Ann. Anim. Sci., Vol. 15, No. 1 (2015) 67–80 *DOI: 10.2478/aoas-2014-0074*

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PEDIGREE ANALYSIS OF TOP MILK YIELDING COWS*

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Abstract

The aim of the research was to identify the sires that left the greatest number of cows with lifetime yield over 100 000 kg of milk, and to indicate the pedigree relations among these sires. The population analysed was of Dutch origin. The database covered the years 1950–2012 and comprised the information on 22 429 HF (Holstein-Friesian) cows with lifetime yield exceeding 100 000 kg of milk. They were the progeny of 3 888 sires. The conducted analysis proved that some bulls sire more top yielding cows (including those with the lifetime yield of 100 000 kg of milk or above) than others. Some of those sires were related to one another, and the ancestors of bulls that sired the greatest number of daughters belonged to the sire lines known worldwide.

Key words: dairy cattle, lifetime yield, top cows

Nowadays, when cows produce over 10,000–11,000 kg of milk per lactation, it is questionable both for economic and health reasons whether to improve this trait any further. Varisella et al. (2007) proved that cow life length decreases over the subsequent generations as the milk production sharply increases.

In order to increase the profitability of production, and at the same time keep the milk yield and its quality high enough, the breeding programmes worldwide include various functional traits, e.g. longevity or high lifetime yield. Cattle breeder associations provide ranking lists of top producing cows, and cows with the best longevity, and the lifetime milk yield of over 100 000 kg. The longevity trait has been widely recognised in the breeding programmes, however different numbers of cows on those ranking lists indicate that it does not have similar weight everywhere.

In the Netherlands such high producing cows have been noted since 1950 (RCV NL, 2013), in Germany since 1964 and in Poland since 1974. Cow longevity is influenced by disease resistance, especially as far as the reproductive system is concerned (Sobek et al., 2005). Thus it is essential to conduct pedigree analysis of the best cows

*Work financed from statutory activity.

and to use the information on their ancestors, as outstanding HF sires are said to have great potential to improve dairy cattle population.

The aim of our research is to identify the most valuable bulls who sired top producing cows and to identify the pedigree connections among them.

Material and methods

The data on top yielding cows covered the years 1950–2012. The research material included information on 22 429 HF cows (daughters of 3 888 sires) with the lifetime yield exceeding 100 000 kg of milk. The information on top yielding cows was provided by the internet database of the CRV Dutch branch.

The analysed cows were grouped according to the sires, and we counted the number of top cows sired by particular bulls. The sires were listed in the descending rank, according to the number of daughters. The ranking list included the bulls who sired top cows with milk yield over 100 000 kg (Table 1). For our pedigree analysis we used the information on 50 sires with the greatest number of top yielding daughters.

The sire pedigrees were created based on the CRV sire catalogue (https://global.crv4all.com/), and based on the pedigree information available on the Holstein Association USA website (http://holsteinusa.com/).

For each top cow the 4-generation pedigree was created, based on the available information (e.g. Figure 1).

	TOP COW							
Parents	S (sire)							
Grandparents	SS				DS			
Great grandparents	SSS		DSS		SDS		x	
Great great grandparents	SSSS	DSSS	SDSS	x	SSDS	DSDS	x	x

Figure 1. The analysed pedigree scheme

A table was created for the top cows' grandsires, whose sons were the top cows' fathers. The grandsires were listed according to the descending number of their granddaughters (Table 2). As previously mentioned, we used the data on the 50 sires with the greatest number of top yielding daughters.

A similar table (Table 3) was created for the top cows' great grandsires (i.e. the fathers of their grandsires).

We also tried to analyse the pedigree of the dams. i.e. the sires' mothers. In Table 4 we present the number of top cows born to their great damsires. The great damsires were listed according to the descending number of their great granddaughters.

On the basis of the above the list was made of the great grandsires appearing on both maternal and paternal side (Table 5). A similar list was made for the great great grandsires (Table 6).

Among the 50 sires with the greatest number of top yielding daughters we found full siblings and half-siblings, sharing either a mother or a father (Tables 7 and 8).

For the analysed top cows we estimated the average values of milk fat (4.23%) and protein (3.39%). The next step was to find the farms with the greatest number of top yielding cows. The farms were listed according to the descending number of cows. For the first three farms on the list we established the number of top cows that were the descendants of the 50 sires (with the greatest number of top yielding daughters).

For the cows with the milk yield over 100 000 kg the pedigree analysis was done and it spanned 4 generations including the male descendants on both sire and dam sides (Figure 1).

Results

In the analysed sire group 32 individuals sired more than 100 daughters (Table 1) and 441 sired at least 5 daughters. The remaining 3447 sires had less than 5 top yielding daughters. The two sires – SUNNY BOY and TOPS were the ones with the greatest number of daughters – 1 788 and 1 127, respectively.

Table 1. Sires with top yielding daughters producing over 100 000 kg of milk (N_1 – number of daughters)

No	Sire (S)*	N_1	No	Sire (S)*	N_1	No	Sire (S)*	N_1
1	Sunny Boy	1788	12	Superstar	239	23	Luxemburg	131
2	Tops	1127	13	Very	235	24	Bert	119
3	Cash	592	14	Addison	222	25	Jaguar	118
4	Celsius	584	15	Laurel	178	26	Triple Threat	116
5	Lord Lily	577	16	Royal	176	27	Graton	110
6	F16	466	17	Bill	167	28	Meadow	105
7	Marconi	457	18	Felix	153	29	Amos	102
8	Jabot	446	19	Novalis	144	30	Bernard	102
9	Labelle	443	20	Marty	141	31	Silver	101
10	Lava	317	21	Gambler	140	32	Constantijn	100
11	Ronald	252	22	Aldo	139			

Total in sire groups	N_1
32 sires with N1>100	10 087
3856 sires with N1<100	12 342
3 888 sires TOTAL	22 429

* (S) – a sire with top yielding daughters (ref. Figure 1).

Grandsires (11 individuals that sired 50 analysed bulls) of the top yielding cows are listed in Table 2. The sires with the largest group of sons were: SUNNY BOY (5 sons), TO-MAR BLACKSTAR ET (4 sons), BIS-MAY TRADITION CLEITUS

(3 sons). Four sires had 2 sons each, and among them CAL CLARK BOARD CHAIRMAN had 606 granddaughters. The remaining 3 bulls sired one son each.

The bull with the greatest number of top granddaughters was NEHLS CHIEF CRUSADER (1 788). He sired one son – SUNNY BOY – who had sired the greatest number of top cows, and at the same time had been the grandsire of 1014 top cows. The second bull with the greatest number of top granddaughters was TO-MAR BLACKSTAR ET. He was the grandsire to 1285 cows and sired 4 bulls: LORD LILLY (577 daughters), MARCONI (457 daughters), LAUREL (178 daughters), KOEMAN (73 daughters). That was the second largest subgroup of sons who sired top cows.

Another grandsire with large number of granddaughters (1127) was FLEETRIDGE MONITOR. All his granddaughters were sired by a renowned TOPS.

Grandsires with the largest groups of top yielding granddaughters often sired only one or two outstanding sons. An interesting example was SUNNY BOY (sired by NEHLS CHIEF CRUSADER) who was the grandsire to 1041 cows. He sired 5 bulls – the most numerous subgroup of sons who sired over 50 daughters each.

The paternal great grandsire and their sons are presented in Table 3. Among them three great grandsires with the largest number of top yielding great granddaughters sired more than one son (the top cow's grandfather). CARLIN M IVANHOE BELL had 5 sons – the greatest number, and OSBORNDALE IVANHOE, and ROUND OAK RAG APPLE ELEVATION had 3 sons each.

The sire with the largest number of granddaughters (1788) was PAWNEE FARM ARLINDA CHIEF, who sired their father, NEHLS CHIEF CRUSADER, who in turn sired the famous SUNNY BOY. The latter had the largest number of top yielding daughters and granddaughters (Table 3).

The analysis also concerned maternal great grandsires and it showed that CARLIN M IVANHOE BELL (2101) and A PUGET SOUND SHEIK (1963) (Table 4) had the largest number of great granddaughters.

Tables 3 and 4 show that there are only two great grandsires found on both paternal and maternal sides, i.e. CARLIN M IVANHOE BELL and BIS-MAY TRADITION CLEITUS.

CARLIN M IVANHOE BELL was on the 2nd position on the paternal side, and on the 1st position on the maternal side with 1679 and 2101 great granddaughters, respectively. OSBORNDALE IVANHOE on the other hand was on the 3rd position on the paternal side and on the 15th position on the maternal side, with 1319 and 167 great granddaughters, respectively.

We made similar collation for great great grandsires found on both paternal (OO) and maternal (MO) sides (Table 6). The number of great great granddaughters was definitely greater on the paternal side. The only exception is PENSTATE IVANHOE STAR with 2101 great great granddaughters on the maternal side.

In the analysed group of 50 sires we also tried to find full siblings with the greatest number of top yielding daughters. We found out that only ADDISON (222 top yielding daughters) and SLOGAN (78 top yielding daughters) are full sibling, with BIS-MAY S-E-L MOUNTAIN ET and TIDY B E STEPH being their father and mother, respectively.

Table 2. Grandsires and sires to the top yielding cows (N_2 – number of granddaughters. N_1 – number of daughters)

No.	Grandsire (OO)	N_2	No.	Sire (O)	N_1
1	NEHLS CHIEF CRUSADER USAM000001723121	1788	1	SKALSUMER SUNNY BOY NLDM000311651443	1788
2	TO-MAR BLACKSTAR ET USAM000001929410	1285	1	ETAZON LORD LILY NLDM000780180664	577
			2	HAVEP MARCONI NLDM000776437936	457
			3	ETAZON LAUREL NLDM000461674583	178
			4	DELTA KOEMAN NLDM000319299993	73
3	FLEETRIDGE MONITOR USAM000001432733	1127	1	TOPS MONITOR LEGEND USAM000001736397	1127
4	SKALSUMER SUNNY BOY NLDM000311651443	1041	1	EASTLAND CASH NLDM000775328514	592
			2	ZANDENBURGER ROYAL NLDM000790545532	176
			3	BERNARD NLDM000814131051	102
			4	STRING MILTON NLDM000320825242	98
			5	EROS 68 NLDM000784902699	73
5	BIS-MAY TRADITION CLEITUS USAM000001879085	653	1	DELTA CLEITUS JABOT NLDM000316419721	446
			2	DELTA JAGUAR NLDM000316420499	118
			3	ETAZON LAUDIA LEXUS NLDM000134528821	89
6	CAL CLARK BOARD CHAIRMAN USAM000001723741	606	1	F16 ROCKET C NLDM000310218418	466
			2	THONYMA GAMBLER ET USAM000001916262	140
7	HOW-EL-ACRES K BELLMAN-ET USAM000001874634	584	1	ETAZON CELSIUS NLDM000460508522	584
8	UGELA BELL USAM000001920807	448	1	DELTA LAVA NLDM000319957882	317
			2	DELTA LUXEMBURG NLDM000776846536	131
9	STAN-BITZIE KIRK BELL BOSS USAM000001882141	443	1	ETAZON LABELLE NLDM000460942030	443
10	MADAWASKA AEROSTAR CANM000000383622	344	1	NEWHOUSE RONALD NLDM000777430664	252
			2	ARCHIBALD NLDM000811488961	92
11	BIS MAY S-E-L MOUNTAIN ET USAM000002070579	300	1	ETAZON SLOGAN NLDM000140915217	78
			2	ETAZON ADDISON NLDM000839380546	222

*(O) – sire to the top yielding cows.
*(OO) – grandsire to the top yielding cows; see: Figure 1.

Table 3. Paternal great grandsires to the top yielding cows (N_2 – number of granddaughters; N_3 – number of great granddaughters)

No.	(OOO)* great grandsire	N_3	No.	(OO)* grandsire	N_2
1	PAWNEE FARM ARLINDA CHIEF USAM000001427381	1788	1	NEHLS CHIEF CRUSADER USAM000001723121	1788
2	CARLIN M IVANHOE BELL USAM000001667366	1679	1	HOW-EL-ACRES K BELLMAN-ET USAM000001874634	584
			2	HUBERVIEW BELL PROMISE USAM000001879890	105
			3	RIPVALLEY NA BELL TROY USAM000001882797	99
			4	STAN-BITZIE KIRK BELL BOSS USAM000001882141	443
			5	UGELA BELL USAM000001920807	448
3	OSBORNDALE IVANHOE USAM000001189870	1319	1	FLEETRIDGE MONITOR USAM000001432733	1127
			2	HARTSBROOK I KEN USAM000001387978	91
			3	PENSTATE IVANHOE STAR USAM000001441440	101
4	CAL CLARK BOARD CHAIRMAN USAM000001723741	1285	1	TO-MAR BLACKSTAR ET USAM000001929410	1285
5	NEHLS CHIEF CRUSADER USAM000001723121	1041	1	SKALSUMER SUNNY BOY NLDM000311651443	1041
6	SWEET HAVEN TRADITION TM USAM000001682485	653	1	BIS-MAY TRADITION CLEITUS USAM000001879085	653
7	MILU BETTY IVANHOE CHIEF USAM000001578139	606	1	CAL CLARK BOARD CHAIRMAN USAM000001723741	606
8	ROUND OAK RAG APPLE ELEVATION USAM000001491007	365	1	HANOVERHILL STARBUCK CANM000000352790	75
			2	LOCUST-GLEN IVANHOE ELEVATION USAM000001644629	69
			3	OCEAN VIEW SEXATION USAM000001672151	221
9	HANOVERHILL STARBUCK CANM000000352790	344	1	MADAWASKA AEROSTAR CANM000000383622	344
10	LEKKER VALIANT ROYALTY USAM000001821208	300	1	BIS MAY S-E-L MOUNTAIN ET USAM000002070579	300

*(OO) – grandsire to the top yielding cows.
*(OOO) – great grandsire to the top yielding cows; see: Figure 1.

Table 4. Maternal great grandsires and the number of their great granddaughters (N_3 – number of great granddaughters)

No.	(OMO)* Maternal great grandsires	N_3
1	CARLIN M IVANHOE BELL USAM000001667366	2101
2	A PUGET SOUND SHEIK USAM000001617427	1963
3	PACLAMAR ASTRONAUT USAM000001458744	1380
4	BIS-MAY TRADITION CLEITUS USAM000001879085	1155
5	ARLINDA ROTATE USAM000001697572	1034
6	MOWRY C CITATION ROCKET USAM000001537886	466
7	THONYMA SECRET USAM000001856904	383
8	EMPRISE BELL ELTON USAM000001912270	300

*(OMO) – great grandsire to the top yielding cows; see: Figure 1.

Table 5. Great grand sires on paternal (OO) and maternal (MO) side (N_3 – number of great grand daughters)

No.	Paternal great grandsire (OOO) and maternal great grand sire (OMO)	N_3 on paternal side	N_3 on maternal side
1	CARLIN M IVANHOE BELL USAM000001667366	1679	2101
2	OSBORNDALE IVANHOE USAM000001189870	1319	167
3	ROUND OAK RAG APPLE ELEVATION USAM000001491007	365	153
4	LEKKER VALIANT ROYALTY USAM000001821208	300	176
5	OCEAN VIEW SEXATION USAM000001672151	90	178

*(OO), (MO) – sire and dam.
*(OOO), (OMO) – great grand sire to the top yielding cows; see: Figure 1.

Table 6. Great great grand sires on paternal and maternal side (N_4 – the number of great great grand daughters)

No.	Paternal great great grandsire (OOOO) and maternal great great grandsire (OOMO)	N_4 on paternal side	N_4 on maternal side
1	PAWNEE FARM REFLECTION USAM000001383926	1788	71
2	PENSTATE IVANHOE STAR USAM000001441440	1679	2101
3	PAWNEE FARM ARLINDA CHIEF USAM000001427381	1647	314
4	OSBORNDALE TY VIC USAM000000848777	1319	167
5	ROUND OAK RAG APPLE ELEVATION USAM000001491007	1087	178
6	TIDY BURKE ELEVATION USAM000001271810	365	153
7	S-W-D VALIANT USAM000001650414	300	176

*(OOOO), (OOMO) – great great grand sire to the top yielding cows; see: Figure 1.

Table 7. Half brothers (sharing the same father) of the bulls siring the top yielding cows (N_1 – number of daughters)

Half sibling group (total of N_1)	No.	Half sibling	N_1	Father of half sibling	Mother of half sibling
1	2	3	4	5	6
1	1	ETAZON LORD LILY NLDM000780180664	577	TO-MAR BLACKSTAR ET USAM000001929410	HI-SI ROT LILY USAF000012951348
	2	HAVEP MARCONI NLDM000776437936	457		ROTATE DAZZLE USAF000012905361
(N_1=1285)	3	ETAZON LAUREL NLDM000461674583	178		SEXATION DAWN USAF000011563909
	4	DELTA KOEMAN NLDM000319z299993	73		O-C-S-DAIRY BELL STREAMER US-AF000011751588
2	1	EASTLAND CASH NLDM000775328514	592	SKALSUMER SUNNY BOY NLDM000311651443	EASTLAND GOLDEN NLDF000514152714
	2	ZANDENBURGER ROYAL NLDM000790545532	176		DELFABIOLAET TL NLDF000315880445
(N_1=1041)	3	BERNARD NLDM000814131051	102		DELTA BERDIEN NLDF000317928824
	4	STRING MILTON NLDM000320825242	98		STRING GEERTJE 445 NLDF000317705359
	5	EROS 68 NLDM000784902699	73		KLASKE 201 NLDF000318302524
3	1	DELTA CLEITUS JABOT NLDM000316419721	446	BIS-MAY TRADITION CLEITUS USAM000001879085	FARLOWS BELL ROSEBUD US-AF000011202086
	2	DELTA JAGUAR NLDM000316420499	118		DARLING B GINNY USAF000011682780
(N_1=653)	3	ETAZON LAUDIA LEXUS NLDM000134528821	89		O-C-S-DAIRY BELL STREAMER US-AF000011751588
4	1	F16 ROCKET C NLDM000310218418	466	CAL CLARK BOARD CHAIRMAN USAM000001723741	FEIKJE 33 NLDF000308134599
(N_1=606)	2	THONYMA GAMBLER ET USAM000001916262	140		THO CON GAZELLA USAF000009738515

5	1	DELTA LAVA NLDM000319957882	317	UGELA BELL US-AM000001920807	DELTA ESMERALDA NLDF000316419187
(N_1=448)	2	DELTA LUXEMBURG NLDM000776846536	131		DELTA SIBERIA NLDF000316418766
6	1	NEWHOUSE RONALD NLDM000777430664	252	MADAWASKA AEROSTAR CANM000000383622	NEWHOUSE INGRID 66 TL NLDF000805719521
(N_1=344)	2	ARCHIBALD NLDM000811488961	92		ETAZON MONA NLDF000515622472
7	1	GARDENIA CHIEF ASTRONAUT US-AM000001571320	82	PAWNEE FARM ARLINDA CHIEF USAM000001427381	GARDENIA C ASTR USAF000006637048
	2	NEHLS CHIEF CRUSADER USAM000001723121	78		NEHLS HARBOR DD USAF000007684390
(N_1=229)	3	TOPS AC LINDY MAGIC USAM000001773621	69		TOPS AST LINDY USAF000008144977
8	1	PALTZER SEXATION BERT USAM000001881504	119	OCEAN VIEW SEXATION USAM000001672151	BOS-HAVEN APACHE BETH US-AF000009611219
(N_1=221)					
	2	FREEBROOK SEXATION AMOS US-AM000001889085	102		FREE ASTRO ANNA USAF000007729114

Table 8. Half sibling (sharing the same mother) of the bulls siring top yielding cows (N_1 – number of daughters)

Half sibling group (total of N_1)	No.	Half sibling	N_1	Father of half sibling	Mother of half sibling
1	1	TOPS MONITOR LEGEND USAM000001736397	1127	FLEETRIDGE MONITOR USAM000001432733	TOPS AST LINDY USAF000008144977
(N_1=1196)	2	TOPS AC LINDY MAGIC USAM000001773621	69	PAWNEE FARM ARLINDA CHIEF USAM000001427381	
2	1	DELTA KOEMAN NLDM000319299993	73	TO-MAR BLACKSTAR ET USAM000001929410	O-C-S-DAIRY
	2	ETAZON LABELLE NLDM000460942030	443	STAN-BITZIE KIRK BELL BOSS USAM000001882141	BELL STREAMER USAF000011751588
(N_1=605)	3	ETAZON LAUDIA LEXUS NLDM000134528821	89	BIS-MAY TRADITION CLEITUS USAM000001879085	
3	1	DELTA LAVA NLDM000319957882	317	UGELA BELL USAM000001920807	DELTA ESMERALDA NLDF000316419187
(N_1=461)	2	DELTA NOVALIS NLDM000817118723	144	CURTMAID EM ACRES TARGET USAM000002030882	

Half brother sires form a much more numerous group. We found 8 groups of half brothers with 1285 – 221 daughters (Table 7). TO-MAR BLACKSTAR ET sired 4 bulls and they were the largest group of half brothers, with 1285 daughters. These four bulls are LORD LILLY, MARCONI, LAUREL and KOEMAN and they sired 577, 457, 178, 73 daughters, respectively.

Half brothers sired by SUNNY BOY were the most numerous group. Among them CASH sired 592 cows, ROYAL and BERNARD sired over 100 cows each, and MILTON and EROS 68 sired 98 and 73 cows, respectively.

The analysis of half brothers sharing the same mother showed only 3 such groups and they were much smaller than those sharing the same father (Table 8).

The most numerous half-sibling group included sires sharing a mother (O-C-S DAIRY BELL STREAMER). These were the following sires: LABELLE, with the greatest number of top yielding daughters in the group (443), LEXUS (89 daughters), KOEMAN (73 daughters). The remaining two half-sibling groups included two half-brothers (sharing a mother).

TOPS AST LINY was the mother of half-sibling that sired the greatest number of top yielding daughters (1196).

For fuller analysis 3 farms with the greatest number of registered top yielding cows were chosen and it was confirmed that only SUNNY BOY sired a far greater number of top yielding cows than other bulls under analysis.

Discussion

Milk production profitability depends on cow productivity level. The higher the productivity, the lower the fertility and longevity. Shorter production period also means higher herd replacement costs (Morek-Kopeć and Żarnecki, 2012; Różańska-Zawieja et al., 2008).

The main problem of the selection for longevity and for other functional traits is their low heritability. Czubska et al. (2009) proved that increasing the production period to 9 or even 18 years is possible without decreasing productivity level.

In Poland the average dairy cattle production period lasts not longer than 3 lactations on large-scale farms. For smaller farms it is longer and lasts 6–7 years, however the productivity then is lower (Antkowiak et al., 2003).

As the milk productivity tends to increase it is very important to analyse relationship between milk production and fecundity . Productivity negatively influences fecundity and this may lead to early removal from the herd (Sawa et al., 2002). Sitkowska et al. (2005) report that as much as 80% of cows were culled because of sterility. Similarly, Czaplicka (2004) determined the main cow culling reason to be sterility.

Nowadays the breeding work aims at increasing milk protein content, in order to make cheese production more efficient. However, the correlation between milk yield and its main parameters (e.g. the protein content) is negative, as selection for increasing milk production leads to decreasing protein and fat percentage (Sawa et

al., 2004). Yet there are distinguished individuals, for whom both milk yield, and protein/fat content values are high (Sobek et al., 2012), and these cows are especially valuable for breeding work.

Another important aspect of modern dairy cattle breeding is inbreeding. Its negative effects cause significant economic loss for the breeders. Inbreeding results in decreasing mean trait values (inbreeding depression), e.g in fat or protein content (Lutaaya et al., 1999; Thomson and Freeman, 1967). When only the best individuals are used for breeding, the relationship coefficient increases, especially among the most valuable sires.

Moreover, inbreeding leads to reducing genetic variability within the population (Stachowicz et al., 2011). Inbreeding in the course of breeding work often seems unavoidable (Thompson et al., 2000; Von Krosigk and Lush, 1958; Muasya et al., 2013). Analysing the population of 1 805 773 HF cows, Thompson et al. (2000) proved that inbreeding significantly reduced productivity.

The most visible production loss was noted for early lactation. The decrease in protein and fat yield was proportional to the decrease in milk yield. For the inbreeding coefficient >0.10 the lactation was 2–8 days shorter on average. Thompson et al. (2000) noted that the survival rate was also reduced by inbreeding.

They also found that the increase of the relationship coefficient in the analysed population was linear. Similarly, Rokouei et al. (2010) showed in their research that the inbreeding coefficient increased yearly (0.22% for females and 0.15% for males). The highest yearly increase in inbreeding was noted for 2000–2007 – 0.31% and 0.21% for females and males, respectively. This might have been caused by using imported semen of a few worldwide renowned sires. Rokouei et al. (2010) report that inbreeding significantly reduces lifespan in cows.

On the Polish top cow ranking list BURKA is on the leading position, with the lifetime milk yield of 136 342 kg (PFHBiPM, 2013). According to CRV NL 2013, another cow, EH IRRE 219, sired by PRELUDE had a lifetime milk yield of 131 077 kg (status as of 1 March 2011).

On the basis of our own research we can determine the prominent HF sire lines known for the greatest number of top yielding daughters. The line founders are, among others: PAWNEE FARM ARLINDA CHIEF (his sons are: Sunny Boy, Addison, Slogan, Lord Lily, Marconi, Laurel, Arlinda Rotate, S-W-D Valiant, Milu Betty Ivanhoe Chief, Cal Clark Board Chairman, To-Mar Blackstar ET); PENSTATE IVANHOE STAR (his sons: Arlinda Penstar, Carlin M Ivanhoe Bell, How-El-Acres K Bellman ET, Celsius, Emprise Bell Elton Huberview Bell Promise, Meadow, Bitzie Kirk Bell Boss, Labelle, Ugela Bell, Lava, Luxemburg) or ROUND OAK RAG APPLE ELEVATION (his sons: Hanoverhill Starbuck, Madawaska Aerostar, Ronald, Archibald, Ocean View Sexation, Amos, Sweet Haven Tradition, Bis-May Tradition Cleitus, Jabot).

Sobek et al. (2012) conducted the pedigree analysis of 1993–2009 German database including 3 187 HF cows with the milk yield over 100 000 kg. In our own research we analysed even vaster database (1950–2012), including information on 22 429 top yielding cows. The authors pointed to the same prominent sire lines as in the present research paper, with the founders being among the others: ROUND OAK

RAG APPLE ELEVATION, PENSTATE IVANHOE STAR or PAWNEE FARM ARLINDA CHIEF.

Stachowicz et al. (2011) in the research conducted on the pedigree database of 8 764 141 Canadian HF cows proved ROUND OAK RAG APPLE ELEVATION and PAWNEE FARM ARLINDA CHIEF to be the most genetically influencing sires for 2000–2008 cow population. The remaining sires were: Hanoverhill Starbuck, To – Mar Blackstar ET, No Na Me Fond Matt, A B C Reflection Sovereign or Carlin – M Ivanhoe Bell. The latter is known also for being the CVM (complex vertebral malformation) carrier (Agerholm et al., 2001).

The data analysed in the presented research paper indicate the importance of prominent sire lines known for the number of top yielding daughters. With proper selection of the most valuable sires, the further dairy cattle improvement seems to be possible.

Conclusions

The conducted pedigree analysis of HF cows with lifetime milk yield of over 100 000 kg proves that some bulls have sired more top cows than the others. Thus their genotypes seem to be the most valuable. However, due to the fact that only a small number of sires are used in breeding work, the inbreeding in dairy cattle is still increasing, making the production less profitable. The profitability of milk production also depends on cow longevity and the length of production period.

The present research suggests that:

1. It is possible to identify sires with the largest number of daughters with the lifetime milk yield over 100 000 kg.
2. Some sires with top yielding daughters had common ancestors.
3. These common ancestors belonged to the prominent sire lines.
4. Sunny Boy of Pawnee Farm Arlinda Chief line sired the largest number of top yielding daughters, and he was on the 3rd place as far as the number of grand daughters is concerned.
5. There are breeding lines predisposed to siring top yielding cows.

References

Agerholm J.S., Bendixem C., Andersen O., Arnbjerg J. (2001). Complex vertebral malformation in Holstein calves. J. Vet. Diagn. Inves., 13: 283–289.

Antkowiak I., Pytlewski J., Dorynek Z. (2003). Lifetime production performance and the causes of culling of cows in the "Lubianka" farm (OHZ Lubiana) (in Polish). Anim. Prod. Rev. Pol. Soc. Anim. Prod., 68: 123–130.

CRV NL (2013). [https://www.crv4all.nl/], last access date: 15-06-2013.

CRV NL (2013). [https://www.global.crv4all.nl/], last access date: 15-06-2013.

Czaplicka M. (2004). Comparison of milk yield of Holstein-Friesian cows imported from the Netherlands and domestic Black-and-White cows. Zesz. Nauk. Prz. Hod., 74: 49–54.

Czubska A., Wójcik P., Kruk M. (2009). Selection for cow longevity as the way to improve small farm profitability (in Polish). Pr. Mat. Zoot., 67: 45–56.

Holstein USA (2013). [https://www.holsteinusa.com/], last access date: 15-06-2013.

Lutaaya E., Misztal I., Bertrand K., Mabry J.W. (1999). Inbreeding in populations with incomplete pedigrees. J. Anim. Breed. Genet., 116: 475–480.
Morek-Kopeć M., Żarnecki A. (2012). Relationship between conformation traits and longevity in Polish Holstein Friesian cattle. Livest. Sci., 149: 53–61.
Muasya T.K., Peters K.J., Kahi A.K (2013). Breeding structure and genetic variability of the Holstein Friesian dairy cattle population in Kenya. Anim. Genet. Res., 52: 127–137.
PFHBiPM (2013). Polish Federation of Cattle Breeders and Dairy Farmers. The results of milk recording in Poland 2012, Warszawa.
Rokouei M., Vaez Torshizi R., Moradi Shahrbabak M., Sargolzaei M., Sørensen A.C. (2010). Monitoring inbreeding trends and inbreeding depression for economically important traits of Holstein cattle in Iran. J. Dairy Sci., 93: 3294–3302.
Różańska-Zawieja J., Nienartowicz-Zdrojewska A., Nowacki P., Sobek Z. (2008). Longevity and reasons of culling in dairy cattle (in Polish). Pr. Mat. Zoot., 65: 59–66.
Sawa A., Jankowska M., Neja W., Bogucki M., Oler A. (2002). High productivity and course of lactation curve and fertility and cow culling (in Polish). Zesz. Nauk. Prz. Hod., 62: 145–153.
Sawa A., Piwczyński D., Bogucki M., Neja W. (2004). Genetic and phenotypic parameters of milk production and milk composition according to the cow and herd milk production (in Polish). Zesz. Nauk. Prz. Hod., 72: 11–20.
Sitkowska B., Mroczkowski S., Lach Z. (2005). Milk performance and reasons for culling of high-performance cows (in Polish). Pr. Kom. Nauk Rol. Biol., 55: 155–159.
Sobek Z., Dymarski I., Piekarska O. (2005). The analysis of a longevity and the reasons of milking cows' cull from the herd ZZD IZ Pawłowice (in Polish). Acta Sci. Pol. Zootech., 4: 97–112.
Sobek Z., Różańska-Zawieja J., Nienartowicz-Zdrojewska A., Figiel M. (2012). Ancestry analysis of cows of record milk yields and its constituents (in Polish). Acta Sci. Pol. Zootech., 11: 117–134.
Stachowicz K., Sargolzaei M., Miglior F., Schenkel F.S. (2011). Rates of inbreeding and genetic diversity in Canadian Holstein and Jersey cattle. J. Dairy Sci., 94: 5160–5175.
Thomson J.R., Everett R.W., Hammerschmidt N.L. (2000). Effects of inbreeding on production and survival in Holsteins. J. Dairy Sci., 83: 1856–1864.
Thomson G.M., Freeman A.E. (1967). Effects of inbreeding and selection in a closed Holstein-Friesian herd. J. Dairy Sci., 50: 1824–1827.
Varisella E.A., Nienartowicz-Zdrojewska A., Dymarski I., Sobek Z., Wolc A. (2007). Longevity with reference to lifespan and value of production traits. Med. Weter., 63: 854–857.
Von Krosigk C.M., Lush L. (1958). Effect of inbreeding on production in Holsteins. J. Dairy Sci., 4: 105–113.

Received: 6 V 2014
Accepted: 12 IX 1014