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A. Zarnecki
Academy of Agriculture

M. Stolzman

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MILK AND BEEF PRODUCTION IN TEMPERATE CLIMATES

A. ZARNECKI[1]) and M. STOLZMAN[2]), POLAND

1) Department of Genetics and Animal Breeding, Academy of Agriculture. Krakow, Poland

2) ul. Korotynskiego 19A, Warszawa, Poland

SUMMARY

Milk production in the temperate climates accounts for 66% of the world milk output. In North America only about 20% of beef originates from dairy herds, while in Europe beef production is a by-product of dairying. Several studies showed small genetic correlations between milk and beef traits, thus suggesting the possibility of simultaneous selection for both characteristics. European breeding programs include dual testing of bulls for milk and beef.

Several experiments proved superiority of North American Holstein-Friesians over European dairy breeds in milk production. In the Polish Friesian strain comparison, the US strain, the Canadian strain and the Israeli Friesians produced 19%, 16% and 16% more milk, respectively, than the Polish Black and White strain. In fat yield New Zealand ranked together with Holsteins. The main disadvantage of crossing European breeds with North American dairy cattle is poorer beef quality.

Further improvement of specialized dairy breeds is expected in North America. In Europe, the introduction of a milk quota system and the necessity of maintaining beef production may require reassesment of current breeding strategies.

INTRODUCTION

In temperate climates, milk production derived from dairy and dual-purpose cattle breeds accounts for approximately 66% of the total world output. According to the FAO Production Yearbook (1983), the number of dairy cows was 35 mil. in Europe, 43 mil. in the USSR, and 13 mil. in North America. They produced: 186 700 Mt of milk (41.3% of the world production), 96 000 Mt (21.7%), and 17 460 Mt (15.7%), respectively (Table 1).

In 1983 total beef production was 8 095 Mt in Western Europe, 2 252 Mt in Eastern Europe, and 6 850 Mt in the USSR. Approximately 80% of the beef in Western Europe derives from dairy and dual-purpose cattle, and probably more than 90% from the same source in Eastern Europe and the USSR. In North America, out of 10 777 Mt of beef produced, only about 20% originates from dairy herds.

During the past 10 years the number of cows has remained fairly stable in most countries. In some Western European countries a drastic fall in the number of dairy cows was observed two decades ago, and a similar decline in the USA by about 20% was recorded between 1954 and 1965.

In recent years consumption of dairy products per capita has shown stability in Western European countries, and in North America, and according to the long-term forecasts, should remain at the same level in the future. An increase in dairy product consumption can be expected only in some Eastern European countries. With milk production per cow increasing by 1-1.5% annually and with more or less constant demand, the total number of cows should further decline in Western European countries (Livestock Production in Europe 1982). It is expected that dairy production will remain constant or decline slightly in Western and Northwestern Europe, and will increase in Southern Europe.

Jacobsen (1984) projects in the USA, based on the assumption of constant consumption of dairy products per capita and increase of 2% in milk production per cow, a decline in the cow population from 11 mil. to 9 mil. head. Declining numbers of dairy cows in the USA should not have adverse consequences on beef production which is derived mainly from specialized beef cattle breeds.

To offset the effect of decreasing cow numbers in Europe where most beef originates from dairy and dual-purpose herds, it is predicted that weight of beef and veal carcasses will increase, and most of the calves reared for veal will be switched into beef production. An increase in the number of beef cows is unlikely considering the availability of land and economic relations between beef and feed prices. Only in France, the UK, Italy and Ireland do beef breeds have considerable economic importance.

GENETIC RELATIONSHIP BETWEEN MILK AND BEEF TRAITS

The genetic correlations between dairy and beef characteristics in specialized dairy and dual-purpose cattle breeds have been studied extensively in Europe and North America; however, the majority of results were published in the sixties and the seventies. Particularly in Europe, the correlated responses in beef traits were important for designing the breeding programs for dual-purpose populations. Many authors reported small and positive genetic correlations between milk yield and growth rate, body weights and measurements of heifers and cows. In Polish Black and White dual-purpose cattle, Zarnecki (1979) found a 0.2 genetic correlation between cow milk yield and body weight. Genetic correlations of less than or equal to 0.18 between milk yield and performance test traits (growth and body measurements) were calculated in the Norwegian experiment on comparison of sons of highly selected Friesian sires from various strains (Roo and Fimland, 1983). In another study on Norwegian Red cattle Zarnecki et al. (1985) found zero genetic correlation between meat index based on performance of bull half-brothers and milk index.

Bar Anan (1971) showed negative genetic correlation between rate of growth of a sire's progeny and his estimated breeding value for milk. Also Mason et al. (1972) found negative correlations between first lactation milk and fat yield, and cow body weight after first calving.

The association between beef and milk yield measured in heifers or cows, and between meat production measured in males and milk yield in closely related females, whether positive or negative, are usually small. This indicates no serious antagonism between milk and beef production, thus suggesting the possibility for simultaneous selection for both traits.

BREEDING PROGRAMS

In most European countries, breeding programs follow a similar pattern. Each year young bulls are performance tested for growth rate, feed efficiency and body conformation. Usually about 50% (or less) of the bulls at 12 months of age are culled. Higher selection intensity for beef traits would decrease the selection pressure for milk production. The other 50% of selected bulls are used for insemination to produce daughters which provide information for progeny tests. Bull breeding values are estimated in most countries by the BLUP methodology (Philipsson and Danell, 1984) and very often involve not only milk yield and its components, but also ease of milking, calving difficulty, fertility, udder and body conformation, etc. Small numbers of the best progeny tested bulls are selected as sires of the next generation of the bulls which are to be mated with top cows. Young bulls resulting from these planned matings enter the performance test for beef traits. Usually about 20% of the best progeny tested bulls are used in AI stations for inseminating this portion of the cow population which is not used for testing young bulls. In some breeding schemes bulls are also progeny tested for beef traits on the basis of male progeny.

There exist differences between countries concerning selection intensities, proportion of cow population inseminated by young unproven bulls and in selection criteria used.

Despite the dual testing of bulls, the European dual-purpose breeds are becoming more specialized in dairy production. Cunningham (1983) analyzed the effective selection differentials of breeding organizations in North America, Europe and New Zealand. Most European countries tested more (350 bulls tested per million inseminations) than in the American populations, with 100 bulls tested per million inseminations. Calculated selection differentials, however, were similar in Europe and North America. The highest bull usage and consequently the highest effective selection differential were found in New Zealand. Cunningham (1983) concludes that in order to increase the rate of genetic gain in in the North American populations, investment in bull testing should be increased, whereas in the European populations the usage of selected bulls should be increased.

CROSSBREEDING OF DAIRY BREEDS

In the early seventies, crossing of the European dairy and dual purpose populations with North American dairy breeds became a widespread practice. North American Holsteins have been replacing European Friesians, and the Brown Alpine and Red Danish populations have been making considerable use of the US Brown Swiss and Red Holsteins. Red Holsteins have been also used in Swiss Simmental, Normande, Fleckvieh and Dutch MRY populations. According to Cunningham (1983) this "American invasion," of

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Holsteins at the current rate would result in a population replacement in less than a decade. The interest in using North American genotypes for improvement of other Friesian populations resulted from many trials in which Holsteins proved their superiority in milk yield. This was demonstrated in W. Germany, The Netherlands, Ireland and other countries. A review of crossing experiments up to 1980 was done by Turton (1981). Holstein bulls not only increased milk production by 10 to 20%, but also increased body measurements and improved udder conformation. On the other hand, because Holsteins produce calves of larger birth weight there result more difficult calvings and stillbirths. The main disadvantage of crossing European dairy and dual-purpose breeds with North American dairy cattle is poorer beef quality. However, carcasses are heavier, they have lower dressing percentages, and lower fleshiness and percentage of saleable meat in slaughter cows, beef bulls and veal calves (Oldenbroek, 1982). It was also been found that Holstein-Friesians are less efficient in feed conversion than Dutch Friesians.

So far the largest experiment on comparison of different Friesian strains has been carried out in Poland. Detailed description of the project design was published by Stolzman et al. (1981). The trial was initiated and coordinated by the FAO. In 1974-1975,nine participating countries provided semen from random samples of about 40 young unproven bulls. The semen was used to inseminate over 30 000 Black and White cows in the Polish State-owned commercial farms. Semen was sent and used in two batches. Bulls from the second batch were used not only to produce F_1 progeny, but also to inseminate F_1 cows to obtain the backcross progeny. For the final analysis in total, about 6500 F_1 heifers and 8500 F_1 bulls were available. In the backcross generation about 1500 heifers were included in milk production analysis. Table 2 presents the mixed model solutions for growth traits of F_1 heifers and bulls expressed as percentage of the Polish strain means. The heaviest were heifers of North American origin (including Israel) and from W. Germany, at both 12 and 18 months of age. This same group of strains showed the fastest growth between birth and 6 months of age. Dutch, Polish and British F_1 heifers were inferior in this respect.

The F_1 bulls followed the same pattern; however, Swedish and German strains were similar to North American strains. New Zealand bulls, after rather slow growth during the first 6 month period, showed highest average daily gain in the second period from 6 to 12 months.

The sample of F_1 bulls was fattened under intensive feeding conditions (Reklewski, 1985). As in the field trial, the highest growth rate was shown by the Holstein-Friesian strains, though Swedish bulls ranked much lower than in the field. New Zealand bulls exhibited slowest growth, fattest carcasses and low dressing percentage. Highest carcass weight and dressing percentage were recorded for European strains, including Dutch, British and Swedish. These strains also had the most favorable lean to bone ratio.

Results of the field experiment concerning dairy traits, showed definite superiority of Holstein-Friesian strains. The differences in mixed model solutions expressed in percentages of the Polish strain means are presented in Table 3. The US Holsteins produced 19% more milk, Canadian and Israeli were superior by 16%, and New Zealand yielded 13% more than Polish Black and White heifers. In fat yield ranking has changed slightly because of the high fat content of the New Zealand strain. New Zealand ranked third in fat production after the USA and Canada. Protein yield was highest in the US and Canadian strains, followed by Israeli and New Zealand heifers.

Ranking of paternal strains in the intensive part of the FAO project was slightly different with respect to milk and fat yield (Jasiorowski et al.,1983). In milk production the first three strains in ranking order were the US, Canada and Israel, which was similar to the field comparison. They were followed by the British and New Zealand Friesians. A very high fat content, 4.14%, resulted in New Zealand ranking first in fat yield, followed by Canadian, British and Israeli strains.

The backcross generation , with 75% of the paternal strain blood in the field trial, showed superiority of Israeli Friesians, which outproduced the US and Canadian Strains by 100 kg of milk and about 3.5 kg of fat. The Israeli strain also produced the largest amount of fat, which was approximately 2.7 kg more than the New Zealand strain.

Estimated heterosis based on F_1 and backcross generations showed in relation to the Polish strain, the highest effects, with over 8% heterosis in milk yield for the USA and Canada, and in the same strains about 10% heterosis in fat yield. The highest heterosis effect for fat test, over 2.5%,was estimated for New Zealand.

CROSSBREEDING WITH BEEF BREEDS

Crossbreeding of dairy and dual-purpose cattle with beef breeds on a large scale is being practiced in France, the United Kingdom and Ireland. The percentages of cows mated to beef bulls varies between 10 to 40% depending on region and year (Cunningham, 1983). In France dairy cows are mated with Charolaise, Limousin and Blond d´Aquitaine bulls, often using specialized sire lines which were developed for this purpose. In an extensive experiment carried out in France, 17 breeds and strains were tested in order to compare their usefulness for terminal beef crossing (Menissier et al.,1982).

In the UK around 30% to 40% of cows are mated with beef bulls. Southgate (1982) concludes that medium size British beef breeds crossed Friesian cows are preferred to the continental breeds. The British breed crosses reduce the total output of calf weight related to cow weight. Differences between breeds in feed efficiency of slaughter animals are small, but overall efficiency favors the continental breed crosses. The introduction of milk quotas in 1984/85 increased demand for beef inseminations by 8.5%, andwhile the number of Hereford inseminations declined, there was a considerable increase recorded in the number of Limousin inseminations (MMB, 1985).

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PROSPECTS

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The percentage of dairy cows bred to beef bulls in Ireland varies greatly from year to year, from 34% to 50% according to Teehan (1982). Data from on-farm testing and from the Central Performance Station made it possible to study the differences between various beef and dairy crossbreds based on beef progeny testing. The continental breeds, i.e. , Charolais, Limousin, Simmental, Blonde d'Aquitaine and Belgian Blue showed increased incidence of calving difficulty and calf mortality. Crosses with continental breeds grew faster, showed better feed conversion, and had better conformation and less fat. The crosses with the Irish Hereford and Angus were slower growing than Friesians, but had better conformation of carcasses (Teehan, 1982).

In other European countries commercial crossbreeding with beef bulls plays a rather marginal role. For example, in W. Germany, despite proven superiority in fattening performance of crosses with beef bulls, the number of beef inseminations is very low. Langholz (1982) explains this situation as follows: 1) the small size of herds is causing a higher demand for replacement, 2) crossbreeding with large beef bulls is increasing the frequency of dystocia and stillbirth, 3) there is a smaller chance for crossbred heifer calves as compared with purebred heifer calves to be used as replacement in suckler herds.

PROSPECTS

Current trends in North America suggest further specialization of dairy cattle breeds. Evolution in the same direction has been taking place in Western Europe. This may create problems since European dairy and dual-purpose breeds are the main source of beef. In most European countries availability of land, small herd size and feed prices have made it impossible to increase beef cow numbers. Introduction of a milk quota system in the EEC in 1984, has created a need for adjusting breeding policies to the new economic situation. Kuipers (1984) has discussed possible changes in strategies, including decreasing the herd size, adjusting the production level of cows and selecting for characteristics other than milk. Averdunk and Alps (1985) and Fewson and Niebel (1985) have proposed changes in the selection index weights, with more emphasis on milk composition, beef traits and several secondary characteristics.

In Eastern Europe both milk production and beef production are expected to rise. There is also a tendency to use more Friesian and Holstein-Friesian genotypes, but the availability of feed grain is the limiting factor.

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Table 1. Number of cows and milk and beef production in some temperate climate countries

Country	No.of cows 1000 head		Milk prod. 1000 Mt		Beef and veal slaughtered 1000 head		Beef and veal production 1000 Mt	
	1974-76	1983	1974-76	1983	1974-76	1983	1974-76	1983
World	207 593	227 901	393 699	454 027	222 093	225 532	42 908	44 627
Canada	2 058	1 717	7 692	7 975	4 988	4 350	1 069	1 035
USA	11 134	11 120	53 095	63 488	45 365	40 147	11 384	10 742
New Zealand	2 046	2 000	6 116	6 800	3 493	3 160	514	530
Europe	50 395	50 450	160 551	186 745	49 121	46 360	10 108	10 327
Austria	1 028	966	3 181	3 760	824	745	189	200
Belgium-Lux.	1 063	1 033	3 891	4 170	1 121	1 000	304	290
Bulgaria	629	695	1 434	2 080	463	713	91	133
Czechoslovakia	1 885	1 970	5 455	6 496	1 560	1 702	375	384
Denmark	1 099	1 002	4 927	5 425	1 130	1 025	239	238
Finland	772	672	3 196	3 173	783	594	115	118
France	10 206	10 300	29 571	35 150	8 516	7 555	1 779	1 820
German DR	2 131	2 260	8 087	8 208	1 785	1 800	383	390
Germany FR	5 416	5 530	21 759	26 927	5 367	5 414	1 346	1 448
Greece	485	349	695	690	637	445	122	90
Hungary	716	751	1 866	2 800	463	462	136	134
Ireland	1 412	1 513	4 279	5 490	1 467	1 240	363	350
Italy	2 954	3 044	9 475	10 650	4 709	4 900	1 020	1 130
Netherlands	2 213	2 475	10 209	13 200	2 024	2 300	394	440
Norway	392	381	1 831	2 017	379	415	66	80
Poland	6 099	5 686	16 521	16 496	4 817	4 058	662	635
Portugal	297	337	677	800	440	545	92	117
Romania	2 061	1 788	3 557	3 134	1 760	1 530	256	209
Spain	1 828	1 854	5 199	6 250	1 936	1 950	429	410
Sweden	676	663	3 175	3 766	710	730	145	161
Switzerland	888	835	3 389	3 725	816	806	145	152
UK	3 339	3 357	14 115	17 252	4 810	3 888	1 115	1 046
Yugoslavia	2 606	2 745	3 662	4 550	2 401	2 300	318	320
USSR	41 749	43 800	90 086	96 000	36 916	39 600	6 470	6 850

Table 2. Mixed model solutions for growth traits expressed as percentage deviations from the Polish strain means (bottom line)

Strain	Heifers					Bulls		
	12-month weight %	18-month weight %	ADG 0-6 month %	ADG 6-12 month %	ADG 12-18 month %	12-month weight %	ADG 0-6 month %	ADG 6-12 month %
USA	102.4	103.0	102.2	102.4	103.1	102.6	102.1	101.6
Canada	102.9	103.2	103.7	102.2	102.9	102.5	103.5	100.8
Danmark	101.0	101.7	101.0	100.7	101.9	100.4	99.7	[illegible]

Finland	772	672	3 196	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
France	10 206	10 300	29 571	35 150	8 516	7 555	1 779	1 820
German DR	2 131	2 260	8 087	8 208	1 785	1 800	383	390
Germany FR	5 416	5 530	21 759	26 927	5 367	5 414	1 346	1 448
Greece	485	349	695	690	637	445	122	90
Hungary	716	751	1 866	2 800	463	462	136	134
Ireland	1 412	1 513	4 279	5 490	1 467	1 240	363	350
Italy	2 954	3 044	9 475	10 650	4 709	4 900	1 020	1 130
Netherlands	2 213	2 475	10 209	13 200	2 024	2 300	394	440
Norway	392	381	1 831	2 017	379	415	66	80
Poland	6 099	5 686	16 521	16 496	4 817	4 058	662	635
Portugal	297	337	677	800	440	545	92	117
Romania	2 061	1 788	3 557	3 134	1 760	1 530	256	209
Spain	1 828	1 854	5 199	6 250	1 936	1 950	429	410
Sweden	676	663	3 175	3 766	710	730	145	161
Switzerland	888	835	3 389	3 725	816	806	145	152
UK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Yugoslavia	2 606	2 745	3 662	4 550	2 401	2 300	318	320
USSR	41 749	43 800	90 086	96 000	36 916	39 600	6 470	6 850

Table 2. Mixed model solutions for growth traits expressed as percentage deviations from the Polish strain means (bottom line)

	Heifers					Bulls		
Strain	12-month weight %	18-month weight %	ADG 0-6 month %	ADG 6-12 month %	ADG 12-18 month %	12-month weight %	ADG 0-6 month %	ADG 6-12 month %
USA	102.4	103.0	102.2	102.4	103.1	102.6	102.1	101.6
Canada	102.9	103.2	103.7	102.2	102.9	102.5	103.5	100.8
Danmark	101.0	101.7	101.0	100.7	101.9	100.4	99.7	100.0
UK	99.9	100.3	100.9	99.3	100.6	100.8	101.3	100.1
Sweden	100.6	101.4	103.1	98.5	102.3	102.0	102.0	102.1
W.Germany	102.3	101.9	102.6	102.4	100.0	102.1	101.4	102.1
Netherl.	98.8	99.5	99.4	98.5	100.2	99.7	101.1	98.3
Israel	102.7	102.6	104.1	102.1	101.0	103.0	104.6	102.0
N.Zealand	101.3	101.2	102.1	101.3	99.6	101.5	99.7	102.8
Poland	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	272.8 kg	367.1 kg	681 g	667 g	515 g	289.5 kg	713 g	708 g

Minimum number of observations was 569 and maximum 1516 per strain

Table 3. Mixed model solutions for dairy traits expressed as percentage deviations from the Polish strain means (bottom line)

Strain	Age et calving	Milk kg	Fat kg	Fat %	Protein kg	Protein %
	%	%	%	%	%	%
USA	97.6	119.1	116.5	97.8	117.6	98.8
Canada	97.1	116.5	115.0	98.0	115.3	99.4
Denmark	99.2	105.7	105.2	99.5	105.2	99.7
UK	98.4	106.5	105.8	99.5	106.3	100.0
Sweden	99.2	108.0	106.9	98.8	107.8	100.0
W. Germany	97.7	106.2	104.9	98.8	105.7	99.7
Netherlands	99.0	103.2	103.3	100.0	103.2	100.3
Israel	98.0	116.1	114.3	98.5	114.5	99.1
New Zealand	98.3	113.4	114.8	101.2	113.0	100.0
Poland	100.0	100.0	100.0	100.0	100.0	100.0
	902.0 days	3265.0 kg	131.5 kg	4.02 %	107.1 kg	3.27 %

Minimum number of observations was 544 and maximum 988 per strain