AGRICULTURAL UNIVERSITY- PLOVDIV
DEPARTMENT ANIMAL SCIENCE

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MODERN TRENDS IN THE CREATION OF HIGH-PRODUCING DAIRY SHEEP POPULATION IN BULGARIA AND POSSIBILITIES OF USING THE PLEVEN BLACKHEAD SHEEP IN THE SELECTION PROCESS

AUTHOR'S SUMMARY
OF DISSERTATION
FOR THE ACQUISITION OF THE EDUCATIONAL AND SCIENTIFIC DEGREE 'DOCTOR'
IN SCIENTIFIC FIELD 'BREEDING OF FARM ANIMALS, BIOLOGY AND REPRODUCTION BIOTECHNOLOGY'

SCIENTIFIC SUPERVISOR
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The dissertation comprises 165 pages and includes 'Literature review'- 26 pages, 'Aims and Objectives'- 2 pages, 'Material and Methods'- 10 pages, 'Results and Discussion'- 101 pages, 'Summary'- 5 pages, 'Conclusions'- 2 pages, 'Recommendations'- 1 page, and 'Literature'- 26 pages. A list of 4 publications connected to the dissertation is also enclosed.

The sources cited are 302 and 57 of them are in Cyrilic script.The data are presented in 53 tables and illustrated in 30 figures.

The dissertation work was discussed in front of the board of professors at the Department of Animal Science, Agricultural University Plovdiv, Protocol № 6/14.04.2025 and allowed to be defended.

The defence of the dissertation will be performed on 28.07.2025 at 11.00 in the meeting hall of the Faculty of Agronomy in Agricultural University-Plovdiv at a meeting of the Specialised scientific jury designated by the Rector of the Agricultural University- Plovdiv following order №RD16-612 от 14.05.2025 г.

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The materials related to the defence are available on the webpage of Agricultural University Plovdiv, www.au-plovidv.bg and in the library of Agricultural University-Plovdiv, Plovdiv, 12, Mendeleev blvd.

Note: The numbering of the tables and the figures in the present author's summary do not corresponed to that in the dissertation.

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ABBREVIATIONS

DSBA- dairy sheep breeding association; EF- East Friesian sheep; MUFA- Monounsaturated fatty acids; SFA- saturated fatty acids; USFA- unsaturated fatty acids; PUSFA- polyunsaturated fatty acids; PBS- Pleven Blackhead sheep; BDSP- Bulgarian Dairy Synthetic Population; gMF- milk fat per gram; CLA- conjugated linoleic acid; BCFA- branched chain fatty acids; ω-3, 6, 9- omega-3, omega-6 omega-9 fatty acids;

INTRODUCTION

The sheep farming is a traditional branch of the animal husbandry in Bulgaria. It is a dairy and milk production resource with considerable potential to provide socio-economic stability in the rural areas. The number of the sheep reared in our country reached 11 000 000 in the mid 1980s. Throughout the years, Bulgaria used to be among the countries with the largest concentration of sheep per decare of land managed. However, as a result of the chaotic liquidation of state-run and cooperative farms, the sheep number had sharply decreased since the beginning of the 1990s. At the end of 2024, there were 10 times (1 021 000) fewer sheep than in the 1980s.

96,2% of the controlled sheep in Bulgaria are farmed for dairy production. Throughout the years, different crossbreeding schemes, mostly with the Awassi and East Friesian breeds and recently with the Assaf and the Lacaune sheep etc., have been applied for the purpose of increasing the milk yield. The current state of the dairy sheep farming shows, however, that the desired crossbreeding quick effect has not been observed yet. It will be impossible to achieve it without a systematic, scientifically based approach towards the breed-formation process and a radical change in the sheep feeding and rearing practices.

The present dissertation aims to determine the state and the trends in the dairy sheep farming by means of analyzing the developmental dynamics and the productivity of part of the controlled dairy population as well as to ascertain the possibilities of using the main local dairy breed-Pleven Blackhead sheep in the selection process upon creation of high-producing dairy sheep population in Bulgaria.

AIM AND OBJECTIVES

Aim: Examination of the contemporary trends in the dairy sheep breeding development and the possibilities of using Pleven Blackhead sheep in the breed-formation process based on a phenology and population genetic analysis of the part of the dairy population in Bulgaria which is subject to selection.

Objectives:

1. Establishment of the developmental directions and the possibilities of managing the productivity of Bulgarian Dairy Synthetic Breed based on the analysis of :
   1.1. The state and dynamics of the part of the breed controlled by DSBA;
   1.2. The exterior characteristics of the sheep in the controlled flocks;
   1.3. The milk yield and the factors which influence it.
2. Establishment of the developmental directions and the possibilities of managing the productivity of the Pleven Blackhead Sheep Breed based on the analysis of:
   2.1. The state and dynamics of the controlled part of the breed
   2.2. The exterior characteristics of the sheep in the controlled flocks;
   2.3. The milk yield and the factors which influence it.
3. Determination whether the Pleven Blackhead sheep can be used as a foundation upon creation of a high-producing dairy population in Bulgaria based on the analysis of:
   3.1. The milk yield of the crosses with the East Friesian sheep;
   3.2. The milk yield of different-generation crosses with Assaf sheep;

3.3. The influence of the crossbreeding with the Assaf breed on the chemical composition and the technological properties of the Pleven Blackhead sheep milk;
3.4. The blood biochemical status of the Pleven Blackhead sheep and crosses with the Assaf sheep as an indicator for the animals' welfare.

4. Determination of whether Pleven Blackhead sheep x Assaf crosses can be used for a year-round production based on the analysis of:
4.1. The milk yield and the lactation persistency during different seasons of lambing;
4.2. The reproduction intensification possibilities.

5. By summarizing the results of the study, to determine the direction of the breeding activities for the purpose of improving the productivity of the part of the breed which is controlled by the breeding organization.

MATERIAL AND METHODS

The following were used for the purpose of evaluating the **current state** of BDSP and PBS: breeding records, primary breeding documentation, studbooks, zootechnical certificates, reports of respectively the dairy sheep breeding association and the Association of Pleven Blackhead sheep since their establishment as well as data obtained from the BFSA and the EASRAB information systems.

The current state of the BDSP and the PBS controlled by the associations was analysed by means of examining the dynamics of the controlled sheep and flocks numbers since the establishment of the associations, the average size of the flocks, the flocks breeding status and the territorial distribution of the farms in the country. **The exterior assessment** was performed in the course of the flocks monitoring.

The **milk yield** of the **BDSP** sheep breed and the influence of some paratypic factors on it were studied by means of an analysis of 18 649 records with reference to the milk yield of the sheep in 30 farms, included in the 'elite' nucleus part of the breed, during three separate years : 2020-2023. 23 of the farms (N 13589) were situated in Northern Bulgaria. We differentiated 4 regions: 1- Ruse and Razgrad (N- 5627), 2- Pleven and Lovech (N- 9150), 3- Veliko Tarnovo (N- 2982), and 4- Montana (N- 890). The sheep in Southern Bulgaria (N- 5060) were reared in 7 farms of which 5 were in Haskovo province, one in Stara Zagora and one in Kardzhali province.

The milk yield of the entire controlled population for 2019 was also examined. The records with reference to 10281 ewes from 132 flocks were processed.

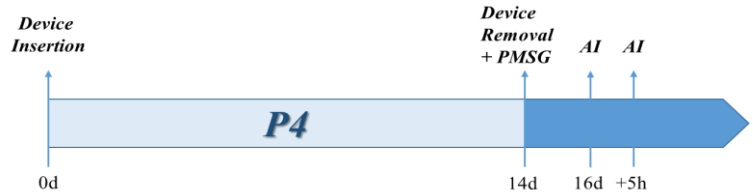
The milk yield of the **PBS** was studied in 5 different farms: two were in Pleven province- Dabovan (661 of the ewes were at first and 275 at their second lactation) and Vabel (64,121), one in the village of Popintsi, Pazardzhik Province (198,123), one in Zagortsi, Sliven Province (451, 295), and the last flock observed was the one of the Agricultural Institute-Stara Zagora (170, 85). The latter was the flock of the Institute of Forage Crops in Pleven, which was relocated in Stara Zagora in 2020. The sheep which were controlled in 5 calendar years: 2020- 374 sheep, 2021- 443, 2022- 406, 2023- 145 and 2024- 175 were at their first (1544) and second (899) lactation.

The study on the efficacy of the **PBS x the East Friesian breed crossbreeding** was performed in the village of Dabovan. A total of 487 F1 crosses were included in three consecutive years 2020-2022. 269 of the ewes were at their first lactation, 150 were at their second, and 68 at their third. The milk yield at second and third lactation was analysed for the same sheep which were at their first lactation in 2020.

The study on the **possibilities of using PBS x Assaf crosses for a year-round production** was performed in 2021 in the sheep farm owned by Galina Mircheva in the village of Petarnitsa, Pleven Province. The flock comprised of 600 ewes. The ewes were reared in two barns all year round separated in two groups depending on the period of lambing. The animals were fed *ad libitum* all year round with a whole ration mixture. The concentrated feed was given individually in a quantity of 0,950 kg per liter of milk. The animals included in the milk yield study were 85 ewes which were F4 crosses between the PBS and the Assaf sheep. The ewes were at their first lactation, born in the same year (2019) and subdivided into 4 groups, depending on the period of lambing. The milking of the ewes began after the colostrum period- on the sixth day after lambing. The first controls in the groups were performed on the 15th day post lambing as follows: 1st group- 11 March (n-19), 2nd- 19 July (n-10), 3rd – 24 August (n-30), and 4th – 24 September (n-26). After the performance of the first control, all groups were controlled every 15-day period. The groups were subject to control until the last ewe in the respective group dried off. However, only the controls over groups comprising at least three sheep were included in the data processing.

Intensification of the reproduction in view of year-round milk production. The estrus synchronization was performed in March and April, i.e. anestrus season, in 289 female animals divided in three age groups: I- one-year-old animals, II- 2 to 4-year- old animals, and III- over 5 year-old animals. The sheep were further divided into 5 groups which were treated in stages at every three-day period. Each group included equal number of ewes from the respective age group.

The ewes synchronization was performed under the following scheme:



The day of insertion of the vaginal sponges (30 mg FGA Synchropart®, Ceva Sante Animal) which remained in the animals vaginas for 14 days was considered day 0. Lyophilized serum gonadotropin hormone (PMSG) (Gonaser, HIPRA), 500 IU/ewe was applied after the sponge removal. The first artificial insemination with evaluated and dissolved semen was performed 48 hours later, and the second one- 5 hours after the first treatment. An ultrasound pregnancy test with a Portable Veterinary Ultrasound device was conducted two months after the synchronization.

All data were processed with the statistical software SPSS 21, IBM. Linear mixed models were used during all production data analyses. The factors analysed in the following sections were included. The group comparison was performed following the LSD method as well as the Tukey and HSD multiple comparison tests.

The sample for the **chemical composition and the technological qualities of the milk** analysis was taken only once from bulk milk collected after the morning milking in the farms of Dabovan and Petarnitsa on the same day at the beginning of May. PBS (200 ewes) were mostly pasture reared and during milking they were additionally fed 0,8 kg/ ewe maize daily. The ration was dispensed for a daily milk yield of 1,1- 1,3 kg and provided: FUM- 2,34, PDI- 222,8, BPR- + 2,732. The BDSP sheep (600 ewes) were reared in barns and fed with a balanced whole ration mixture dispensed for a daily milk yield of 1,6- 1,8 kg providing: FUM- 2,34, PDI- 222,8, BPR- + 2,732. The milk analysis was performed in the laboratory of Food Technology Department of The Institute of Cryobiology and Food Technologies, Sofia. The youghurt and the cheese were produced there in compliance with the technologies established in the country.

The heamatological parameters examination was performed at the beginning of the lactation period in April 2022. The blood samples were taken from 40 female animals- 20 PBS from Dabovan and 20 PBS x Assaf F4 crosses from Petarnitsa. The animals were between 18 months and 2 years old. The blood sample was taken from v. jugularis with vacuum tubes coated with the anticoagulant lithium heparin. The blood parameters were examined via automatic biochemical analyser Seamaty SMT- 120 V within 24 hours of their receipt. The reagent discs used in

the analysis covered main heamatological parameters- Glucose (GLU), Total Protein (TP), Albumin (ALB), Total Bilirubin (TB), Creatinine (Crea), Urea Nitrogen (BUN), Triglycerides (TG), Total Cholesterol (TC), Total Bile Acids (TBA), Total Carbon Dioxide/Bicarbonate (tCO_2), Calcium (Ca), Phosphorus (P), Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), Alkaline Phosphatase (ALP), Amylase (AMY), Gamma-glutamyltrasferase (GGT), Lipase (LPS), Lactate Dehydrogenase (LDH), Creatine Kinase (CK). The Globulin (GLOB= TP-ALB) and the Albumin/Globulin (AG) ratio were automatically calculated. The values for 'ewes'(RBA) in the biochemical analyser software were considered reference values.

RESULTS AND DISCUSSION

BULGARIAN DAIRY SYNTHETIC POPULATION- STATE AND POSSIBILITIES OF PRODUCTIVITY MANAGEMENT

Current state of the population controlled by DSBA, dynamics and developmental trends

Upon commencing its activities in 2011, DSBA began work with a relatively small number of flocks (37) and animals (7035) (table 1). However, in the next 5 year the number of farms increased nine times, and the controlled animals- 8,4 times reaching the maximum of 59 243 animals in 2015. In 2016, due to the liquidation of some of the farms, the number of the controlled animals decreased by 20% yet it managed to remain steady in the following two years despite the continuing fall in the number of farms (table 2). The next more significant decrease was in 2019, afterwards the dynamics slowed down but the trend exhibited by the controlled population was upward.

Table 1. Dynamics of the controlled population 2011-2016, nr.

Category	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total:	7035	10953	11216	17714	59243	47375
Including ewes	5773	8817	9236	14401	49406	35417
- rams	177	264	239	358	1059	1004
- ewe lambs	1036	1762	1657	2828	8442	10757
- ram lambs	49	110	84	127	336	197
Farms	**37**	**49**	**52**	**84**	**335**	**299**
Average size	190	224	216	211	177	158

When taking into account the statistical data of the MAF pointing to an annual decrease in the sheep numbers, it could be stated that the BDSP

Table 2. Dynamics of the controlled population 2017-2023, nr.

Category	2017	2018	2019	2020	2021	2022	2023
Total:	47650	48354	40984	41674	42441	43123	43272
Including ewes	39300	39765	33812	34686	35154	35507	36394
-rams	860	860	886	793	788	797	820
-ewe lambs	7362	7611	6137	6118	6430	6703	5904
-ram lambs	128	118	149	77	69	116	154
Farms:	254	241	228	212	207	217	222
Average size:	188	201	180	197	205	198	195

controlled by us was relatively stable. The members of the breeding association are predominantly large farms which are more resilient to the dynamics of the economic environment. There are flocks in which up to 1000 ewes are reared.

In the last studied year- 2023, the breeding association controlled sheep in 14 provinces (table 3).

Table 3. Territorial distribution of the controlled population in 2023, nr

№	Province	Flocks	Total	Main flock		lambs	
				Ewes	Rams	Ewe	Ram
1	V. Tarnovo	14	2865	2311	45	508	1
2	Vidin	7	1534	1351	35	137	11
3	Dobrich	1	141	133	8		
4	Kardzhali	3	866	734	15	117	
5	Lovech	5	607	507	15	82	3
6	Montana	17	3608	2836	103	652	17
7	Pleven	12	3647	3071	91	475	10
8	Plovdiv	2	367	320	7	40	
9	Razgrad	5	936	757	22	155	2
10	Ruse	21	3118	2608	67	431	12
11	Silistra	10	1678	1320	43	308	7
12	St. Zagora	4	874	603	17	184	70
13	Targovishte	39	6673	5893	120	660	
14	Haskovo	82	16358	13950	232	2155	21
Total		**222**	**43272**	**36394**	**820**	**5904**	**154**

The number of the farms and sheep controlled in six provinces was small. This had a negative influence on the financial status and the financial stability of the organisation. As of 2023 farms in Varna, Vratsa, Shumen and Yambol Province were no longer subject to control. Throughout the years a more considerable increase in the number of farms was observed in Veliko Tarnovo, Pleven and Lovech province, and a decrease in those in Vidin, Silistra and Haskovo province. The increase reported in Pleven province was mostly due to the reorganisation of the flocks with PBS.

Overall, the breeding association maintains an optimal breeding structure of the population with some deviations in the number of breeding rams and breeding ram lambs. Thus, in the last year studied, the association had only 154 male and 5904 female lambs although according to estimations aligned with the Breeding programme for the breed (Nikolov et al., 2021), the normal reproduction of 35000 ewes required 778 rams, 7277 female and 385 breeding ram lambs.

Characteristics of the sheep from the controlled population

Exterior

Currently, the sheep controlled by the association may be generally divided into two types. The first type were the sheep in flocks with fine and semi fine wool with the participation of the East Friesian and the Stara Zagora breeds. Rams from the Agricultural Institutes in Shumen and Stara Zagora were used in big part of these flocks. Assaf and Lacaune rams were also used in part of the flocks. Overall, the animals from these flocks complied with the exterior listed in the breed certificate. The animals were white, and only very rarely did they have small spots on their faces and legs. The second sheep type in which the PBS and the Awassi bloodlines were prevalent had black and brown spots mostly on the faces and the legs. The fleece was often coloured. As a whole, both types had exterior which was typical for the dairy sheep- dense constitution, tall, long body with elongated and thin shapes and bones. The sheep udders were generally big, deep and firmly attached, and most of the animals had a well-defined groove. The teats position, however, was worse than that of the PBS. In most of the sheep they had a slightly lateral position and pointed vertically. There were also udders with poorly developed groove and lateral teat position. The udders were positioned high above the hocks.

BDSP milk yield and factors which influence it.

For the purpose of studying the BDSP milk yield, we initially analysed the milk yield of the entire controlled population in 2019. We processed separately the milk yield of the flocks which were included in the so called

'elite unit', defined as ram producing, and the rest of the controlled population (table 4).

Table 4. Milk yield of the sheep from the 'elite' and the 'controlled' unit of the breed in 2019.

Breed unit	Flocks, number	Sheep, number	Milk yield, l			
			per milking		Per 120 days	
			LS	SD	LS	SD
'Elite' unit	28	2742	142.7	19,56	133.2	17,62
Controlled unit	104	7539	137.9	38,75	128.2	32,42

Due to the small insignificant differences and the enormous data obtained, we continued our study only in the nucleus part where more thorough examinations could be performed. The milk yield was analysed in the context of the influence of major factors which could be differentiated based on the data gathered from the control carried out by the breeding association. Initially, we included the factors region, year, suckling period and control in the linear model of the analysis of variance. We ascertained that these specific factors had influence on all parameters examined (P<0,001).

In the second linear model we replaced the 'region' factor with 'farm'. Table 5 shows that the farm had a strong significant influence on the parameters examined. The influence of the year was also confirmed. This model, however, indicated that the factor 'suckling period' did not influence the parameters examined. Due to the fact that the suckling period was specific for the separate farms, and because the farm was not included in the first linear model, its influence was mistakenly interpreted as influence of the 'suckling period'.

The region had significant influence on the milk yield but the differences between Northern and Southern Bulgaria were small (table 6). The highest milk yield was reported in Veliko Tarnovo Province, and the lowest in Montana. The milk yield per milking period difference between the three major regions Ruse-Razgrad, Pleven- Lovech and Veliko Tarnovo was from 3,2 to 7,7%, and that per daily milking- from 3,2 to 6,6%. The milk yield differences for all three years studied were not big (table 7). They ranged from from 2,6 to 8,3% with reference to milk yield per milking period and from 0,4 to 5,2% with reference to 120-day period milk yield.

The period which we analysed was too short to allow us to make conclusions regarding trends, however, it was obvious that at this stage, the milk yield per milking period of the sheep controlled by DSBA was at

Table 5. Influence of the farm, year and suckling period length on the parameters characterizing the milk yield

Factor	Farm	Year	Suckling period	Farm * Year	Year *Suckling period	Farm * Suckling period	Farm * Year* Suckling period
Daily milk yield	1042,746	1154,471	0,448-	2229,951	1,882	0,443-	1,550**
Milk yield per milking period	704,152	607,207	0,429-	1366,586	1,900	0,367-	1,492**
Milk yield per 120 days	993,611	582,527	0,541-	2224,105	1,837	0,339-	1,628
Control1	879,317	526,409	1,000-	1429,797	2,564	1,144-	2,061
Control 2	515,147	1439,753	1,409-	1200,584	2,437	0,631-	2,203
Control 3	742,680	281,618	0,468-	1321,910	1,313*	1,488-	1,415*
Control 4	813,679	251,899	0,452-	1407,321	2,842	1,963*	2,151

*The values without an index are significant P<0,001; *P<0,05; **P<0,01; - insignificant*

Table 6. Influence of the region on the parameters characterizing the milk yield

Parameter	Northern Bulgaria (N 13589)			Southern Bulgaria (N 5060)		
	LS	SE	SD	LS	SE	SD
Average daily milk yield, l	1,161	0,003	0,299	1,201	0,001	0,098
Milk yield per milking period, l	158,1	0,289	33,700	164,2	0,195	13,886
Milk yield per 120-day lactation, l	143,3	0,478	55,690	147,9	0,119	8,486

Table 7. Influence of the year on the milk yield parameters of BDSP, l

Milk yield	2020 (N 6628)			2021 (N 6408)			2022 (N 5613)		
	LS	SE	SD	LS	SE	SD	LS	SE	SD
Daily	1,224	0,005	0,404	1,116	0,001	0,091	1,168	0,001	0,111
Milking period	164,6	0,553	44,99	152,0	0,152	12,23	160,5	0,208	15,61
Per 120 days	146,9	0,596	48,54	139,6	0,134	10,74	145,3	0,176	13,19

the steady level of around 160-165l, and the milk yield per 120 days- at 140-150l. The potential, however, was significantly higher which was clearly displayed by the values of the parameters controlled in the separate farms. The difference in the 120-day lactation milk yield was 56,7% and it varied from 126,2 to 197,8 l. The milk yield per milking period fluctuated from 140,8 to 223,6l, and the average milk yield per a controlled day- from 1,027 to 1,628 l. A considerable variation was observed in most of the farms.

Overall, the average milking period milk yield of the population studied (ram-producing flocks) was 163,9±0,22 l, and the average 120-day lactation milk yield- 149,1±0,23 l.

PLEVEN BLACKHEAD SHEEP- STATE AND POSSIBILITIES OF PRODUCTIVITY MANAGEMENT.

Current state of the controlled part of the breed, dynamics and developmental trends

In the recent years, the trends in the PBS numbers have not been different from the sheep farming trends in the country. What is more, PBS used to be a breed with a relatively sustainable population but has now entered in the 'endangered species' list.

The breeding association initially started work with only several flocks. In 2006-2007, the association controlled 24 herds with 6500 ewes, of which 8 flocks with 2211 ewes were considered sheep genetic resources. The flocks were from Pleven, Veliko Tarnovo, Vratsa and one from Lovech Province. In 2011 the farms had already become 51, and the sheep controlled 13 497 (table 8) with the number of the controlled sheep constantly increasing.

In 2016 the controlled population reached its peak and from then on the number of animals started to gradually decrease, however, the number of farms was relatively stable (table 9). In the three years following 2019, the annual decrease in the sheep numbers was 2200 on average (fig. 1) reaching the endangerment threshold in 2022. The decline in the number of the controlled sheep was observed in all major regions. In the last years 2021-2024, the controlled population numbers remained steady around the low level already reached (fig.1). As a whole, the breeding structure was optimal per the normal reproduction of the population. The ewe lambs were 14,5% of all animals controlled. The relative share of the rams was 2,35%, and that of the ram lambs- 25,3% of the ram numbers.

Table 8. Dynamics of the controlled population 2011-2014.

Category	2011	2012	2013	2014	2015	2016
Sheep- total, nr	13947	13379	14852	16340	21650	22081
Including ewes	11603	10835	12359	13601	18118	16186
-rams	283	313	357	388	491	404
-ewe lambs	2018	2158	2079	2287	2875	5166
-ram lambs	43	73	57	64	166	325
Farms, nr	51	54	54	52	92	92
Average size, nr	233	206	235	269	232	240

Table 9. Dynamics of the controlled population 2015-2018, nr.

Category	2017	2018	2019	2020	2021	2022
Sheep-total	20427	17853	17081	15621	13695	12437
Including ewes	16384	15328	14233	12816	11654	10265
-rams	454	341	324	276	228	292
-ewe lambs	3552	2133	2446	2417	1745	1806
-ram lambs	37	51	78	112	68	74
Farms	89	87	88	81	77	69
Average size	230	205	195	193	178	180

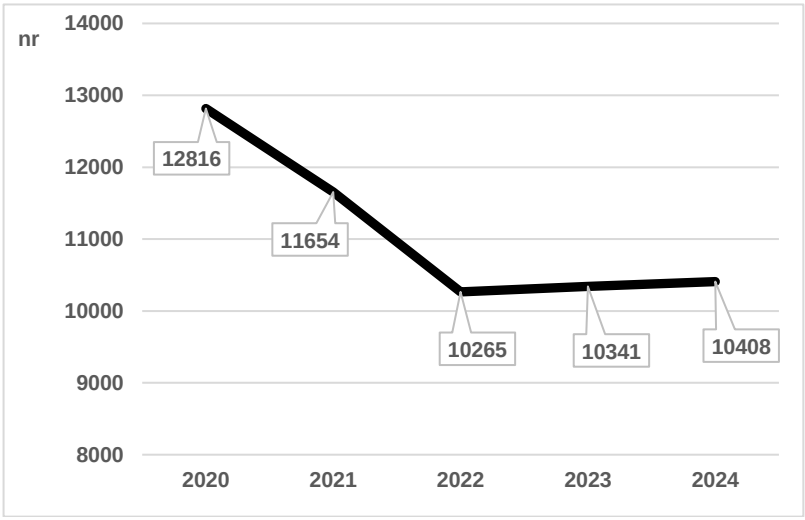


Fig. 1. Dynamics of the controlled Pleven Blackhead sheep numbers in the period 2020-2024.

Characteristics of the sheep from the controlled population

There were two exterior types formed in the controlled Pleven Blackhead sheep population. The sheep from the first type were smaller and more compact. The head was smaller, lean and with a straight profile line. The ears were moderately long, straight. The sheep from this type were reared in small and average farms in the traditional way- mostly on the pasture and in barns during the winter period. The second type were larger, had higher milk yield and were preferred by the bigger farms where they were mostly barn-reared. The head of these sheep was big with a pronounced convex profile, the ears were long and wide, often slightly curved outwards at the tips. The animals looked elongated and narrower. They often exhibited the characteristics of more fragile animals- a ridge between the shoulders, saggy back and thinner limbs

The two sheep types did not differ in any of the other parameters. The head was not covered with fleece. The face was covered with short black guard hairs. Part of the animals had small white spots on the nape of the neck. The ears and the legs were also pigmented. The latter might be coloured with white spots of different size. The fleece was semi-open and white, and only rarely with pigmented spots. There were animals with no fleece on the neck and the belly. The wool was uniform, and more rarely not uniform. The udder was well-developed with correctly set teats suitable for machine milking.

Pleven Blackhead sheep milk yield and factors which influence it.

The main production obtained from PBS is the milk. We studied the PBS milk yield in 5 model farms in Northern and Southern Bulgaria. The milk yield of the population examined (table 10) wac comparable to that of the breed (Boykovski et al., 2021) which showed that the farms selected were typical.

Table 10. Milk yield of Pleven Blackhead sheep breed, l

Lactation	N	Average daily milk yield			Milk yield per 120-day lactation		
		LS	SE.	SD	LS	SE.	SD
First	1544	0,990	0,010	0,357	119,5	1,185	42,8
Second	899	1,010	0,024	0,133	122,1	2,891	34,0

The minimum daily milk yield per first lactation was 0,280 with only 2% of the ewes having an average daily milk yield of up to 0,5l. The ewes with milk yield from 0,501 to 1,0 l were the most (54,1%), however, more than a third of the ewes (33,7%) had a milk yield from 1,00l to 1,5l. 6,86%

of the ewes at first lactation had an average daily milk yield from 1,5 to 2,0l, 40 ewes- from 2,00l to 2,5l, and 10 ewes had an average daily milk yield from 2,50l to 3,020l- the maximum value.

The lactation number was not a significant source of variation for the milk yield. The milk yield distribution of the sheep at their second lactation was similar to that of that of the ewes at first lactation, but the variation was considerably lower.

The year of control had a significant influence (P<0,001) on the milk yield of the ewes. In the separate years, the average daily milk yield for first lactation varied from 7,8 to 44,4%, and for second- from 9,51 to 28,2%.

Of all the factors we examined, the farm had the most significant influence (P<0,001) on the milk yield of the sheep. The highest milk yield was reported for the farm in Dabovan (table 11), with the average daily milk yield per first lactation difference with the other farms being from 14,0 to 30,6% and that per second lactation- from 13,7% to 27,2%.

Table 11. Milk yield of the Pleven Blackhead Sheep Breed in the Flocks Studied

Farm	First lactation				Second lactation			
	N	LS	SE	SD	N	LS	SE	SD
Average daily milk yield, l								
Dabovan	661	1,178	0,013	0,483	275	1,175	0,021	0,418
Vabel	64	1,033	0,043	0,122	121	1,028	0,028	0,138
Popintsi	198	0,984	0,022	0,117	123	0,980	0,030	0,103
Zagortsi	451	0,946	0,014	0,164	295	1,033	0,075	0,190
Agricultural Institute	170	0,902	0,023	0,089	85	0,924	0,033	0,038
Milk yield per 120-day lactation, l								
Dabovan	661	141,4	1,54	57,9	275	140,9	2,53	50,1
Vabel	64	123,9	5,13	15,7	121	123,4	3,31	17,4
Popintsi	198	118,1	2,61	14,0	123	117,6	3,65	12,3
Zagortsi	451	113,5	1,74	19,7	295	123,9	9,05	22,8
Agricultural Institute	170	108,2	2,76	10,6	85	110,8	3,94	11,1

The PBS milk yield did not differ considerably from that of BDSP. The breed has displayed great potential and if the breeding activity is appropriately organized, the selection effect can be achieved.

POSSIBILITIES OF USING THE PLEVEN BLACKHEAD SHEEP AS A FOUNDATION FOR THE CREATION OF HIGH-PRODUCING DAIRY POPULATION IN BULGARIA

CROSSBREEDING WITH EAST FRIESIAN SHEEP

The observation was performed in the village of Dabovan where the crossbreeding between Pleven Blackhead ewes with rams from the East Friesian sheep breed had already began. The crossbreeding may be considered unsuccessful as it was expected the crosses to achieve considerably higher milk yield than that which was actually reported (table 12).

Table 12. Milk yield per 120-day period and average daily milk yield per milking period of F1 PBS x East Friesian Sheep crosses

Lactation	N	Average daily milk yield, l			Milk yield per 120-day lactation, l		
		LS	SE.	SD	LS	SE.	SD
I	269	0,960 [a]	0,027	0,299	115,1	3,19	35,9
II	150	1,133[a]	0,029	0,483	135,9	3,51	57,9
III	68	1,677[a]	0,041	0,542	201,2	4,96	64,9

[a]P<0,001;

The milk yield of the crosses at their first lactation was lower than the average milk yield of the BDSP and PBS as indicated by the data of the present study. The milk yield was 18,0% and 74,7% higher (P<0.001) at second and third lactation. It needs to be pointed, however, that only 63,6% of the crosses reached second lactation, and only 44,2% reached third lactation (table 13). The table clearly displays that the higher values at second lactation were actually due to the higher milk yield of the ewes in 2022.

The year had a significant influence on the milk yield (P<0,001). In 2021, the difference between the ewes from the second and the first group in their average milk yield per 120-day lactation was 3,8%. In the third year when the conditions were obviously better and there were opportunities for achieving the dairy genetic potential, the difference between the 2nd and the 1st lactation was 17,4%, between 2nd and 3d- 12,8%, and between +th and 1st- 32,4%.

When the milk yield of the crosses was compared to that of the purebred ewes from the same farm, it was clear (fig. 2) that during the first 2 years, the PBS milk yield was considerably higher than that of the crosses: it was 43,1% and 74,9% higher at first and 56,7% higher at second lactation.

Table 13. Milk yield dynamics of F1 Pleven Blackhead x East Friesian crosses by years

Year	Lactation								
	I			II			III		
	N	LS	SD	N	LS	SD	N	LS	SD
Average daily milk yield, l									
2020	154	0,863	0,280						
2021	88	0,752	0,217	98	0,780	0,189			
2022	27	1,266	0,300	52	1,486	0,530	68	1,677	0,542
Milk yield per 120-day lactation, l									
2020	154	103,5	33,6						
2021	88	90,0	26,1	98	93,4	22,5			
2022	27	151,9	36,1	52	178,4	63,6	68	201,2	64,9

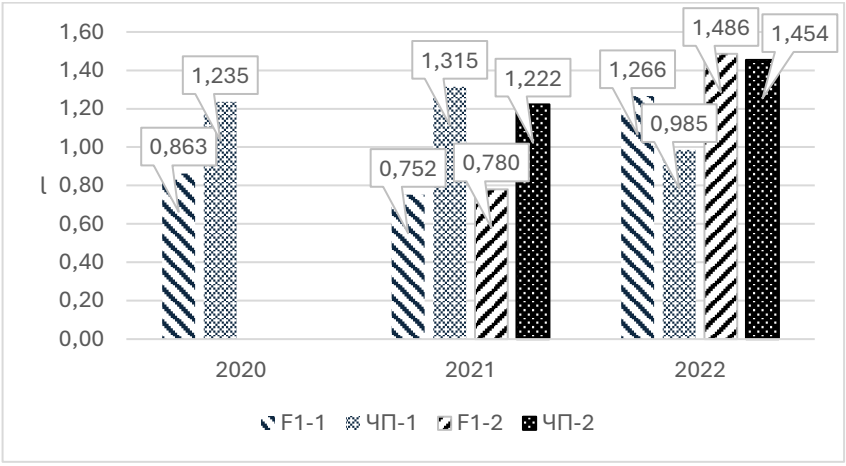


Fig. 2. Average daily milk yield per 120-day period in PBS and F1 PBS x East Friesian crosses (F1) at first (1) and second (2) lactation

During the third year the milk yield per second lactation was similar, with the crosses surpassing the purebred by 2,2%. The milk yield of the crosses at first lactation was 28,5% higher than that of the Pleven Blackhead Sheep due to the low milk yield of the latter. Comparing the milk yield of the Pleven Blackhead sheep during the previous years and that of the ewes at second lactation in 2022, it can clearly be seen that the reason for the above mentioned was the poor selection of sheep at

first lactation in 2022 which could also be due to the selection of more productive sheep for crossing.

Overall, it can be concluded that the PBS x East Friesian Sheep crossing under the conditions of the farm in the village of Dabovan was unsuccessful. Unlike the milk yield of the purebred animals, that of the crosses was heavily influenced by the conditions of the year. Even in more favourable conditions, the F1 crosses did not have a 120-day lactation milk yield which was significantly higher than that of the purebred animals.

CROSSING WITH ASSAF

Milk yield

The study on the milk yield of the PBS x Assaf crosses was performed in the village of Petarnitsa where backcrossing of the Pleven Blackhead sheep breed was performed. The sheep were controlled at 15-day intervals from 26.02.2020 to 16.03.2022. At the beginning of the control the sheep from the different types of crossings were at a different age (table 14). Therefore, it was impossible a comparative analysis of part of the variants to be performed with absolute accuracy. Nevertheless, a range of authors (Pollott and Gootwine, 2004; Gootwine and Pollot (2000)) report low dynamics of the milk yield of the ewes after second lactation.

The different-generation Assaf crosses did not differ significantly in terms of their lactation duration It was significantly affected by the complex of paratypic factors- year*month*day at first control. This was clearly visible in the crosses which were controlled in two consecutive years. The milking period during the second year was shorter for all cross types with the exception of F3.

The crosses generation had a significant influence on the milk yield but it was obviously not the leading factor as the influence within the year, month and the day of control was insignificant (table 15).

When we commenced the control (2020), there were 48 purebred Pleven Blackhead Sheep in the flock. According to the year of birth data, the sheep were at their 6^{th} and 8^{th} lactation. Table 15 clearly shows that the sheep had a very high milking period and standard milk yield. It was natural that it was only the high-producing sheep that were kept until that age but the PBS also demonstrated extremely high genetic potential both with reference to the milk yield and the length of use.

Fig. 3 displays that, as a whole, the milk yield of the crosses from F1 to F3 did not change. The F4 crosses had 1,67-15,3% higher milk yield than F3, and the F4 crosses from internal breeding -24,1-29,7% higher milk yield than that of F3. The F5 crosses had 42,0-46,1% higher milk yield than F4, and 26,2% higher milk yield than F44.

Table 14 Milk yield of PBS x Assaf crosses per milking period and 120-day lactation period

Breed Generation	Year of birth.	Year of control	Lac-tat-ion	N	Milking period milk yield , l			Average daily milk yield per milking period, l			Milk Yield per 120 days, l			Average daily milk yield per 120 days, l		
					LS	±SE	SD	LS	±SE	SD	LS	±SE	SD	LS	±SE	SD
PBS	2011	2020	8	26	237,8	26,7	93,4	1,217	0,098	0,442	189,4	16,5	69,3	1,578	0,138	0,577
	2013	2020	6	15	299,7	35,1	168,9	1,486	0,129	0,613	225,0	21,7	104,7	1,875	0,181	0,872
F1	2014	2020	5	39	190,6	21,8	94,8	1,044	0,080	0,425	156,0	13,3	72,2	1,300	0,111	0,602
F2	2015	2020	4	93	229,9	14,1	104,3	1,205	0,052	0,499	181,7	8,46	77,5	1,515	0,071	0,646
	2015	2021	5	4	167,8	68,1	36,9	0,941	0,251	0,086	155,8	42,1	30,8	1,299	0,351	0,256
F3	2016	2020	3	44	178,4	20,5	84,9	0,971	0,076	0,406	148,1	12,6	63,8	1,234	0,105	0,531
	2016	2021	4	3	202,0	78,6	153,3	0,949	0,289	0,645	192,8	48,6	154,5	1,606	0,405	1,287
F4	2017	2020	2	121	258,6	12,4	132,0	1,228	0,076	0,475	192,7	7,56	80,7	1,606	0,063	0,672
	2017	2021	3	13	179,9	37,8	139,7	1,083	0,139	0,615	166,9	24,4	113,3	1,391	0,212	0,944
	2018	2020	1	33	256,5	23,7	97,6	1,318	0,087	0,412	207,6	14,7	63,3	1,730	0,122	0,527
	2018	2021	2	13	169,6	37,8	101,9	1,048	0,139	0,607	156,6	23,4	91,6	1,305	0,195	0,764
F44	2019	2020	1	144	271,9	11,3	160,0	1,283	0,042	0,553	207,4	7,15	92,2	1,728	0,060	0,768
	2019	2021	2	27	221,7	26,2	86,1	1,248	0,096	0,400	199,6	16,5	66,8	1,664	0,138	0,557
F5	2020	2020	1	85	292,8	14,8	192,1	1,208	0,054	0,543	219,5	9,14	101,3	1,829	0,076	0,844
	2021	2021	1	3	330,0	78,6	78,9	1,847	0,289	0,528	310,7	48,6	84,8	2,590	0,405	0,705

Table 15. Influence of the breed, year, month and day of the first control on the PBS x Assaf crosses milk yield per milking period and 120-day period.

Milk yield	Parameter	Breed(generation)		Year*Month*Day		Breed*year*month*day	
		F	Sig.	F	Sig.	F	Sig.
Milking period	Average daily, l	4,149	0,001	2,403	0,001	1,217	0,162
	Milking days	1,633	0,149	5,433	0,000	1,050	0,386
	Per the entire period, l	2,728	0,019	2,348	0,001	0,665	0,955
Per 120 days	Average daily, l	3,296	0,006	2,584	0,000	1,138	0,255
	Per the entire period, l	3,484	0,000	2,431	0,000	1,138	0,255

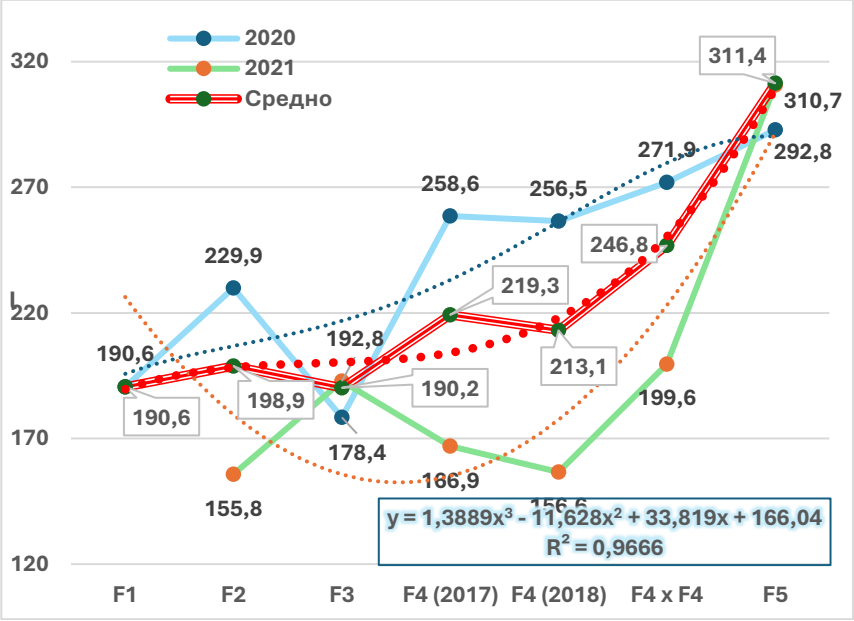


Fig. 3. Milking period milk yield of PBS x Assaf crosses

The same pattern but with lower values was observed with reference to the 120-day milk yield (fig. 4). During the control in 2020, the milk yield of the crosses from F1 towards F5 displayed an upward trend.

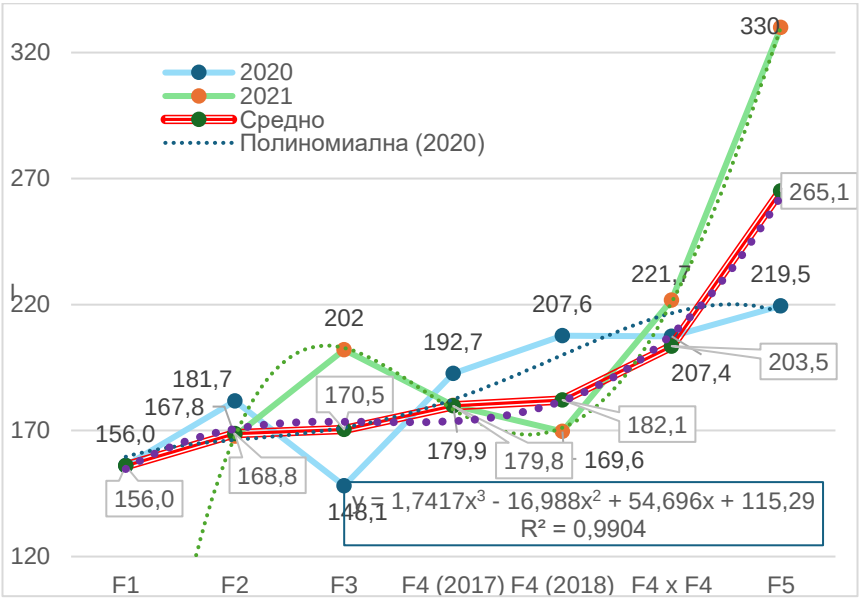


Fig. 4. Milk yield of PBS x Assaf per 120 lactation period

Pointing to the age differences in part of the crosses once again, but stemming from the analysis performed, we can claim that as a whole the PBS x Assaf crosses exhibit a trend towards an increase of the milk yield with the increase of the Assaf breed gen

The figures also show that the higher F crosses reacted more strongly to the unfavourable conditions in 2021. We did not consider F5 due to the small number of animals (3). The milk yield of the Assaf crosses was relatively high when compared with that of the BDSP, PBS and its crosses with the East Friesian sheep.

Chemical composition and technological parameters of the milk and dairy products

The sheep milk productivity in our country is subject to control only with reference to the milk yield. We firmly believe that this is a wrong approach as the sheep milk in our country is not traditionally consumed

fresh. Most of the milk is used for the production of cheese, and the cheese yield is determined by the fat and protein content.

The milk of the traditionally reared PBS had 10,2% higher dry matter content in comparison to the F crosses with Assaf (Table 16). The difference stemmed mainly from the 24,5% higher fat content but also from the 11,7% higher lactose and 6,2% higher salt content.

Table 16. Physico- chemical properties and somatic cells count in the milk of PBS and its F4 Assaf crosses.

Parameter	PBS	Crosses	Difference Crosses/ PBS			
			Natural values			%
			value	F	p	
Dry matter, %	17,628	15,990	-1,638	58,331	0,000	-9,29
Fat%	8,505	6,830	-1,675	60,239	0,000	-19,69
Protein, %	3,915	4,467	0,552	2,857	0,142	14,10
Lactose, %	4,523	4,048	-0,475	1,431	0,277	-10,50
Salts, %	0,685	0,645	-0,040	0,662	0,447	-5,84
NFDM, %	9,123	9,16	0,037	0,712	0,431	0,41
Density, ^{o}g	26,93	29,66	2,73	35,116	0,001	10,14
Somatic cells, x10^{3}/ml	585	155	-430	1584,857	0,000	-73,50
Conductivity, mScm	3,638	4,108	0,470	147,677	0,000	12,92
Ph	6,552	6,59	0,038	5,488	0,058	0,58
Freezing point, ^{o}C	-0,574	-0,519	0,055	1,518	0,264	-9,58

The crosses had 14,1% higher milk protein content which influenced the non-fat dry matter content. The NFDM difference was not big. However, while for the crosses its content was mostly formed by the protein, in PBS it was at the expense of the lactose which had no role in the dairy products yield.

but in PBS it was in exchange of the lactose which had no role in the yield upon dairy products production.

The PBS milk contained 3,8 times more somatic cells. The reason for the aforementioned cannot be determined without additional analyses as their count might be influenced by a number of factors.

The sheep's milk yoghurt, produced under the standard technology, of both breeds had dense coagulum and normal content (table 17). When compared with the feedstock, the chemical composition was better in view of the modern nutrition, and the more considerable changes were those reported for the PBS milk.

Table 17. Chemical composition of yoghurt, curd and cheese produced from the milk of sheep from the Pleven Blackhead Sheep and its (F4) crosses with the Assaf breed.

Product	Parameter, % in the product	PBS		Crosses		Difference	
		∆X	SD	∆X	SD	F	Sign.
Yoghurt	Fat	6,907	0,085	5,897	0,205	62,117	0,001
	Protein	8,400	2,270	8,950	2,370	0,084	0,786
	Salt	1,580	0,430	1,560	0,460	0,003	0,959
Curd	Fat	20,19	1,100	21,42	0,825	2,388	0,197
	Protein	26,03	1,925	24,58	2,635	0,592	0,484
	Salt	1,280	0,020	1,300	0,035	0,510	0,515
Cheese	Fat	16,49	0,690	15,12	1,210	2,918	0,163
	Protein	24,93	2,735	25,12	0,383	0,014	0,910
	Salt	2,510	0,400	2,497	0,130	0,003	0,959

A similar trend of change was also observed in the curd production. The curd produced from the PBS milk had 5,9% more protein and 5,7% lower fat content. The milk protein in the feedstock of the crosses was 14,1% more than that of the PBS, and the difference with reference to the cheese was only 0,76%. The latter as well as the lower protein content in the curd may lead to the conclusion that the higher protein content in the milk of the crosses (0,552%) was at the expense of the whey proteins.

Fatty Acids

Milk

In the recent years, the fatty acids profile has been paid special attention upon evaluation of the dietary qualities of the milk and the dairy products. We analysed the fatty acid profile of the milk and the dairy products produced from the milk of the PBS and its crosses with the Assaf breed. Taking into account the important role of the feeding for the fat content, we would like to point that the aim of the present study was not ascertaining the effect of the breed, but examining the complex set of the breed, its typical feeding and manner of rearing i.e. the usual way in which the milk was obtained. The PBS was traditionally pasture bred, and the supplementary fodder was mostly provided at the beginning of the lactation. We chose a farm rearing F crosses PBS x Assaf which was a typically industrial one, directed towards year-round production of maximum quantity. The conditions there involved barn breeding, proper nutrition, and regulated reproduction for two-time lambing. In this respect, the ‘breed’ factor will be used conditionally and will include the abovementioned complex set.

The data obtained during our study indicated that under the specified manners of feeding and rearing of the two breeds, the milk fat in PBS contained 7,0% (P<0,05) more SFA (table 18). The total quantity of the short- and the medium-chain (C-4:0 – C-12:0) SFA in PBS was 21,0 g/ 100 gM, and in the crosses- 20,69 g/100 gM or 30,3 and respectively 32,0% of the total SFA content.

Table 18. Fatty acid profile of sheep's milk of pasture-reared Pleven Blackhead Sheep breed and its barn-reared F4 crosses with the Assaf breed, g/100 g fat

Amino Acid Groups	PBS		Crosses		F	P
	ΔX	SD	ΔX	SD		
ΣCLA	0,983	0,148	1,183	0,148	0,918	0,392
ΣC-18:1Trans-FA	7,167	0,399	10,36	0,399	32,07	0,005
ΣC-18:1Cis-FA	17,03	0,680	17,83	0,680	0,692	0,452
SFA	69,20	0,734	64,66	0,734	1,696	0,263
MUFA	27,24	0,802	31,22	0,802	12,31	0,025
PUSFA	4,98	0,310	5,77	0,310	3,274	0,145
Σω-3	1,180	0,123	1,403	0,123	1,638	0,270
Σω-6	2,967	0,129	3,450	0,129	6,999	0,057
Σω-6/Σω-3	2,533	0,220	2,507	0,220	0,007	0,936
BCFA	2,893	0,089	2,427	0,089	13,82	0,021
CLA	0,890	0,139	0,997	0,139	0,296	0,615

The main SFA difference between the crosses and the PBS stemmed from the palmitic acid. It was prevalent in both groups but was 18,4% (P<0,01) more in the PBS milk. The second most present acid in the PBS milk was the myristic acid, and in the crosses- the stearic acid.

The lauric, myristic and palmitic are those acids which are considered to increase the risk of cardiovascular disease while the rest do not have any negative metabolic effect. Their total content in the milk of the PBS was 41,1 g/100 gMF or 59,4% of the total SFA content. These values were respectively 34,41 g/100 gMF and 53,2% with reference to the milk of the crosses.

Not only were significant differences observed with reference to the palmitic but also to the heneicosanoic acid (C-21:0) content which was 2,1 times (P<0,05) more in the crosses. The heneicosanoic acid is a saturated fatty acid with an uneven number of hydrogen atoms which have attracted interest in the recent years. Similar interest has also been sparked with reference to the branched-chain fatty acids (BCFA), and more often than not, the two groups are analysed jointly (Nudda et al.,

2021) due to their similar properties and their positive effect on the human organism.

The milk of the PBS had significantly (P<0,05) more BCFA than the milk of the crosses. All fatty acids with the exception of C-17iso had higher content in the milk of the former, with the differences regarding the content of C-13aiso – 54,0% (P=0,001), C-14iso – 55,8% (P<0,05), C-15iso – 17,3% (P<0,01) being significant. The total quantity of BCFA and the fatty acids with uneven atom numbers in the crosses and the PBS was approximately the same- 3,508 g and respectively 3,874 g/ 100 gMF.

Unlike the still controversial SFA intake influence on the human health, the role of the unsaturated fatty acids is unanimously considered beneficial. The MUFA in the milk of the barn-reared crosses were 14,6% (P<0,05) more than those in the milk of the PBS. The MUFA were mostly represented by various cis and trans isomers of the octadecenoic acid. The main MUFA content difference in the milk of the two breeds stemmed from the vaccenic acid (C-18:1t11) whose content in the milk of the crosses was 3,5 times (P<0,001) higher than that in the Pleven Blackhead sheep. The vaccenic acid is a trans-fatty acid (TFA) but unlike the rest of the TFAs, its effect is considered positive.

The crosses also displayed 15,69% more PUSFA in their milk than the PBS but the difference was insignificant. However, there were also significant differences with reference to some fatty acids. With the exception of C-18:1c9/C-18:1t12/13/, whose content was identical in the milk of both breeds, and the vaccenic acid, the trans fatty acid content in the milk of the PBS was 18,8% more. The content of the rest of the USFA in the PBS milk was 11,7% less when compared with that of the crosses reared in industrial conditions.

During the analysis of the PUSFA, a special attention was paid to the ω-6 and ω-3 fatty acids which are not synthesiszed in the bodies of the mammals, people included. Their ratio is considered especially important as it is a key factor for the maintenance of the lifelong homeostasis, normal development and mental health. The maximum healthy ω-6/ω-3 values for people are 5/1. The milk of the crosses had higher content of both Σω-3 and Σω-6 but as a whole the Σω-6/Σω-3 ratio for both breeds was identical and considerably lower than the maximum beneficial value.

Yoghurt

In terms of the fatty acid content, the yoghurts produced had certain nonlinear differences (in both breeds) from the milk. This shows that the when the feedstock is technologically processed, its content as well as the fatty acids and the fatty acid groups ratios also change to a certain degree.

The SFA content in the yoghurt of both breeds did not differ significantly from that in their milk (table 19). Overall, the short-chain fatty acids in PBS decreased significantly, while the heptadecanoic acid was the only one which increased significantly. The changes reported for the crosses were in the quantity of 7 fatty acids: the palmitic decreased and the pentacosanoic was barely detectable, while the butanoic, enanthic, pelargonic, heptadecaonic and the tricosylic acids increased. The BCFA also changed positively. Once again, they were more in the yoghurt of the PBS. However, their decrease, when compared to that in the milk, was 4,29% while in the crosses there was only a 0,24% fall. The MUFA exhibited an opposite trend. They were 4,22% more in the PBS yoghurt than in its milk, while they were 0,80% more in the crosses yoghurt than in their milk. As a whole, during the production of yoghurt, it was the biological sufficiency in the crosses that increased.

Table 19. Fatty acids profile of yoghurt samples of pasture- reared PBS and its barn-reared (F4) Assaf crosses, g/100 g fat

Amino Acid Groups	PBS			Crosses			PBS/Crosses	
	∆X	SD	± in relation to the milk	∆X	SD	± in relation to the milk	F	p
ΣCLA	1,320	0,293	0,337	1,780	0,293	0,597	1,233	0,329
ΣC-18:1 *Trans*-FA	4,267	0,784	-2,900*	8,773	0,784	-1,587	16,53	0,015
ΣC-18:*1Cis*-FA	21,96	1,317	4,927*	20,37	1,317	2,534	0,731	0,441
SFA	66,79	1,805	-2,413	63,47	1,805	-1,193	1,696	0,263
MUFA	28,39	1,511	1,147	31,47	1,511	0,250	2,081	0,223
PUSFA	4,623	0,609	-0,350	5,307	0,609	-0,460	0,629	0,472
Σω-3	0,987	0,244	-0,193	1,473	0,244	0,070	1,982	0,232
Σω-6	2,507	0,261	-0,460	2,283	0,261	-1,167***	0,366	0,578
Σω-6/Σω-3	2,697	0,464	0,164	1,653	0,464	-0,854	2,527	0,187
BCFA	2,767	0,176	-0,126	2,430	0,176	0,003	1,833	0,247
CLA	1,230	0,275	0,340	1,590	0,275	0,593	0,854	0,408

*The differences in relation to the content in the milk were significant *P<0,05; **p<0,01; ***P<0,001*

When compared with the milk, the yoghurt in both groups displayed an insignificant decrease in the PUSFA content- with 0,348% in PBS and 0,466 % in the crosses.

The fatty acid content in the yoghurt of both breeds summary data indicated that the crosses yoghurt was generally more biologically sufficient despite the fact that significant differences were observed only with reference to the ΣC-18:1Trans-FA content (table 38).

Although the differences were insignificant, the yoghurt of the crosses contained more ΣCLA-34,8%, monounsaturated- 10,8% and polyunsaturated- 14,8% fatty acids as well as ω-3 fatty acids- 49, 2%. Even though the ω-6/ω-3 ratio was favourable to the human health in both breeds (Bishehkolaei and Pathak, 2024), it was 38,7% lower in the crosses than in the PBS.

White brined cheese

The second main sheep's milk product is the Bulgarian white brined cheese. The cheese produced from the milk of the PBS and its (F4) crosses with the Assaf was characterised by its high biological sufficiency. It contained large quantities of unsaturated and BCFA fatty acids (table 20). The ω-6/ω-3 ratio was considerably lower than the recommended 5/1 ratio which is considered beneficial for the human health.

Table 20. Fatty acid profile of cheese produced from the milk of pasture-reared PBS and its barn- reared (F4) Assaf crosses, g/ 100 g of fat

Amino Acid Groups	PBS			Crosses			PBS/Crosses	
	ΔX	SD	± in relation to milk	ΔX	SD	± in relation to milk	F	p
ΣCLA	0,767	0,003	-0,217	0,547	0,003	-0,637*	2178	0,000
ΣC-18:1 Trans- FA	10,67	0,071	3,507**	12,79	0,071	2,433**	449,9	0,000
ΣC-18:1Cis-FA	12,35	0,082	-4,680**	14,56	0,082	-3,277**	364,4	0,000
SFA	69,87	0,430	-0,670	64,18	0,430	-0,477	87,49	0,001
MUFA	27,29	0,176	0,047	31,61	0,176	0,387	302,1	0,000
PUSFA	5,640	0,029	0,667*	5,953	0,029	0,187	59,70	0,002
Σω-3	1,390	0,002	0,210	1,427	0,002	0,023	121,0	0,000
Σω-6	3,773	0,025	0,807*	4,197	0,025	0,747***	139,0	0,000
Σω-6/Σω-3	2,710	0,011	0,177	2,943	0,011	0,437	222,7	0,000
BCFA	3,003	0,016	0,110	2,430	0,016	0,003	643,1	0,000
CLA	0,567	0,002	-0,323	0,340	0,002	-0,657*	4624	0,000

*The differences in relation to the content in the milk were significant *P<0,05; **p<0,01; ***P<0,001*

Unlike in the yoghurt, the ω-6/Σω-3 ratio was more beneficial in the cheese produced from the PBS milk (P<0,001). However, the absolute values of the amino acids showed that their content in both groups was 10,1% (P<0,001) lower for the ω-6 and 2,59% (P<0,001) for the ω-3. The PBS cheese had more BCFA- 23,6% (P<0,001) and CLA- 73,4% (P<0,001). The crosses cheese had more mono- 15,8% (P<0, 001) and poly- 5,54% (P<0,01) USFA. When compared with the feedstock, the MUFA content significantly decreased (P<0,05) in the cheese prepared from the PBS milk. The content of part of the long-chain fatty acids, however, significantly increased.

The crosses displayed a significant decrease in the fatty acid (P<0,001) as well as in all 17-24 hydrogen-atom fatty acids. When compared with the milk feedstock, the cheese had significantly higher content of enanthic, palmitic and pentacosanoic fatty acids. When compared with their content in the milk, the BCFA in the cheese also changed in different directions (table 41) but, as a whole, they remained the same for the crosses- +0,12%, while in the PBS cheese their content increased by 3,80%. Overall, the total unsaturated amino acids quantity was insignificantly higher than in the milk. However, the octadecenoic acid content was significantly lower in both breeds. The 3,17 % increase of the PUSFA in the cheese of the crosses and their 13,25% (P<0,05) rise in the PBS cheese was a positive change.

Haematological parameters

Apart from the productivity, the sheep sustainability, their adaptability and flexibility in the local ecological and economic conditions are of vital importance for the efficient sheep farming. The biochemical blood parameters are indicative of the physiological and health condition of the animals as well as an objective factor for the evaluation of their welfare.

Our study showed that the traditional manner of rearing for both breeds provided the sheep with metabolisable sources of energy. The blood glucose levels in both breeds were within the normal range, and the parameter values of the crosses were significantly higher (18,2%) (P<0,001) than those of the PBS (table 21).

The total protein levels of the animals examined were higher (table 21) both due to the high albumin and the elevated globulin levels, with the former average value for the PBS being significantly higher than that of the crosses. The globulin was higher in the crosses, however, the difference with the PBS was insignificant. Irrespective of its high values, the albumin of both breeds was within the MSD border line which showed that during the period of the study, there was a balance between the nitrogen intake from the food and the endogenous needs (Macrae, 2017) in both farms. It is of vital importance to highlight the lack of protein

Table 21. Biochemical blood parameters of pasture-reared Pleven Blackhead Sheep and its barn-reared (F4) Assaf crosses.

Parameter	PBS			Crosses			Range	
	ΔX	SD	SE	ΔX	SD	SE	Min	max
GLU, mmol/L	3,043 [a]	0,424	0,089	3,598 [a]	0,373	0,089	2,78*;2,78**	4,44;4,44
TP, g/L	92,12	10,36	1,958	90,56	6,789	1,958	56; 60	78; 79
ALB, g/L	36,65[c]	3,499	0,689	34,29 [c]	2,600	0,689	24; 24	37; 30
GLOB, g/L	54,92	8,114	1,534	56,27	5,309	1,534	32; 35	41; 57
ALB/GLOB	0,683 [b]	0,074	0,015	0,612 [b]	0,057	0,015		
TB, umol/L	2,905	1,462	0,285	2,890	1,052	0,285	2	7
Crea, umol/L	59,89 [a]	19,50	3,714	85,51 [a]	13,10	3,714	53	133
BUN, mmol/L	8,638 [a]	2,987	0,526	2,967 [a]	1,467	0,526	1,8	7,1
BUN/Crea	153,2 [a]	54,83	9,114	34,96 [a]	17,77	9,114	15	122
tCO_2 mmol/L	27,37	4,014	0,809	25,53	3,176	0,809		
Ca, mmol/L	2,621	0,405	0,069	2,601	0,170	0,069	2,28; 2,88	2,70; 3,20
Phos, mmol/L	2,262 [b]	0,460	0,093	1,848 [b]	0,362	0,093	1,29; 1,62	2,87; 2,36
TG, mmol/L	0,375	0,403	0,066	0,294	0,101	0,066	0,3	0,54
TC, mmol/L	1,980 [a]	0,510	0,098	2,736 [a]	0,349	0,098	1,14	2,12
TBA, mmol/L	45,59 [c]	19,44	7,601	65,39 [c]	43,96	7,601		

**BA- biochemical analyser ; **MSD (MERCK & CO., INC., KENILWORTH, NJ, USA) MANUALVeterinary Manual;The differences between the values with the same index on the lines were significant: [a]- P<0,001; [b]- P<0,01; [c]- P<0,05.*

insufficiency in the PBS, which was reared on the pasture during the period of our study and often exhibited low albumin values.

The high globulin levels may be due to dehydration, infestation, some chronic inflammations, etc. Judging by the elevated liver enzyme levels (table 22), we can assume that there was a F. hepatica infestation present.

The other blood biochemical parameters were mostly within the physiological range. When compared with PBS, the crosses displayed significantly higher creatinine levels (P<0,001), lower BUN (P<0,001) and BUN/Crea ratio (P<0,001). The lower values of the latter two parameters against the high TO, normal ALB and borderline Crea values may be attributed to a certain load on the liver or pathological changes in the muscles (Hosten et al., 1990). However, we once again point to the fact that the values were within the normal range.

The crosses exhibited higher total cholesterol, with the difference with the PBS being significant (P<0,001). Significantly lower were the bile acids levels (P<0,05). At the same time the GGT considerably exceeded the range limit by over 47% which is considered indicative of bile duct epithelium damage due to a F.hepatica invasion. The PBS GGT levels also exceeded the upper reference limit but with only 12,2%, with the difference with the crosses being significant (P<0,001). The crosses had

Table 22. Enzyme content in the plasma of pasture-reared Pleven Black Sheep and its barn-reared (F4) Assaf crosses.

Parameter	PBS			Crosses			Range	
	ΔX	SD	SE.	ΔX	SD	SE.	min	max
ALP, U/L	140,2 [c]	84,26	18,76	190,0 [c]	83,57	18,76	50*; 68**	228;387
ALT, U/L	70,60 [b]	27,28	5,733	47,95 [b]	23,88	5,733	5; 26	17; 34
AMY, U/L	22,45	29,73	5,073	23,70	12,06	5,073	0	30
AST, U/L	218,5	60,85	13,47	188,9	59,66	13,47	40; 60	96;280
GGT, U/L	61,70 [a]	11,84	3,443	81,00 [a]	18,28	3,443	33; 20	55; 52
LPS, U/L	26,35	3,787	0,758	26,35	2,943	0,758		
LDH, U/L	503,8	110,8	25,12	516,6	113,9	25,12	504; 238	1049; 440
CK, U/L	123,9	77,58	31,45	158,1	183,2	31,45	10; 8,1	100; 12,9
Crea, umol/L	59,89	19,50	3,714	85,51	13,10	3,714	53	133

**BA- biochemical analyser; ** MSD. The differences between the values with the same index on the lines were significant [a]- P<0,001; [b]- P<0,01; [c]- P<0,05.*

significantly higher ALP (P<0,05) and significantly lower ALT (P<0,01) levels than the PBS.

Overall, the biochemical blood parameters of the pasture-reared PBS were closer to the physiological norms. What was observed in the crosses was a more serious liver functions strain. The reason may be rooted in the elevated protein levels in the fodders as well as the immobilization of the animals.

POSSIBILITIES OF USING PLEVEN BLACKHEAD SHEEP X ASSAF BREED CROSSES FOR YEAR-ROUND PRODUCTION

MILK YIELD AND LACTATION PERSISTENCY IN DIFFERENT SEASON OF LAMBING

We examined the possibility of year-round milk production in some of the crosses between the PBS and the Assaf in the farm in Petarnitsa. The data showed that the crosses reared in the conditions of intensive farming had high milk yield (table 23). The milk yield was almost twice higher than that of the mother breed- 0,714-0,893 l (Petkova et al., 2018) and that reported for other dairy breeds and their crosses in Bulgaria and abroad.

The sheep had a relatively long lactation period. Only 4,9% of the ewes stopped lactating before the 120th day. 82,3% of the ewes studied were still milked up to 180th day, and 55,3% were milked up to 300 days.

The minimum daily milk yield reported per 180-day lactation was 0,050kg, and the maximum- 4,6 kg.

Table 23. First lactation milk yield of (F4) crosses between PBS and the Assaf at different periods of the lactation, l

Days	N	Morning			Evening			Per control day		
		LS	SE	SD	LS	SE	SD	LS	SE	SD
120	81	0,946	0,018	0,459	0,767	0,015	0,383	1,713	0,032	0,813
150	76	0,908	0,017	0,456	0,728	0,014	0,384	1,636	0,029	0,812
180	70	0,881	0,016	0,456	0,702	0,013	0,385	1,584	0,028	0,815
210	62	0,872	0,015	0,454	0,693	0,013	0,383	1,565	0,028	0,812
240	56	0,858	0,015	0,457	0,681	0,013	0,385	1,539	0,027	0,817
270	50	0,846	0,015	0,458	0,670	0,013	0,387	1,516	0,027	0,821
300	47	0,838	0,015	0,459	0,662	0,013	0,389	1,500	0,027	0,824

The lambing periods studied were 4, and the highest milk yield per standard 180-day lactation was reported for the ewes which lambed in July (table 24).

Table 24. Milk yield (kg) per 180-day lactation period of (F4) crosses between the PBS and the Assaf at first lactation, irrespective of the month of lambing.

First control	Period	Number of controls	LS	Std. Er	SD	Min.	Max.
11 March	morning	208	0,909	0,034	0,487	0000	2,110
	evening	208	0,705	0,028	0,405	0,050	1,880
	total	208	1,614	0,058	0,836	0,150	3,560
19July	morning	103	0,889	0,049	0,498	0,200	2,550
	evening	103	0,741	0,044	0,443	0,100	2,000
	total	103	1,630	0,092	0,932	0,330	4,550
24 August	morning	283	0,868	0,023	0,389	0,100	2,050
	evening	283	0,699	0,019	0,325	0,080	1,900
	total	283	1,567	0,041	0,694	0,180	3,950
24 September	morning	241	0,869	0,031	0,484	0,050	3,000
	evening	241	0,689	0,026	0,406	0,000	2,000
	total	241	1,558	0,056	0,875	0,050	4,600

However, the period of lambing was not a significant source of parameter variation. The difference between the ewes which lambed in July and March was only 0,016kg (0,99%), and between those which lambed in July and those with the lowest milk yield which lambed in September- 0,072 kg (4,62%). This is indicative of the fact that the

additionally fed and barn-reared crosses between the PBS and the Assaf can be successfully used for year-round milk production.

The ewes which were included in the study had a relatively steady lactation curve (fig. 5), with the control number having significant influence on the daily milk yield of the ewes (P<0,001). The difference between the morning and the evening milking was also significant (P<0,001).

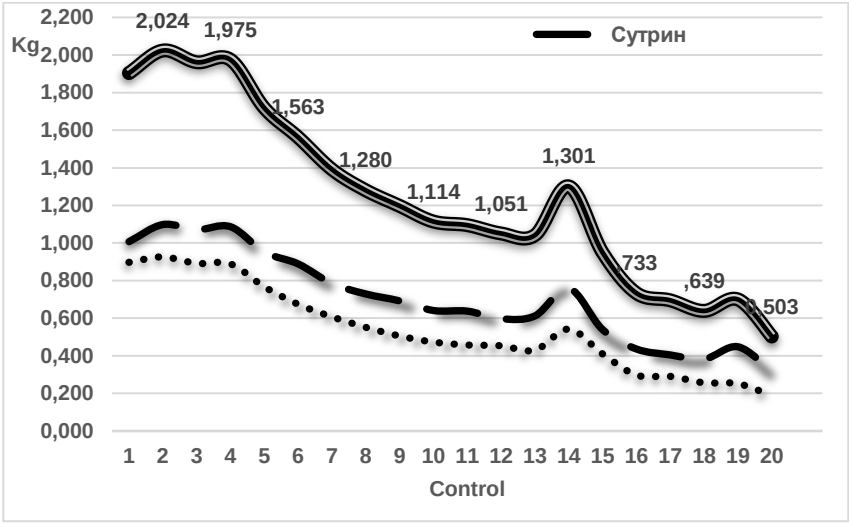


Fig. 5. Parallel lactation curves of (F4) PBS and Assaf crosses at first lactation.

Irrespective of their month of lambing, the animals examined by us displayed a 'specific' lactation curve (Ivanova, 2013) which is typical for the intensive production systems (Elvira et al. (2013)) (fig. 5). The milk yield of the ewes which lambed in September decreased most significantly (fig. 6), while the most dynamic lactation curve was that of the ewes which lambed in July. The milk yield at the first control and the maximum milk yield of the latter were the highest, but obviously, the following summer heat had a negative influence on the high milk yield maintenance. The ewes which lambed in the spring had the most stable lactation curve although it started from the lowest level.

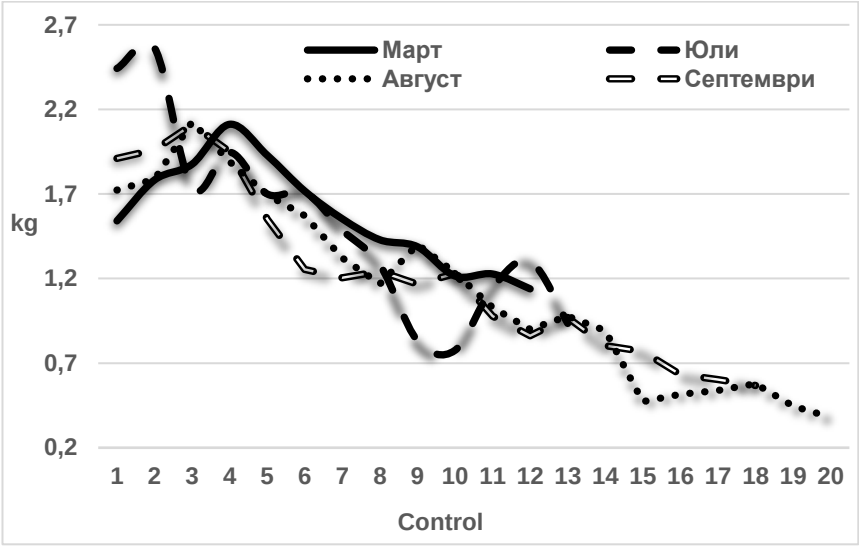


Fig. 6. Lactation curves of (F4) PBS and Assaf crosses which lambed in different calendar months.

REPRODUCTION INTENSIFICATION

Reproductive capacity

Upon creation of the BDSP, its biological fecundity was determined as follows: 150 lambs per 100 ewes. In fact, however, it is lower. In 2019, only 32930 out of the 33812 ewes controlled lambed- 97,1%. The average economic fecundity of the controlled farms was 125,0%, and the biological- 128,3%. The highest pregnancy rates, which were close to the standard for the breed, were reported for Pleven province- 146% economic and 148,7%- biological. The pregnancy rates of the ewes which were part of the national gene pool were considerably higher- 135,9%- economic and 138,2% biological, with figures reaching 160% in some flocks.

In order year-round milk production to be achieved, it is necessary the ewes to be serviced during both the estrus and anestrus periods. With the purpose of ascertaining the possibility of overcoming the estrus cyclicity, we subjected 289 PBS x Assaf crosses in the village of Petarnica to synchronization and then artificial insemination. The average pregnancy rate of the ewes was 61,6% (table 25). It was the highest in the second age group (2 -4 years)- 72,9%.

Table 25. Fecundity of ewes.

Age group	N	Pregnancy rates % (n/N)	Economic fecundity	Biological fecundity
1	54	42,59[a]	41,07	115,8
2	144	72,92)[ab]	63,89	122,7
3	91	54,95[b]	41,76	115,2
Total	298	61,59	52,60	119,7

a-P<0,001; b – P<0,05

After the completion of the lambing campaign, we ascertained that the economic fecundity in the flock studied was 52,6%. It was the lowest in the first age group- 41,1%. The biological fecundity was 116%, and the multiple pregnancies- 15,8%. The second age group exhibited the highest values for economic and biological fecundity as well as multiple pregnancies- 63,9%, 123% and 22,7%. The total biological fecundity and the twin percentages were respectively 120 and 19,7.

SUMMARY

State and trends in the dairy population selection

Currently, the relative share of the dairy population is increasing, strengthening its position as the most promising sheep farming sector in Bulgaria. As of 2024, the breeding association controlled 362 000 sheep, and 59,5% of them were reared for dairy production. Milk was also obtained from the local breeds, which were 36,7%, or from the national dairy population, which comprised 96,2% of the total number of controlled ewes.

The dairy sheep breeding association controls 43272 sheep, including 36394 ewes and 820 rams in 222 flocks, which provides the opportunity for effective reproduction-improvement activities to be organised. In the last 10 years, the population has been stabilized and no considerable dynamics in the number of flocks and sheep has been observed. In order the selection effects to be intensified it is necessary: the selection of rams to be made in the entire controlled part of the breed; more younger animals to be left for breeding as this provides the opportunity the selection to be more precise; a system for evaluation of the rams on the basis of the quality of the progeny to be developed and applied.

The BDSP sheep which are controlled by the DSBA have typical dairy sheep exterior- dense constitution, tall, with long body, elongated and thin shapes and bones. The average milk yield of the ram-producing flocks per milking period of 135,4 ±0,03 days was 163,9 ± 0,217 l, per 120-day

lactation it was 149,1± 0,230 l, with the average daily milk yield for this period being 1,243 ± 0,002 l. The milk yield for 120-day lactation in some farms varied from 126,2 to 185,8 l, the milking period milk yield- from 140,8 to 223,6 l, and the average daily milk yield- from 1,027 to 1,628 l. The region, the year and the farm had a significant influence on the milk yield. The ewes in Northern and Southern Bulgaria had similar productivity rates, with the average daily milk yield in Southern Bulgaria being 3,45% higher than in Northern Bulgaria. The reason for the aforementioned was perhaps the more stable lactation from 1st towards 4th control: the milk yield of the ewes in Southern Bulgaria decreased by 38,2%, and in Northern Bulgaria- by 42,6%.

After the resumption of the PBS breeding activities in 2000 and reaching 18 000 ewes in 92 farms, enhancing the habitat, including in Southern Bulgaria, there has been a collapse in the recent years, and since 2022, the breed has been considered endangered of extinction.

The average milk yield for 120-day lactation of 1544 ewes at first lactation was 119,5± 1,185 l, and of 899 ewes at second- 122,1± 2,891 l. These results were displayed by controlled Pleven Blackhead ewes from 5 farms and the difference was insignificant. The farm and the year of control were significant sources of variation. The PBS breed had high genetic potential and selection possibilities: 6,86% of the sheep at their first lactation and 5,23% of the ewes at their second had an average daily milk yield per standard lactation from 1,50 l to 2,000 l. The milk yield varied widely- CV of the average daily milk yield per first lactation was 36,1%. The intensively farmed purebred ewes were not outperformed by their crosses with the Assaf breed in terms of milk yield.

The cross breeding of PBS and EF is inappropriate. The milk yield of the crosses for 120- day milking period at first lactation was 115,1± 3,19 l, at second- 135,9± 3,51 l and at third – 201,2± 4,96 l. Unlike the purebred animals, the crosses were heavily influenced by the conditions of the year when it came to their milk yield. Most of the observations showed that the purebred Pleven ewes had from 43,3% to 74,9% higher milk yield than that of the crosses. Even in more favourable conditions, the F1 crosses failed to considerably outperform the purebred animals regarding their milk yield. A more significant difference (28,5%) was observed in one case only.

When performed in the conditions of intensive, year-round barn rearing and feeding with whole ration mixtures, the PBS x Assaf cross breeding gave good results. Under favourable conditions, the milk yield of the F4 crosses at their first and second lactation was over 250 l, and the milk yield for 120-day milking period- 207,6 and 192,7 l respectively. Upon F4 crosses internal breeding, the milk yield remained generally the same. The milk yield of the F5 crosses was higher- 292,8 l and 219, 5 l

for full and respectively 120-day lactation, with the potential milk yield being over 330 and 310 l respectively. The higher generation crosses were more vulnerable to worsening conditions- their milking period milk yield decreased from 35,5 to 39,4%, with the decrease for the F4 internal breeding crosses being lower- 26,6%.

When compared with the milk of its crosses with the Assaf breed, that of the PBS had 24,5% higher fat content, 11,7% more lactose and 6,2% more salt, however, it had 12,4% less protein, with part of the higher protein content in the crosses probably being at the expense of the whey protein. During the production of yoghurt and curd, the biological sufficiency of the milk increased (the relative share of the fats decreased, while the protein content increased). More positive changes were reported for the milk of the PBS.

The milk of the pasture-reared PBS, which was not supplemented with fodders, and that of its barn-reared crosses with the Assaf, which were fed with winter fodders, differed considerably and significantly in the content of a range of fatty acids. The milk fat in PBS had significantly ($P<0,05$) higher SFA- 69,2%/ 100gMF against 64,7 g/100100gMF in the crosses with the difference being mostly due to the palmitic acid content 26,8g/100 100 gMF against 22,63 g/100 gMF ($p<0,01$). The short and medium-chain SFA (C-4:0- C-12:0) had similar levels-21,0 g/100 gMF and 20,69 g/100 gMF for the PBS and the crosses respectively. The BCFA content in the former was significantly ($P<0,05$) higher: 2,893 g/100 gMF against 2,427 g/100 gMF. The milk of the crosses had significantly higher USFA content- 31,2 g/100 gMF against 27,2 g/100 gMF in PBS ($P<0,05$) with the difference mostly stemming from the vaccenic acid- 6,647 g/100 gMF against 1,890 g/100 gMF ($P<0,001$). The content of the other trans fats was 18,8% higher in the milk of the crosses. The milk fat in this breed had significantly higher content of linolelaidic (0,160 g/100 gMF against 0,110 g/100 gMF ($P<0,05$)) and linoleic (2,650 g/100 gMF against 2,223 g/100 gMF ($P<0,05$)) acids, while that of the PBS had more gamma-linolenic acid (0,300 g/100 gMF against 0,173 g/100 gMF ($P<0,001$)). The milk of the crosses had more ω-3 – 1,406 g/100 gMF against 1,180 g/100 gMF for PBS and ω-6- 3,450 g/100 gMF against 2,967 g/100 gMF respectively. The ω-6/Σ-3 ratios were almost identical- 2,51 in the crosses and 2,53 for PBS.

The yoghurt produced from PBS x Assaf crosses displayed higher biological sufficiency trend than the yoghurt produced from the PBS. Despite the difference being insignificant, the former had 34,8% higher ΣCLA content, 10,8% more monounsaturated, 14,8% more polyunsaturated fatty acids, and 49,2% ω-3 fatty acids. The ω-6/ω-3 ratio was within the healthy range with reference to both breedc, however, it was 38,7% lower in the crosses.

Unlike the yoghurt, the Bulgarian white brined cheese produced from PBS milk had better ω-6/ω-3 ratio (P<0,001). It had higher BCFA content- 23,6% (P<0,001) and CLA- 73,4% (P<0,001). The cheese produced from the milk of the crosses had higher mono- 15,7% (P<0,001) and poly- 5,54% (P<0,01) USFA content.

The biochemical blood parameters of the pasture-reared PBS were closer to the physiological norms than those of the crosses with the Assaf. The latter exhibited a more serious liver functions strain. The reason may be rooted in the elevated protein content in the fodders as well as the immobilization of the animals.

The PBS x Assaf crosses can be successfully used for a year-round intensive milk production. The year-round barn-reared (F4) crosses which fed on standardized high quality fodders had high average daily milk yield at their first lactation-1,584±0,028 kg for 180-day and 1,500±0,027 kg for 300-day lactation. 82,4% of the ewes were milked until the180th lactation day, and 55,3%- until the 300th. No significant differences were reported with reference to the milk yield of the ewes which lambed in the 4 lambing periods- March, July, August and September. The monthly lactation dynamics of the ewes was significantly influenced (P<0,001) by the month of lambing. As a whole, the lactation peak was reached at the end of the first month post lambing (2,024 kg/d). The milk yield remained stable until the end of the second month post lambing (97,6% of the peak value), and from then on it started to gradually decrease reaching 63,2% of the maximum milk yield on day 120, and 51, 9% of the maximum milk yield on day 180. The most stable lactation was that of the ewes which lambed in the spring. The average daily milk yield dynamics during the lactation period showed that the morning and evening milking milk quantities were similar, with the closest values being reported for the ewes which lambed in July and August. The greatest differences were displayed by the ewes which lambed in March.

CONCLUSIONS

1. The dairy sheep breeding association controls BDSP which is stabilized in terms of the number of flocks and animals (24,6% of the total sheep numbers) and sufficient for the organisation of effective breeding and improvement activities.
2. The milk yield of the nucleus flocks of the controlled population was relatively low- 163,9 ± 0,217 l per 135,4 ±0,03-day milking period and 149,1± 0,230 l for 120-day lactation. The region, farm and the year of control had significant influence on the milk yield.
3. The controlled part of the Pleven Blackhead Sheep has exhibited a steady downward trend in the last 7 years, and since 2022, the breed has been included in the group of breeds endangered of extinction.

4. The Pleven Blackhead sheep had relatively high milk yield. The average milk yield for 120-day lactation period in 1544 ewes at first lactation was 119,5± 1,185 l, and that of 899 ewes at second lactation- 122,1± 2,891 l. The farm and the year of control were significant sources of milk yield variation.
5. The use of Pleven Blackhead Sheep as a foundation upon crossbreeding with high-producing breeds had different effects. The (F1) crosses with the East Friesian sheep had 120-day lactation period milk yield of 115,1± 3,19 l at first lactation, 135,9± 3,51 l and second and 201,2± 4,96 l at third, with the difference with the purebred animals being heavily influenced by the conditions of the year.
6. The crosses between the Pleven Blackhead Sheep and the Assaf had high milk potential but were more vulnerable in terms of the influence of some unfavourable conditions of the environment, with the vulnerability increasing with the generation number increase. The haematological parameters analysis reported more strain in the functions of the organisms of the crosses than in those of the purebred PBS.
7. In favourable conditions, the milking period milk yield of (F4) PBS x Assaf crosses at their first and second lactation was over 250l, and the milk yield for 120-day milking period- 207,6 and 192,7 l respectively.
8. The Pleven Blackhead Sheep had a significant milk yield potential and if reared under suitable feeding conditions, it would not be outperformed by its crosses with the Assaf.
9. When compared with that of its crosses with the Assaf, the milk of PBS had 24,5% higher fat content, 11,7% more lactose and 6,2% salt. However, it had 12,4% lower protein content, with part of the higher protein content in the crosses being at the expense of the whey proteins which did not have any significance for the yield during the production of cheese.
10. The milk of the pasture-reared PBS had lower USFA, significantly higher branched-chain fatty acids content, and lower *trans* fatty acids than the milk of its (F4) crosses with the Assaf which were reared in barns and fed on fixed rations. The short and medium-chain SFA had similar levels. The milk of the crosses had more ω-3 fatty acids but the ω-6/ω-3 ratio was almost identical- 2,51 in the crosses and 2,53 for the purebred animals.
11. The milk of the PBS ewes increased its biological sufficiency upon processing for the production of Bulgarian white brined cheese, and that of the crosses with the Assaf- during the production of yoghurt.

12. The high generation intensively reared crosses with the Assaf may be successfully used for a year-round milk production in the environmental and geographical conditions of our country.
13. The ewes fertilization in the anestrus period through estrus synchronization experiments performed had relatively low results- pregnancy rates- 61,59%, economic fecundity- 52,60%, biological fecundity- 119,7%.

RECOMMENDATIONS

1. Instead on being focused on fruitless crossbreeding schemes, the activities aimed at the creation of high-producing dairy population in Bulgaria need to pay closer attention to increasing the number of the animals and conducting scientifically substantiated targeted selection based on the milk yield of PBS with reference to each the breed has great potential.
2. Upon crossbreeding between PBS and Assaf, it is necessary to determine the optimum breed generation by taking into account the milk yield, the milk quality, and sustainability before commencing internal breeding of the crosses.
3. The development of effective estrus synchronization and ewes fertilization in the anestrus season needs to continue for the purpose of creating sustainable possibilities for a year-round sheep's milk production.
4. Due to the small productivity differences between the nucleus flocks and the rest of the controlled animals, the ram selection, in view of its increased efficiency, needs to be performed in the entire part of the breed following the open nucleus system. In addition, it is necessary to implement a system evaluating the quality of the progeny.

CONTRIBUTIONS

1. The state and the trends in the development of part of the Bulgarian Dairy Synthetic Sheep breed in terms of selection was subject to analysis. It was ascertained that in the recent years the population has been stabilized with reference to the number of the flocks and the controlled animals (24,6% of the total number of sheep). It was also reported that the milk yield of the nucleus flocks was relatively low-163,9 ± 0,217 l for a milking period of 135,4 ± 0,03 and 149,1± 0,230 l for 120-day lactation. The region, the year of control and the farm had significant influence of the milk yield.
2. The state and the development trends of the Pleven Blackhead Sheep were analysed. It was ascertained that in the last 7 years, the

controlled part exhibited a steady downward trend, and as of 2022, the breed has been in the group of breeds endangered of extinction.

3. It was confirmed that the Pleven Blackhead Sheep had relatively high productivity- the average milk yield for standard first lactation was 119,5± 1,185 l, and 122,1± 2,891 l for second. It was reported that the farm and the year of control were significant sources of milk yield variation. It was ascertained that the breed significant milk yield potential and, under the suitable conditions, it did not perform worse in this respect than the crosses with the Assaf.
4. It was ascertained that the crossbreeding between the Pleven Blackhead Sheep and the East Friesian Sheep did not result in milk yield increase. The (F1) crosses at first lactation had 120-day lactation period milk yield of 115,1± 3,19 l, it was 135,9± 3,51 l at second and 201,2± 4,96 l at third lactation. It was also ascertained that the milk yield of the crosses was significantly influenced by the conditions of the year, while that of the purebred animals was relatively stable.
5. It was ascertained that when the conditions were favourable, the crossbreeding between the Pleven Blackhead Sheep and the Assaf breed was effective. The milking period milk yield of (F4) PBS x Assaf crosses at first and second lactation was over 250 l, while their milk yield for 120-day milking period- 207,6 and 192,7 l respectively.
6. It was ascertained that the high generation crosses had significant milk yield potential, and they could be successfully used for a year-round milk production under intensive farming technology. It was reported that the crosses were more vulnerable to unpleasant environmental conditions and exhibited higher strain in the functions of the organism. It was also ascertained that with the generation increase, the vulnerability to unfavourable influences increased.
7. It was ascertained that the PBS breed milk had 24,5% more fat content, 11,7% more lactose and 6,2% more salt than the milk of the crosses. The latter, however, had 12,4% higher protein levels at the expense of the whey proteins.
8. Considerable differences were ascertained between the PBS milk and dairy products and those of its (F4) crosses with the Assaf in terms of the fatty acids profile. The milk of the pasture-reared PBS had lower USFA content, significantly higher branched-chain fatty acids content, and lower *trans*-fatty acids than the milk of the barn-bred and ration fed (F4) crosses with the Assaf. The milk of the crosses had more ω-3 fatty acids but the ω-6/ω-3 ratio was almost identical- 2,5l in the crosses and 2,53 for the purebred animals.
9. Non-linear changes were ascertained upon the production of dairy products from the milk of both the purebred animals and the crosses.

It was ascertained that the milk of the PBS increased its biological sufficiency when being processed for the production of Bulgarian white brined cheese, and that of the Assaf- during the production of yoghurt.

PUBLICATIONS RELATED TO THE DISSERTATION

1. Petkova, Z., Georgiev, D., Stoycheva, I. (2018) Past and Present of the PBS Breed J. of Mountain Agriculture in the Balkans, 21 (4): 24-38. (**10 points)**

2. Petkova, Z., V. Nikolov, P. Gospodinov, (2021). Population and Breeding Status of the Bulgarian Dairy Synthetic Population, Controlled by the Breeding Association of the Bulgarian Dairy Sheep Breeds. Agricultural Sciences, 13, 99-109. (**10 points**)

3. Petkova, Z. & Nikolov, V. (2022). Study on the milk yield and lactation persistency of F4 crosses between Pleven blackhead sheep and the Assaf sheep during different lambing. Bulg. J. Agric. Sci., 28 (Supplement 1), 72–79 (**15 points**)

4. Mircheva, G., Malinova, R. & **Petkova, Z.** (2022). Efficacy of the application of estrus synchronization in sheep during non-breeding season. Bulg. J. Agric. Sci., 28 (Supplement 1), 80–83 (**10 points)**