat, kg	Fat, %	Protein,kg	Protein,%
1075	HHF	1.	11	7924	318	4.01	250	3.15
	EHF	1.	20	6705	284	4.24	214	3.19
	+/-			**+1219****	**+34**	**-0.23***	**+36**	**-0.04***
	HHF	2.	10	9996	414	4.14	319	3.19
	EHF	2.	46	7428	311	4.19	245	3.30
	+/-			**+2568*****	**+103*****	**-0.05**	**+74*****	**-0.11**
	HHF	3.	8	9017	370	4.10	308	3.42
	EHF	3.	11	7951	336	4.26	272	3.42
	+/-			**+1086***	**+34**	**-0.16**	**+36**	**0**
1219	HHF	1.	12	7298	291	3.99	221	3.03
	EHF	1.	20	6601	268	4.06	202	3.06
	+/-			**+ 697***	**+23**	**-0.07**	**+19**	**-0.03**
	HHF	2.	12	8376	338	4.04	266	3.18
	EHF	2.	41	7724	326	4.22	248	3.21
	+/-			**+ 652***	**+ 12**	**-0.18**	**+18**	**-0.03**
	HHF	3.	6	8840	377	4.26	295	3.34
	EHF	3.	12	8182	330	4.03	268	3.28
	+/-			**+ 658**	**+ 47**	**+0.23**	**+27**	**+0.06**
718	HHF	1.	35	5809	248	4.27	175	3.01
	EHF	1.	194	5391	239	4.43	176	3.26
	+/-			**+ 418***	**+ 9**	**-0.16***	**- 1**	**-0.25*****
	HHF	2.	27	7266	304	4.18	249	3.43
	EHF	2.	77	6579	287	4.36	219	3.33
	+/-			**+ 687*****	**+ 17**	**-0.18***	**+30****	**+0.10**
40402	HHF	1.	34	6218	286	4.60	199	3.20
	EHF	1.	39	6074	270	4.45	188	3.10
	+/-			**+ 144**	**+ 16**	**+0.15**	**+ 11**	**+0.10**
	HHF	2.	30	9359	385	4.11	317	3.39
	EHF	2.	52	7345	331	4.51	240	3.27
	+/-			**+2014*****	**+54*****	**-0.40*****	**+77*****	**+0.12**

") 1075 – Maasikamäe; 1219 – Soone; 718 – Adavere Risti; 40402 – Adavere 2.

Conclusion

102 Dutch Holstein heifers were imported from Holland into three Estonian enterprises in 1997 and 1998. The comparison with other cows on the same farm

confirmed the Dutch Holsteins` better results in milk yield (+619...1480 kg), milk fat yield (+21...46 kg) and protein production (+16...50 kg). However, during two lactations their milk fat content was even lower and milk protein content did not vary. The reaction of Dutch Holsteins to the changes of feed ration after the 1st lactation was stronger.

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RELATIONSHIP BETWEEN GESTATION LENGTH AND GENETIC ORIGIN OF COW

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Introduction

One of the major problems in dairy cattle reproduction is a service period, when a lactating cow should be re-inseminated. Duration of the longer gestation period of the reproduction cycle is relatively stable . There is no need to modify the duration of the fetal period, however, the extent of gestation period is highly important in paternity establishment of offspring. It will become a serious problem, when parentage of females comprises the representatives of several breeds (heterogeneous genotype) and the cows have been inseminated with semen from the bulls of relatively alien parentage.

The pregnancy duration of the Estonian cattle breeds was studied 30 years ago. The studies carried out by O. Saveli (1970) involved 3,461 gestation periods, whereas the gestation periods that lasted less than 250 and more than 300 days were not included in the analysis. The average was 280 days, being by 1.7 days longer in case of bull calves, compared with female calves. 109 bull calves, among twins even 195, were born per 100 heifer calves. In case of twins the duration of gestation period was only 272 days.

According to O. Leesment (1939; reported by Tehver, 1971), the pregnancy duration of the Estonian Red breed cows was 282.96 days and that of the Estonian Black-and-White breed cows was 278.78 days. In case of giving birth to a bull calf, the period was by 1-2.5 days longer, and in case of twins by 6-21 days shorter.

According to K. Kurm (1961), the pregnancy duration of the Estonian Red breed cows was 283.3 days, whereas in case of a bull calf it was 284.4 days. The herd control directions (1969) considered 284+/-15 days to be a normal duration. Comparison of the above data referred to the coincidence of the data, and also to the specific features of a breed.

On the basis of the obtained results amendments were made in the pregnancy calendar to be published in a reference book, to avoid further problems in completing calving units in loose housing cattle farms.

In Canada, 52,862 three first calvings were analysed (Nadarajah et al., 1988). An average gestation period lasted for 281.3+/-6.0 days, whereas it prolonged with a cow's age and was related to calf's and cow's size. At 1st calving the gestation period was shorter, and about a day shorter in case of bull calf's birth. In case of giving birth to a medium-sized or a big calf, the gestation periods were by 1.7 and 3.6 days longer, respectively. Comparing the influence of a cow's sire and sire of foetus, the latter was more important. According to sire of foetus and sire of cow, h^2 was 0.33 and 0.06, respectively.

The aim of the present study was to investigate the gestation duration of cows on the basis of breed combinations of their parents. For this purpose the genetically heterogenous herds were selected, where A.I. bulls of different breeds and from different countries have been used during many years.

Material and Methods

A dataset was based on the milk recording data of cattle from AS Melmilk, Põlva POÜ, and Tartu Agro. Over the years, in two herds the breeding of the Estonian Red breed has been substituted for the Estonian Holstein breed, and semen of Dutch Red-and-White bulls has been extensively used. In AS Tartu Agro two breeds are being bred. The gestation duration of the cows having been in herd in the control year of 1999, was analysed, whereas the periods less than 260 and more than 300 days were not included as doubtful. Sex and number of calves, including multiple calves, were considered. Origin by breed was taken into consideration on the basis of the insemination code of cow's sire and sire of foetus.

The material was statistically processed by Tanel Kaart, M Sc Math. Variance analysis was used to study the effect of the factors "farm", "mother's breed", and "calf's breed" on the gestation duration. The analysis was based on the following model:

$y_{ijke} = \mu+M_i+T_j+S_k+e_{ijke}$, where

y_{ijke} - gestation duration of j breed cow from farm i,having given birth to calf of sex k;

μ - average gestation duration;

M_i – effect of farm i (Melmilk, Põlva, Tartu);

T_j – effect of breed j (EMK, EPK);

S_k –effect of calf's sex k (male, female, multiple);

e_{ijke} – random error.

Means of least-squares of gestation duration were computed according to calf's sex, whereas the effect of a breed and a farm was eliminated, and then compared to find out statistic differences.

Results and Discussion

Effect of a cow's breed on pregnancy duration was studied on the basis of 5,738 gestation periods, whereas the average length was 279.7 days (Table 1). The difference between breeds was 2.4 days, because the gestation period of the Estonian Red cows was longer. These data fully coincide with the data published in 1970.

Table 1. Gestation duration of two breeds of cattle according to farm and calf's sex

Farm	Estonian Red			Estonian Holstein			Mean
	male	female	multiple	male	female	multiple	
Melmilk	531	510	41				1082
	279.9	278.7	273.7				279.1
	5.8	5.7	6.6				5.9
Põlva	33	24	3	837	884	53	1834
	295.3	294.4	297.0	277.1	277.6	275.1	277.9
	3.9	3.8	5.2	6.7	6.4	5.3	7.2
Tartu	796	765	62	640	539	20	2822
	282.3	281.2	279.8	280.3	280.2	277.1	281.0
	6.6	6.6	8.6	73	7.5	8.7	7.1
Average	2765			2973			5738
	280.9			278.5			279.7
	6.8			7.1			7.1

Big variation was observed regarding the farms. In Melmilk herd, the extensive use of Red-and-White Holstein semen may be the cause of shorter gestation period of cows. Unexpectedly long gestation period was observed in Põlva herd, although the number of cows was quite small. The gestation duration of Estonian Holsteins occurred to be ordinary in Põlva herd, but more than two days longer on the Tartu farm.

The male calves of the Estonian Red breed were born a full day later than the female calves, whereas in the Estonian Holstein breed no differences were observed. Multiple calves were born 2 to 6 days earlier than single ones.

After elimination of the effect of farm and breed, the least-square means indicated the decrease in the difference between the gestation duration in case of male calves (279.6 days) and female calves (279.1 days). The embryonal period of multiple calves was approximately 3 days shorter (276.4 days, $P<0.001$).

On the basis of these analyses, it appears that during the last 30 years the gestation duration of Estonian cattle breeds has not changed, but farm as a factor has a higher effect than expected. In milk recording, this may give a basis for a groundlessly high number of calves with doubtful sires or without sires at all. Obviously, a further analysis by farms is needed, where the gestation duration is the number of days calculated from the calf's birth date to the impregnation. Based on this, a calf's paternity will be established.

Furthermore, the effect of breed origin of both foetal sire and cow's sire on duration of gestation were studied. The bulls with uncertain origin were marked with "0" code. The analysis of gestation duration of the Estonian Red breed cows indicated similar variation in relation to both fetal ancestors (Table 2).

Table 2. Gestation duration of Estonian Red breed cows according to the breed origin of cow's sire and fetal sire

Cows	Origin fetals' sire								Total
sire	0	EPK	RDM	ANG	SRB	RHF	EHF	HHF	
0		2	7		1		2	4	16
		278.5	276.0		289.0		284.5	281.0	279.4
EPK	69	324	766	78	177	270	84	153	1926
	277.7	279.9	280.7	279.8	279.2	282.7	282.8	281.3	280.7
RDM	24	44	28	55	6	150	18	38	363
	277.8	280.6	283.6	278.3	282.7	283.4	281.2	279.7	281.4
SRB	2	22	39	10	10	1	12	10	106
	279.0	275.3	277.7	276.2	274.5	284.0	285.8	284.4	278.4
AP		18	32	9	8		15	11	93
		284.8	282.8	284.6	278.8		284.1	287.2	283.7
RHF	8	37	115	13	30	37	6	15	261
	279.1	281.7	281.5	283.9	278.8	283.8	290.0	286.5	282.0
Σn	103	447	987	165	232	458	137	231	2765
x	277.9	280.1	280.8	279.7	279.1	283.0	283.3	281.8	280.9

*) EPK – Estonian Red; RDM – Danish Red; ANG – Angeln; SRB – Swedish Red-and-White; RHF –Red Holstein; AP – Brown Swiss; EHF – Estonian Holstein; HHF – Dutch Holstein.

When fetal sire or cow's sire was Swedish Red-and-White bull (SRB), the gestation period was shorter by 279.1 and 278.4 days, respectively. The fetal period was longer, when fetal sires were Red- (RHF) or Black-and-White (EHF; HHF) Holsteins. The gestation period was longer, when cow's sires were Brown Swiss (AP) or Red-and-White Holstein (RHF) bulls. However, when the effect of Swiss breed was considerably logical, then that of Dutch Holsteins was less expected. As cow's sires, however, they had similar effect on the gestation duration of Holstein cows (Table 3).

The same effect was observed in case of Canadian Holsteins. Relatively long fetal period was observed in the offspring of American Holsteins. Unfortunately, only 3 gestation periods were analysed, when beef bulls were used for insemination (292.3 days).

Table 3. Gestation duration of the Estonian Holstein breed cows according to breed origin of cow's sire and fetal sire

Cow's sire from	Fetal sire from				Mean
	Estonia	Holland	Germany	USA	
0	42	5		1	48
	281.0	277.6		290.0	280.8
Estonia	1612	477	144	57	2291
	278.6	274.5	278.1	279.8	277.7
Holland	282	76	130	13	501
	282.3	279.9	282.2	285.5	282.0
Canada	4				4
	288.8				288.8
Germany	50	38	6	1	95
	275.0	275.8	276.0	277.0	275.4
USA	17	13	4		34
	278.1	279.5	276.8		278.4
Average	2007	609	284	72	2973
	279.1	275.3	279.9	281.0	278.5

Taking into consideration the data found in the special literature as well, it can be stated that the gestation period of dairy cows, inseminated by beef bulls, prolongs by 7 to 10 days.

Conclusion

The gestation duration of cows has not changed during the last 30 years. The average gestation duration of the Estonian Red breed was 280.9 days, and that of the Estonian Holstein breed was 278.5 days. The embryonic development of a bull calf was almost a full day longer, and multiple calves were born by 2 to 6 days earlier. The breed origin of fetal sire and cow's sire affected the duration of period.

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MILKABILITY AND TEMPERAMENT IN LATVIAN DAIRY BREED

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Introduction

Dairy farming in Latvia is accepted as the prior branch of agriculture. Therefore milk production must be competitive and profitable. The cattle breeding has great importance for it. For daity cows the main breeding traits are cows milk produktivity and body conformation. But there are the additional traits as animal reproduction, health and another functional traits that have great importance,too.

As mentioned by Groen (1998) functional traits in cattle breeding have economical weight. They impress animal genetical level and therefore have influence on cows production and on profit obtaining from milk production. These functional traits have direct impression on animals health, too.

Groen (1997) cows functional traits divides in some different groups and one separate group with such traits,is that determine cows suitability for milk producing. These traits are milkability and temperament. Vagi (2000) points to cows milkability as a trait that determine cows ability to mechanaized milking. Cows milkability is directly connected with udder health, too. In the world's cattle breeding is widely used system where cows milkability is scored with helping points. Therefore in Latvia"Instruction for cows breeding value estimation " demands the milkability and temperament to be scored with points system (Ciltsdarba normatīvie dokumenti,1999).

Material and Methods

Our aim was to investigate the mentioned selection traits in Latvian Brown dairy breed in order to work out methods for breeding value indexes calculation to determine milkability and temperament. In our investigations we cleared up what genetic and ungenetic factors are impressing these functional traits.

We utilized herds from "Sigulda" with 258 dairy cows and "Vidzemes Putniņi" with 339 cows in investgations. These cows had various age and were daughters from 124 sires with various bloodness of some red and Swiss dairy breeds.

In Latvia functioning "Instruction for estimation daity cows breeding value" defines that these functional traits must be scored by farmers themselves in points system from 1 to 9. Milkability was determined visually in the time of cows milking after the duration of milking time and milkyield. Points 1 means, that milking is slow, 5 – middle and 9 – fast. The cows temperament was scored after their behaviour. Point 1 means that cow is very nervous, 5- quiet and 9 – phlegmatic.

Obtained data were processed statistically calculated data probability after Students criterion and computed correlations between some traits.

Results

The functional traits data of both farms are presented in table 1.

Milkability in "Sigulda" is scored by 5.84 points. That is near the needing optimum – 6 points. Between some herds and some herds and farm average the differences were statistically reliable (P>0.95-0.999).

Table 1.Estimation functional traits of dairy cows

Herd	n	Milk ability	Temperament
Farm "Sigulda"			
Pelītes 1	39	6.62 ± 0.21	4.33 ± 0.21
Pelītes 2	36	6.58 ± 0.27	4.94 ± 0.21
Jūdaži	49	5.10 ± 0.21	4.51 ± 0.14
Daudas 1	28	5.78 ± 0.28	4.64 ± 0.15
Daudas 2	30	5.33 ± 0.26	4.66 ± 0.14
Kundziņi 1	37	6.16 ± 0.25	4.46 ± 0.14
Kundziņi 2	39	6.03 ± 0.26	4.77 ± 0.21
Ø	258	5.84 ± 0.10	4.56 ± 0.06
Farm "Vidzemes Putniņi"			
1	98	5.29 ± 0.17	5.08 ± 0.19
2	112	5.88 ± 0.14	5.43 ± 0.20
3	129	5.02 ± 0.14	5.26 ± 0.12
Ø	339	5.39 ± 0.09	5.27 ± 0.09

Milkability in "Vidzemes Putniņi" was estimated a little lower – 5.39 points. The difference between the second and the third herd in this trait is reliable d= 0.86 (P>0.999).

Cows temperament in "Vidzemes Putniņi" was estimated a little higher than in "Sigulda" 5.27 against 4.56. Differences in this trait between separate herds und farms average are hot statistically reliable.

By analysing estimated values of functional traits separate sires in different herds established that there are statistically reliable differences. It means, that traits are impressed not only by animal genetic level, but by cattle-breeder subjectivity, too.

In the table 2 are presented estimated values functional traits in connection with cows age in lactations.

In both farms tendency is established that younger cows had better milkability than olders ones. It might be explained that the younger cows have genetically higher sires than olders cows have.

In both farms milkability of first calving cows are higher than average data (d=0.50-0.50; P>0.99).

Differences in milkability between first lactation cows and cows of 6th and 7th lactation in “Vidzemes Putniņi” are d =1,13 and 1,88 (P>0,99-0,999). The same tendency is in farm “Sigulda”.

Table 2. Estimation functional traits of dairy cows in lactations

Lactation	n	Milkability	Temperament
"Vidzemes Putniņi"			
1	63	5.88± 0.17	5.00 ±0.22
2	75	5.48± 0.20	5.43 ±0.22
3	36	5.55± 0.26	4.94± 0.32
4	69	5.43± 0.18	4.97± 0.21
5	32	5.19± 0.26	5.56± 0.30
6	24	4.75± 0.35	5.58± 0.22
7	16	4.00 ±0.45	5.75± 0.40
Ø	339	5.38 ±0.09	5.26± 0.10
"Sigulda"			
1	79	6.40± 0.15	4.43 ±0.12
2	67	6.01± 0.19	4.73 ±0.13
3	60	5.81 ±0.21	4.70± 0.12
4	21	5.14± 0.45	4.50± 0.21
5	13	4.69 ±0.46	4.69 ±0.29
6	9	5.33 ±0.53	4.55± 0.29
7	3	5.00 ±0.00	5.00 ±0.00
Ø	258	5.84 ±0.10	4.56 ±0.06

The breeding value of cows temperament have opposite tendency in both farms. Older cows become quiet and estimated values in points are higher. There are not probable differences in estimated values between various lactation cows.

In the table 3 are shown estimated breeding values of functional traits on concrete sire daughters. It is genetic factor. There are shown only those sires having 10 daughters in estimation. We established that milkability between various sires varies more than temperament. There were reliable differences in estimated values of both functional traits between some concrete sires.

We have analysed the sires breed and bloodness. Every sire had bloodness of 2-3 various dairy breeds. It is established that daughters from sires with Swiss breed blood are more nervous.

Table 3.Estimation functional traits of sires daughters

Sire	n	Milkability	Temperament
"Sigulda"			
Rosens Bits LB 30634	20	5.45 ± 0.37	4.85 ± 0.18
Bartons Disaks LB 30967	15	4.53 ± 0.89	5.73 ± 0.57
Freds Burtons LB 31129	14	4.64 ± 0.62	5.29 ± 0.40
Žaks Toppers LB 31035	13	6.92 ± 0.23	4.62 ± 0.28
Fantoms Bits LB 31126	11	2.91 ± 0.67	6.27 ± 0.56
Duburs Toppers LB 31061	11	5.54 ± 0.28	4.09 ± 0.32
Žigalo Delegāts LB 30930	10	4.00 ± 0.32	4.80 ± 0.39
Average	258	5.84 ± 0.10	4.56 ± 0.06
"Vidzemes Putniņi"			
Rings Delegāts LB 30634	33	5.12 ± 0.25	5.18 ± 0.28
Šalfejs ReimaLB 29616	31	5.45 ± 0.26	4.61 ± 0.33
Brencis Delegāts LB 31011	22	6.36 ± 0.28	5.73 ± 0.34
Jansons Pučs LB 31115	17	5.47 ± 0.40	4.76 ± 0.45
Meteors Hanovers LB 31181	14	6.00 ± 0.27	4.71 ± 0.19
Rosens Bits LB 30634	14	5.14 ± 0.44	5.43 ± 0.43
Freds Burtons LB31129	13	4.64 ± 0.63	4.23 ± 0.66
Liedis Rudme LB 26072	11	5.54 ± 0.47	4.64 ± 0.70
Vīksnis Odins LB 28580	11	6.00 ± 0.37	5.20 ± 0.70
Average	339	5.39 ± 0.09	5.27 ± 0.09

Daughters who had born from Sweeden Red and Angler dairy breed characterized with good milkability, but more nervous.

The best milkability had cows with bloodness from 3 and 4 red breeds.

But the main influence on inheritance of functional traits as milkability and temperament for dairy cows is the concrete sire, but not his breed.

If to clear up the connections between cows milkability and their temperament we calculated the correlation coefficients. In farm "Sigulda" it was r= -0.116, but "Vidzemes Putniņi" r= 0.083. They were not statistical reliable. There are not reliable correlation between milkyield and milkability (r= 0.056) and between milkyield and temperament (r= 0.144).

Conclusion

- Cows milkability and temperament are impressed by genetic factors: her sire, his breed and bloodness.
- and ungenetic factors:cows age, herd and farm;
- First calving cows have reliable better milkability than older cows.
- By increasing cows age they become quieter;
- The are not reliable statistical connections between cows milkability and their temperament, between milkyield and milkability and milkyield and temperament.

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ON CULLING OF DAIRY HERD AND RAISING OF REPLACEMENT CATTLE

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Abstract

Investigation of dairy herd culling and reproduction problems in herds of Estonian 8 joint-stock companies was carried out. 9469 heifers and cows of the Estonian Holstein (EHF) and the Estonian Red (ER) breed were tested. The data analysis showed that the culling of cows from studied herds was up to 1/3. The three main culling reasons were: udder diseases, infertility and feet diseases. The average age of cows in herds was 4 years and 9 months; the average age at first calving of cows was 29 months. Therefore the productive age of cows was less than 3 years (on average 2.5 lactations). The average daily gain of heifers was 601 g, which correlated with body weight ($r=0.6755$; $P<0.0001$) and age at first calving ($r=-0.7430$; $P<0.0001$). The productivity of cows was investigated and the correlation with body weight ($r=0.4724$; $P<0.0001$) and age at first calving ($r=-0.1421$; $P<0.001$) as well as daily gain of heifers ($r=0.4147$; $P<0.0001$) were observed. The investigating the effect of growth intensity on the age at first calving and the milk productivity of cows showed, that together with increasig the growth rate of heifers, the age at first calving decreases from 34 months to 25 months. Growth intensity of replacement (young) cattle was accompanied by increase in the milk productivity of cows in all 3 lactations.

Key words: culling from herds and productive age of cows; dairy herd reproduction and growth intensity of heifers; body weight and age at first calving

Introduction

Both, breeding as well as the economic aspects are important in dairy herd reproduction, because selection effect and profit from milk production are depending on them (Heinrich, 1993). In the countries with developed cattle breeding, the economical using age (productive age) of cows is shortened due to the increase in their producing capacity (Powell, 1985). Similar tendency is observed in Estonia as well. Moreover, we have problems with rather advanced age at first calving. Therefore the dairy herd reproduction problems need attention. The quantitative side of dairy herd reproduction depends greatly on culling of cows, and qualitative side depends on raising of replacement cattle.

The body weight, condition and age at first insemination are related to growth intensity and development of heifers. All these factors affect the milk productivity of future cows. There are different points of view about raising replacement cattle. Some authors suggest, that heifers must be inseminated at the age of one year to get their first calf at the age of 21 months (Powell, 1985; Quigley, 1997). Other authors find, that heifers will reach sexual maturity not before 15…17 months and their suitable age for first calving will be 24…26 months (Lin et al., 1998). On the other hand, it is important not to be late with impregnation, as after reaching sexual maturity the fertility will decrease according to the age of heifers. This cause the increasing the number of repeat inseminations, which again increases the age at first calving (Lin et al., 1998).

There are different standpoints about age at first calving of heifers and future milk productivity of cows. Heinrich and Vazques-Anon (1993) reported that yong first calvers would produce less milk in the future than older first calvers. Others have come to the conclusion, that older calvers have little higher milk productivity, whereas their lifetime milk-yield will be lower in comparison with younger first calvers. In addition, the rearing expenses of older first calvers increased significantly, compared to young calvers (Gardner et al., 1988).

The aim of the present research was to study the following:

a) number of culled cows from herds and reasons for culling
b) influence of growth intensity of heifers on the weight and age at first calving as well as on the future milk productivity of cows

Material and Methods

Heifers and cows of the Estonian Holstein (EHF) and the Estonian Red (ER) breed were tested. Total number of investigated animals was 9469 (EHF – 8324 and ER – 1145). The animals used in experiment were chosen from the herds of 8 joint-stock companies of Estonia. The data were obtained from the Agricultural Registers and Information Centre. Statistical data of the farms in 1997…1999 were analysed (number of culled cows and culling reasons; body weight and age at first calving; 305 day milk productivity of cows).

The test-animals were separated in to 5 groups to study the effect of growth intensity of heifers on the age at first calving and future milk productivity of cows. The test-groups were formed by daily gain as follows: up to 500 g/day, 500–600 g/day, 600–700 g/day, 700–800 g/day and over 800 g/day.

The data were analysed using the statistical computer program SAS.

Results and Discussion

The analysis of culling data indicated, that in year up to 1/3 of cows a year were culled from herd (1997 – 29.8%; 1998 – 30.65; 1999 – 38.7%9).

The reasons for culling in 1999 are presented on the diagram (see Figure 1). The data showed that the main culling reasons were: udder diseases (24.5% from culled cows), infertility (18.7% respectively) and feet diseases 18.5% respectively). Low productivity of cows (culling for breeding purposes) was the reasons for culling only the 5.5% of culled cows. The high culling percentage of cows from herds by reason of diseases and barrenness referred to several shortcomings in the dairy cattle management (feeding and keeping; milking technique and hygiene; veterinary service).

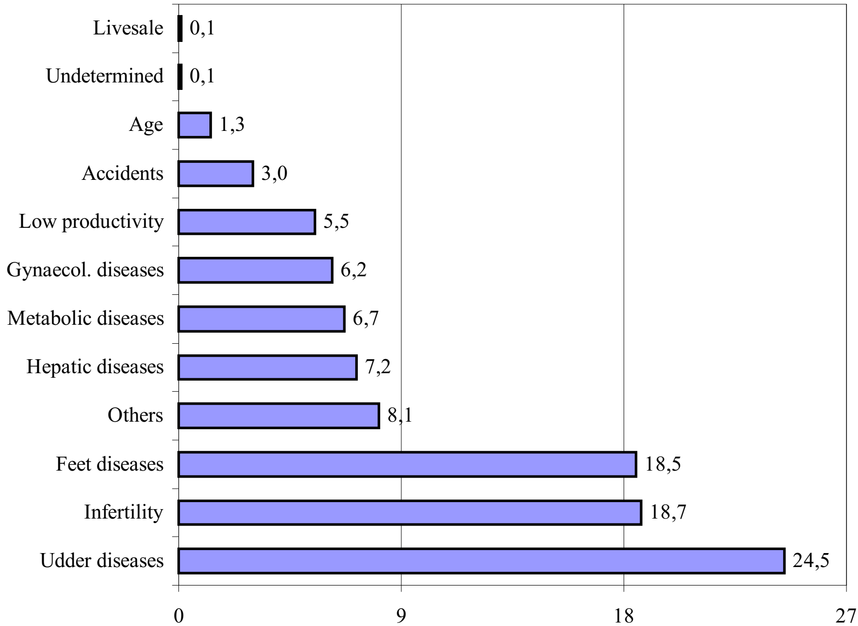

Figure 1. Culling reasons and percentage of culled cows from herds

The data showed, that the number of first calvings in 1997 and 1998 was greater than that of culled cows (+230 and +141), therefore the herd reproduction (turnover) was 2.6% and 1.5% respectively. However, in 1999 the number of first calvings was 3007 and culling of that was 3434, which showed the decrease in the number of cows (-427) in herds.

The average age of cows in studied herds was 4 years and 9 months and the average age at first calving was 29 months. Thus, the average productive age of cows was less than 3 years (2.5 lactations). Due to the early culling of cows, they did not reach to their best productive age – from 3^{rd} to 5^{th} lactation.

For example, if there were 9469 1^{st} lactation cows and 5270 2^{nd} lactation cows, then there were only 2225 3^{rd} lactation cows in the studied herds.

The data analyses indicated, that average age at first calving in studied herds was 29 months (EHF – 28.5 months, ER – 31.4 months). The average body weight at first calving was 555 kg (EHF – 559 kg, ER – 521 kg). The average daily gain of heifers was 601 g, which correlated with body weight at first calving (r=0.6775; P<0.0001) and age at first calving (r-0.7430; P<0.0001). The lactation productivity of cows was investigated and the correlation with weight at first calving (r=0.4724; P<0.0001), age at first calving (r=-0.1421; P<0.001) and daily gain of heifers (r=0.4147; P<0.0001) were observed.

Investigation of the effect of growth intensity on the age at first calving and the milk productivity of cows in 3 lactations was carried out (see Figure 2). The data analyses of both breeds demostrated that with increasing the growth intensity of heifers, the age at first calving decreases from 34 months to 25 months. In case of high growth intensity of heifers (from till 500 g/day to more 800 g/day), the 305 day milk productivity of cows increased from 4676 kg to 6256 kg in the 1st lactation, from 5324 kg to 7191 kg in the 2nd lactation and from 5390 kg to 7385 kg in the 3rd lactation.

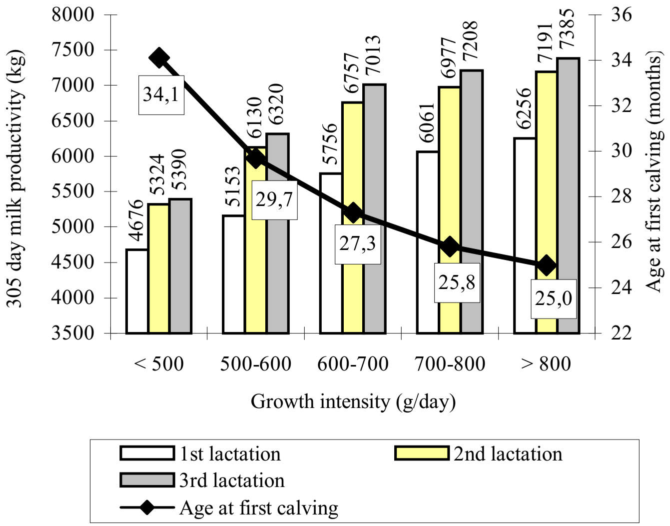

Figure 2. Age at first calving of heifers and milk productivity of cows

According to the results of previous studies (Suurmaa et al., 2000) and by the data found in the literature (Capuco et al., 1995), the high growth rate of heifers (over 800 g/day) in the rearing period may cause the decrease in milk productivity of cows in the future (fattening of mammary tissue).

Conclusions

- In case of the high age at first calving and too short period of cows in the herds, their productive age was less than 3 years, which is is not economical – high costs of raising and low profit from milk production
- Due to the high culling percentage from herds by reasons of diseases and barrenness, the dairy cattle management must be improved – feeding and keeping; milking technique and hygiene; veterinary service. It is possible to prolong the productive age of cows.
- The optimum growth intensity of heifers would be 700…800 g/day, age at first calving 24…26 months and body weight 545…565 kg. The first gestation (unigravida) must take place at the age of 15...17 months, at the body weight of 355…375 kg respectively.
- By the results of previous studies and the data fond in the literature, the high growth intensity of heifers (over 800 g/day) in the rearing period may cause the decrease in milk productivity of cows in the future.

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ANALYSIS ON COW MILK PRODUCTION AND QUALITY ACCORDING TO SOMATIC CELLS COUNT IN BLACK-AND-WHITE CATTLE HERD

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Introduction

Every productive diary farm seeks for the lowest cost price of production and the biggest profits. One of the major problems in diary farms at the moment is the spreading of cow disease mastitis which directly affects the cost price of the production with the decrease in productivity and increase in expenses spent on veterinary medicaments, reduction in carcass quality, and early rejection of cows [1,3]. Economical loss caused due to the decrease in milk production in the case of mastitis comprise 50-55% from the total income loss, when 20-22% are attributed to treatment expenses, 30-35% of the expenses are arisen from the rejection of cows [6]. Considering all the non-genetic factors the biggest influence of farms was found on the number of somatic cells count in milk. In case of unbalanced feeding and poor hygiene the risk for cows to be ill with mastitis increases [5]. Genetic correlation between the frequency of falling ill with mastitis and the number of somatic cells count in the herds was established in the tests [2]. Therefore, when improving the quality of cow milk according to somatic cells count, it is important to establish the influence of different farms on the somatic cells count in milk.

Material and Methods

The research was carried out in the Laboratory of Animal Breeding Value Estimation and Biometry using LINUX operating system, SQL database management system and 'R' statistical package.

The research was based on 1996-1999 data of productivity control and recording of Black-and-White cows for 3 lactations in 9 Lithuanian regions (the total number of records is 29332). The data were taken from State Laboratory 'Pieno tyrimai' and Public enterprise 'Rural Business Development and Information Centre'. Diary farms were grouped according to the number of cows, owner and farm type.

Results and Discussion.

According to the data of Food and Veterinary Service, small diary farms prevail in Lithuania at present: 97.7 % milk producers have 1-5 cows, i.e. 81.7% from the total number of cows. An average herd in Lithuania consists of 2 cows. In the conditions that exist in a small farm it is hard to apply massive selection means in order to improve herds as well as the latest milk production technologies used in the production of high quality milk. The quality of milk depends on the healthiness of cows, which is determined by genetic factors, feeding, keeping and care conditions.

Table 1. Farms distribution according to the number of cows in Lithuania (at 01.11.00)

No. of cows in a herd	*Farms*		*Cows*	
	Number	*%*	*Number*	*%*
1 – 5	218728	97.72	380016	81.69
6 – 10	4095	1.83	28529	6.13
11 – 20	567	0.25	7603	1.63
21 – 50	177	0.08	5405	1.16
51 – 100	88	0.04	6393	1.38
101 – 150	58	0.03	7305	1.57
151 >	105	0.05	29946	6.44
Total	223818	100	465197	100

Milk production and quality traits dependency on the size of herd is illustrated in table 2 and figure 1.

Table 2. The herd size influence on cows milk production and quality traits.

Class	Herd size	No. of farms	No. of records	Somatic cells count th/ ml $\bar{x}$ / σ	Milk yield kg $\bar{x}$ / σ	Milk fat % $\bar{x}$ / σ	Milk protein % $\bar{x}$ / σ
1	0-5	644	2389	293.9	14.7	4.35	3.30
				567.9	5.01	0.95	0.46
2	6-10	629	4822	326.7	14.4	4.39	3.29
				662.4	4.86	0.97	0.44
3	11-20	394	5547	314.8	14.3	4.34	3.28
				626.4	5.06	0.95	0.45
4	21-50	105	2948	329.5	14.4	4.42	3.32
				627.5	5.16	1.02	0.48
5	51-100	12	905	396.5	12.8	4.39	3.35
				792.6	6.13	1.04	0.47
6	101-200	8	1303	425.1	11.0	4.26	3.28
				735.9	4.55	0.93	0.47
7	201>…	21	11418	356.1	11.5	4.40	3.21
				667.6	5.15	0.97	0.43
Total		1813	29332	340.0	13.1	4.38	3.26
				655.6	5.29	0.97	0.45

From the provided data we can conclude that average cow milk yield per day regarding the size of herd was ranging from 14.7+/-0.1kg in small herds, and up to 11.0 +/- 0.1kg in bigger farms (P<0.001). The size of herd doesn't have any influence on milk fat and protein. Milk yield underwent only a slight change and an average number of somatic cells count in milk dropped to its lowest level (293.9+/-116 th/ml) in farms of 1-5 cows while the biggest number (425.1-/+20.4 th/ml) was found in a 101-200 cows farm (P<0.001). The factor of high milk quality according to the somatic cells count in small herds is explained by better individual care provided for cows.

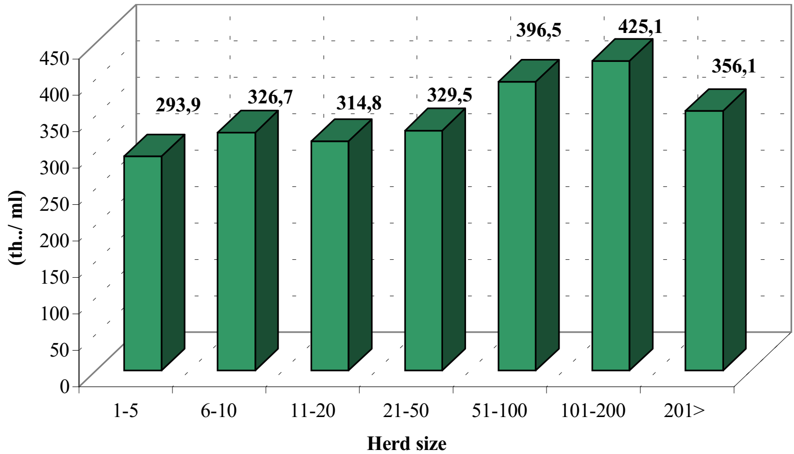

Figure 1. Average change in the number of somatic cells count according to the size of farm

Phenotypic correlation coefficients between herd size and milk yield indicate a negative relation (r = -0.26, P<0.01), and a slight positive correlation with milk fat percentage (r = +0.01, P<0.05). With milk protein percentage – a slightly negative relation (r = -0.07, P<0.05). Upon the increasing of the number of cows in the herd, the number of somatic cells count in milk had a tendency to increase as well.

The number of somatic cells count in milk and milk production traits in private farms and companies are demonstrated in table 3 which illustrates that average cow milk yield per day was 3.1kg more in communities than in companies (P<0.001), while the average number of somatic cells count was higher in companies (364.8±5.9th/ ml) than in communities (319.4±5.0 th./ ml); P<0.001.

Table 3. Traits of cow milk production and quality in companies and communities.

Farms	Number of cows	Somatic cells count th/ ml $\bar{x}$ / σ	*Milk yield kg* $\bar{x}$ / σ	Milk fat % $\bar{x}$ / σ	Milk protein % $\bar{x}$ / σ
Private dairy farms	16024	319.4	14.5	4.37	3.30
		634.4	5.05	0.97	0.45
Companies	13308	364.8	11.4	4.39	3.22
		679.5	5.08	0.97	0.44

The distribution of farms into communities and companies did not produce any considerable influence on milk fat and protein qualities.

Table 4. Traits of cow milk production and quality in breeding and production herds.

Farm type	Number of cows	Somatic cells count th/ ml $\bar{x}$ / σ	**Milk yield kg** $\bar{x}$ / σ	Milk fat % $\bar{x}$ / σ	Milk protein % $\bar{x}$ / σ
Breeding herds	4479	333.9	14.3	4.64	3.19
		640.9	5.29	1.00	0.42
Production herds	24853	340.1	12.8	4.33	3.27
		658.3	5.26	0.96	0.45

It is obvious from the data provided in table 4 that after grouping farms into breeding and production herds, only slight differences in indices of milk production and quality are noticed. In breeding herds an average milk quantity per day was 1.5 kg more than in production herds, while milk fatness was 0.31 % more in breeding herds than in production herds. There was only a slight difference in the average number of somatic cells count in those herds.

Conclusions.

1. In Lithuania somatic cells count in the milk of Black-and-White cattle population had a tendency to increase (r= +0.04) with the increasing of cow number in herd. This number was the lowest in small farms of 1-5 cows (293.9 th/ ml) and it was the highest in farms of 101-200 cows (425.1 th./ ml). The explanation for this is found in better individual care provided to cows.

2) An average number of somatic cells count in milk was 45,4 th/ ml more in companies than in private dairy farms (P<0.001).

3) Classification of farms on breeding herds and production herds did not produced any considerable influence on the calculated traits.

Summary.

The largest influence of farm(of all non-genetic factors) on somatic cells count in milk was found. There was established influence of dairy farm for somatic cells count in milk by the grouping of data according to number of cows in dairy farm, keeper and type of dairy farms. The smallest average somatic cells count in milk was established in a small dairy farms (1-5 cows) – 293.9 th/ ml, and the largest - of dairy farms (101-200 cows) – 425.1 th/ ml. In join-stock companies was found larger average somatic cells count in milk than in private dairy farms. Grouping of farms to breeding and productive types had not noticeable influence on calculate milk traits.

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THE LEANNESS OF PIGS RAISED IN LITHUANIA

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Introduction

Lean meat content in pigs is dependent on numerous factors. Breed is one of them [1, 3, 8]. Different pig breeds have different fat and lean tissue deposition peculiarities at different periods of their growth [5]. Control slaughtering of pigs is the most accurate method for evaluation of the carcass traits of pigs. More intense selection for higher lean meat content stipulates phenotypic evaluation of carcass traits on live pigs at test stations and breeding centres by ultrasonic measurements alongside with control slaughtering of pigs. The ultrasonic apparatus *Piglog 105* has been introduced for measurements of backfat thickness and determination of the meat percentage [2, 6-10]. Since 1996, breeding progeny in the breeding centres of Lithuanian has been selected by *Piglog 105* measurements [3, 4]. High (r=0.76 and 0.86) and statistically significant (P<0.01) correlation coefficients between backfat thickness and lean meat content determined by *Piglog 105* and control slaughtering indicate the prospects of phenotypic evaluation of leanness in pig selection [3]. On a 100-point system applied in Lithuania, the score for leanness can amount up to 30 points.

The objectives of the present study were, first, to compare the meat percentage data for purebreds and crossbreds obtained by *Piglog 105* and, second, to study the intensity of subcutaneous fat (backfat) and lean tissue deposition in some of the pig breeds raised in Lithuania.

Materials and Methods

The study was carried out in 2000. The analysis of the ultrasonically measured meat percentage data for purebred Lithuanian White (LW), bacon-type Lithuanian White (LW-B1), meat-type Lithuanian White (LW-M1), Swedish Yorkshire (SY), Danish Yorkshire (DY), German Large White (GLW), German Landrace (GL), Finnish Landrace (FL), Norwegian Landrace (NL), Danish Landrace (DL), Pietrain (P), Hampshire (H) and Duroc (D) pigs as well as for the crossbreds of different breed combinations has been carried out on the basis of the preliminary data supplied by the state pig breeding station by October 1. From January to October 2000, 4372 purebred and 2867 crossbred pigs were evaluated in the breeding centres of the country, where breeding progeny was evaluated for the lean meat content at 85-110 kg liveweight.

At the control fattening performance test station, purebred Lithuanian White (n=16), meat-type Lithuanian White (n=7), Swedish Yorkshire (n=15) and Norwegian Landrace (n=11) pigs were used to determine the formation intensity of subcutaneous fat and lean tissue using the ultrasonic apparatus *Piglog 105*. Feeding and housing conditions were the same for all groups of pigs. Backfat thickness was measured for pigs of 30 to 80 kg weight, and from 80 kg to slaughter weight determination of the meat percentage was added.

Backfat thickness (mm) was measured on live pigs with *Piglog 105* at two points [7]: 1) at the last rib and 7 cm sidewards from the middle of the dorsal line (FAT-1); 2) 10 cm from the last rib towards the cranial part and 7 cm sidewards from the middle of the dorsal line (FAT-2). *Piglog 105* estimates the meat percentage according to the in-coded formula. The data have been processed biometrically.

Results and Discussion

Ultrasonic measurements with *Piglog 105* indicated (Fig. 1) that in the breeding centres of the country the average meat percentage of purebred Lithuanian White pigs was 50.8%, German Large White 52.3%, bacon-type (LW-B1) and meat-type (LW-M1) Lithuanian White, respectively, 52.6 and 52.9%, German Landrace 54.4%, Finnish Landrace, Hampshire and Swedish Yorkshire 56.1-56.2%, Danish Yorkshire 57.1%, Danish Landrace and Duroc both 58.1, Pietrain 59.5% and Norwegian Landrace 59.9%.

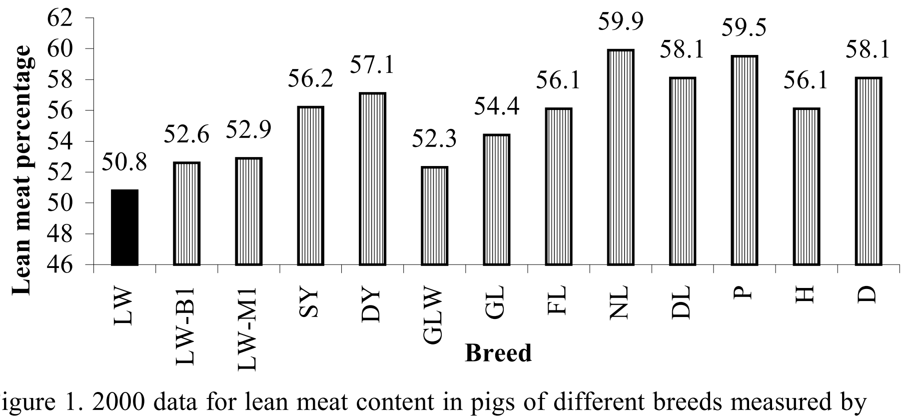

Figure 1. 2000 data for lean meat content in pigs of different breeds measured by *Piglog 105*

The crossbred pigs produced by crossing Lithuanian White pigs with boars of the imported breeds (Fig. 2) had by 0.8-4.1% higher lean meat content ($P < 0.05$-0.001) compared with purebred Lithuanian Whites. The German Landrace and Swedish Yorkshire breeds had the lowest influence on the meat percentage of crossbreds, respectively 51.6 and 51.7%, while Norwegian Landrace (54.9%), Duroc (54.4%) and Pietrain (54.3%) breeds had the highest influence. Crossbreds in other group were intermediate (52.6-53.8%) according to this indicator.

Crossbred boars suitable for three- or four way commercial crossbreeding are also prepared by the breeding centres that raise the imported breeds.

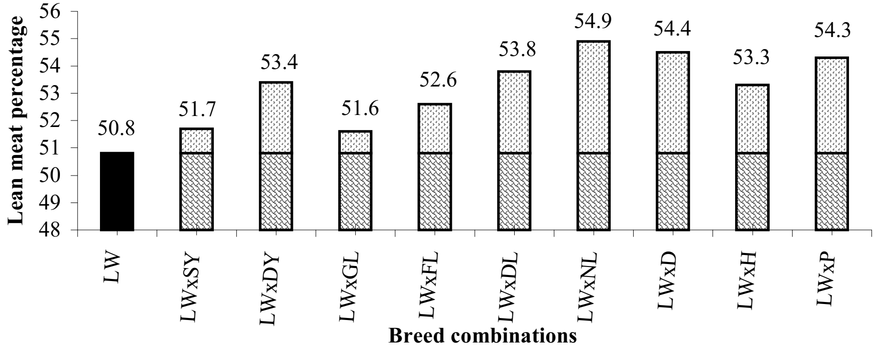

Figure 2. The effects of crossbreeding on lean meat content of Lithuanian White pigs (*Piglog 105* data)

The average meat percentage of crossbreds produced by crossing the pigs of imported breeds varied from 51.9 to 59.0% depending on the combination of breeds (Fig. 3). Norwegian Landrace x Norwegian Yorkshire, Norwegian Landrace x Hampshire and Hampshire x Pietrain crossbreds were distinguished by the highest lean meat content, respectively, 59.0, 58.7 and 58.5%.

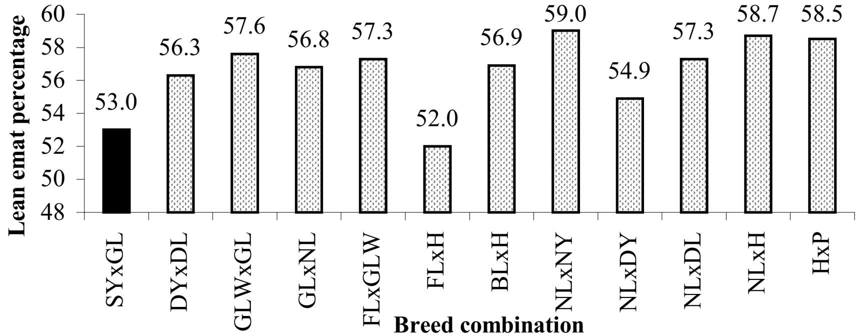

Figure 3. Measurements of lean meat content in crossbred pigs of imported breeds with *Piglog 105* at the breeding centres by Oct. 1, 2000

Fat deposition in pigs is an indicator of their meatiness. The lower is the backfat thickness, the higher is the meat percentage (r=-0.6-0.8). Pigs of some breeds from 30 to 100 kg weight were used for *Piglog 105* measurements to determine the intensity of subcutaneous fat and lean tissue deposition. The data from our study (Table 1) indicated that fat thickness of Norwegian Landrace and Swedish Yorkshire pigs at the beginning of the control fattening was, respectively, by 4.5 and 4.0 mm lower than that of purebred Lithuanian Whites.

Table 1. Intensity of subcutaneous fat and lean tissue deposition

Liveweight, kg	Average weight, kg	Average fat thickness, mm*	Lean meat percentage	Fat increase, mm
Pure-bred Lithuanian White (n=16)				
30-45	39±1.0	13.87±0.45		7.83
46-60	53±0.9	16.18±0.56		
61-75	67±0.9	18.15±0.65		
76-90	82±0.8	19.94±0.66	49.63±0.87	
91-105	97±1.0	21.70±0.75	48.00±1.03	
Lithuanian White (meat type) (n=7)				
30-45	39±1.2	13.64±0.67		7.29
46-60	55±1.8	15.43±0.63		
61-75	67±1.8	16.78±0.62		
76-90	83±1.8	18.21±0.53	51.73±0.80	
91-105	100±1.9	20.93±0.58	49.07±0.72	
Swedish Yorkshire (n=15)				
30-45	35±1.2	9.90±0.25		6.57
46-60	52±1.4	11.43±0.25		
61-75	69±0.9	13.47±0.30		
76-90	84±0.7	14.96±0.37	54.55±0.57	
91-105	100±1.3	16.47±0.57	52.48±0.80	
Norwegian Landrace (n=11)				
30-45	37±1.2	9.41±0.31		4.73
46-60	55±1.1	10.27±0.32		
61-75	68±1.2	11.09±0.34		
76-90	84±1.3	12.45±0.39	57.50±0.46	
91-105	104±2.9	14.14±0.51	56.16±0.57	

*Mean of fat deposition measured at FAT-1 and FAT-2.

The formation of the lean tissue of the imported pig breeds was more intensive under favourable feeding and housing conditions. During the fattening period, backfat thickness of Norwegian Landrace pigs has increased by 4.73 mm, of Swedish Yorkshire by 6.57 mm, of meat-type Lithuanian White by 7.29 mm and of purebred Lithuanian White by 7.83 mm. The meat percentage of pigs at 100 kg weight was on the average 56.16, 52.48, 49.07 and 48.0%, respectively. The higher was the weight of pigs, the higher was their fat deposition and relatively lower lean tissue deposition.

Conclusions

It can be concluded, that carcasses of desirable lean meat content may be produced provided the pigs of various breeds have most efficient use.

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LEANNES OF LITHUANIAN WHITE PIGS BELONGING TO DIFFERENT LINES AND FAMILIES

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Introduction

The Lithuanian White pig breed as a breed of meat-bacon type was recognized in 1967 [1, 3-5, 7]. At that time, the Lithuanian White breed consisted of 9 main genealogical lines of boars and 19 more widely spread genealogical families of sows [1, 3-5]. At present, Lithuanian White pigs are divided into 3 types: purebred, bacon type Lithuanian White (LB-B1) and meat type Lithuanian White (LB-M1). By January 1, 1998, Lithuanian Whites consisted of 8 boar lines and 20 sow families, LB-B1 type pigs of 18 boar lines and 14 sow families and LB-M1 type pigs of 9 boar lines and 6 sow families [3-5]. From the beginning of 1996, phenotypic evaluation of leanness of breeding pigs is carried out by ultrasonic *in vivo* measurements with the aparatus *Piglog-105* [2, 6] and in 2000 determination of meat percentage was started on fattening pigs at fattening performance control stations.

Materials and Methods

In 2000, at the fattening performance control station measurements were taken on fattening pigs at 85-100 kg weight [9, 10] during the last weighing before the delivery to the slaughterhouse. The leanness data of 78 purebred Lithuanian White (LW), 148 bacon-type Lithuanian White (LB-B1) and 38 meat-type Lithuanian White (LB-M1) pigs belonging to different genealogical lines and families have been analysed. The backfat thickness was measured using the ultrasonic apparatus *Piglog-105* at two points, first, behind the last rib and 7 cm sideways from the middle dorsal line (FAT-1) and, second, 10 cm towards the head from the last rib and 7 cm sideways from the middle dorsal line (FAT-2). The thickness (mm) of the *musculus longissimus dorsi* was measured at the first point [8].

Results and Discussion

The average meat percentage of purebred Lithuanian White pig progeny belonging to different lines and families was 48.5% (Figure 1). Within the breed the progeny of Imperatorius line (49%) and Rozeta family (53.1%) had the highest meat percentage, while the pigs of Karalius line (44.5%, $P < 0.001$) and Baltutė family (46.7%) were noted for the lowest meat percentage.

The average meat percentage of LB-B1 type progeny belonging to different lines and families (Figure 2) was 48.8%. Within this type, the highest and the lowest meat percentage had the progeny belonging, respectively, to Neras line (51.4%, P < 0.01) and Ilganosė family (52.6%, P < 0.001), and Grenas line (47.6%, P < 0.05) and Lina family (47.3%, P < 0.05).

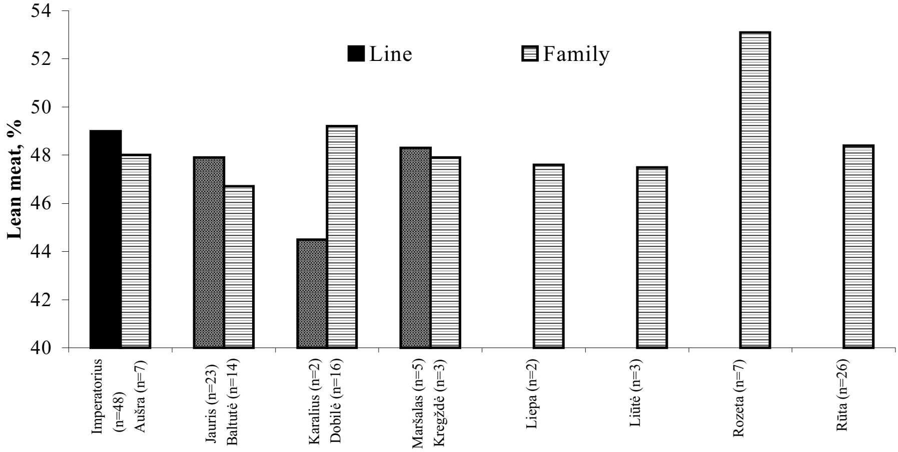

Figure 1. Meat percentage of purebred Lithuanian White progeny belonging to different lines and families

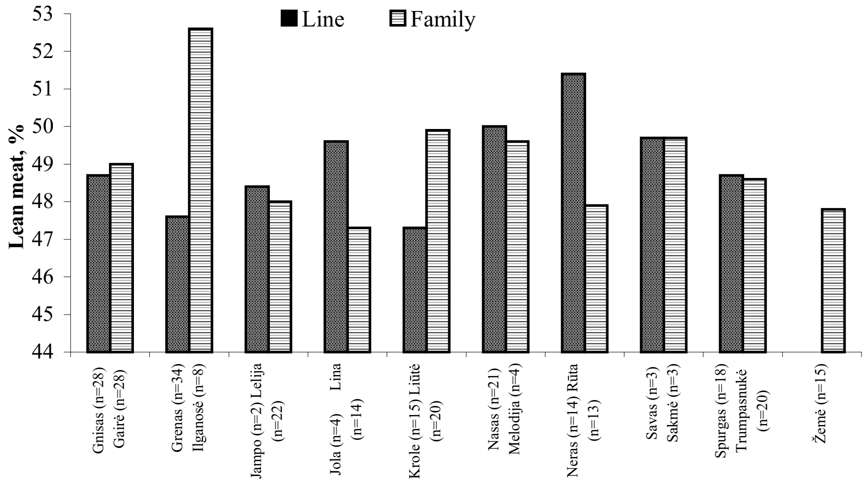

Figure 2. Meat percentage of bacon type Lithuanian White (LB-B1) progeny belonging to different lines and families

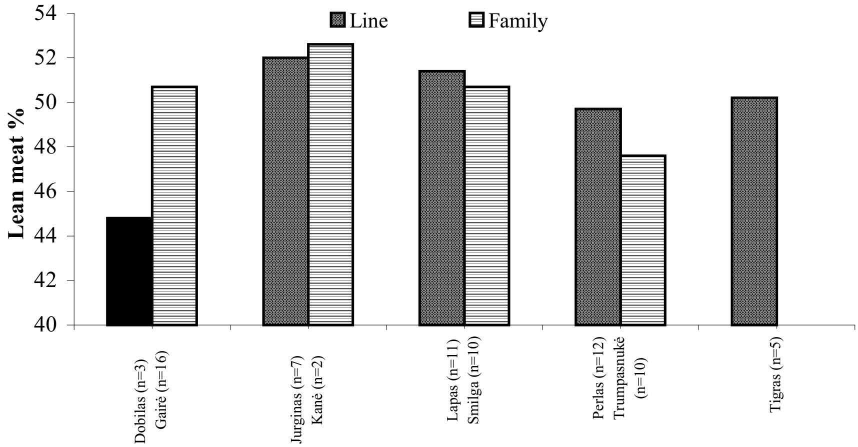

Figure 3. Meat percentage of meat type Lithuanian White (LB-M1) progeny belonging to different lines and families

The average meat percentage of LB-M1 type progeny belonging to different lines and families (Figure 3) was 50%. Within this type, the pigs of Lapas line (51.4%) and Kanė family (52.6%) had the highest, while those of Dobilas line (44.8%) and Trumpasnukė family (47.6%) the lowest meat percentage.

The comparative analysis of the lean meat content of purebred Lithuanian White, LB-B1 and LB-M1 type progeny indicated that the pigs of the LB-M1 type had the highest meat percentage (50%), while the meat percentage of Lithuanian White purebreds and pigs of the LB-B1 type was, respectively, by 1.5% ($P < 0.05$) and 1.2% ($P < 0.05$) lower.

Conclusions

The leannes of Lithuanian White pigs belonging to different types was different. The pigs of the LB-M1 type had the highest meat percentage (50%) and those purebred and of the LB-B1 type had respectively by 1.5 ($P < 0.05$) and 1.2% ($P < 0.05$) lower lean meat content.

Within the purebred Lithuanian White type, the pigs of Imperatorius line and Rozeta family had the highest meat percentage, respectively, 49 and 53.1%. Within the LB-B1 type, the highest meat percentage was that of pigs belonging to Neras line (51.4%, $P < 0.01$) and Ilganosė family (52.6%, $P < 0.001$), and within the LB-M1 type, the progeny of Lapas line and Kanė family had the highest lean meat percentage, respectively, 51.4% and 52.6%.

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CORRELATION BETWEEN PERFORMANCE OF PUREBRED AND CROSSBRED PROGENY OF IDENTIAL LITHUANIAN ABORIGINAL SOWS

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Introduction

Lithuanian aboriginal pigs with a pair of wattle hanging from the neck are characterized by medium body length, strong constitution, quiet temper and high prolificacy, but at the same time by fat carcasses, poor feed efficiency and low growth rates. Breeding of small population of aboriginal pigs takes place as a maintaining selection of purebreds and conservation, but the conservation of the breed should be connected with the inclusion of the breed into the pig breeding system. However, slaughter pigs in commercial pig breeding are produced by crossbreeding. A possible way to increase production of aboriginal pigs is to take advantage of the outstanding growth and leanness ability of some foreign lean breeds. Studies should be carried out to determine the efficiency of aboriginal pigs as a maternal breed in different crossing variants. In most breeding programmes selection takes place only at the nucleus level, based on purebred performances. The influence of the selection at the nucleus level on the rate of genetic change at the production level is highly dependent on the genetic correlation between purebred and crossbred performance for the same trait. To use this model, a full pedigree from all purebreds and all crossbreeds back to the common parents or grand parents is required. Most of the available crossbred data cannot fulfil this requirement. Therefore, the purpose of the present study was to determine the correlation between the traits of purebred and crossbred progeny from the same Lithuanian aboriginal sows.

Materials and Methods

The study was conducted at the Lithuanian Institute of Animal Science. The station test data contained individual performance records for growth and carcass traits on 60 pigs from 16 litters, produced from the same aboriginal sows mated with aboriginal boars and Swedish Yorkshire and Duroc boars.

The investigation data were processed biometrically, and the correlations were computed by G.W. Snedecor.

Results and Discussion

Mating Lithuanian aboriginal pigs with aboriginal boars in one parity and crossing them with Swedish Yorkshire boars is in the next parity resulted a higher growth rate and carcass quality of crossbred progeny in comparison with their purebred Lithuanian aboriginal half-sibs. The average daily gain of crossbreds was by 43.7 g ($P > 0.400$) higher than that of purebreds and feed consumption per kg gain was by 0.63 FU (P < 0.001) lower. The backfat thickness at 6-7 rib and behind the last rib of crossbred pigs were, respectively, by 7.73 (P < 0.010) and 5.9 mm (P < 0.050) lower, and the loin lean area and ham weight were, respectively, by 3.5 cm^2 (P > 0.200) and 0.7 kg (P < 0.050) higher than those of purebred half sibs. Both purebred progeny and Lithuanian aboriginal with Swedish Yorkshire crossbreds were noted for comparatively high variability of growth and carcass traits. However, crossing slightly increased variability of most traits. The largest variability in both purebred and crossbred groups was for the backfat thickness.

The correlation between growth and carcass traits is of great importance in pig selection. However, crossing of such genetically distant breeds of different selection as the Lithuanian aboriginal and Swedish Yorkshire or Duroc may produce crossbreds, whose farming traits may have different correlation, because correlations of traits even for the single breed - Lithuanian White – were different in individual herds (J. Šveistys et al., 1978).

The correlation between daily gain and feed conversion was negative and that between feed conversion and back thickness was positive for purebred aboriginal pigs and their crossbred half sibs (Table 1). The correlation between carcass length and backfat thickness was negative for both purebred and crossbred pigs. The correlation between daily gain and carcass length and backfat thickness, and that between feed conversion and carcass length as well as the correlation between backfat thickness and loin lean area were contradictory.

Table 1. Correlation between performance of purebred and crossbred progeny of Lithuanian aboriginal sows

	Group	Feed conversion	Carcass length	Backfat thickness		Loin lean area
				at 6-7 tib	behind last rib	
Daily gain	purebred	-0.534	0.385	-0.225	-0.391	0.463
	crossbred	-0.601	-0.480	0.387	0.362	0.565
Feed conversion	purebred		-0.370	0.684**	0.642*	-0.545
	crossbred		0.304	0.289	0.324	-0.067
Carcass length	purebred			-0.721**	-0.489	0.371
	crossbred			-0.379	-0.176	-0.333
Backfat thiskness:						
at 6-7 rib	purebred				0.699*	-0.380
	crossbred				0.709**	0.232
behind last rib	purebred					-0.125
	crossbred					0.576

*P<0.050; **P<0.025; ***P < 0.010; ****P < 0.005; *****P < 0.001.

Crossing another group of Lithuanian aboriginal sows with Swedish Yorkshire boars in one parity and the same sows with Duroc boars in the next parity showed that Duroc boars were more efficient in weight gains than Yorkshire boars. There were no significant differences among the progeny of Yorkshire and Duroc boars for most aspects of carcass quality. Variability of growth rate for the progeny of Duroc boars was higher, but variability of carcass traits was lower than that for the progeny of Swedish Yorkshire boars. The correlation between daily gain and feed conversion was negative as well as that between carcass length and backfat thickness (Table 2).

Table 2. Correlation between performance of different crossbreds

	Group	Feed conversion	Carcass length	Backfat thickness		Loin lean area
				at 6-7 rib	435	
Daily gain	purebred	-0.049	0.275	-0.248	-0.391	0.117
	crossbred	-0.398	-0.430	0.814*****	0.314	-0.140
Feed conversion	purebred		0.498	-0.260	-0.147	0.120
	crossbred		-0.190	-0.054	0.199	-0.454
Carcass length	purebred			-0.377	-0.380	-0.231
	crossbred			-0.572**	-0.196	0.425
Backfat thiskness:						
at 6-7 rib	purebred				0.730****	-0.073
	crossbred				0.648****	-0.192
behind last rib	purebred					0.036
	crossbred					0.196

The correlation between daily gain and carcass length, between backfat thickness and loin lean area, and between feed conversion and carcass length also loin lean area were contradictory. The correlation between backfat thickness at 6-7 rib and loin lean area was negative, and the correlation between backfat thickness behind the last rib and loin lean area was positive. However, the correlation coefficients were very low.

It can be seen from Table 3 that correlations between purebred and crossbred performances for the same traits were positive only for backfat thickness and ham weight. The correlations between crossbred performance in different crossing variants were contradictory.

Table 3. Correlation between purebred and crossbred performances for the same trait

Traits	Breeds	
	Lithuanian aboriginal / Lithuanian aboriginal – Swedish Yorkshire	Lithuanian aboriginal / Lithuanian aboriginal – Duroc
Daily gain	-0.533	-0.359
Feed conversion	-0.413	-0.063
Carcass length	-0.401	0.117
Backfat at 6-7 rib	0.263	-0.301
Backfat behind last rib	0.277	-0.163
Loin lean area	-0.529	0.127
Ham weight	0.596	0.321

As this data set is limited in size, no genetic analysis could be made. Therefore, only phenotypic correlations were presented in this study, and results should be interpreted with caution.

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ESTIMATION OF GENETIC PARAMETERS FOR LITHUANIAN WHITE PIGS BY THE USING DIFFERENT MODELS

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Summary

Genetic parameters were estimated by PEST and VCE from performance test data of the Lithuanian White pigs. Estimation was done on two stages. At firs some ratio traits were included. Production traits from the field test (ultrasonic backfat thickness – BFUS, ultrasonic muscle depth, 12594 records) and from the station test (feed conversion ratio – FCR, backfat thickness – BFST, average daily gain – DGAIN, 5363 records) were analysed jointly resulting in a 5-trait model. Later only original production traits (straight absolute values) were included from field test (lean meat percentage determined by Piglog – LEAN, age by days on test – AGE, about 13700 records) and from station test (days on test – DoT, amount of feed consumed – FEED, loin eye area – EYE, 5697 records). Also joint analysis of 5-trait model was done in this stage. Few different combinations of effects were analysed in models and results were compared. The most substantial heritabilities were got by using only original traits models with random year*season*station, year*season*farm, litter, farm (or without farm) and fixed sex effects. The most acceptable genetic correlations were estimated also for this model without farm effect included. Genetic correlations in some cases were unacceptable on first stage of research.

Introduction

In the Lithuania, pig selection is based on data from field and station tests. Multivariate genetic analysis is performed for traits from the station test of castrates and gilts and field test for gilts and boars, attempting to a joint analysis of field and station test data Lithuanian White pigs. An attempt is made to replace ratio traits such as daily gain and feed conversion ratio by straight absolute values, which have more desirable statistical properties and whose effect on selection can be gauged more directly.

Material and Methods

Data from station and field test were available for the Lithuanian White pigs from years 1993 and 1998 respectively. Tables 1.1 and 2.1 give an overview of numbers involved and some basic statistics.

Station test in Lithuania has been run as a progeny test. From one litter 3-4 piglets (castrates and females) are sent to the test station at around 25 kg. The test is from 30kg to 100kg. Animals are weighed 4 times: at arriving (1), at the beginning of test (2), before end (3) and at the end of test (4). The difference between 2 and 4 weighing dates gives the number of days on test (DoT). Animals are fed ad libitum, penned individually, and thus feed intake is recorded individually (FEED). Feed conversion ratio (FCR) and average daily gain (DGAIN) are computed. On slaughter area of loin eye is measured (EYE). In the field, two ultrasonic back fat measurements and muscle depth measurement are taken from boars and gilts between 85 and 110kg, and computed lean meat percentage is reported by Piglog. Data from both field and station testing schemes should be used together to predict the genetic merit of animals to be selected. Therefore, the genetic parameters for all traits have to be estimated. PEST and VCE software was used to obtain results.

Results and Discussion

Tables 1.2. – 1.7. showing information and results from first stage of research – when some ratio traits were used in the models. There are three models (A1, A2, A3) with different combinations of effects. Genetic correlations and heritabilities for each model are given.

Table 1.1 General statistics for models with ratio traits

Traits	No. of rec.	min	max	avg	stdev
FCR	5363	1.97000	5.47000	3.70459	0.43793
BFST	5363	5.00000	43.00000	23.02925	5.2564
DGAIN	5363	342.47000	1157.09998	706.76984	109.32517
BFUS	12594	8.00000	38.00000	19.32785	3.62569
MUSCLE	12593	16.00000	67.00000	39.13889	5.75921
Weight_re	17961	70.00000	130.00000	94.17343	7.74368

Table 1.2. Model A1 information

Factor	Type	Levels	FCR	BFST	DGAIN	BFUS	MUSC
weight_re	C	1	-	x	-	x	x
animal	A	24128	x	x	x	x	x
sex	F	3	x	x	x	x	x
farm	R	89	x	x	x	-	-
yssta	F	64	x	x	x	-	-
ysfarm	F	211	-	-	-	x	x
litter	R	3958	x	x	x	x	x

Table 1.3. Heritabilities and genetic correlations for Model A1

	FCR	BFST	DGAIN	BFUS	MUSCLE
FCR	**0.312**	0.062	-0.700	0.437	0.507
BFST	-	**0.154**	0.211	*-0.835*	0.806
DGAIN	-	-	**0.593**	-0.468	-0.266
BFUS	-	-	-	**0.708**	-0.384
MUSCLE	-	-	-	-	**0.282**

Table 1.4. Model A2 information

Factor	Type	Levels	FCR	BFST	DGAIN	BFUS	MUSC
weight_re	C	1	-	x	-	x	x
animal	A	24128	x	x	x	x	x
sex	F	3	x	x	x	x	x
yssta	F	64	x	x	x	-	-
ysfarm	F	211	-	-	-	x	x
litter	R	3958	x	x	x	x	x

Table 1.5. Heritabilities and genetic correlations for Model A2

	FCR	BFST	DGAIN	BFUS	MUSCLE
FCR	**0.395**	0.133	-0.504	0.003	0.010
BFST	-	**0.269**	0.060	-0.024	0.016
DGAIN	-	-	**0.600**	-0.012	-0.004
BFUS	-	-	-	**0.678**	-0.146
MUSCLE	-	-	-	-	**0.398**

Table 1.6. Model A3 information

Factor	Type	Levels	FCR	BFST	DGAIN	BFUS	MUSC
weight_re	C	1	-	x	-	x	x
animal	A	24128	x	x	x	x	x
sex	F	3	x	x	x	x	x
farm	R	89	x	x	x	-	-
yssta	R	64	x	x	x	-	-
ysfarm	R	211	-	-	-	x	x
litter	R	3958	x	x	x	x	x

Table 1.7. Heritabilities and genetic correlations for Model A3

	FCR	BFST	DGAIN	BFUS	MUSCLE
FCR	**0.255**	0.081	-0.700	0.386	0.594
BFST	-	**0.141**	0.177	*-0.868*	0.755
DGAIN	-	-	**0.462**	-0.446	-0.286
BFUS	-	-	-	**0.659**	-0.351
MUSCLE	-	-	-	-	**0.275**

As we can see from these tables heritabilities in all cases were too high for backfat thickness in field (BFUS) and to low for backfat thickness ih station (BFST). Also genetic correlations between BFST and BFUS estimated for models A1 and A3 were very high negative. It shows probably non meaningful values of these traits. Quite high heritabilities were got also for daily gain (DGAIN). In model A2 with all fixed effects genetic correlations between field and station traits were too small – close to zero.

Tables 2.2. – 2.7. show information and results from second stage of research – when only original (absolute values) traits were used in the models. There are also three models (B1, B2, B3) with different combinations of effects. Genetic correlations and heritabilities for each model are given.

Table 2.1 General statistics for models for original traits

Traits	No. of rec.	min	max	avg	stdev
DoT	5697	51.00000	169.00000	97.33667	14.90570
FEED	5697	108.40000	401.79999	248.17764	35.07834
EYE	5697	15.50000	55.40000	31.09891	4.36432
LEAN	13736	32.40000	62.00000	50.23134	3.61211
AGE	13686	100.00000	298.00000	213.39581	22.71453
Weight_re	19433	70.00000	130.00000	94.01292	7.64422

Table 2.2. Model B1 information

Factor	Type	Levels	Dot	FEED	EYE	LEAN	AGE
weight_re	C	1	x	x	x	x	x
animal	A	26442	x	x	x	x	x
yssta	R	68	x	x	x	-	-
ysfarm	R	230	-	-	-	x	x
litter	R	4138	x	x	x	x	x
sex	F	3	x	x	x	x	x
farm	R	96	x	x	x	-	-

Table 2.3. Heritabilities and genetic correlations for Model B1

	DoT	FEED	EYE	LEAN	AGE
DoT	**0.310**	0.640	0.139	0.162	-0.107
FEED	-	**0.248**	0.043	-0.296	0.189
EYE	-	-	**0.172**	-0.098	0.758
LEAN	-	-	-	**0.655**	0.012
AGE	-	-	-	-	**0.366**

Table 2.4. Model B2 information

Factor	Type	Levels	Dot	FEED	EYE	LEAN	AGE
weight_re	C	1	x	x	x	x	x
animal	A	26442	x	x	x	x	x
yssta	F	68	x	x	x	-	-
ysfarm	F	230	-	-	-	x	x
litter	R	4138	x	x	x	x	x
sex	F	3	x	x	x	x	x
farm	R	96	x	x	x	-	-

Table 2.5. Heritabilities and genetic correlations for Model B2

	DoT	FEED	EYE	LEAN	AGE
DoT	**0.676**	0.625	0.143	0.245	0.093
FEED	-	**0.466**	0.043	-0.230	0.402
EYE	-	-	**0.211**	-0.163	0.728
LEAN	-	-	-	**0.941**	0.011
AGE	-	-	-	-	**0.523**

Table 2.6. Model B3 information

Factor	Type	Levels	Dot	FEED	EYE	LEAN	AGE
weight_re	C	1	x	x	x	x	x
animal	A	23317	x	x	x	x	x
yssta	R	68	x	x	x	-	-
ysfarm	R	230	-	-	-	x	x
litter	R	4138	x	x	x	x	x
sex	F	3	x	x	x	x	x

Table 2.7. Heritabilities and genetic correlations for Model B3

	DoT	FEED	EYE	LEAN	AGE
DoT	**0.298**	0.582	0.115	0.497	0.103
FEED	-	**0.278**	-0.011	-0.302	0.337
EYE	-	-	**0.280**	0.205	0.533
LEAN	-	-	-	**0.630**	0.012
AGE	-	-	-	-	**0.277**

As we can see the quite substantial heritabilities were got by the using B1 and B3 model. In model B2 they were too high. The most acceptable genetic correlations were estimated for model B3. For models B1 and B2 in some cases they were too low or too high between field and station traits: -0.107 and 0.093 between AGE and DoT, 0.758 and 0.728 between AGE and EYE.

Conclusions

The most substantial heritabilities were got by using only original traits models with random year*season*station, year*season*farm, litter, farm (or without farm) and fixed sex effects (B1, B3). The most acceptable genetic correlations were estimated also for this model without farm effect included (B3). Genetic correlations in some cases were unacceptable on first stage of research.

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BODY DEVELOPMENT OF CROSSBRED PIGS OF DIFFERENT BREEDS

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Introduction

Boars of various specialized breeds have been imported to Lithuania with the aim of improvement lean content of carcasses and commercial crossbreeding. Body development is an indicator of pig productivity, especially as regards carcass traits (Džiaugys et al., 1996).

The purpose of the present study was to determine the effect of boars of various specialized breeds on conformation traits, constitution indices, internals and flare fat of Lithuanian White pigs.

Material and Methods

The study was carried out in 1998-2000. Seven experimental groups of pigs were formed: group 1 - purebred Lithuanian White (LW), group 2 - hybrids from Lithuanian White and bacon type Lithuanian White (LWxLW-B1), group 3 - hybrids from Lithuanian White and German Large White (LWxGLW), group 4 - hybrids from Lithuanian White and Polish Landrace (LWxPL), group 5 - hybrids from Lithuanian White and Finnish Landrace (LWxFL), group 6 - hybrids from Lithuanian White and Pietrain (LWxP) and group 7 - hybrids from Lithuanian White and Hampshire (LWxH) breeds. Pigs (n=134) of 95 to 105 kg weight have been measured during their fattening.

Housing and feeding conditions were the same for all groups of pigs. The development of internals and weight of flare fat were determined at control slaughtering of pigs (n=117).

Results and Discussion

The study indicated that purebred Lithuanian White pigs had the highest measurements of heart girth, chest width and height at withers, respectively 111.04, 28.46 and 64.21 cm (Fig. 1). Lithuanian White x Hampshire crossbreds had the lowest measurements of chest width (27 cm, $P<0.025$), while the lowest height at withers was that of Lithuania White and Polish Landrace crossbreds (61.22 cm, $P<0.001$). The lowest measurements of body length, heart girth and chest depth were determined for Lithuanian White x Pietrain crossbreds, respectively 111.88, 106.12, 31.24 cm ($P<0.001$). Lithuanian White x bacon type Lithuanian White pigs had the highest chest depth and body length measurements, respectively 34.26 ($P<0.01$) and 120.74 cm. Lithuanian White x Finnish Landrace crossbreds were second by the body length (120.38 cm), however, the difference was insignificant compared with the control group. The collected data indicated that Lithuanian White x Pietrain and Lithuanian White x Hampshire crossbred pigs had the highest carcass quality.

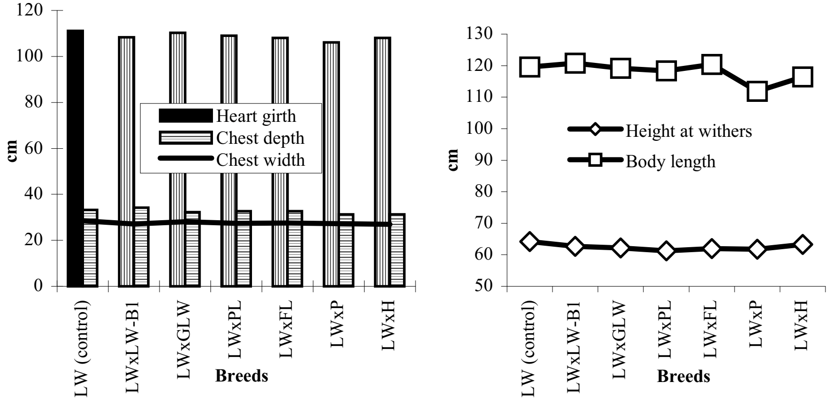

Figure 1. Body measurements, cm

Table 1. Constitution indices, %

Group	Breed	of pigs	Weight of pigs	Indices				
				Extension	Compactness	Chest	Massiveness	Long-leggedness
I	LW (control)	24	100.38	186.39 ±1.26	92.9 ±0.73	86.05 ±1.11	173.16 ±1.51	48.3 ±0.46
II	LWx LW-B1	19	96.84	192.72 ±1.43$*^4$	89.92 ±1.03$*^2$	79.19 ±0.93$*^5$	172.98 ±1.5	45.3 ±0.41$*^5$
III	LWxGLW	24	101.5	191.78 ±1.47$*^3$	92.7 ±0.69	87.24 ±0.69	177.44 ±0.93$*^2$	48.01 ±0.6
IV	LWxPL	18	97.06	193.56 ±1.66$*^4$	92.38 ±1.23	84.13 ±1.35	178.29 ±1.6$*^2$	46.63 ±0.68$*^2$
V	LWxFL	24	97.63	194.47 ±1.55$*^5$	89.97 ±0.88$*^2$	84.55 ±1.28	174.62 ±1.41	47.15 ±73
VI	LWxP	17	94.94	181.49 ±2.16	95.04 ±0.85	87.93 ±1.61	172.08 ±1.4	49.36 ±0.79
VII	LWxH	8	100.25	184.26 ±2.47	92.85 ±0.95	88.11 ±4.73	170.97 ±2.27	50.65 ±1.35

$*^2P < 0.025$; $*^3P < 0.01$; $*^4P < 0.005$; $*^5P < 0.001$.

The data in Table 1 show that pigs of group 5 had the highest extension index and exceeded Lithuanian White pigs by 8.08% (P < 0.001). The indices of chest and long-leggedness were highest for LWxH pigs, respectively, 88.11 and 50.65%, but compared with the control group, the data were statistically insignificant.

Table 2. Absolute (g) and relative (% of live weight) weight of internals and flare fat in abdominal cavity

Group	Breed	No. of pigs	Absolute weight	Relative weight	Absolute weight	Relative weight
			Heart		Lungs	
I	LW (control)	22	304.55±5.28	0.3	774.77±19.97	0.77
II	LWxLW-B1	18	303.33±7.3	0.31	675.00*4±21.63	0.69
III	LWxGLW	21	372.38*5±0.37	0.37	694.76*2±23.09	0.69
IV	LWxPL	18	321.11*1±5.3	0.33	664.44*5±22.18	0.69
V	LWxFL	20	336.00*3±9.56	0.35	784.80±32.72	0.81
VI	LWxP	12	322.50±10.45	0.34	662.50*4±24.48	0.7
VII	LWxH	6	310.00±15.81	0.31	761.67±52.01	0.77
			Liver		Kidneys	
I	LW (control)	22	1830.91±27.81	1.83	325.23±5.01	0.33
II	LWxLW-B1	18	1868.89±31.9	1.92	320.56±5.47	0.33
III	LWxGLW	21	1710.95*3±33.05	1.7	349.05*4±5.23	0.35
IV	LWxPL	18	1625.56*5±38.52	1.68	342.22±7.6	0.35
V	LWxFL	20	1684.00*5±30.28	1.73	358.50*3±11.22	0.37
VI	LWxP	12	1419.17*5±40.07	1.5	303.75±12.46	0.32
VII	LWxH	6	1635.00*2±77.2	1.61	365.00*5±9.44	0.36
			Spleen		Flare fat	
I	LW (control)	22	150.45±2.77	0.15	1586.36±65.35	1.57
II	LWxLW-B1	18	185.00*5±4.72	0.19	1549.44±61.22	1.59
III	LWxGLW	21	177.62*5±3.55	0.18	1358.57*2±56.94	1.35
IV	LWxPL	18	150.56±4.18	0.16	1591.11±80.94	1.64
V	LWxFL	20	184.00*5±5.04	0.19	1405.00±89.96	1.43
VI	LWxP	12	160.00±8.26	0.17	1185.00*4±110.77	1.25
VII	LWxH	6	176.67*2±9.07	0.17	1361.67±90.56	1.35

*1P < 0.05; *2P < 0.025; *3P < 0.01; *4P < 0.005; *5P < 0.001.

The pigs in groups 4 and 6 had, respectively, the highest indices of massiveness (178.29%) ($P < 0.025$) and compactness (95.04%). LWxLW-B1 pigs were characterized by the lowest indices of compactness (189.92%), chest (79.19%) and long-leggedness (45.3%). The differences were statistically significant in comparison with the control group.

The investigation data showed that the internals, except for the heart and spleen, were most poorly developed in LWxP pigs (Table 2). The absolute weight of lungs was by 14.49 ($P < 0.005$), of liver by 22.49 ($P < 0.001$), of flare fat by 25.3 ($P < 0.005$) and of kidneys by 6.61% lower compared with the purebred Lithuanian White pigs. LWxLW-B1 pigs had the smallest heart (303.33 g), but the highest weight of lungs and spleen, respectively 675 and 185 g. The difference was statistically significant compared with the control group. Pigs in group 3 had the highest absolute weight of heart (372.38 g), in group 4 – of flare fat (1591.11 g), in group 5 – of lungs (784.8 g) and in group 7 – of kidneys (365 g) in comparison with the control group.

Conclusion

The study indicated that LWxP and LWxH pigs had the highest carcass quality. The internals were most poorly developed in LWxP crossbreds. Crossbred pigs of other combinations had well developed internals, and the lowest relative weight of flare fat was determined in LWxP crossbred pigs.

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OPTIMIZATION OF FEED INTAKE AND GROWTH PERFORMANCE IN PIGS

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Introduction

Optimization of fattening performance due to selection on backfat thickness and food conversion ratio will be limited, because backfat thickness should not decline below an optimum, which is reached in several lines. Future selection strategies will have to include the increase in feed intake and growth at each stage of the fattening period, in order to improve efficiency by changing the shape of the feed intake curve (WEBB, 1995). The required information on individual feed intake over time can be obtained from electronic feeding stations. These feeding stations are increasingly implemented in performance test stations as they allow to test pigs under more practical conditions of group-housing (KNAP, 1995). Based on individually recorded feed intake data obtained from such a performance test and additional weight information, the possibility of influencing feed intake and growth rate at different stages of growth was investigated.

Material and Methods

Performance test data were obtained for 661 boars between August 1997 and April 1998 from the central test station of PIC Germany. During the age dependent performance test on station between the 100th and 170th day of age animals were fed ad libitum a diet containing 12.6 MJME, 18% crude protein and 1% lysine per kg of food. Individual feed intake of the group-penned animals was recorded by electronic feeding stations of type ACEMA48 during the first, third, fifth, seventh, and ninth week on test. During the remaining test weeks food was supplied with conventional feed dispensers and feed intake was not recorded. Each animal was weighted in bi-weekly intervals. A second order polynomial and a third order polynomial were individually fitted on feed intake and live weight as functions of age. From these functions, individual information about daily feed intake, daily gain and food conversion ratio were derived for five periods of 12 days and for the entire period. The means and standard deviations are shown in Table 1. Daily gain increased from 883 g in period one to maximum growth rate of 1021 g in the fourth period. Feed intake increased from 1883 g in period 1 with decreasing increments to an average daily feed intake of 2998 g in last period. The best feed efficiency was found in the first period with 2232 g food per kg gain. The mean values for daily feed intake, daily gain and food conversion over the entire period were 975 g, 2478 g, and 2552 g/kg, respectively. Backfat thickness was ultrasonically measured at the end of performance test and was on average

10.2 mm. The boars started performance test with an average live weight of 45 kg and finished with 112 kg.

Table 1: Means (8) and standard deviations (s_8) of average estimated feed intake, average estimated daily gain for periods of 12 days each

Trait [1]	Period 1		Period 2		Period 3		Period 4		Period 5		Period1-5	
	8	s_8	8	s_8	8	s_8	8	s_8	8	s_8	8	s_8
ADG (g)	883	207	957	149	1003	169	1021	153	1011	163	975	112
DFI (g)	1883	435	2220	426	2518	471	2778	448	2998	529	2478	359
FC (g/kg)	2232	725	2340	407	2546	478	2752	445	3017	608	2552	311
Weight [2]	45-57		57-71		71-85		85-100		100-112		45-112	

[1] Average daily gain (ADG), daily feed intake (DFI), and food conversion (FC) determined for 5 periods of 12 days

[2] Average measured start weight and final weight for bi -weekly intervals

The estimation of variance components of numerous traits was accomplished with multivariate REML program MTDFS of MISZTAL (1993). Fixed effects were birth farm (5 farms), seasons (3 levels), line (3 lines), feeding system (2 levels), and as a covariable start weight was considered. Standard errors of genetic correlations were approximated by the method of ROBERTSON (1959).

Results

Performance and feed intake traits were adjusted for all environmental effects. Based on the adjusted means of average daily gain (975 g) and backfat thickness (10.1 mm) different types of pigs were defined. The feed intake and growth development during performance test for these types of pigs are shown in Fig. 1.

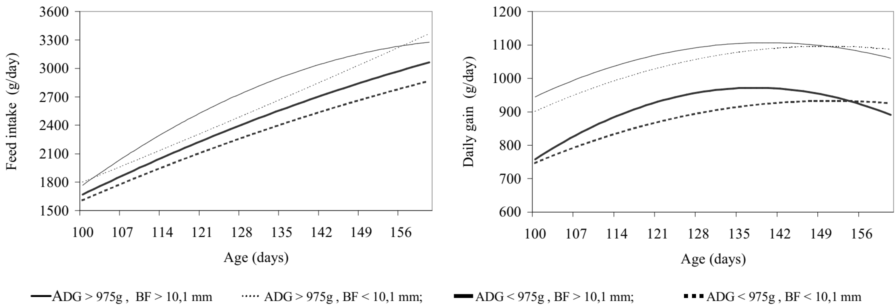

Figure 1: Feed intake and daily gain as functions of age for different levels of performance in average daily gain (ADG) and backfat thickness (BF)

The figures indicate that a high feed intake in the first part of the performance test (between 100. and 114 day of age) was necessary to reach a high growth performance. The slow growing animals (thick lines) consumed 200 g less food per day than the fast growing pigs (thin lines). Thereafter, rate of change in daily feed intake was higher in animals with a higher backfat thickness. The growth curves of obese animals (full lines) showed a stronger bend and reached maximum growth rates 14 day earlier than leaner pigs (dotted lines) who reached maximum growth rates at the end of the performance test (149-156 day of age).

Genetic correlations between measured and estimated traits for average daily gain ($r_{g=}$ 0.96), daily feed intake (r_g= 0.98) and food conversion (r_g = 0.93) showed that the used functions had a high accuracy in prediction of the observed performance traits. SCHULZE et al. (2000) found in a previous study that the use of a function was advantageous in the case of missing test weeks or periodical recording as in the present data. Another objective of the investigation was the simultaneous analysis of feed intake and growth in identical time periods. Therefore, only results of the estimated performance traits are presented in the following.

High heritabilities of h^2 = 0.50, 0.55, 0.40, and 0.39 for traits of entire test period were obtained for backfat thickness, average daily gain, daily feed intake, and food conversion ratio, respectively (Tables 2). The genetic correlations among the performance traits of the entire test period indicated the difficulty when using these traits to improve feed intake capacity and to optimize fattening performance. A high feed intake is necessary to achieve a high growth rate, but this will also increase backfat thickness and food conversion ratio.

Table 2: Heritabilities (on the diagonal) genetic correlations (above diagonal) for performance traits of the entire test period

Trait		BF	DFI	ADG	FC
Backfat thickness	(BF)	0.50 (0.05)	0.47 (0.06)	0.42 (0.05)	0.11 (0.09)
Daily feed intake	(DFI)	-	0.40 (0.06)	0.70 (0.03)	0.46 (0.08)
Average daily gain	(ADG)	-	-	0.55 (0.05)	-0.30 (0.07)
Food conversion	(FC)	-	-	-	0.39 (0.06)

Standard errors in parenthesis

In general, the moderate to high heritabilities for average daily gain, feed intake and food conversion in each period enables to use part test information (Table 3). While estimates for daily gain were similar in the first four periods (h^2 = 0.50 to 0.56) and lower in period 5, the heritablity of feed intake in the first period (h^2 = 0.18) was substantially lower than in the following four periods.

Estimates of heritabilities for food conversion were similar in all parts of the performance test.

Table 3: Heritabilities (h^2) and standard errors (s_{h^2}) for daily gain (TDG), daily feed intake (DFI) and food conversion ratio (FC) in each period and for the entire period

Trait [1)]	ADG		DFI		FC	
	h^2	$\pm s_{h^2}$	h^2	$\pm s_{h^2}$	h^2	$\pm s_{h^2}$
Period 1	0.50	0.05	0.18	0.09	0.34	0.07
Period 2	0.56	0.04	0.43	0.06	0.42	0.06
Period 3	0.54	0.05	0.46	0.06	0.46	0.06
Period 4	0.50	0.05	0.45	0.06	0.44	0.06
Period 5	0.37	0.07	0.39	0.06	0.38	0.06
Period 1-5	0.55	0.05	0.40	0.06	0.39	0.06

[1)] Abbreviations see Table 1.

As shown in Table 4, the genetic correlation between daily gain and food conversion in period one (r_g = -0.84) was significantly different from correlations between these traits in the following periods (r_g = -0.32 to -0.51). Genetic correlations between daily gain and daily feed intake in each period were r_g = 0.56 to 0.42 from first to last period. Except of the first period (r_g = -0.11), genetic associations between food conversion and daily feed intake for periods were similar in magnitude (r_g = 0.52 to 0.56).

Table 4: Genetic correlations (r_g) and standard errors (s_{rg}) between daily feed intake, average daily gain, food conversion, and backfat thickness in corresponding periods

Traits [1)]	DFI- ADG		DFI-FC		ADG-FC	
	r_g	$\pm s_{rg}$	r_g	$\pm s_{rg}$	r_g	$\pm s_{rg}$
Period 1	0.56	0.10	-0.11	0.20	-0.84	0.03
Period 2	0.62	0.04	0.55	0.06	-0.32	0.06
Period 3	0.54	0.04	0.56	0.05	-0.38	0.06
Period 4	0.53	0.05	0.52	0.06	-0.44	0.07
Period 5	0.42	0.06	0.56	0.08	-0.51	0.09
Period 1-5	0.70	0.03	0.46	0.08	-0.30	0.07

[1)] Abbreviations see Table 1.

Conclusions

The possibility of changing the feed intake curve of growing pigs was investigated in several studies in recent years (SCHULZE et al. 2000; EISSEN, 2000, SCHNYDER et al., 2000). In these studies linear or linear quadratic polynomials were found to be sufficient to describe feed intake during growth but the benefit of the curve parameters was limited to influence feed intake curves. The use of a function to determine feed intake was beneficial compared to measured feed intake in case of missing feed intake data or a periodical recording of feed intake as in the present study. The derivation of part test information from those functions increased also accuracy of estimation of feed intake as residual variance could be reduced.

The differences in feed intake and growth curves in the present study indicated that at each stage of growth or age a sufficient amount of variation exists for selection. A high feed intake in the first period of the performance test is necessary to achieve a high growth rate. Thereafter, a maximum in feed intake is undesirable as it is associated with an increased fat deposition. Animals with a higher backfat thickness reached maximum growth rates at an earlier age than leaner pigs. An early maximum in growth rate is associated with a lower mature weight and an earlier age at puberty (KRIETER and KALM, 1989). The genetic associations indicate that a high feed intake at the beginning of the fattening period is desirable, while afterwards a more reduced feed intake should be achieved to improve efficiency of fattening performance. However, in dam lines undesired effects of a selection on high a feed efficieny on the reproduction performance of primiparus sows are reported by KARSTEN et al. (2000) so that different selection of dam and sire lines concerning feed intake and fattening performance during growth is necessary. This can be achieved by using part test information of growth rate and feed intake in a multiple trait animal model.

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MEAT QUALITY RESEARCH OF PURE- AND CROSSBRED PIGS IN ESTONIA

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Abstract

Characteristics of meat quality are becoming more and more important for pork producers and customers. This work was carried out to study the differences between pig breed combinations and their effect on meat quality. All tests were conducted in Valga Meat and Canning Factory, in Meat and Feed Laboratory of the Estonian Agricultural University. Five groups of pigs were under observation – pure-bred - Estonian Landrace (EL), Estonian Large White (ELW), Finnish Yorkshire (FY) and crossbred - Hampshire♂xELW♀ (H♂xELW♀); H/EL/ELW♂xEL♀. 193 pigs were tested. pH24 and pH48 were measured. Chemical composition of meat i.e. dry matter, protein, fat and ash, were determined. Water capacity of meat was determined and cooking loss was found. Loin eye area was measured by planimeter. The largest loin eye area was in crossbred H/EL/ELW♂xEL♀, smaller in purebred ELW. PSE or DFD meat is very closely related with pH; we have to admit, that such meat quality complex was not found. Water binding capacity was the best in crossbred H♂xELW♀ with value 27.04%, the worst in purebred FY with 18.36%. Cooking loss was highest in crossbreeds of H/EL/ELW♂xEL♀ with 45.67%, the lowest in pure-bred ELW with 42.98%. Breed had no significant effect on pH and boiling loss. Breed combinations with EL and H had a better meat quality than other breeds.

Introduction

Pork production has been leading agricultural activity in Estonia for many years. As nowadays customers are more informed, demand for high quality pork has increased rapidly. BSE problems in West-Europe have more and more negative influence to consumption of beef.

This work was conducted to study the differences between pig breed combinations and their effect on meat quality.

Materials and Methods

All tests were carried out in Valga Meat and Canning Factory, in Meat and Feed Laboratory of the Estonian Agricultural University. Five groups of pigs were under observation – purebred - Estonian Landrace (EL), Estonian Large White (ELW), Finnish Yorkshire (FY) and crossbred - Hampshire♂xELW♀ (H♂xELW♀); H/EL/ELW♂xEL♀. 193 pigs were tested.

Test animals originated from 22 farms over Estonia. All meatiness traits for carcass were measured by ultrasonic equipment ULTRA FOM 100 in Valga Meat- and Canning Factory. Live pig measurements were taken by ultrasonic equipment Piglog 105 and A-Scan Plus (Tänavots, et. al., 2000). pH24 was measured with portative pH metre Metter-Toledo MP120 in the meat processing company. A test slice of meat from loin eye was also taken to determine pH48, chemical composition of meat, water holding capacity and cooking loss of meat.

To determine chemical composition of meat, test slice was groud in microcutter until homogeneous structure of meat was achieved. Chemical composition of meat, dry matter, protein, fat and ash, was determined in Feeding Department of Estonian Agricultural University.

The dry matter of meat was determined by EC Directive 73/EEC Annex 1 from 5th of December 1972 (Feeding Department of Estonian Agricultural University 2001).

Raw fat was determined by Soxtec equipment (Tecator Application Note AN 23/80). Raw protein was determined by using Kjeltec equipment (Tecator Application Note AN 30/81).

The water holding capacity of meat was determinate by methods of R. Grau and R. Hamm (1957), modified by V. Volovinchkaja and B. Kelmani (1961). The principle of this method is based on determination of water quantity, which will demerge from meat. There was following formula used:

$$B = \frac{(\mathrm{A - XV})}{\mathrm{A}}\text{, where}$$

A - total quantity of water in weighted meat, mg;
X - water content of 1 cm^2 large wet splash (8.4 mg - constant);
V - area of wet splash cm^2.

The water binding capacity was also determined with planimeter by using filter paper. Cooking loss of meat was determined from 20 g meat slice, which was boiled for 45 minutes at 95 ^{o}C. The difference between meat slice weight before and after cooking was cooking loss in percentages.

Loin eye area was determined by drawing loin eye shape from carcass to test paper and later on this area was measured with planimeter HAFF No 317 E.

The GLM procedure was used for analysing the data by analysis of variance (SAS Inst. Inc., 1991). The following formula was used:

$$Y_{ijkl} = \mu + W_t + F_i + T_j + S_k + e_{ijkl},$$

where: F - searched character; T_j - breed (1...5);
μ - average; S_k - season (1...4);
W_t - pork weight; e_{ijkl} - residue.
F_i - farm (1...22);

All the results are presented by least square means where essential differences between breeds are shown with different letters like a, b, c (Parring *et al.*, 1997).

Results and Discussion

The largest loin eye area was found in crossbreds H/EL/ELW♂xEL♀ with 41.97 cm^2 (Figure 1) and in crossbreds of H♂ x ELW♀ with value 39.96 cm^2. The smallest loin eye area was in purebred ELW with 33.42 cm^2.

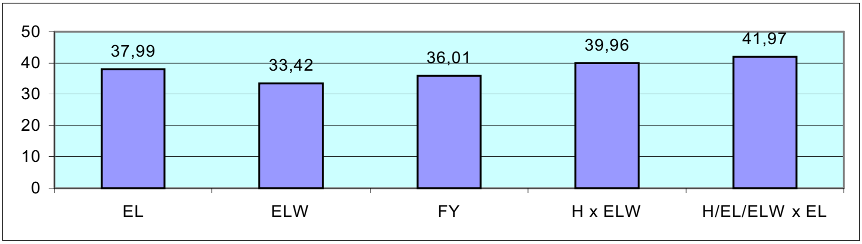

Figure 1. Loin eye area (cm^2)

The pH of meat is showing possible meat quality complexes like DFD (dark, firm, dry) or PSE (pale, soft, exudative). PSE-meat can arise if intra-muscular lactic acid will accumulate into the muscles with in one hour and when temperature of carcass is still high. In some extremal cases of PSE -meat pH can fall 0.02 or even 0.1 unit per minute (Essen-Gustavsson, 1993; Swatland, 1993).

Normal process of glycolyse can stop if pH will be one the level 5.6...5.8. DFD-meat can arise if pH level will not fall as level of glycogen in muscles is too low. In such cases pH will stand on the level 6.8...7.0. Test results of pH24 and pH48 are presented in Table 1.

Table 1. pH24 and pH48 values of pork in different breed combinations

Trait	EL	ELW	FY	H♂ x ELW♀	H/EL/ELW♂ x EL♀
n	137	38	7	7	4
pH 24	5.57^a	5.57^a	5.51^a	5.49^a	5.41^a
pH 48	5.54^a	5.55^a	5.37^a	5.77^a	5.50^a
pH difference	0.05	0.03	0.16	-0.03	-0.08

PSE or DFD meat is very closely related with pH; we have to admit, that such meat quality complex was not found.

The results of cooking loss were showed, that the smallest cooking loss (42.98%) was in purebreds ELW. The biggest cooking loss (45.67%) was found three breed cross H/EL/ELW♂ x EL♀. Cooking loss is a very important factor for meat-processing factories, as the further use of meat will depend on this.

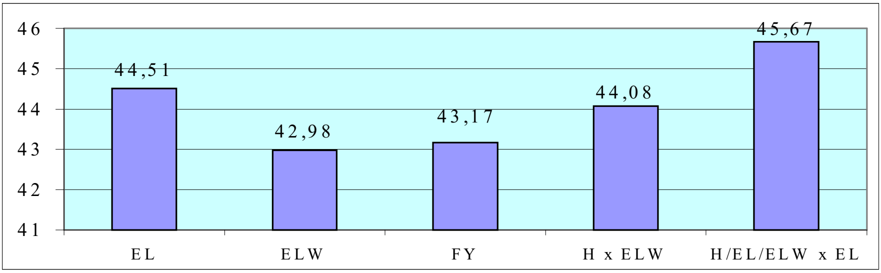

Figure 2. Cooking loss by different breeds

The highest water binding capacity was in crossbreds of H♂ x ELW♀ with 27.04 % and the lowest water binding capacity was in FY with 18.36 %.

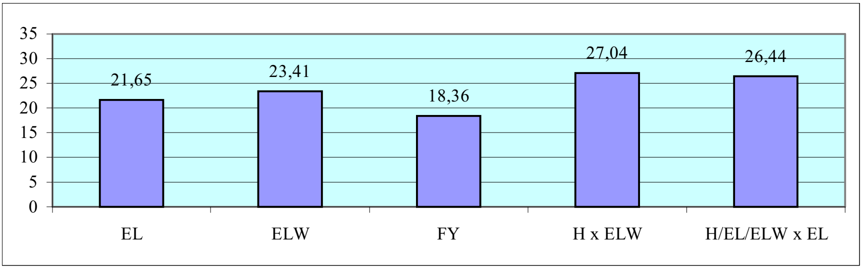

Figure 3. Water binding capacity of tested breeds

Good result in water binding capacity was also obtained in crossbreds of H/EL/ELW♂ x EL♀ with 26.44%.

Table 2. The chemical composition of meat

Trait	Breeds				
	EL	ELW	FY	H♂ x ELW♀	H/EL/ELW♂ x EL♀
n	137	38	7	7	4
Dry matter	25.60	27.69	27.10	26.65	27.41
Protein	22.73	23.22	23.27	22.58	22.99
Fat	1.59	3.22	2.51	2.80	3.15
Ash	1.28	1.25	1.32	1.27	1.28

The content of lean meat showed, that the best protein content was in meat of FY with 23.22% from dry matter. The lowest protein content was observed in meat of crossbreds H♂ x ELW♀ with – 22.58 %. The highest fat content was in meat of purebred ELW with 3.22 % and the lowest fat content was in meat of purebred EL with 1.59 %.

Table 3. Meat quality characteristics of differed breeds combinations and purebreds

Trait	Breed combinations					F	Pr>F
	H/EL/ELW ♂ x EL ♀	H♂ x ELW ♀	EL	FY	ELW		
pH24	5.405[a]	5.491[ab]	5.567[b]	5.515[ab]	5.571[ab]	1.95	0.0051**
pH48	5.506[a]	5.770[a]	5.542[a]	5.372[a]	5.555[a]	0.68	0.8931
Water binding capacity	26.449[a]	27.042[a]	21.646[a]	18.361[a]	23.407[a]	1.42	0.0891
Cooking loss	45.669[a]	44.075[a]	44.508[a]	43.170[a]	42.983[a]	2.61	0.0001***
Dry matter	27.410[a]	26.651[ab]	25.602[b]	27.098[ab]	27.691[a]	3.75	0.0001***
Protein	22.986[a]	22.584[a]	22.730[a]	23.273[a]	23.219[a]	0.97	0.4264
Fat	3.147[ac]	2.790[abc]	1.594[b]	2.506[abc]	3.221[ac]	2.73	0.0001***
Ash	1.279[a]	1.276[a]	1.277[a]	1.319[a]	1.251[a]	1.47	0.0701

As shown in Table 3 there was no significant effect of pH on meat quality of different purebreds and crossbred, as PSE or DFD meat was not determined. There was significant difference in value of pH24 between H/EL/ELW♂ x EL♀ and EL.

No significant differences in pH48, protein content, water binding capacity, cooking loss and ash content were found. The dry matter content of meat showed that there was a significant difference between breeds of H/EL/ELW♂ x EL♀ and EL versus ELW.

The fat content of meat showed, that there is a significant difference between H/EL/ELW♂ x EL♀ and EL versus ELW.

Summary

From current research work we can conclude that with regard to meat quality (loin eye area, chemical composition of meat) the best results were obtained from crossbred H/EL/ELW♂ x EL♀. Very important was also the fact PSE or DFD meat was not found.

From the point of technological quality of meat like water binding capacity or cooking loss we have to admit that the meat from cross-breeds of H/EL/ELW x EL had highest cooking loss. The smallest cooking loss was in pure-breeds meat of ELW. Good water binding capacity was in meat of H♂ x ELW♀ crossbred and the lowest water binding capacity was in meat of FY.

Our conclusion is that for meat production is best way to use crossing of differences breeds like H/EL/ELW x EL. Pure-breeds are not effective for production of meat and can be used for production of crossbreeds.

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FACTORS AFFECTING MEAT TRAITS AND FERTILITY OF PIGS IN ESTONIA

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Summary

Local pig breeds have had high fertility during the times. Recently, however, attention has been paid to improve meatiness traits. The aim of this study was to evaluate effect of different factors on meat traits and fertility. Database was collected from 38 farms during 1998...2001. Backfat thickness and loin eye depth were measured in 26,514 pigs with ultrasonic equipment Piglog-105. The following pig breed combinations were under observation: purebred – Estonian Landrace (EL), Estonian Large White (ELW), Hampshire (H), Pietrain (P) and crossbreds – EL♂xELW♀, ELW♂xEL♀, P♂xH♀. The following factors were included in general linear model: breed, sex, advisor, season, year, parity, farm. Purebred P and crossbred P♂xH♀ pigs had significantly higher lean meat percentage (62.59% and 61.69%), compared with other breeds. Purebred H meat traits were almost at the same level as in local breeds. From local breeds EL breed with lean meat percentage 59.93% was considered better. High lean meat percentage (60.74%) was observed in ELW♂xEL♀. ELW breed had high fertility (11.27), which did not increase by crossing with EL♂. P breed had high mortality (1.65) from birth till weaning. Meat traits have not been improved during last years, except loin eye depth. High fertility was in parities 6...8 and lower in 1st. To improve meat traits, P and EL breeds should be used, whereas high mortality rate of P breed must be considered.

Introduction

During the times local pig breeds have had high fertility as a result of selection of breeding animals by fertility. Recently, however, more attention has been paid to improve meatiness traits. Advisors actively estimate live pigs meat traits with ultrasonic equipment Piglog-105 in Estonia and more attention has been paid also to improve slaughter pigs' meat quality by crossbreeding. The aim of this study was to evaluate effect of different factors on meat traits and fertility.

Material and Methods

Dataset was completed in Estonian Animal Recording Centre from pigs database, which was collected from 38 farms during 1998...2001 in Estonia. Six advisors from Estonian Pig Breeding Association measured 26,514 pigs' backfat and diameter of loin eye with ultrasonic equipment Piglog-105. The following traits were recorded: backfat thickness at last (x1) and 11...12th (x3) rib, 7 cm from midline (mm), and diameter of loin eye (x2), 7 cm from midline (mm) (PÕMm RTL, 1998). Lean meat percentage (y) was calculated using the formula (Piglog 105, 1991). Pigs were tested at 65...150 kg live weight, whereas by using regression relationships between the traits being studied and testing weight, the value of traits investigated was corrected to 100 kg testing weight in all animals.

The following pig breed combinations were under observation: purebred – Estonian Landrace (EL), Estonian Large White (ELW), Hampshire (H), Pietrain (P) and crossbreds – EL♂xELW♀, ELW♂xEL♀, P♂xH♀. The following factors were included in general linear model: breed, sex, advisor, season, year, parity, farm. The testing year was divided into four parts: spring - March, April, May; summer - June, July, August, fall - September, October, November and winter - December, January, February.

General Linear Model (GLM) was used to analyse dataset by SAS software (SAS Inst. Inc., 1991).

$$\mathbf{Y_{ijklmno}=\mu+T_i+M_j+K_k+S_e+A_m+P_n+F_o+e_{ijkl},}$$

Y= dependent variable;	S_e = season (n=1...4);
μ = general mean;	A_m = year (n=1...4);
T_i = breed (n=1...7);	P_n = parity (n=1...13);
M_j = sex (n=1...2);	F_o = farm (n=1...4);
K_k = advisor (n=1...6);	e_{ijkl} = random residual effect

The results are given as least-square means (Parring et al., 1997). Level of significances expressed conventionally: a, b, c – least square, within each effect with one letter in common do not differ significantly.

Results and Discussion

Hampshire and Pietrain are well known for their excellent meatiness traits, but also for their low fertility. Table 1 shows that purebred Pietrain and crossbred P♂xH♀ pigs had thinner backfat, larger diameter of loin eye and higher lean meat percentage, compared to other combinations. On the other hand, Hampshire, meat traits were almost on the same level as those of local breeds. Estonian Large White had a little higher backfat and significantly lower diameter of loin eye (48.35 mm); therefore, lean meat percentage was also significantly lower (59.42%), compared with Estonian Landrace (59.93%). Klimiene *et al.* (2000) found lean meat percentage between 49.20...51.68 in Lithuanian White in 1996...1998. Crossbreeding between local breeds resulted in slightly lower backfat and significantly higher diameter of loin eye than purebreds.

Significantly higher fertility was found in purebred Estonian Large White pigs and their crosses with Estonian Landrace boar, but on the other hand high fertility caused also high mortality from birth till weaning.

Table 1. Meat traits and fertility traits of pig breed combinations

Traits	EL	ELW	H	P	ELxELW	ELWxEL	PxH
n	8910	14303	185	87	2040	966	23
x1 (mm)	13.83[a]	13.92[a]	14.18[a]	11.29[b]	13.38	12.90	11.41[b]
x2 (mm)	49.69[a]	48.35	50.40[ab]	53.55[c]	50.26[b]	50.22[b]	51.82[bc]
x3 (mm)	13.70[a]	14.18[b]	13.88[ab]	11.15	13.64[a]	12.83[c]	12.37[c]
y (%)	59.93[a]	59.42	59.80[a]	62.59[b]	60.13	60.74	61.69[b]
No. of piglets at birth	10.25[a]	11.27[b]	9.00[c]	9.83[ad]	11.28[b]	10.24[a]	9.02[cd]
No. of piglets at weaning	9.99[a]	10.35[b]	8.60[c]	8.18[c]	10.38[b]	10.05[a]	8.73[c]
Difference	0.26	0.92	0.4	1.65	0.90	0.19	0.29

In 1997 the author found (Tänavots, 1997) heterosis effect on fertility in crossing, but in this study, fertility of the purebred pigs was about same level as their crosses. Hampshire and its cross with Pietrain had low fertility, compared with other breeds. Purebred Pietrain had very high mortality from birth till weaning (1.65 piglets).

Difference between sexes showed significantly lower backfat and higher lean meat percentage in male pigs (Table 2).

Table 2. Sex influence on meat traits

Traits	Female	Male
n	20462	6052
x1 (mm)	13.69	12.29
x2 (mm)	50.65[a]	50.58[a]
x3 (mm)	13.67	12.54
y (%)	60.11	61.12

Testing season showed significantly lower lean meat percentage (60.50%) in autumn and higher (60.74%) in spring (Table 3).

Table 3. Meat traits depending on testing season

Traits	Winter	Spring	Summer	Fall
n=	6933	4800	6071	8710
x1 (mm)	12.93[a]	12.90[a]	13.11	13.02
x2 (mm)	50.30	50.62[a]	50.99	50.55[a]
x3 (mm)	13.12[a]	12.94	13.11[a]	13.26
y (%)	60.59[a]	60.74	60.62[a]	60.50

Thus, better periods for fattening are autumn and winter and the worst are spring and summer.

During the years, backfat thickness was not considerably changed (Figure 1).

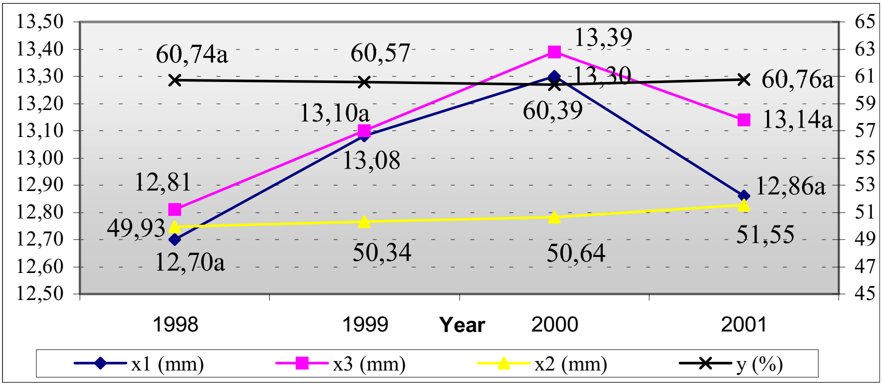

Figure 1. Trend of meat traits in 1998...2001

Trend for backfat thickness was increasing from 1998 to 2000, and decreased at the beginning of this year, whereas difference between two measuring points is higher than in other years. Diameter of loin eye was increasing during the years, from 49.93 mm in 1998 to 51.55 mm in 2001, but lean meat percentage is today on the same level as in 1998.

Significantly lower fertility was in first parity, which increased till parities 6...8 and decreased in parities 9...13 to the same level as in parities 2...5 (Figure 2)

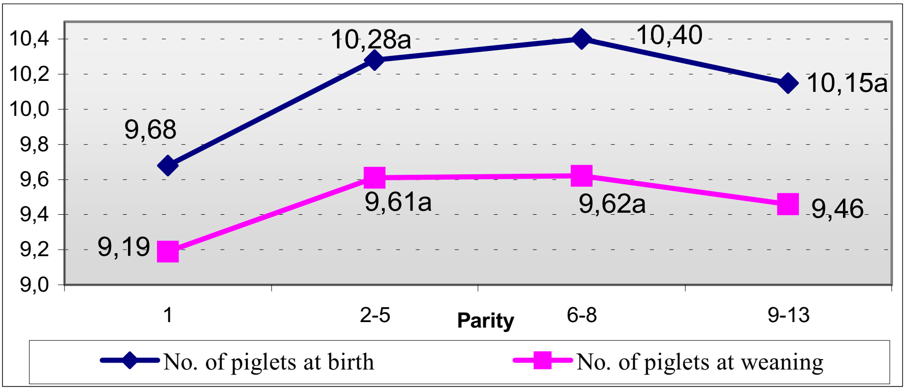

Figure 2. Fertility according to different parities

High fertility is related to high fertility, being in 6...8 parities 0.78 piglets and lower in 1st parity (0.49 piglets).

Finally, it should be noted, that the best local breed to produce fattening pigs was Estonian Landrace. Crossing between local breeds improved meat traits slightly, but fertility was on the same level as in purebreds. From imported breeds, Pietrain breed should be preferred to improve meatiness traits because its meat traits were better than in Hampshire breed. Estonian Large White from local breeds and Pietrain from imported breeds had higher fertility, but it should be taken into consideration, that Estonian Large White had high mortality and that of Pietrain was extremely high. Therefore, to select these breeds, farmers should have good conditions to rear piglets. Farmers should also consider, that litter size will increase till 8th parity, after which it will decrease.

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CORRELATION RELATIONSHIP OF HATCHING EGGS OF LAYERS

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Introduction

More than 70% of cross Lohmann Brown layers are being used for egg production in Latvia. Breeding material - parent stock birds are bought from company Lohmann Tierzucht GmbH, and it is important to rear every purchased chick well. Rearing in cage batteries L121 is not always success with good results. It has been proved in earlier studies that live weight and egg weight of pullets negatively correlate with laying. However, early sexual maturity has no effect no egg weight, but it influences laying results in its beginning stage more [2]. What is essential in pullet rearing period is to achieve the live weight of birds that is recommended by the company otherwise underweight birds will produce comparatively lighter eggs not appropriate for hatching purposes [4].

More eggs with a lower weight are produced by layers of a lower live weight than the recommendation of the company is. When hatching these eggs and rearing chicks live weight of layers may be significantly reduced already after two generations [5]. It is proved by a correlative relationship between egg weight and newly - hatched chicks weight as well as between further live weight of pullets [4]. Appropriate development of both sexes (females and males) is vital for breeding pullet rearing. Too high differentiation of live weight of males is not requested. There are references in literature that heavier males are "lazier", but females with a high live weight are "more inert" [3]. These birds affect egg fertilisation which is an essential trait in parent stock.

The aim of the study was to investigate a correlative relationship of morphological traits of hatching eggs being produced by layers of a different live weight (light, medium and heavy) [1].

Materials and Methods

The studies were performed from 1997 to 2000 using parent stock of cross Lohmann Brown. According to the development of live weight pullets (females) were divided into three groups: heavy birds - 1481-1720 g (group 1), medium weight birds - 1242 -1480 g (group 2) and light birds - 1000 - 1240 g (group 3). The eggs of these groups of birds were analysed morphologically at the age of 32 weeks according to ВНИТИП (1980.1982) method.

Results

The obtained average data of morphological traits of eggs indicate better indices of eggs in groups 1 and 2 both in egg weight and Haugh unit.

Average data of morphological analyses of eggs are summarised in table

Table 1. Average data of morphological analyses of eggs

Data	Groups		
	1	2	3
Egg weight, g	57.53 ± 0.48	54.95 ± 0.57	53.98 ± 0.50
Shell weight, g	5.52 ± 0.06	5.43 ± 0.08	5.47 ± 0.08
Yolk weight, g	15.27± 0.21	14.78 ± 0.16	14.52 ± 0.21
Indexes:			
forms	1.29 ± 0.007	1.29 ± 0.007	1.30 ± 0.008
white	0.11± 0.04	0.12 ± 0.004	0.10 ± 0.004
yolk	0.50 ± 0.005	0.48 ± 0.006	0.49 ± 0.05
Haugh unit	85.1 ± 1.31	88.3 ± 1.19	83.8 ± 1.34

Analysing correlation relationships of morphological analyses of eggs per bird group according to the distribution of live weight, see tables 2, 3 and 4, one can notice differences among the groups in particular traits.

Table 2. Correlation of morphological traits of eggs in group 1

	Egg weight, g	Shell weight, g	Form index	White index	Yolk index	Haugh unit	Yolk weight, g
Egg weight, g	1						
Shell weight, g	0.546	1					
Form index	-0.007	0.007					
White index	0.113	-0.161	-0.415	1			
Yolk index	0.434	0.376	0.087	0.054	1		
Haugh unit	0.124	0.046	-0.367	0.588	0.133	1	
Yolk weight,g	0.515	0.264	0.239	0.001	0.178	0.068	

Table 3. Correlation of morphological traits of eggs in group 2

	Egg weight, g	Shell weight, g	Form index	White index	Yolk index	Haugh unit	Yolk weight, g
Egg weight, g	1						
Shell weight, g	0.389	1					
Form index	-0.001	-0.064	1				
White index	0.034	0.266	-0.144	1			
Yolk index	0.155	-0.260	0.089	-0.094	1		
Haugh unit	0.075	0.286	-0.067	0.967	-0.144	1	
Yolk weight, g	0.420	0.021	0.093	-0.348	0.165	-0.351	1

Table 4. Correlation of morphological traits of eggs in group 3

	Egg weight, g	Shell weight, g	Form index	White index	Yolk index	Haugh unit	Yolk weight, g
Egg weight, g	1						
Shell weight, g	0.603	1					
Form index	0.159	0.078	1				
White index	-0.233	-0.112	-0.135	1			
Yolk index	-0.473	-0.243	0.042	0.084	1		
Haugh unit	-0.221	-0.089	-0.162	0.969	0.032	1	
Yolk weight, g	0.547	0.178	-0.113	-0.196	-0.111	-0.152	

It means that it is possible to do an indirect selection based on these relationships of correlative traits. For instance, there were margins 0.43 to 0.47 in correlation of egg yolk index and egg weight respectively. There was a marked difference per study groups, negative correlation in egg form index and egg white index –0.42 – 0.13.

Conclusions

1. There was a marked difference, i.e., from positive to negative in correlation of morphological traits of eggs in particular groups (divided according to live weight):
   - egg weight and white index + 0.113 … - 0.234
   - egg weight and yolk index + 0.434 … - 0.473
   - egg weight and Haugh unit + 0.124 … - 0.221
   - shell weight and white index + 0.266 … - 0.161.
2. Particular morphological traits of eggs were stable:
   - egg weight and yolk weight + 0.420 … + 0.547
   - white index and Haugh unit + 0.589 … + 0.969.

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HETEROSIS IN THE LINES OF SPECIALISED EGG LAYERS

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The results of crossing the specialised lines show, that positive heterosis of hen egg production was compensated by: less average egg weight, shorter length of time of sexual maturity and better vability of hens. It was determined, that crossing the cocks from pure lines with hybrid hens specific combining ability made a major effect on their egg production. When crossing the hybrid cocks from generation F_1 with the hybrid hens from generation F_1 general combining ability manifested itself. Consequently, egg production of hybrid hens is usually more even among the groups. Maternal combining ability had the largest effect on egg weight heterosis in two line crossings, when in three or four line crossings the paternal line of paternal form.

Both father and mothers had the same influence on hen sexual maturity.

Live weight heterosis depend more on specific combining ability, but better results were obtained from paternal line of paternal form. Both paternal general combining ability and paternal line of paternal form had major effect on hen viability.

Keywords: heterosis, specialised lines, paternal and maternal lines.

Introduction

Genetic homeostasis manifests itself more cleary, when specialised lines are being crossed, i.e., when steady and standardized production is maintaned even under unfavouvable environmental conditions (1, 2). It was determined, that the value of line in crossings depends not only on the size of cleary manifested useful traits, but also on its combining ability with another line or a hybrid form in helping to produce heterotic offspring, which should be higher production according to this trait. Heterosis is a genetic increase of animal and poultry production reserve using crossing in separate lines or breeds, which combine and widen those useful hen and line properties in hybrid offspring (3).

Selectors have many difficulties in selecting specialised inter–combining lines as well as paternal and maternal hybrid forms, in particular from which complex crosses are formed, as there are no other effective techniques for heterosis chech up (4). While crossing specialised lines and their hybrid forms we wanted to find out general and specific combining abilities of the lines and pecularities of heterosis manifestation due to different traits of production.

Methods and Materials

It was determined, that the maximum utilization of heterosis occurrence is possible only in three or four line crosses. Moreover, the lines have to be crossed only according to a certain formula (5). In determining the pecularities of heterosis manifestation paternal lines C_1 and C_2 we re crossed with maternal lines K_5 and L_4. The paternal lines distinquished themselves for their lower egg production and vitality and for their higher egg production and hen weight, while the maternal lines showed their better egg production and viability, but had lower egg and hen weight (Table 1).

Table 1. Production of initial lines

Lines, h^2	Egg members at 73 weeks	Egg weight at 52 weeks g	Sexual maturity d	Body weight g	Livebility %
C_1	198.9	62	167.9	1654	75.3
h^2	0.09	0.17	0.02	0.1	–
C_2	275.6	59.8	165.9	1680	76.9
h^2	0.05	0.08	0.04	0.09	–
K_5	250.9	58.7	165.5	1532	92.2
h^2	0.05	0.12	0.08	0.13	–
L_4	246.8	58.5	163.1	1576	89.8
h^2	0.05	0.10	0.05	0.12	–

Paternal forms C_1C_2 and C_2C_1 were crossed with maternal hybrid forms K_5L_4 aiming to obtain complex crosses. Twelve hybrid combinations were formed altogether, each of them haing 200 to 250 hybrid hens. The analyzed indices were as follows: egg production at 72 weeks of age; egg and hen weight at 52 weeks of age; sexual maturity and viability.

Results and Discussions

When paternal lines C_1 and C_2 were crossed with pure lines K_5 and L_4 and hybrid hens, the results obtained varied differently. The degree of heterosis in two line crossings depended on general combining ability of maternal lines. Egg production of daughters in line K_5 were 244 eggs. Heterosis – 8.4 % ($P < 0.01$). Egg production of the daughters from line L_4 were 232 eggs. Heterosis – 3.6 % 9P < 0.05). The degree of heterosis in the combination of three lines $\Gamma C_2 \times EK_5L_4$ was the highest – 18.5 % ($P < 0.001$) (Tables 2 and 3). When crossing hybrid cocks with pure line K_5 hens, hybrid daughters were obtained. Their egg production was 250.5 eggs. Egg production of daughters from line L_4 was lower – 242.8 eggs. Heterosis – 8.5 % ($P < 0.01$). The highest egg production was obtained from four line hybrid hens $ГC_1C_2$ and C_2C_1 × EK_5L_4. Average egg production was 268.5 eggs. Heterosis – 15.2 % ($P < 0.001$).

Table 2. Heterosis degree of paternal lines by separate production traits

Lines forms	Egg production		Egg weight		Sexual maturity		Body weight		Livebility	
	a	b	a	b	a	b	a	b	a	b
C_1	0.5	5.9^{*}	-0.1	-1.3	1.6^{*}	0.1	4.7^{**}	-0.9	7.9^{**}	2.8
C_2	1	18.5^{***}	-0.6	1.2	-1.9^{*}	-2.7^{*}	1	3.6^{**}	9.3^{**}	8.1^{**}
C_1 C_2	7.9^{**}	12.9^{***}	-1.5^{*}	-1.5^{*}	-3.4^{**}	1.1	1.5	1.6^{*}	9.4^{**}	11.7^{***}
C_1 C_2	6.0^{*}	17.5^{***}	-1.7^{*}	0.8	-3.5^{**}	-2.5^{*}	-2.5^{*}	-3.6^{**}	9.6^{**}	12.7^{***}

a) in crossings with pure lines fowls (K_5, L_4)
b) in crossings with hybrids fowl (K_5L_4)
*– P<0.05, **– P<0.01, ***– P<0.001

Egg weight of hybrid hens in almost all combinations was lower, i.e. their heterosis was negative from – 0.1 % to 2.6 % ($P < 0.05$). There were two exeptions, where the daughters from line K_5 heterosis reached to +0.1 % ($P>0.05$) and that of hens from combination $ГC_2$ × EK_5L_4 was +1.7 % ($P<0.05$). The degree of heterosis in four line hybrids was insignificant, but it had a tendency to be positive. Sexual maturity of all hybrid hens, the mothers of which were the hens from pure lines was two or three days earlier. Heterosis was from 2.0 to 3.9 % ($P<0.01$). When maternal form was hybrid K_5L_4, sexual maturity of three or for line combinations was from one to three days longer. Heterosis was from -0.7 % to –1.5 % ($P<0.05$).

Table 3. Heterosis degree of maternal lines by separate production traits

Lines forms	Egg production		Egg weight		Sexual maturity		Body weight		Livebility	
	a	b	a	b	a	b	a	b	a	b
K_5	8.4^{**}	11.2^{***}	0.1^{*}	-1.8^{*}	-2.4^{*}	-3.5^{*}	1.8^{*}	-2.4^{*}	10.0^{***}	13.4^{***}
L_4	3.6	8.5^{**}	-3.2^{**}	-2.2^{*}	-2.0^{*}	-3.9^{**}	0.9	-1	-3.0^{**}	12.8^{***}
K_5L_4	12.7^{***}	15.1^{***}	-0.3	-0.3	-1.5	-0.7	0.2	-1	8.5^{**}	12.1^{***}

a) in crossings with pure lines fowls (C_1, C_2)
b) in crossings with hybrids fowls (C_1C_2 , C_2C_1)
*– P<0.05, **– P<0.01, ***– P<0.001

The highest live body weight (1691 g) of hybrid hens were obtained in combination $ГC_1$× EK_5. Heterosis +6.2 % ($P<0.01$) and (1697 g) in combination

Г $C_1C_2 \times EK_5$, heterosis +4.6 % (P<0.01). The lowest weight of daughters (1599 g) was obtained, whoo cocks C_1C_2 were crossed with pure line K_5L_4 and hybrid K_5L_4 hens. Heterosis was –0.8 % (P>0.05).

Both fathers and mothers had a great effects on hen viability. The offspring obtained from line C_1 cocks and line L_4 hens were less viable. Their average survival formed 83.8 %. Heterosis of line C_1 and L_4 were 1.4 % and 9.5 %, respectyvely (P<0.005).

More viable daughters wre obtained using hybrid cocks. Survival of pure lines hens formed 88.9 to 94.1 %. Heterosis from 10.3 to 15.6 age hybrid hen survival was 93.7 %. Heterosis – 12.3 % (P<0.001).

Conclusions

The results of crossing shows, that positive heterosis of hen egg production was compensated by: less avarage weight, shorter length of time of sexual maturity and better viability of hens. It was determined, that crossing the cocks from pure lines with hybrid hen specific combining ability made a major effect on their egg production. When crossing the hybrid cocks from generation F_1 with the hybrid hens from generation F_1, general combining ability manifested itself. Consequently, egg production of hybrid hens is usually more even among the groups. Maternal combining ability had the largest effect on egg weight heterosis in two line crossing, when in three or four line crossings the paternal line of paternal forms.

Both fathers and mothers had the same influence on hen maturity.

Live weight heterosis dependet more on specific combining ability, but better results were obtained from paternal line of paternal form. Both paternal general combining ability and paternal line form had a major effect on hen viability.

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SELECTION OF THE INITIAL LINES OF THE LOHMANN WHITE LSL CROSS IN FOUR GENERATIONS

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Introduction

Selection for one or two traits is most efficient. However, heterosis effect for several traits should be the aim at selection of pure lines. The main selection traits in the selection of individual lines of the laying hen cross are egg production, egg weight and incubation data, and the secondary traits are body weight and morphological indicators of eggs. The adaptation process and survival rate of birds should be analysed too.

Sire and dam lines are selected by different traits. The higher is the differentiation of sire and dam lines by productivity, the higher is the effect of heterosis.

Commercial layers of the Lohmann White LSL cross can produce 305 eggs per year by consuming 2.1-2.2 kg of feed per kg of egg weight, provided there was a positive heterosis effect.

However, adaptation of the newly imported birds might result in different productivity of individual lines, and, therefore, scrupulous breeding work should be carried out.

Materials and Methods

Initial lines A, B, C, D of birds of the Lohmann White LSL cross were brought to Lithuania in 1995. Young and adult birds of initial lines were housed in batteries. Control nests of 2 cockerels and 12 pullets were arranged at 17 or 18 weeks of age. Birds for the control nests were selected according to the specific requirements for each line.

- Birds of the male combination lines A and B were selected for the increase in body and egg weights and higher egg production.
- Birds of the female combination lines C and D were selected for higher egg production and reproductive performance.

Beside these main traits set for individual lines, secondary traits, such as body weight of birds of female combination lines C and D, survival rate of birds at different age, reproductive performance of male combination lines A and B have been analysed. The productivity of birds was analysed until 68 weeks of age.

Results and Discussion

The analysis of the data for the male combination A and B lines in four generations indicated that at 18 weeks of age, the body weight of both cockerels and pullets in both lines had significantly increased, on the average by 347 g for cockerels and 291 g for pullets. However, this had no effect on the egg production. In four generations, the egg production has also increased on the average by 18 eggs. The egg weight in both lines has not changed significantly, though there was a tendency towards higher weight (Table 1).

Table 1. Weights of pure line birds and eggs and egg production in four generations

Item	Generation	Lines			
		A	B	C	D
Male body weight, g	F_0	1585.2	1567.1	1603.3	1598.5
	F_1	1519.7	1501.2	1627.3	1585.0
	F_2	1637.2	1669.4	1821.5	1819.6
	F_3	1902.4	1943.8	1903.4	1964.9
Female body weight, g	F_0	1142.7	1165.3	1297.6	1371.0
	F_1	1248.6	1244.4	1310.6	1292.4
	F_2	1242.5	1298.3	1375.4	1333.5
	F_3	1411.75	1457.5	1501.3	1521.4
Egg weight, g	F_0	59.3	58.8	58.2	58.9
	F_1	60.3	58.9	59.2	59.1
	F_2	60.2	59.2	59.0	58.0
	F_3	60.0	59.0	58.7	58.3
Egg production in 68 weeks	F_0	199.6	208.0	219.7	213.1
	F_1	223.2	216.7	225.4	231.4
	F_2	214.6	224.8	204.1	224.3
	F_3	219.3	225.7	202.9	223.3

Selection of the female combination lines C and D also resulted in higher weights of both cockerels (333.3 g) and pullets (177.1 g). In all generations, the body weights in lines C and D were higher than those of male combination lines A and B though genetics specialists of the German company *Lohmann Tierzucht* are of opinion that such data do not contradict the selection purposes. The egg weight in the female combination lines C and D was lower than that in the male combination lines A and B.

Pullets in line A produced eggs of the highest weight which was by 0.4-2.2 g ($P < 0.05$) higher compared with the other lines. In all generations egg laying rate was higher in the female generation lines B and D by 6.0 to 20.4 eggs (Table 1).

The analysis of the egg incubation data indicated that the female combination lines C and D had the highest fertility ($P < 0.001$). Rate of chickens and hatchability were also higher in the female combination lines C and D compared with the male combination lines in all generations (Table 2).

Table 2. Egg incubation and survival rate of pure line birds in four generations

Item	Generation	Lines			
		A	B	C	D
Fertility, %	F_0	82.7	85.5	87.3	94.0
	F_1	75.0	75.0	86.9	81.5
	F_2	80.6	91.3	83.3	91.2
	F_3	79.3	84.0	89.5	90.1
Rate of chickens, %	F_0	64.5	48.3	65.5	72.2
	F_1	61.1	62.8	80.2	81.0
	F_2	56.5	70.1	73.9	79.8
	F_3	65.9	68.5	74.8	79.4
Hatchability, %	F_0	78.0	56.5	75.1	76.9
	F_1	81.5	83.7	92.3	95.4
	F_2	70.1	76.8	88.7	87.5
	F_3	83.1	81.6	83.6	88.1
Survival rate of birds from 0 to 18 weeks, %	F_0	74.1	80.3	83.4	69.1
	F_1	82.0	80.5	87.7	77.4
	F_2	92.2	92.4	92.2	96.3
	F_3	90.2	92.3	96.2	95.9

The analysis of the survival rate data of birds from 0 to 18 weeks indicated that birds of the C line were most resistant in all generations. Their survival rate increased from generation to generation (from 83.4 to 96.2%). The survival rate was also high for the female combination line D (from 69.1 to 95.9%).

Conclusions

1. The selection of female combination birds resulted in their higher body weights compared with male combination birds, and the highest egg weight was determined in male combination line A.
2. Female combination lines C and D had higher reproductive performance than male combination lines A and B.
3. The highest survival rate of birds from 0 to 18 weeks of age was in the female combination line C. The survival rate increased from 83.4 to 96.2% in four generations.
4. The process of adaptation continued in the direction of positive heterosis

BLOOD GROUP AND PROTEIN POLYMORPHISM GENE FREQUENCIES FOR THE LARGE-TYPE ŽEMAITUKAI AND OTHER HORSE BREEDS

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Introduction

The horse has a fossil record of a least 75 million years. Domestication and concomitant human intervention in mating selection have influenced the horse for only the last few thousand years, but have resulted in breeds which serve a variety of purposes. In the last 100 years, several hundred-breed societies throughout the world have defined salient characteristics and established studbooks in an attempt to preserve unique collections of traits.

One of the utility horse breeds is the large-type Žemaitukai. They are most suitable draft horses, easy manageable, not shy, highly disease resistant and undemanding as regards feeding. The development of the horses of this type began at the end of 19^{th} century, when the demand for larger emerged. Žemaitukai horses were crossed with the horses of the Orlov Trotter, North Swedishand Arabian breeds.

Materials and Methods

Two 10 ml blood samples were submitted for each horse, one in ADTA anti-coagulant to use as a source of red cells and one in a dry tube to use as a serum source.

Standard immunological procedures involving hemagliutination and complement mediated hemolysis [3] were used to detect red cell alloantigens at 6 internationally recognized blood group loci: A, C, D, K, Q, P (1995) [2]. The reagents used to detect the antigenic specifities were:

A system	a, b, c, d
D system	a, c, d, f, g, h, k, l, m
C system	a
Q system	a, b, c
P system	b
K system	a

Standard methods of polyacrylamide [1] gel electrophoresis were used to identifity inherited variants at the following protein loci: albumin (Al), transferrin (Tf), esterase (Es), Gc (Vitamin D binding protein), Xk (A1B glycoprotein). Frequency of antigenic factors was calculated as follows:

$$p = n / N,$$

where p – frequency of antigenic factor;

n – number of animals with investigated antigen;
N – total of investigated animals.
The allele frequencies were detected as follows:

$$q = F / 2N,$$

where q – frequency of the allele;
F – number of the allele in the population;
N – total of investigated animals.

Results and Discussion

50 large-type Žemaitukai, 48 Žemaitukai, 25 Lithuanian Heavy Draught and 66 Arabian horses were used in a study designed for blood group and protein polymorphism analyses.

Table 1. Gene frequencies of alloantigenic red cell markers

System	Antigenic factor	Allele	Allele frequency		
			Žemaitukai (n=48)	Large-type Žemaitukai (n=50)	Arabian (n=66)
A	a	ad	0.33	0.44	0.48
	b	bc	0.20	0.08	0.04
	c	c	0.08	0.04	0.04
	d	b	0.08	0.09	0.05
D	a	dghm	0.49	0.18	0.01
	c	cgm	0.18	0.12	0.22
	d	dk	0.04	0.11	0.09
	f	ad	0.10		0.01
	g	dl	0.01	0.11	0.11
	h	bcm	0.05	0.11	0.05
	k	dkl		0.07	0.29
	l	cdf		0.01	
	m	dfk		0.02	
	b	dc			0.07
		cfgkm		0.12	
Q	a	b	0.05	0.15	0.04
	b	c	0.35	0.01	0.08
		bc		0.06	0.02
	c	abc	0.03	0.06	0.14
C	a	a	0.49	0.44	0.48
P	b	b	0.03	0.02	0.02
K	a	a	0.06	0.10	0.05

The genetic analysis of alleles (Table 1) indicated that D^{cfgkm} allele was typical of large-type Žemaitukai and not identified in the Žemaitukai horse. D^{dghm} allele was typical of Žemaitukai, fairly frequent among of large-type Žemaitukai and not identified in Arab horses. Allele also D^{ad}, D^{bcm} alleles were typical of Žemaitukai, while D^{dcm}, D^{dkl} alleles were typical of Arab horses.

The protein polymorphism analysis (Table 2) indicated that there were differences for the phenotypic frequencies between large-type Žemaitukai, Žemaitukai and Lithuanian Heavy Draught horses.

Table 2. Phenotype frequency of blood protein

Locus	Phenotype	Žemaitukai	Large-type Žemaitukai	Heavy-Draught	Arab horses
AL	AA	67.56	36.00	28.00	6.10
	AB	32.43	58.00	56.00	60.60
	BB		6.00	16.00	33.30
Gc	FF	50.00	82.00	80.00	89.40
	FS	50.00	14.00	16.00	10.60
	SS		4.00	4.00	
Est	FF	16.21	12.00	24.00	1.50
	FI	24.32	28.00	44.00	1.50
	II	21.16	52.00	12.00	97.00
	FS	18.91	6.00	8.00	
	IS	18.91	2.00	12.00	
Xk	KK	100.00	90.00	84.00	100.00
	KS		10.00	16.00	
Tf	DD	18.91		4.00	3.00
	FF	18.91	44.00	24.00	27.30
	DF	40.54	14.00	24.00	18.20
	DO	16.21	10.00	8.00	10.60
	FH		6.00	8.00	6.10
	FM		2.00		1.50
	FO	5.40	16.00	24.00	19.70
	FR		2.00		
	DH			4.00	4.50
	HO		2.00	4.00	4.50
	OO				4.50
	MO		2.00		
	OR		2.00		

The protein polymorphism analysis at the transferrin locus indicated that phenotype FF (44%) was more typical of the large-type Žemaitukai, while phenotype DF (40.54%) of the Žemaitukai breed. Phenotype FO, DF, FF was more typical of Heavy Draught horses.

Ten transferrin phenotypes were detected for the large-type Žemaitukai, 5 for the Žemaitukai and 8 for the Lithuanian Heavy Draught horses.

The analysis of albumins (AL) indicated that allele BB was not identified in Žemaitukai horses, though allele AA was rather frequent. However, allele AB was more frequent in Arab horses. Allele AB was more frequent (58%) in large-type Žemaitukai and allele AA was somewhat less frequent (36%), while allele BB was rate (6%). Allele AB was quite frequent (56%) in the albumins of the Lithuanian Heavy Draught horse. There were differences at the Gc locus too. High frequency of allele FF was registered for the large-type Žemaitukai and Lithuanian Heavy Draught horse (82 and 80%), while the frequency of alleles FF and FS was the same (50% and 50%) from the Žemaitukai horse. The analysis of esterase phenotypes showed that II phenotype (52%) was typical of the large-type Žemaitukai, FI phenotype (44%) of Lithuanian Heavy Draught and the Žemaitukai had all 5 known phenotypes almost equally distributed from 16.21 to 24.32%, II phenotype was frequent in Arab horses (97%).

At the postalbumin locus (2 phenotypes known), Lithuanian Heavy Draught and large-type Žemaitukai horses had KK and KS phenotypes, while the Žemaitukai and Arab horses had only KK phenotype.

Conclusions

1. Allelefond of the Žemaitukai, large-type Žemaitukai and Lithuanian Heavy Draught horses has been determined.

2. The analysis of the antigenic polymorphism by blood groups and blood protein indicated that the Žemaitukai horses were different from the large-type Žemaitukai and Lithuanian Heavy Draught horses as regards many antigenic factors of the genetic system and allele frequency.

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DEVELOPMENT OF NONINBRED LINES OF THE ŽEMAITUKAI HORSE BREED

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Introduction

One of the oldest horse breeds in Europe – the Žemaitukai – has only two remaining stallion lines, i.e. those of Erelis[3] and Astūras 634 [1]. It is well known that there should be no less than 5 or 6 unrelated inter se lines in a bred, and, therefore, development of the new lines in the Žemaitukai breed is inevitable [2, 4].

The present study was designed to create some distance in the relationship of the Žemaitukai by developing two new stallion lines.

Materials and Methods

The two new stallion lines are being developed in the Žemaitukai breeding herd belonging to the Lithuanian Institute of Animal Science. The founders of the new lines were selected to be Saturnas ŽRg64 having half of the Žemaitukai and another half of heavy-type Žemaitukai blood and Torgel 768 which is a stallion of the Estonian native breed. Two groups of purebred Žemaitukai mares are mated to these stallions. The breeding work was started in 1999.

The stallions for the development of the new lines were selected according to these criteria:

1) Origin-both heavy-type Žemaitukai and Estonian native horses are genetically close to the Žemaitukai.

2) Individual traits – the selected stallions are close to the Žemaitukai by their body conformation traits, temperament features, movements and type.

3) Body-measurements – the body measurements of the two stallions are close to those of the Žemaitukai.

4) Former experience of the breeders – earlier combinations of the two mentioned breeds have been successful in their results.

Results and Discussion

The breeding herd of the Žemaitukai horses by the Institute of Animal Science has its breeding scheme based on the intrabreeding population method (see scheme). The breeding schemes for the newly developed lines were prepared in accordance with the general breeding scheme, and it was fore seen when and by what criteria the progeny in the new lines could be included into the general breeding scheme.

It is planned that stallions produced in the second or third generation and having 1/8 non-Žemaitukai blood will be considered equal to purebred

Žemaitukai horses and included into the general breeding scheme for the Žemaitukai as the representatives of the new lines. The selection of the young stallions will be carried out according to the evaluation rules for the Žemaitukai horse breed [3]. At first young stallions will be evaluated at 6 to 8 months and 1.5-2 years of age for parentage and body conformation. Adult 3 to 3.5 year old stallions will be evaluated for parentage, body conformation and constitution, breed type, body measurements, character and movements.

Scheme 1. The breeding scheme for the Žemaitukai in the breeding herd by the Institute of Animal Science

	Stallion lines of breeding	
Intrebreeding population method	Čempionas 906	-Č
	Klevas 907	-Kl
	Korys 904	-Ko
	Aidas 905	-Ai
Founders of the newly developed lines	Saturnas ŽRg64	-S
	Torgel 768	-T

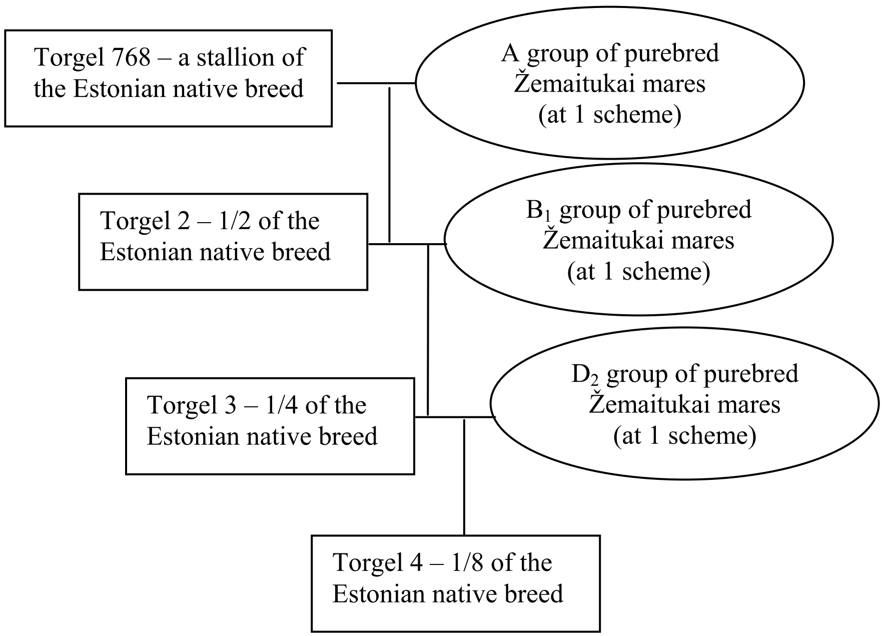
Mare groups of breeding	
Žibuoklė, Kalvarija, Alfa	-A
Audra, Kaukė, Kuba	-B
Aura, Kupolė, Žemyna	-C
Kelmė, Karamelė, Alantė	-D

Year	Stud-horse lines (Č; Kl; Ko; Ai)				New lines (S; T)	
	♀ ♂	♀ ♂	♀ ♂	♀ ♂	♀ ♂	♀ ♂
Parents (1998-2001)	AxČ	BxKl	CxKo	DxAi	BxS	AxT
Daughters and sons (1st generation)	A_1; $\check{C}_1$	B_1; Kl_1	C_1; Ko_1	D_1; Ai_1	B_S; S_B	A_T; T_A
Inbreeding coefficient,%	6.2-12.4	7.1-9.4	8.4-9.4	9.4	3.7-4.7	0
Parents (2001-2005)	A_1xAi_1	B_1xKo_1	C_1xKl_1	$D_1x\check{C}_1$	B_SxAi A_1xS_B	$A_Tx\check{C}$ B_1xT_A
Daughters and sons (2nd generation)	A_2;Ai_2	B_2;Ko_2	C_2;Kl_2	D_2;$\check{C}_2$	B_{SAi} S_{BA1}	$A_{T\check{C}}$ T_{AB1}
Inbreeding coefficient,%	9.9-11.7	7.8-8.8	5.9-7.8	7.1		
Parents (2005-2015)	A_2xKl_2	B_2x $\check{C}_2$	C_2x Ai_2	D_2x Ko_2		$A_{T\check{C}}xKl_2$
Daughters and sons (3rd generation)	A_3;Kl_3	B_3;$\check{C}_3$	C_3;Ai_3	D_3;Ai_3		
Parents (2015-2025)	A_3xKo_3	B_3xAi_3	$C_3x\check{C}_3$	D_3;Kl_3		
Daughters and sons (4th generation)	A_4;Ko_4	B_4;Ai_4	C_4;$\check{C}_4$	D_4;Kl_4		

The stallions to 5 years of age will be evaluated for working test and wait not a little two seasons foals (not a little six) will be evaluated for breeding value of their progeny. Will be leaved 1-2 beast stallions to continue the line.

If the representatives of the newly developed lines do not meet the requirements, they will be excluded from the breeding herd and used as working or pleasure horses.

Scheme 2. Torgel 768 line



Formation of the new lines results in crossbred mares of which only the most typical will be further mated to purebred Žemaitukai stallions.

At the end of 1999 – beginning of 2000 four offspring, two foals and two fillies (of which one has died), were born in the Saturnas ŽRg 64 line. So far only two horse foals sired by Torgel 768 were born. The growth and development of the above-mentioned foals is studied according to the methods applied to purebred progeny.

Conclusions

The weight and body measurements of the foals at birth and further development does not differ from that of purebred Žemaitukai horses. However, the number of foals is too small to draw any conclusions. The breeding work should be finished in 2011.

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THE RACIAL EXTERNAL FEATURES AND HONEY PRODUCTION OF BEES

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Introduction

In recent years the number of swarms of bees in Estonia decreased from 36 000 in 1986 to 20 700 in 1999. This decrease was induced by several reasons: 1) an increase in frequency of bee diseases; 2) difficulties in realisation of honey; 3) a decrease in profitability. The latter happened due to using native crossbred bees descended from unknown parentage in many (over 50%) apiaries in Estonia. Reproducing the queens from crossbred F_1 swarms is giving the queens F_2, whose honey production is 30…50% less than in swarms with purebred or crossbred F_1 queens. For that reason it is very important to determine the racialityy of bees in apiary. Raciality of bees is determined by external features of bees, mainly by the coloration and the cubital index of bees.

According to the statistics, the Carniolan (Apis mellifera Carnica) and Italian (A.m. ligustica) races are mixed with local Nigra (A.m. mellifera) bees. The Italian bees had yellow tergites, the Carniolan and Nigra bees black or brown tergites. Among the honey bees the yellow coloration of tergites is dominant (A) and black or brown coloration (a) is recessive.

If the Italian queen (AA) mates with two Italian (A) and two Carniolan (a) drones, than in the first generation (Filia 1) all workers and drones have the yellow tergite as the yellow coloration is dominant.

When the queen (Aa) from the first generation (F_1) mates with Italian (A) and Carniolan (a) drones, then in the second generation (F_2) 50% of drones have the yellow and 50% the black tergites. 75% of workers have the yellow tergite and 25% the black tergite.

If the Carniolan queen (aa) mates with Italian (A) and Carniolan (a) drones, then in the first generation (F_1) all drones have black (a) coloration, but half of workers have the yellow (A) tergites and half of workers the black (a) tergites.

Therefore the drones F_2 are multicoloured and the drones F_1 self-coloured. Thus, the coloration of workers does not indicate the affiliation of bees into purebred or crossbred (F_1 or F_2) bees. In that case raciality can be determined by the cubital index of bees. The Italian bees had the cubital index from 40…45%, the Carniolan bees from 45…50%, Nigra bees from 60...65%, and it was not subject to seasonal changes (Bilaš and Krivtsov, 1991).

The ability to collect nectar is characterized by the length of proboscis, the length and the width of wing and the width of tergite.

The ability to collect pollen is stamped by the tarsal index on posterior leg and it is modified 30...90% (Nõmmisto, 1999; Nõmmisto and Kalda, 1998, 2000).

Material and Methods

In 2000 the raciality, the external features of bees and honey production were determined in 17 swarms of one apiary. The bees were selected by black coloration. The number of investigated bees was 412. The raciality of bees was determined by the coloration of tergites and the cubital index.

The cubital index was found as the ratio measurements of neighbour obstructions of cubital obstructions in percents on the first wing. The length of proboscis and wing, the width of wing and tergite, the width and length of the first paw segment on posterior leg were measured with a gauge. The tarsal index was found as the ratio of the width and length. The data were analyzed by using the method of variation statistics.

Results and Discussion

The determination of the raciality of bees indicated that there were 47% purebred Carniolan (C) and Nigra (N) bees (29.4 and 7.6%, respectively), 17.7% swarms belonged to F_1 generation (Carniolan x Nigra, or Nigra x Italian (I)), 35.5%swarms belonged to F_2 generation (C x N; N x I; C x I)

The results of measurements of external features of bees and the data on honey production are presented in Tables 1,2,3 and 4.

The external features of Nigra (N) bees and honey production are presented in Table 1.

Table 1.External features and honey production of Nigra bees (C)

No. swarm		Length of pro-boscis, mm	Width of tergite, mm	Length of wing, mm	Width of wing, mm	Tarsal index, %	Cubital index, %	Honey, kg
No 1 (n=23)	$\bar{x}$	5.9	4.7	9.5	3.1	59.1	69.6	2.0
	V	7.2	7.9	8.3	6.4	16.5	12.2	
No 2 (n=27)	$\bar{x}$	5.7	5.0	10.0	3.2	55.4	68.2	27.8
	V	7.2	6.7	6.3	5.1	15.0	16.5	
No 3 (n=23)	$\bar{x}$	6.1	4.8	9.7	3.2	56.3	63.0	25.0
	V	3.8	7.1	5.2	4.4	11.7	12.7	
Total (n=73)	$\bar{x}$	5.9	4.8	9.7	3.2	56.9	66.9	18.3
	V	7.2	7.6	6.5	5.6	14.7	14.8	

The Nigra bees were housed in 3 swarms. On an average of the length of proboscis the Nigra bees was 5.9 mm, the width of tergite 4.8 mm, the width of wing 3.2 mm, the length of wing 9.7 mm, tarsal index 56.9%, cubital index

66.9%, and they gathered 18.3 kg honey. Swarm No 1 gave only 2 kg honey, because the bees had narrow tergite and wing, and shorter wing than bees in swarm No 2 and 3. By the cubital index, the swarm No 1 consisted of Nigra bees, other 2 swarms consisted of some Carniolan bees. The Nigra bees had larger tarsal index than the Carniolan and crossbred F_2 bees ($P<0.001$).

In Table 2 the external features of bees and honey production of Carniolan (C) bees are presented.

Table 2.External features and honey production of Carniolan bees (C)

No. swarm		Length of pro-boscis, mm	Width of tergite, mm	Length of wing, mm	Width of wing, mm	Tarsal index, %	Cubital index, %	Honey, kg
No 4 (n=29)	$\bar{x}$	5.3	5.0	10.2	3.2	57.6	47.7	10.0
	V	7.4	5.5	4.8	7.4	11.7	12.1	
No 5 (n=17)	$\bar{x}$	5.4	4.7	9.7	3.1	44.0	50.4	44.0
	V	10.6	8.2	5.4	5.1	9.6	13.4	
No 6 (n=12)	$\bar{x}$	5.0	4.9	9.8	3.1	48.8	50.6	4.0
	V	6.9	5.6	4.8	3.0	10.2	15.8	
No 7 (n=25)	$\bar{x}$	5.2	4.9	9.8	3.1	45.1	51.7	28.0
	V	9.4	5.9	6.6	10.5	16.6	11.6	
No 8 (n=32)	$\bar{x}$	5.6	4.9	9.9	3.1	55.2	50.5	25.0
	V	9.9	6.5	5.7	5.6	13.1	12.7	
Total (n=115)	$\bar{x}$	5.3	4.9	9.9	3.1	50.1	50.0	22.2
	V	9.7	6.9	5.3	7.1	15.8	115	

They were housed in 5 swarms. On an average, the length of proboscis of the Carniolan bees was 5.3 mm, the width of tergite 4.9 mm, the length of wing 9.9 mm, the width of wing 3.1 mm, the tarsal index 50.1%, cubital index 50.0% and their honey production was 22.2 kg. They gave 3.9 kg more honey than the Nigra bees. The tarsal index of Carniolan bees was diminutive 2.8…6.8 ($P<0.001$) than it was in crossbred F_1, F_2 and Nigra bees.

The swarm No 6 only 4 kg, because the bees in this swarm had shorter proboscis and small wings. The swarm No 5 gave 44.0 kg honey and the bees had the smallest tarsal index – 50.1%

Table 3 presents the external features and honey production of crossbred F_1 bees.

Table 3. External features and honey production of crossbred F_1 bees

No. swarm		Length of pro-boscis, mm	Width of tergite, mm	Length of wing, mm	Width of wing, mm	Tarsal index, %	Cubital index, %	Honey kg
No 9 (n=27) (N x I)	$\bar{x}$	6.1	4.9	9.7	3.3	55.3	60.1	33.5
	V	4.6	6.8	5.1	6.2	8.1	9.4	
No 10 (n=21) (N x I)	$\bar{x}$	5.9	5.0	10.4	3.2	55.1	64.8	30.5
	V	6.4	4.0	3.7	4.5	13.1	12.5	
No 11 (n=26) (N x C)	$\bar{x}$	6.0	4.7	10.1	3.1	57.1	61.8	34.0
	V	6.5	7.5	4.6	5.9	12.8	13.2	
Total (n=74)	$\bar{x}$	6.0	4.9	10.1	3.2	55.8	62.2	32.7
	V	6.1	6.7	4.8	5.8	12.2	12.3	

Crossbred F_1 bees were housed in 3 swarms and they had crosses of Nigra and Italian (swarms No 9 and 10), and Nigra and Carniolan bees (swarm No 11). The crossbred F_1 bees had 0.7 mm ($P<0.001$) longer proboscis than Carniolan and crossbred F_2 bees, 0.1 mm ($P<0.001$) wider tergite than Nigra and crossbred F_2 bees 0.4…0.1 mm (<0.001) bigger wings than Carniolan, Nigra and crossbred F_2 bees 2.9…5.7% bigger tarsal index than Carniolan and crossbred F_2 bees. They gave 10.5…19.6 kg more honey than the Nigra, Carniolan and crossbred F_2 bees. The variety (V) of morphological external features was smaller than it was in Nigra, Carniolan and crossbred F_2 bees.

In Table 4 are presented the external features and honey production of crossbred F_2 bees. They were housed in 6 swarms and they had the crosses Nigra, Carniolan and Italian bees. In the swarms No 13 and 17 dominated the influence of Carniolan bees (cubital index 49.3…53.0%). In the swarms No 15 and 16 dominated the influence of Nigra bees (cubital index 60.4…60.5%).

On an average the length of proboscis of crossbred F_2 was 5.3 mm, width of tergite 4.8 mm, length of wing 9.9 mm, width of wing 3.1 mm, tarsal index 52.2% and cubital index 54.4%. The value of cubital index indicated the great influence of Carniolan and Italian bees among crossbred F_2 bees.

The crossbred F_2 bees had 0.6…0.7 mm shorter proboscis ($P<0.001$) than as the Nigra and crossbred F_1 bees, 0.1 mm (P<0.001= narrow tergite than the Carniolan and crossbred F_1 bees, the shorter wing than crossbred F_1 bees, 2.8…4.0% ($P<0.001$) smaller tarsal index than it was in Nigra, Carniolan and crossbred F_1 bees. They gave 6.4…19.6 kg less honey.

Table 4. External features and honey production of crossbred F_2 bees

No. swarm		Length of pro-boscis, mm	Width of tergite, mm	Length of wing, mm	Width of wing, mm	Tarsal index, %	Cubital index, %	Honey, kg
No 12 (n=19) (C x N)	$\bar{x}$	4.9	4.8	9.6	3.4	48.7	54.1	7.5
	V	12.5	7.9	4.9	9.9	15.4	14.6	
No 13 (n=21) (C x N)	$\bar{x}$	5.0	4.8	9.8	3.0	46.8	49.9	14.0
	V	5.5	6.8	7.4	7.9	24.3	12.3	
No 14 (n=26) (C x I)	$\bar{x}$	4.7	4.6	9.7	3.1	47.9	48.6	14.5
	V	11.8	7.4	6.0	7.8	17.6	13.0	
No 15 (n=25) (N x I)	$\bar{x}$	5.8	4.9	10.4	3.2	59.8	60.4	7.0
	V	6.4	5.3	4.1	6.7	10.7	12.4	
No 16 (n=32) (N x C)	$\bar{x}$	6.0	4.8	10.1	3.1	57.9	60.5	13.0
	V	5.0	5.4	4.1	4.6	10.2	16.5	
No 17 (n=27) (C x N)	$\bar{x}$	5.2	4.8	9.4	3.0	54.2	53.0	22.5
	V	5.8	5.9	5.1	6.4	15.1	13.3	
Total (n=150)	$\bar{x}$	5.3	4.8	9.8	3.1	52.9	54.4	13.1
	V	12.1	6.6	6.1	8.1	17.2	16.8	
All swarms (n=412)	$\bar{x}$	5.6	4.8	9.9	3.2	53.9	58.4	20.1
	V	10.9	7.0	6.2	7.0	15.5	17.1	

The investigation of external features, raciality and oney production indicated that the purebred Nigra and Carniolan, and crossbred F_1 bees possessed longer probscis, wings, wider tergites and wings, bigger tarsal index, and they gave more honey than crossbred F_2 bees.

Conclusions

1. Selection of bees by black coloration gave in an apiary Nigra, Caniolan and crossbred F_1 and F_2 bees. The Nigra bees made up 7.6% from swarms in an apiary.
2. The Nigra bees had 0.6 mm (P<0.001) longer proboscis than the Carniolan and crossbred F_2 bees, 0.1 mm (P<0.01…0.001) narrower tergite, and 0.2…0.4 mm (P<0.001) shorter wings where as the Carniolan and crossbred F_1 bees, they had 0.1 mm (P<0.001) widder wings, 4.0…6.8% (P<0.001) bigger tarsal index as that of Carniolan abd crossbred F_2 bees. They had the highest cubital index – 66.9%, and it was 4.7…16.4% greater than it was in Carniolan and crossbred bees. The honey production of Nigra bees was

3.9…14.7 kg smaller than it was in Carniolan and crossbred F_1 bees. Meanwhile, the Nigra bees were supposed to be perished in Estonia. The investigation of raciality of bees did not confirm that opinion.

3. The Carniolan bees made up 29.4% among the swarms in an apiary. The Carniolan bees had 0.6…0.7 mm ($P<0.001$) shorter proboscis that of Nigra and crossbred F_1 bees, 0.1 mm ($P<0.001$) as wider tergite that of Nigra and crossbred F_2 bees, 0.1 mm ($P<0.001$) shorter wings than the crossbred F_1 bees, 0.1 mm ($P<0.001$) longer wings Nigra bees, 0.1 mm ($P<0.001$) as narrower wings than Nigra and crossbred F_1 bees, 2.8…6.8% ($P<0.001$), smaller tarsal index than the crossbred F_2 and F_1 and Nigra bees. The cubital index was 50.0% on an average. The Carniolan bees gave 3.9…10.1 kg more honey than the Nigra and crossbred F_2 bees.
4. The crossbred F_1 bees made up 17.7% among 17 swarms in an apiary and they were as the crosses Nigra and Italian or Carniolan and Nigra bees. All crossbred F_1 drones were self-coloured, workers self-coloured or multicoloured. Therefore crossbred F_1 bees had bigger and they gave more honey than the pure-bred or crossbred F_2.
5. The crossbred F_2 bees made up 35.3% among the swarms in an apiary and they were the crosses of Nigra Carniolan and Italian bees. The honey production was small - 13.1 kg. The crossbred F_2 drones and workers were multicoloured. Therefore the crossbred F_2 bees were small and they gathered little honey.
6. The crossbred F_2 bees gave by 2.5 times less honey than crossbred F_1 bees, 1.4 times less than Nigra bees and 1.7 times less than Carniolan bees.
7. The queen breeding is very important to obtain the raciality of swarms, and does not permit to reproduce the crossbred F_1 and F_2 queens.

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CHANGES IN MEASURES OF THE ESTONIAN NATIVE HORSE

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Introduction

The Estonian Native Horse belongs to the group of Northern Forest horses and was well known already in the "good old days". Different autors have given different information about the Estonian Native Horse. It has been stated that the Finno-Ugrians have domesticated the horse a long time ago, before the Age of Migration, coming to the Baltic coast not on foot but riding. The existence of horse in Estonia can be observed from the VII century BC.

The Baltic wild horse might have been 120-144 cm tall, most of the medieval horses' height at withers was 136-144 cm.

It is known, that Estonian Native Horses' head is proportionally small, wide and deep. The neck is wide and thick. The chest is wide, buttock round, limbs strong and clean, and feet hard. Temperament is lively, character good. As a fault, there is sometimes incorrect standing and sway back. The predominant colours are bay, chestnut, black and grey.

At the same time its reputation was also destructive. It was dragged out of Estonia and it has been crossed with other breeds.

However, it has still retained its characteristic features.

One of the bases of evaluation of horses is exterior. The faults in exterior affect horses' ability to work, however, there are many exceptions.

The systematic breeding started in this century with establishing of Estonian Native Horse Breeding Society (originally named "The Society of Estonian Country Horse Breeders") in 1921, and with the establishment of studbook in 1922. In 1925, the height of the mares (described in studbook) was 134-147 cm, and the height of the stallions 134-142 cm. Cannon bone girth of the mares was 17-18 cm, and that of the stallions 17-19 cm.

Conclusion

In the summers 1997 and 2000, the measured 105 grown-up horses' average height at withers was 143 cm, chest girth 176 cm, cannon bone girth 18.6 cm. The measures of two-year-old young horses were 139.5-162.7-17.9 cm and those of three-year-olds 141-170.6-18.5 cm, respectively.

The height at rump was mostly greater than height at withers.

To calculate the body weight, a formula *2.56 x chest girth* was used. As a result, the average weight of grown-up horses was 450.8 kg, that of mares 453.3 kg and geldings 448.6 kg. The analysis of the changes of mares' measures shows, that there is no clear logic. Bigger changes are only in chest girth. This indicator has enlarged over 10 cm, as compared with 1921-1930. The cannon bone girth has enlarged 1 cm.

The sway back has also increased. This shows inpersistent height of back at the same time as the heights of withers and rump have enlarged 5 and 4 cm, respectively. The oblique body length was the greatest in 1977 – 156 cm, whereas later studies show the decreasing tendency of this indicator (146 cm). The enlargement shows a straight link to the import of Finnish Horse in 1921-1938.

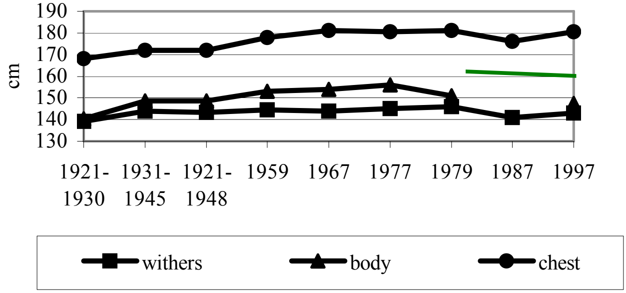

Figure 1. Changes in mares` measures

In changes of stallions' measures can be seen the same logic as by mares. Almost all the measures have slowly grown during the years (especially the width and length of chest and rump).

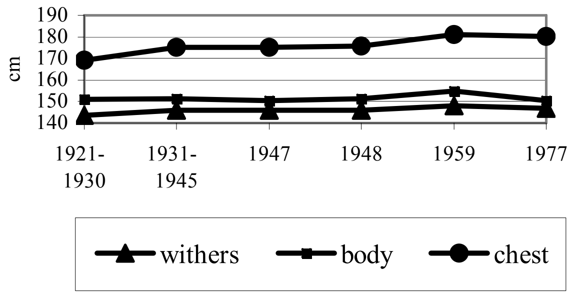

Figure 2. Changes in stallions' main measures

The changes in coat colours show, that the colour of a horse has become more important for the owner. A hundred years ago, most important was considered the horses' ability to work, but today a colourful horse is considered "beautiful". The number of grey horses is increasing (form 10.9% to 20.3%), and chestnut colour is decreasing (from 33.9% to 15.1%).

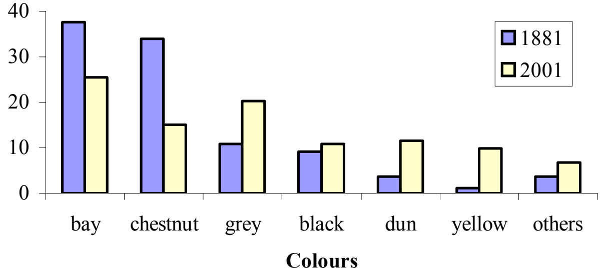

Figure 3. Changes of coat colours

Summary

1. The planned and purposeful pure-breeding of the Estonian Native Horse started in 1921, when the Estonian Native Horse Breeders' Society was founded.

2. The traditional agricultural horse has become a popular riding horse for children and youth in Estonia. Industrial, one-time crossing with Shetland pony or Arab Horse produced numerous ponies. Fortunately, we carried out strict selection among thoroughbreds and thus we succeeded to keep our breeding horses.

3. The Estonian Native Horse is one of the few breeds, which has retained the characteristic features of the native horse and was not significantly influenced by crossing with other breeds.

4. There is no clear logic in the changes of measures. Slow and uneven growth of most measures was observed.

5. The latter have increased white markings and chestnut colour of the Estonian Native Horses who were mostly bay and without markings. We have less more typical aborigine horses now.

The coat is more colourful than 100 years ago.

The number of Estonian Native Horses has decreased sharply over the last few years and the breed has been entered in the Watch List of Endangered Domestic Animals. Presently, the total number of Estonian Native Horses is around 500; 1/2 mares (less than half were used for breeding) and 18 breeding-stallions.

Estonian Native Horses inhabit mainly the islands and western Estonia. In local conditions, the breed has developed into what we know today as the Estonian Native Horse breed. Its essential originality is its smallish growth and modesty. It looks almost like 1000 years ago, and there is no doubt that this breed will remain almost as he is.

CARCASS TRAITS, CARCASS COMPOSITION AND FATTY ACID CONTENT OF THE ESTONIAN LOCAL BREED OF GOAT.

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Introduction

The importance of goat husbandry is trivial in Estonia. Although goat husbandry constitutes a low economic importance to the national income it provides employment to a large number of rural families living in small holdings in Estonia. Most breeders keep small non-commercial herds for home consumption of milk, cheese and meat or for hobby purposes, with the exception of a few commercial milk producers. Estonian local breed of goat is the only goat breed and it is spread all over the country. The usual colour is white, but they are also found as grey, brown or black or various shades or combinations of these colours. Usually they are shorthaired and horned individuals. The goat population in Estonia has been very little affected by foreign breeds. However, recently some blood of Saanen buck and Norwegian elite bucks has been imported.

Estonian local goats are kept primarily for milk production. The main product of goat farming- raw milk is consumed in unprocessed form within a farm, but in limited quantities is converted into several milk products for example soft cheese and yoghurt. Goat meat is produced mainly of castrated male kids and this is additional income for goat farmers. Up to now there was no data about the Estonian local goat meat performance.

Material and methods

A study was carried out in 2000/2001 in Tubri goat farm, Läänemaa, Estonia. The control slaughter of male goat kids at 12 months of age were carried out in abattoir of Ridamäe Sünalepa Ltd. The carcass dissection procedures used have been outlined by Wolf, Smith and Sales (1980). Chemical composition of goat meat was analysed by the Laboratory of Chemistry, the Department of Animal Nutrition at the Institute of Animal Science. Fatty acid content of male goat kid's subcutaneous fat was analysed using gas chromatography by the Laboratory of Ecochemistry, the Department of Chemistry at the Institute of Animal Science. Feeding of goat kids was extensive during the whole growing period. Weaning of goat kids at the age of 2 months is normally preferred in dairy goat farms in Estonia. Cereals were fed until grazing period as ad libitum. There was no supplementary cereal feeding for goat kids during grazing on grass. When goats were housed the daily ration consists of hay, potatoes and 300 g compound feed (mixed oats, barley and minerals).

Results

Slaughter traits and carcass composition of male goat kids at 12 months of age are given in table 1.

Tabel 1. Slaughter traits and carcass composition of male goat kids at the 12 months of age (* Fat= kidney fat + subcutaneous fat + channel fat)

Traits	n=7
Pre-slaughter bodyweight, kg	28.2
s	4.0
Carcass weight, kg	12.4
s	1.59
Killing out, %	44.0
s	1.19
Chilled carcass weight, kg	12.2
s	1.53
Half carcass weight, kg	6.33
s	0.87
Lean, kg	4.35
s	0.67
%	68.7
s	2.59
Bone, kg	1.68
s	0.19
%	26.5
s	2.58
Fat*, kg	0.3
s	0.1
%	4.8
s	1.12
Lean/bone ratio	2.4
s	0.31

Pre-slaughter body weight of male goat kids at 12 months of age was 28.2 kg, carcass weight 12.4 kg with average killing out 44 %. Average daily weight gain from birth to 12 months of age 68 g was for slaughter animals. This data is reflecting that Estonian local goat like most milking goat breeds are maturing rather slowly. Growth rate of goats is pure compared with sheep, but in adequate level compared with other milk type of goat breeds. Shalash et al (1970) compared body weight at 48 weeks of kids with different breed status (Saanen, Baladi, Zaraibi, Saanen x Baladi) and reported that Saanen progeny was heavier (23.4 kg) than any other breed groups (19.1-19.7 kg). The half carcass dissection indicated a low proportion of fat (4.8 %) in the carcass of Estonian local goat kids. Lean: bone: fat ratio (%) in the carcass of 12 months old male goats was 68.7:26.5: 4.8 % respectively. Many authors have reported comparable ratios in the carcass of different local goat breeds (Aboul-Naga, 1984). Morphological and chemical composition carcass of Estonian local goat kids showed that goat meat consists of substantially less fat than lamb or other kind of mammalian meat, but the lean content is remarkable (Table 1 and 2).

Tabel 2. Chemical composition of male goat meat at the 12 months of age (lean + fat)

Item	n=7
Crude protein, %	19.1
s	0.66
Crude fat, %	5.1
s	1.17
Ash, %	1.1
s	0.11
Dry matter, %	27.1
s	2.84

Tabel 3. Fatty acid content of male goat kid's subcutaneous fat

Fatty acid group	Fatty Acid	% of total lipids
Saturated	14:0 myristic acid	2.7
	15:0 pentadecanoic acid	1.0
	16:0 palmitic acid	22.5
	17:0 heptadecanoic acid	2.5
	18:0 stearic acid	38.5
	20:0 eicosanoic acid	0.5
Monounsaturated	16:1 palmitoleic acid	1.6
	17:1 heptadecenoic acid	0.5
	18:1 oleic acid	24.1
	20:1 eicosenoic acid	0.1
Polyunsaturated	18:2 linolenic acid	2.6
	18:3n3 α linolenic acid	0.4
	20:4n6 arachidonic acid	0.1

Goat meat of 12 months old animals contained 19.1 % protein, 5.1 % fat, 1.1 % minerals, dry matter content was 27.1 % which means that goat meat is a good source of fit food with low fat deposition.

Fatty acid content of goat meat (Table 3) is very close to the sheep meat. Most fats of goat meat are saturated (67.7 % of the total lipids) or monounsaturated (26.3 %) and only a small proportion of polyunsaturated (PUFA) like usually in mammalian fat. Goat and sheep fat contain more stearic acid than pig and beef fat, but the proportion of oleic acid is lower (McDonalds, P. et al, 1988) Goat fat contains a small proportion of polyunsaturated acids like linolenic acid and omega 3 fatty acid α linolenic acid (2.6 and 0.4 %of the total lipids), while beef fat does not contain omega 3 fatty acid at all and pig fat contain a similar amount with goat fat.

Conclusions

Pre-slaughter body weight of male goat kids at 12 months of age was 28.2 kg, carcass weight 12.4 kg with average killing out 44 %. Growth rate of Estonian local goat is pure compared with sheep, but in adequate level compared with other milk type of goat breeds. Lean: bone: fat ratio (%) in the carcass of 12 months old male goats was 68.7:26.5:4.8 % respectively. Morphological and chemical composition carcass of Estonian local goat kids showed that goat meat consists of substantially less fat than lamb or other kind of mammalian meat, but the lean content is remarkable. Goat meat of 12 months old animals contained 19.1 % protein, 5.1 % fat, 1.1 % minerals, dry matter content was 27.1 % which means that goat meat is a good source of fit food with low fat deposition. Fatty acid content of goat meat (table 3) is very close to the sheep meat. Most fats of goat meat are saturated (67.7 % of the total lipids) or monounsaturated (26.3 %) and only a small proportion of polyunsaturated (PUFA) like usually in mammalian fat.

To obtain heavier carcass from Estonian local goat kids more intensive pre-slaughter management during the last 2 or 3 months is essential. It can be achieved by using bigger daily quantities of compound feed (500-600 g).

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SCIENTIFIC SUBSTANTION OF GOAT MILKING TERMS

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Milking goats is easier than milking cows or sheep because the major part of milk is already in the udder. When milking a goat the milk is released only after the hormones influence on the glands, which is a reaction on manipulating the udder. There are two ways of milking a goat:

- milking by hands,
- using a milker.

Milking by hands. There are three methods of milking by hands: fists, clipping and craning.

The fist method is better and more lenient. The thumb and forefinger holds the dug tightly to the udder while the middle, ring-finger and minimus are squeezing the milk out. The hand itself is not moving up or down and twitching the udder. If the goat's dug is very short, it can be squeezed by 2 or even 1 finger.

If the dugs are very short, the milking can be done by a method of clipping. With this method the thumb is bent and the base of the dug is pressed away from the udder and the milk is squeezed out by the middle finger. When milking with the fist method firstly the excretory duct is closed in the direction of milk flow with the thumb and forefinger. Then the milk is squeezed out with the remaining fingers in succession. Brutal pulling or pressing is not allowed as it may cause irritation of the sensitive skin inside the udder.

Milking with the craning method is wrong and even dangerous to the goat's skin because milk is squeezed by thumb and forefinger and the dug is pulled too strong.

If you are milking a goat from the right side then the left hand is holding the goat's right dug and the right hand is holding the goat's left dug. When the milk flow decreases continue milking with right hand only and rub the udder from up to down.

Using a milker. The goats' milking machine is very much alike cows' milkers, though it, of course, has only 2 dug cups. It imitates a yeanling sucking milk. It works in vacuum changing the sucking and resting phases regularly. The proportion of sucking and rest periods has to be 1:1 or 2:1, 70 – 90 sucking – resting steps per minute are recommended and the vacuum has to be 40 – 44 kPa. It is very important to follow all of the technical parameters otherwise the milker can cause serious damage to the goat's udder. The milker has to be disconnected immediately after the milk flow ends, because blind (empty) sucking affects udder's tissues and can cause irritation. If the udder is empty and flabby switch the vacuum off and take away the milker. You can control the udder by milking it by hand a few times. As the work consumption while cleaning, disinfecting and maintenance of the milker is rather big, the use of it pays only with 20 – 25 milk goats. Whereas if the main reason for using a milker is the relieving of milking process the milker is beneficial with even less goats (10 – 15). There are special compact mobile milkers for small goat herds.

The udder should be cleaned before milking, preferably with a paper tissue. Wet pieces of cloth can carry vector diseases from one goat to the others.

The work is easier to do with a milker positioned high enough to avoid bending and cleaning. If there are only 1 or 2 goats to milk it should be enough with a simple wooden platform 50 – 80 cm high. The goat will jump on it when lured by a bit of nourishment. When goats get used to the milker many of them even do not have to be tied up. With bigger milkers several (up to 30 and more) goats can be milked simultaneously.

Disinfecting. Disinfection is recommended to avoid carriers of udder irritations, which penetrate the udder generally after the milking. After milking, especially after using a milker the dugs should be treated with a special iodine disinfector. Goats with udder infections always must be milked the last.

Causative agents of udder irritations. As the udder is one of the most active organs it can be attacked by a whole range of infectuous diseases. The most important ones are those caused by uncareful milking. Infections are caused by microorganisms, mainly bacteria, which penetrate the udder after milking. In most cases penetration happens right after milking, when the udder is empty. The infection carriers are in the environment around the goat. It is seldom when infection is brought by the blood system from other organs. The inner tissues of goat’s udder are very defensive against microorganisms, but if the udder is injured or the microbs are in very large quantities, the irritation can begin. Injuries of udder tissues are mainly a result of wrong milking. If milking by hands there should not be is too much pulling and when using a milker it can be a wrong vacuum level, wrong pulse tact and continued milking when the udder is already empty. When misusing the milker there is a danger of carrying infections from one goat to the others.

The irritations (mastitis) must be treated with antibiotics. The directions of veterinarian must be followed precisely and the subscribed dosage must not be decreased just because the irritation seems to have descended.

The main method of preventing mastitis is clean and careful milking.

Storage of milk. The milk has to be strained through cotton wool filter immediately after milking. Any filter cloth is not appropriate because they have to be boiled after each use. Paper coffee filters can be used as a fill-in only because the milk flow-through is very slow.

Goat milk has to be stored cold, small amounts refridgerated, bigger amounts in coolers or cooler tankers. The cooler tank (2 – 5 ^{0} C) must be placed separately from the milking place Goat milk can be stored in cellar for one day or canned and placed in a manger with a cold water flow. For a longer storage the milk should be kept in steel tankers for this material is the easiest to clean and disinfect.

MILK YIELD OF MARES AND GROWTH OF FOALS IN THE LARGE-TYPE ŽEMAITUKAI BREED

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Introduction

Growth of horse progeny is one of the topical issues. The studies of the researchers of farm animal development indicated that the energy of growth is not even and can be characterized by some dominating direction at different growth periods, i.e. some organs and body parts develop more intensively at one particular time and others at another time. If at some period of development, the growth of the animal becomes slower due to insufficient feeding, the organs with the most intensive development at that period can be affected most significantly. And vice versa the improvement of housing and feeding conditions is most beneficial to the organs developing most intensively at that particular period (Tchivinsky N.P., 1949; Maligonov A.A., 1927). The growth of foals is most intensive in the first months of their age. As the mother's milk is their main feed, the milk yield of mares is of great importance for the successful growth of foals.

Until now, no studies have been conducted in Lithuania to determine the growth peculiarities of foals and milk yields of mares in the large-type Žemaitukai breed. Therefore, this study was designed to investigate the biological traits of the large-type Žemaitukai horse breed which is currently under conservation.

Materials and Methods

The growth rate of 9 fillies and 3 horse foals has been observed and body measurements analysed. The chemical composition of milk of 9 mares in five lactation months has been analysed.

The growth rate of foals was determined by measuring them at birth, one, 3, 9, 12, 18, 24, 30 and 38 months of age.

The milk yield of mares was determined by the method of V. Dobrynin (1955, 1984) according to the foals weight. The milk yield of mares in five lactation months was determined using the mare lactation curve by A.S. Krasnikov (1973).

The composition of milk was analysed at the Chemical Laboratory of the Lithuanian Institute of Animal Science (LIAS). The following indicators were analysed: dry matter, fat, protein, lactose, ash, calcium, phosphorus, zinc, copper, manganese and iron contents in milk and milk acidity.

Results and Discussion

The analysis of the growth data for the large-type Žemaitukai progeny indicated that the height at withers of the newly born horse foal made 65.1% of the withers height of a four-year-old stallion (that of fillies respectively 63.7%). Next followed cannon bone girth (58-60.3%), forehead width (59.1-60.4%) and head length (56.8-58.8%). During the embryonic growth, chest width (36.8-37.4%), chest girth (46.0-44.8%), chest depth (41.8-42.6%) and body length (46.6-46.7%) have developed least intensively. The body parts which had developed more slowly during the embryonic period, grew more intensively in the postembryonic period, e.g. in the first postembryonic month the body length increased even by 15%, while the height at withers only by 5%.

The body measurements of the newly-born foals and fillies were almost the same, except for the height at withers and height of the back and loins that were by 3.4 cm higher for foals. In the first month of their age, the development of fillies and foals was of the same intensity. Beginning from the third month, the chest width, chest depth, head and body length of the fillies increased more intensively than the corresponding measurements of the foals.

During months 3-6, the height at withers and back became the same for both fillies and foals, and the loin height measurements of the fillies exceeded those of the foals. However, starting from month 9, the foal measurements of the height at withers, at the back and loins always were higher than those of the fillies. The body length of the fillies was always higher than that of the foals.

A significant increase in all body measurements was registered in the first six months (sucking period). At that period, the measurements of the height at withers, at the back and loins made up more than 4/5, and the measurements of the body length, cannon bone girth and chest girth almost ¾ of the same measurements for the foals and fillies at 4 years of age. The body measurements of large-type Žemaitukai horses at 3 years of age have almost reached the measurements of adult horses.

The most intensive growth from birth to 3 months of age was registered for the body length and chest girth. The height at withers, back and loins, cannon bone girth and head length increased significantly slower. The first three months of horse growth witnessed the highest growth energy of all body measurements. Fairly intensive development was registered in months 3 to 6. Later, the growth intensity of all body measurements gradually decreased.

Weight gain analysis indicated that large-type Žemaitukai mares can be distinguished by high milk yields. According to the daily weight gains, the average daily milk yield of mares in the first month of the foal growth was 15.07 kg (11.9-20.9). There were differences in the milk yields of individual mares most likely due to different housing and feeding conditions of mares.

The average milk production of large-type Žemaitukai mares in five lactation month was 2219 kg, the highest yield being 2901 and the lowest 1651 kg of milk. The average daily milk yield in five lactation months was 14.7 kg (min - 11 kg, max – 19.3 kg). The mares of the large-type Žemaitukai breed are more milk productive, than those of the Žemaitukai, Thoroughbred and Orlov Trotter breeds, but less productive than the mares of the heavy-draught breeds. However, the large-type Žemaitukai mares produce on the average more milk per kg of their own body weight compared with the heavy-draught and light-type mares. Large-type Žemaitukai mares produce 28.2 g of milk per kg of their body weight (Table 1).

Table 1. The relationship between milk production and body weight of mares

Breeds	Average daily milk production in 5 lactation months		Average body weight		Milk per kg body weight, g
	kg	% of Shetland pony	kg	% of Shetland pony	
Heavy type Žemaitukai	14.7	129	520	236	28.2
Heavy type	17.1	150	710	323	24.1
Light type	14.3	125	590	263	24.2
Žemaitukai	11.8	104	390	177	30.2
Shetland pony	11.4	100	220	100	52.0

Our study indicated that the content of dry matter was highest (14.24%) in the milk of mares in 2 to 5 days after foaling. Later, the dry matter content decreased and made up only 96% ($P < 0.05$) at month 5.

Milk fat content was highest during the first lactation days and made up 2.74%. The decrease of the milk fat content was slow and made up 2.08% at month 5.

Protein beginning of lactation was also highest (3.89%) at the beginning of lactation and made up 2.16% ($P < 0.01$) at the end of lactation.

The content of lactose in the milk of large-type Žemaitukai was increasing from the beginning (5.86%) to the third lactation month (6.66%). At month 5, the content of lactose (5.86%) was the same as that at the beginning of lactation.

The ash content was highest (0.62%) at the beginning of lactation and decreased to 0.35% ($P < 0.001$) by the third lactation month. At month 5, the ash content was by 0.04% higher than that at month 3 ($P < 0.005$).

Conclusions

1. Large-type Žemaitukai foals are distinguished by high growth rate under normal conditions. The growth is most intensive to 6 months of age and afterwards it slows down. The chest girth and body length increase most intensively to one year of age. The body measurements of the adult horse are reached at the age of 3 to 4 years.

2.The studies of the milk production by large-type Žemaitukai mares indicated that the mares yielded daily on the average 15.07 kg of milk in the first lactation month and on the average 2219 kg of milk in five lactation months.

3. Large-type Žemaitukai mares produced on the average 28.2 g of milk per each kg of their own body weight and by this indicator surpassed heavy-draught and light-type mares. The average milk composition of large-type Žemaitukai mares was 2.4% (1.35-3.51%) fat, 2.9% (1.49-4.93%) protein, 6.1% (4.89-8.04%) lactose, 0.4% (0.28-0.73%) ash and 11.6% (7.94-24.07%) dry matter.

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THE INFLUENCE OF SEASON AND FREQUENCY OF LAMBING ON FERTILITY AND PROGENY WEIGHT OF LITHUANIAN LOCAL COARSEWOOLED SHEEP

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Introduction

Seasonal reproduction is characteristic of sheep. The heat is most intensive in autumn except for Romanov, Finnish landrace and local coarsewooled sheep breeds that can be mated all the year round. Proper management of sheep mating affects their fertility and performance of the future progeny.

The literature survey indicates that in order to increase the number of lambs, sheep can be mated every 8 or 6 months. More frequent lambing has no negative influence on wool production and sheep weight. Only more frequent mating of sheep results in lower conception rate and weaker, under weight progeny [1, 2, 3, 4].

In 1995, a herd of almost extinct local coarsewooled sheep was formed at the Institute of Animal Science. The herd was started with two ewes and one ram. At present, the number of sheep amounts to 30. The herd is kept with the aim of conservation of the genofond of local sheep and studies of their biological and farming qualities.

Lithuanian local coarsewooled sheep are distinguished by exceptionally non-seasonal heat, and, therefore, these sheep can drop lambs at any time of the year. The present study was designed to determine the effect of season and frequency of lambing on fertility of the sheep and growth rate of the progeny.

Materials and methods

The data of sheep reproduction in 1996 to 2000 have been analysed. Fertility of sheep was determined by the number of lambs born and the milk yield of ewes by the weight of 20 day-old lambs. All the lambs were weighed at day 1 and 20, at two months, at weaning and 10-12 months of age.

Results

The data for sheep reproduction in respect to their lambing season are presented in Table 1.

The analysis of the data indicated that sheep lambing in spring were by 25% more fertile than those lambing in summer and by 15% more fertile than those lambing in autumn and winter. However, ewes dropping lambs in autumn and summer were most milk productive and in 20 lactation days produced approximately by 4.0 kg of milk more compared with the ewes lambing in winter and spring.

Table 1. Influence of lambing season on sheep fertility and weight of lambs

Item	Lambing season			
	Autumn (n=9)	Winter (n=15)	Spring (n=7)	Summer (n=6)
No. of lambs per sheep (1996-2000)	1.70	1.70	2.00	1.50
Including:				
those lambing once a year (1996-2000)	2.00	2.00	2.50	-
lambing every 8th month and more often (1996-2000)	1.60	1.70	1.60	1.40
Milk yield in 20 lactation days, kg	21.30	17.80	16.40	21.40
Weight of newborn lamb, kg	3.15	2.99	3.10	3.51
Lamb weight at 20 days, kg	7.33	6.66	6.38	7.70
Lamb weight at 2 months, kg	15.75	12.89	10.17	15.76
Weight of weaned lamb, kg	17.67	18.17	15.77	21.92
Lamb weight at 10-12 months, kg	39.61	37.04	37.07	40.01

Weight of the lambs born in summer was by 0.4 kg higher than that of the lambs born in spring, autumn and winter. The autumn and summer lambs had the highest growth rate. By the age of 20 days and 12 months they exceeded the weight of their contemporaries born in spring and winter by 1 and 3 to 5 kg, respectively. The growth rate of lambs was mostly influenced by the milk yield of ewes, pasture grass and good care. It is well known that ewes are most milk productive at the time of grazing.

It is also important that in 1999-2000 out of 11 ewes, four ewes dropped lambs every 8th month, four twice a year and three ewes lambed only once a year. The litter size of the latter amounted to 2.2 lambs, and their survival rate till weaning was 78%. More frequent lambing resulted in 13% of stillborn and undeveloped lambs and 9.7% of weak lambs which died in 1 to 3 days. Besides, the litter size of more frequently lambing ewes was only 1.6 lambs and their survival rate till weaning was only 58%.

Thus, in two years time, 8 frequently lambing ewes dropped and enlarged the flock by 18 lambs and 3 ewes lambing once a year by 6 lambs. Consequently, frequent lambing of ewes resulted in only by 9% more lambs than usual.

Separate body parts of yearling ewes were measured in order to have a more precise estimation of the growth rate of the progeny. Indices for body measurements were estimated too. The measurements indicated that female lambs dropped in summer had the best exterior (Table 2).

Table 2. Body measurements of yearling ewes dropped at various seasons

Item	Season of dropping female lambs			
	Autumn (n=3)	Winter (n=3)	Spring (n=3)	Summer (n=3)
Body measurements, cm:				
Height at withers	56.67	58.00	57.33	61.33
Height at rump	63.33	62.33	61.67	64.67
Chest depth	25.00	25.50	22.67	27.00
Chest width	18.33	16.50	15.33	18.67
Oblique body length	60.33	60.33	59.67	63.67
Width at hips	15.33	13.50	12.50	13.67
Forehead width	8.00	9.00	9.83	9.83
Head length	17.17	17.00	17.00	18.17
Horn length	6.00	9.00	11.50	10.50
Ear length	11.67	9.33	9.67	10.83
Chest girth	76.33	75.50	74.67	79.00
Cannon bone girth	7.83	7.63	7.67	7.67
Tail length	21.33	20.67	19.83	23.50
Index, %:				
Long-leggedness	55.88	56.03	60.46	55.98
Extension	106.46	104.02	104.08	103.82
Compactness	126.52	125.15	125.14	124.08
Chest	73.32	64.71	67.62	69.15
Massiveness	134.69	130.17	130.24	128.81

Conclusions

1. Frequent lambing is not advisable for ewes. Yearly lambing and consequent stronger lambs should be the aim.

2. Mating time for sheep should bechosen taking into account availability of feeds.

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