1986

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SUMMARY

In most European dual purpose breeds beef merit is paid attention to by selection among performance tested bulls where comparatively much weight is given to growth rate of performance tested bulls and relatively little weight to muscling and thus to carcass meat content. The genetic correlation between beef and dairy merit appears to be negative. This, in combination with large and effective selection pressure on milk leads to negating the effects of the little and relatively inccurate selection for beef merit at the best. Field progeny testing for beef merit can be economical and will permit to neutralize or even improve the beef merit of dual purpose cattle without much reduction in genetic progress of dairy merit.

In dual purpose cattle breeds milk and meat are of roughly equal importance, i.e. the minor trait should not contribute less than some 20 - 25 % to the total income.

The selection objectives for dairy traits are clearly defined and there exists a close correspondence with selection criteria such as lactation or part lactation yield. The selection objective in case of beef production is the quantity of lean meat or the efficiency of lean meat production. However, the selection criteria are numerous and they need to be included in fairly complex prediction equations. Frequently their commercial relevance is not obvious. Also, prospective feeder animals are usually marketed very early - frequently at an age of one week - where the fattening quality can be poorly appraised and no or little price differentiation is practized.

INTRODUCTION

Organized breed improvement for dairy performance is well established. Progeny testing of bulls for milk yield became general after WW II. The selection schemes are all based on progeny testing and they are fairly standard in all major dairying areas.

In contrast testing of bulls for their genetic merit for beef production is comparatively new and less developed. The approach taken varies widely between and even within European countries. One reason for this discrepancy between testing for beef and dairy merit is the comparative ease with which size, and therefore growth, and muscling can be judged on the live animal. In contrast, dairy performance not only is sex-limited but even in females accurate appraisal requires measuring the milk yield. Therefore, objective and systematic milk recording has been instituted rather early while for meat performance one was satisfied with visual appraisal, in some cases right up to the present. Nevertheless, before the advent of progeny testing for milk the accuracy of estimating the genetic merit for milk and beef was not very different.

In all European countries some improvement schemes for beef production in dual purpose breeds are in operation. The improvement rests mostly on performance testing of young bulls. On a rather limited scale progeny testing is also practiced either in stations or on field records. Since station testing incurs rather large expenses it is reserved, in general, for performance testing. In the EC there are in excess of 5 000 places, in the Comecon countries (except the Soviet Union) some 6 000 places available for performance testing of young bulls for meat production. However, animals are often grouped and then no feed consumption records are collected. Also a large proportion of young bulls is still bought either in auctions or directly from breeders' herds.

Station progeny testing is carried out in some countries on a limited scale and slaughter data are available. In some countries the progeny testing for meat production is reserved for the selection of future bull sires (Pribyl et al., 1984). In Bavaria the progeny test capacity suffices for some 15 % of the bulls (Averdunk, 1984) and in Denmark the best 30 of the 120 progeny tested (for milk) bulls are subjected to a progeny test for beef performance (Andersen, 1982).

METHODICAL PROBLEMS

Testing for beef performance involves several problems, some of which shall be briefly discussed. Most of these are relevant to testing for beef performance in general while the genetic connexion between meat growth and dairy performance is special and in some way central to dual purpose breeding.

As mentioned above performance testing frequently involves only measuring the growth rate and, possibly, appraisal of muscularity either by scoring or by ultrasonic measurement. A European working group (Andersen et al., 1981) has outlined how the feeding regime in the testperiod influences components of lean tissue growth (LTG). In the perticent production areas concentrate feeding is restricted while roughage is offered ad libitum. However, the level of concentrate feeding is fairly high so that LTG and residual feed conversion efficiency should receive considerable selection pressure.

For termination of the testing period three alternatives are possible: 1) age constant termination 2) weight constant termination and 3) testing to constant finish. At Clay Center (Smith et al., 1976) the three methods were compared and methods 1) and 2) were shown to be biased in favor of large sized, late maturing cattle. When comparison was made at equal degree of fatness the bias was absent. Also marketing of cattle occurs at comparable degree of finish. Therefore method 3) should be favored in testing or the records should be corrected to equal finish.

The correlation between size and muscularity on one hand and calving ease on the other is negative for direct and, somewhat less, for maternal effects (Fewson, 1985).

A problem general to all station testing concerns the possible interaction between environments and genotypes. Since testing of young bulls at stations is comparatively popular, care must be taken to avoid serious interactions. However, if progeny testing for beef traits should become more popular, it would be carried out in the field and genotype environment interactions should be of less importance unless female (heifer) or calf progeny is utilized. British experience (Anon., 1983) indicates that heifer muscling scores are good predictors of carcass conformation of bulls. In contrast El-Hakim (1982) reports interactions between genotypes (breeds and twins) and veal or beef traits.

The correlation between dairy performance and LTG or its feed efficiency is of direct relevance to dual purpose breeding. The correlation is poorly known mainly because a sufficiently large volume of data on the lean meat content of carcasses is not available on account of the difficulty and cost of measurements. However, several studies were concerned with the comparison of breeds, strains and crosses, such as the Polish FAO Friesian comparison (Reklewski, 1982). A number other comparisons mostly of European dual purpose Friesian or Red and White cattle with US-Holsteins were published (O'Ferrall, 1982). There is consensus that introduction of Holstein genes or of Brown Swiss genes impaires carcass composition and if published data on meat-%, meat growth and carcass lean are corrected to equal fatness, their correlations with the dairy performance of the genotypes is negative (Table 1).

Table 1
Genetic Connexion between Dairy and Beef Merit

Correlation of Dairy Performance with		
Meat/Bone Ratio	-0.36[1)]	
Meat/Carcass	-0.26[1)]	
Meat/Bone Ratio in Hindquarter	-0.40	Mason et al.
Meat Gain	-0.38	Suess et al.
% 4-legs	0.40	Rutzmoser

Performance Differences of Dairy (D) and Dual Purpose (DP) Breeds	2)	3)
Meat/Bone Ratio	-0.36	-0.40
LTG, g/d	-30	-17
Milk Yield, kg	600	500

[1)] computed from results given by Reklewski et al. (1978) and Stolzman et al. (1978) after correction of beef traits for differences in % carcass fat. [2)] D - DP = 3/4 Brown Swiss - Braunvieh, Kögel et al. 1978. [3)] D - DP = Holstein-Friesian - Dutch Friesian, de Boer et al. 1967.

Another possibility of estimating the genetic correlation between meat and milk yield is provided by the comparison of the respective performances of the American dairy breeds Holstein-Friesian and Brown Swiss with their European parent breeds (Black-and-White, Braunvieh). The changes in carcass composition can be considered as correlated response to nearly exclusive selection for milk yield in America. Therefore a realized genetic correlation may be estimated. Again it turns out to be strongly negative, somewhere between -0.3 and -0.6, depending on the assumptions about the other genetic parameters which are necessary for the estimation. Several auxiliary criteria are correlated rather closely with the carcass muscle content and again they all are negatively correlated with dairy performance (Table 1). In contrast to the near consensus of most published estimates of meat-milk correlations there is considerable variability among the published correlations between growth rate and dairy performance. However, they are small, either slightly negative or slightly positive. Some of the differences could be due to the different ways of determining growth rate - to fixed age, weight or finish, with ad lib or under restricted feeding. However, no investigation of the consequences to the correlation of measures taken in different ways, is available.

EUROPEAN IMPROVEMENT SCHEMES

In most European countries testing for beef merit of dual purpose bulls consists of performance testing for growth rate and sometimes muscularity and only rarely is this information supplemented with progeny tests and if so these are not infrequently based on heifer progeny. The first selection involves culling of roughly one half of young bulls on the basis of the performance test or of an index combining the dairy performance of dam and halfsisters with growth rate and in some cases muscularity of the tested bulls themselves. In table 2 the relative contribution of

Table 2
Relative Contribution of Breeding Values of Various Traits to the Aggregate Genotype

	Denmark	Finland	Germany[1]		Norway	Sweden[2]
			FV	HF		
Milk	32	52	47	61	30	1
Beef	23	8	42	28	20	0.5
Milkability	3+	11			10	
Conformation	37	5	11	11	10	
Fertility	7	16			10	0.3
Calving Ease	6	3			7	
Disease					13	
Temperament	4	6			2	

Milk: including fat, protein yield. Beef: Growth Rate (Finland only), area of loin eye, muscling score; in general performance test. Conformation: feet and legs, udder and teats. Fertility: non-return-rates of bulls, inseminations/conception for cows. Calving ease: both direct and maternal components. Disease: mastitis, ketosis, milk fever.

[1] for young bull selection only, [2] for secondary traits subjective weights are used. Source: Fimland and Gravir, 1984, Gjol-Christensen, 1984, Lederer, 1984, Mäntysaari et al., 1984, Philipsson, 1984.
FV Fleckvieh HF German Friesians

various traits to the index is given. The contributions were computed by multiplying the published weights times the genetic standard deviation or the standard deviation of the indices. In most instances the indices refer to the selection of progeny tested bulls which obviously had been selected in a first stage on their own performance. The German indices are destined to select young bulls which in a second stage are selected according to their progenies' dairy performance. However, when young bulls have been through a performance test on a station about 40 to 50 % are culled and the remainder ranked by index. In the Netherlands about the same selection intensity is applied to performance in stations (Wismans, 1984). In Denmark about 20 % and in East Germany about 1/3 of the performance tested bulls enter AI service as test bulls (Zelfel, 1984). In table 3 the culling rates which are applied in the CSSR are given. In model calculations Fewson (1985) found culling rates of 80 % or more optimal.

Table 3
Culling Rates in CSSR Breeding Program

	Performance Test	Progeny Test	
		Proven Bulls	Bull Sires
Weight gain	29	10	20[2)]
Conformation	12.5		10
Health	13.4[1)]	5	10
Milk Yield		65	> 70
Fat %		10	10
Fertility		14	14
Milkability		5	5
Udder		5	10

[1)] including semen quality, [2)] carcass gain of progeny.
Source: Pribyl et al. 1984.

The various indices are usually computed independently, i.e. information on milk is disregarded when computing the beef index and vice versa. The efficiency of the various selection methods are compared in table 4 on hand of four partly abstracted schemes for which traits, genetic parameters and economic weights similar to those used in Germany were utilized. However, the genetic and phenotypic correlations between growth rate on one hand and milk fat yield and muscle scores on the other, were assumed to be zero and 0.2, respectively, while the genetic correlation between muscle scores and milk yield is taken to be -0.3. The selection schemes are a three stage selection (A), selection according to an empirical index as used for German Fleckvieh (B), an optimal index (C) and no selection for beef traits (D). The variants B, C and D are two-stage selection schemes where stage one involves index selection of young bulls and stage two selection based on progeny tests for dairy performance, respectively. In scheme A stage 1 is selection of young bulls for dairy merit, stage 2 involves independent culling for beef performance and stage 3 finally progeny test selection for milk yield. For all schemes it is assumed that 10 % of young bulls are retained on account of estimated dairy merit and beef performance. Of course, selection intensity can be greater but additional traits probably need to be taken into account. After the progeny test 20 % of the bulls are retained for AI. As is evident from the figures given in the table selection for dairy performance impaires muscling.

Separate selection for muscling as in scheme A but also with an optimal index cannot neutralize this indirect genetic change, not even in young bulls where accuracy of estimating dairy merit is not very high. The exception is scheme B patterned after the index of the Bavarian Fleckvieh. In all cases progeny test

Table 4
Breeding Values of Bulls

	A				B			C			D			E		
	1	2	3	Σ	1'	2'	Σ	1"	2"	Σ	1*	2*	Σ	1**	2**	Σ
Milk Fat (F), kg	9.7	-.7	12.9	21.9	7.7	12.9	20.6	8.2	12.9	21.1	12.1	12.9	25.0	8.2	11.2	19.4
Growth Rate (GR), kg/d	0	.046	0	.046	.060	0	.060	.067	0	.067	0	0	0	.067	.040	.107
Muscling Scores (MS)	-.18	.18	-.22	-.22	.11	-.22	-.11	-.04	-.22	-.26	-.23	-.22	-.45	-.042	.044	.002
Σ				65.8			68.5			70.2			55.4			82.5

A 3-stage selection, stage 1, i=1.4 based on dam's (3 lactations) and halfsisters' dairy performance (n=50), stage 2 beef performance test, i=1, stage 3 progeny test for dairy performance, i=1.4. B 1' Selection according to index for German Fleckvieh, i=1.75, 2' as 3, i=1.4. C 1" Optimal young bull index, i=1.75, 2" as 3. D Selection for dairy performance only, 1* as 1 but i=1.75, 2* as 3. E 1** as 1", 2** optimal progeny test index, i=1.4.

		r_G					
		F	GR	MS	σ_p	economic weights	
r_p	F	.25	0	-.3	7	2.43	h^2 on diagonal
	GR	0	.40	.2	.12	330	
	MS	-.3	.2	1	1	12	

Table 5
Accumulated Profits (DM) from Beef Testing

	Selection											
	Dairy Merit (D)				Dairy Merit and Beef Merit in Performance Test (C)				Dairy Merit and Beef Merit in Performance and Progeny Test (E)			
stage	1*		2*		1"		2"		1**		2**	
	c	b	c	b	c	b	c	b	c	b	c	b
Milkfat	60.4	526	125.0	1088	40.8	355	105.4	917	40.8	355	97.0	844
Growth Rate	0	0	0	0	45.5	396	45.5	396	45.5	396	72.6	632
Muscle Scores	-5.7	-49	-11.2	-97	-1	-9	-6.4	-56	-1	-9	.05	.5
		476		991		742		1257		742		1475

D, C, E as in table 4, c accumulated, discounted profit per cow, in DM, d accumulated, discounted profit of 20 000 inseminations, 8 700 lactations, 8 700 slaughter animals, in 1 000 DM. Realizations of dairy and beef expressions over 12 years.

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stage	1*		2*		1"		2"		1**		2**	
	c	b	c	b	c	b	c	b	c	b	c	b
Milkfat	60.4	526	125.0	1088	40.8	355	105.4	917	40.8	355	97.0	844
Growth Rate	0	0	0	0	45.5	396	45.5	396	45.5	396	72.6	632
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selection for dairy performance has a clear detrimental effect on muscling score. In contrast improvement of growth rate of the young bulls is carried through all stages of selection which is of cause a consequence of the zero correlation assumed. However, comparison of scheme D, where no performance test selection is considered with the other schemes makes it obvious that young bull selection for growth rate and muscling reduces the impairment of muscling score to about half as much as is suffered by exclusive selection for dairy merit, and leads to a noticeable improvement in growth rate. If the traits are weighted by the relative economic values used in German Fleckvieh the total improvements of the four schemes are 65.8, 68.5, 70.2 and 55.4 units, respectively.

All three dual purpose schemes are superior to the single trait scheme by nearly 20 % because the improvement in growth rate and the reduction in impairment of muscling outweigh the value of the reduction of genetic gain in milk fat yield. The use of the optimal index C leads to the largest benefit but the empirical Fleckvieh index is not very much inferior.

If dual purpose selection uses, in addition to dairy traits, growth rate as the sole beef trait, the deterioration of muscling is expected to be considerably larger than if this has a separate weight, even under our comparatively favorable assumptions about the correlation matrix. Danish experience (Andersen, 1982) is that selection for growth rate impairs dressing-% and muscling.

Selection for muscling and for growth rate will impede calving ease. In several countries attempts are made to control undesirable developments in the calving process by restricting changes in gestation length which serves as proxy for calf birth weight (Wismans, 1984, Andersen, 1982). For our examples we have assumed genetic correlations of -0.3 and -0.1 between muscling score and growth rate on one hand and calving ease on the other, this being considered as maternal trait. The correlations with the direct effect would be similar if not more undesirable. However, direct effects could be controlled largely by mating heifers to specially selected bulls. Changes in growth rate and muscling brought about by selection schemes A, B, C should change calving ease by 0.034, 0.019 and -0.015 points on a scale with σ=3 and h^2= 0.1. The small changes, in case of three stage selection and of the optimal index selection positive, in case of the Fleckvieh index negative, are a consequence of the impairement of muscling scores which in turn derives from the rather large and effective selection pressure on dairy performance.

PROGENY TESTING

It is evident and corroborated by experience (Wismans, 1984, Andersen, 1982) that selection for dairy performance and crossing to dairy strains will impair the carcass muscle content. Selection of young bulls on estimates of their own muscle content is insufficient to counteract the very effective selection pressure for milk. In practically all improvement schemes both pressure and accuracy of selection for beef traits are much less than for milk yield (culling rates ca. 50 %, $r_{IG} \approx 0.6$, respectively, for beef traits vs. 10 to 20 % and $r_{IG} > 0.8$ for progeny performance of milk yield, respectively). Obviously nearly all testing ressources are allocated to milk recording and progeny testing for dairy traits and few means are reserved for testing meat traits. Now progress in the traits will depend very much on the extent and quality of recording and evaluation of collected information and only partially on the economic value of the traits. The reason for the lack of more attention to beef traits is historical to some extent but mainly it is caused by the experience and opinion of breeders that returns from dairy improvement are greater than from beef improvement, which of course gets the question back to the economics.

The efficiency of progeny testing for beef performance is indicated in col. E of table 4. It is assumed that beef performance was tested on 30 progeny in the field which has, as consequence, a lower heritability of growth rate ($h^2 = 0.16$) than station testing. However, the heritability of muscling scores was assumed to be equal to that of station test ($h^2 = 0.4$). Selection according to an optimal index comprising progeny averages for milk fat yield, growth rate and muscling scores is assumed. The variances and covariances are corrected for previous selection. As is evident, the genetic merit for muscling score of the bulls is improved a little in spite of the negative genetic connexion with milk fat yield at the cost of a relatively minor reduction in the improvement of the latter. Also the stabilizing of muscling and the considerable gain in growth rate impairs calving ease (-0.078 points).

Another possibility would be the application of restricted indexes (Kempthorne and Nordskog, 1959, Niebel and Van Vleck, 1983) or of a desired gain index (Pesek and Baker, 1969). However, they lead to rather large reductions in overall genetic gain if the acurracy of ascertaining the trait to be restricted is comparatively small.

EFFICIENCY OF TESTING

The feasability of testing for beef merit is not infrequently questioned. For example Wisman (1984) quotes a benefit/cost ratio of only 8.4 for beef improvement of Dutch cattle in contrast to such a ratio of 180 for dairy improvement. However Cunningham and Moioli (1982) find much more favorable ratios under Irish conditions. They quote benefit/cost ratios of 21 and 12 for performance test and subsequent progeny test for beef merit and 27 for dairy progeny test. If beef merit is improved only by performance test the benefit/cost ratio is 33 compared to 28 for dairy progeny test. Glaser et al. (1985) find that beef performance testing causes less than 10 % of costs but contributes between 1/4 and more than 1/3 of the genetic gain in breeding programs. Inclusion of beef progeny testing adds between about 1/10 and 1/6 of costs of breeding programs without attention to beef merit but its contribution to genetic gain can be between 40 and almost 50 %.

In table 5 the benefits accrueing from some of the improvement programs for beef merit outlined in table 4 are indicated. The genetic improvements calculated in this are utilized and the following returns over feed costs are assumed: 1 kg butterfat 5 DM, 1 g daily gain 0,679 DM and one point of muscling score 24,70 DM. These values were derived from the relative importance attributed to the traits in the German Fleckvieh index. The returns are computed for 20 000 inseminations of one bull. It is assumed that 56 % of the inseminations result in productive off-

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spring and that for each birth 0.78 lactations and 0.78 slaughter animals accrue in the course of 12 years, discounted to the time of birth. This results in 8 700 discounted lactations and the same number of slaughter animals. As costs for beef testing are assumed 1 200 DM for performance testing of a young bull and 15 DM per animal for progeny testing in the field (Schild, 1985).

The benefit/cost ratios are above 20 in case of performance testing relative to no beef testing at all and 96 for beef progeny testing in the field relative to performance testing only. Glaser et al. (1985) quote 150 DM as costs per animal when progeny testing is carried out on contract farms. With 15 progeny per bull the benefit/cost ratio is about 20. The magnitude of the ratios indicate that efficient selection for beef merit in dual purpose breeds can be very profitable.

CONCLUSIONS

It has been shown that for countries where the price of concentrates is relatively high and land for beef cows expensive, dual purpose cattle are economically superior to specialized dairy and beef cattle for supplying milk and beef (Hoffmann et al., 1980). Therefore one may question why comparatively little attention has been devoted to the beef component of milk cattle.

One problem is inherent in the practice of selling calves in many areas at very young ages - one week - when differences in beefing qualities cannot be recognized by the buyer (Anon., 1982). However, there are exceptions. Colleau (1982) reports a genetic correlation of nearly 0.40 between classification at sale of one week old calves and carcass compacity of veal at about 200kg live weight. When calves are sold at later ages, e.g. 2 to 2 1/2 months as is common in Bavarian Fleckvieh, the correlations are more favorable (Schild et al., 1983). It would appear that a selling system where the potential beefing merit of calves can be ascertained should make obvious the need of serious attention to the estimation of the beef merit of AI bulls.

Another reason for the little weight given to improvement of the beef merit is the contention of many researchers that differences in it are of relatively minor importance vis-à-vis improvements in dairy merit. For example Wismans (1984) points out that genetic variance of beef merit is 50 % of the variance of dairy merit and Philipsson (1984) estimates that in Swedish Friesians 70 % of the variance of bull indices is due to the milk subindex and only 6,8 and 19 % are caused by variation of the subindices for meat, fertility and other functional traits, respectively. On the other hand, Glaser et al. (1985) find that up to nearly 50 % of the genetic progress in total genetic merit is contributed by beef improvement and the model calculations in table 5 as well as the figures given by Cunningham and Moioli (1982) also point to rather larger influence of the beef component on total genetic merit.

The discrepancy between these conclusions are partly explained by the inadequacies of marketing which as discussed above reflect only little of differences in beef merit but they are also due to the relative low weight given to carcass conformation and therefore to lean content in the calculations.

Our knowledge of the genetic correlation between dairy and beef merit is clearly wanting and data should be collected which permit good estimates. The rather large volume of completely dissected carcasses at meat research institutes frequently lacks pedigree information and is not suitable for such investigations. It is urgent that in future such work should be performed on material which permits genetic analysis.

Further studies on the optimal organization of testing for beef merit where proper attention is given to carcass value are needed. However, improvement of methods and/or organization of marketing which permit recognition of quality differences of dairy breed calves are necessary to ensure proper attention by farmers to the beef component of dual purpose cattle.

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GENETIC IMPROVEMENT FOR MILK AN

N. KÜNZI*, and W.

INTRO

Theoretical and practical ways to impr
pics by selection within local Bos ind
cus composite populations, upgrading c
through different crossbreeding progra
and summarized by Mason and Buvanendra
man (1979). Only few publications (Aur
and Roberts, 1984) exist on successful
ping agencies (FAO, 1985; SDC, 1985) i
exploited and that various breeding pr
siderable improvement of meat and/or m
reports are based on small numbers of
observed over a short period. Main rea
rally crossbreeding programs which com
to harsh environments, the production
lead to large heterosis effects charac
ses. The problem of the appropriate br
heritance in tropical cattle populatio
rus breeds to be crossed with local z
number of reports (FAO, 1984; FAO, 19
ple Meyn and Wilkins (1974, 1975), Ma
and Vercoe (1982), Hickman (1981), Ca
others. The main conclusion is that B
to 75 %. In other words, the existenc
generally accepted. There is no conse
different Bos taurus breeds for cross

The application of new techniques lik
and eventually transgenic animals ope
tion in the tropics. For consultants
the choice of the appropriate breedin
tion, more than in temperate countrie
nerally not just a business, but rath
cal complex.

In relation to the large number of co
there are only a few scientific publi
are analyzed in retrospect (Acharya a
and Morris, 1984).

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