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Performance testing of AI bulls for efficiency and beef production in dairy and dual-purpose breeds

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CONTENTS

GENERAL INTRODUCTION

In 1981, an EAAP working group reported that central bull performance testing had widespread application in European cattle-breeding schemes. Large differences in testing techniques were observed. Therefore, the group proposed general recommendations on procedures for performance testing for beef characteristics and on needs for further research.

Since last publication, experiences and results have accumulated in several countries on genetic parameters of efficiency of growth, feed intake, metabolic and immunological traits and on estimation of breeding values. Through the introduction of milk quotas and new technical developments, conditions that have an effect on the importance of performance testing in the total breeding scheme have also changed.

These proceedings contain contributions of the EAAP-seminar of the study commissions on Cattle Production and Animal Genetics "Performance testing of bulls for efficiency and beef production in dairy and dual-purpose cattle". This seminar was held 27-29 April, 1987 in Wageningen, The Netherlands.

The objectives of the seminar were:

- A review and an exchange of results and experiences about performance testing of bulls in dairy and dual-purpose breeds with experts from different countries.
- Recommendations for testing procedure and further research.

During the seminar the following topics were discussed:

- Comparison of performance test results for beef characteristics with male progeny tests in different environments.
- Comparison of performance test results for efficiency traits with female progeny tests in different environments.
- Fertility traits and value of metabolic and immunological parameters of performance tested bulls for predicting traits of progenies.
- Estimation of breeding values of performance tested bulls.
- Implications of performance test results for breeding programmes.

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GENERAL ASPECTS OF PERFORMANCE TESTING OF BULLS IN AI: DAIRY AND DUAL PURPOSE BREEDS

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Introduction

A working group of the EAAP-commission on cattle production had presented in 1981 a report about the objectives of performance testing of potential AI-bulls, guidelines about testing environment and recommendations for further research (Andersen et al., 1981). This paper will summarize a number of the extensively described general aspects of performance testing.

Andersen et al. (1981) also presented a survey of performance testing of bulls in EAAP countries. Up to date figures about capacity for performance testing, number of tested bulls, housing- and feeding system will be presented in this paper.

Traits for testing and selection

In dairy and dual-purpose breeds in Western Europe the main objective of performance testing is to improve or to maintain the genetic capacity of efficiency of lean-meat production. Lean-meat in these populations are produced by male and female calves reared to slaughter and to females as culled cows. Secondairy objectives are focussed on the efficiency of milk production by selection on e.g. appetite, hormones, enzymes, etc.

The most important traits for testing and selection in performance test are:

- Growth rate. Rate of gain has a great impact on the cost of feed, invested capital and labour. Most veal and beef operations have fixed slaughter weights or fixed growing periods and in both systems differences in profitability of individuals could be explained by growth rate.

- Feed efficiency. Feed efficiency could be defined as overall efficiency namely the ratio of input to output and is highly correlated with daily gain. The different underlying components of efficiency are:
  - maintenance requirement
  - relative proportions of lean tissue and fat deposition
  - feed intake
  - digestibility and efficiency of deposition fat and protein.

  The knowledge about the genetic parameters of these components is limited.

- Carcass quality. The performance test is mainly focussed on lean-meat and this imply measuring the carcass composition. For the performance test predictive parameterws are used to estimate the muscle mass. This trait may be measured or assed visually. Fleshiness and fatness are inexpensive to measure subjectively but they are very rough predictors. Ultrasonic measurements of subcutaneous fat and longissimus dorsi are to some extend better predictors.

- Appetite. The advantages of a good appetite are intake and digestion of less concentrates and more roughage and reduction of the negative energy-balance in first part of lactation.

- Other traits. Measurements of hormones, enzymes and antigen responses could make it possible to include indirect selection for dairy or constitutional traits into the performance test. A correlated increase in birth-weight arising from selection for growth rate can have an undesirable effect on ease of calving. Ease of calving can be measured on the tested progeny bulls.

Testing circumstances

- Adaptation period. This period should be long enough to equalize the body conditions of the animals and to decrease the effect of pre-test environment. The difference in pre-test environment could be eliminated when bull calves arrive at the test centre as soons as possible after birth. The minimum adaptation period should be three weeks.

- Feeding system. Daily gain in growing animals depends on intake (energy and protein) and the way of using nutrients. There are differences between animals in using energy for maintenance, deposition of fat and protein and the conversion of gross energy to net energy. Table 1 summarized the influence of the feeding regime on the selection response. The appropriate feeding system will depend on the breeding objective. In most dairy and dual-purpose breeds the system 3 and 4 seems most relevant.

Table 1. Schematic illustration of the importance of feeding regime for selection response when selection is based on growth rate (Andersen et al., 1981).

	Selection response on:			
	residual efficiency	L.T.G. capacity	physiolog. appetite	physiolog. appetite
Feeding Regime				
1. Roughage restr./ concentrate restr.	+++	++	+	(+)
2. Roughage restr./ concentrate ad lib.	++	++	+	(+)
3. Roughage ad lib./ concentrate restr.	++	++	(+)	+++
4. Roughage ad lib./ concentrate ad lib.	+	++	++	++

- Length of test period. The length of the period and the age of the bulls is dependent on the breeding goal of the breed and the genetic variation of the traits. Experiments have shown that genetic variation of growth rate and fleshiness increases with months of age until a year. The impact of the breeding goal could be the differences between veal and beef.

Survey of performance testing of bulls in EAAP-countries

During the last 25 years considerable facilities have been established for the performance testing of AI bulls in many European countries. Information in reply to a questionaire is presented in table 2 about test stations and breeds (dairy/dual-purpose on beef). The total test capacity in 1987 is comparable with the capacity in 1981.

Housing systems (table 3) have been divided into three types: animals kept tied, loose-housed individually, or in groups. Since 1981 the group-system is increased. The feeding system is presented in table 4. There is a clear tendency favouring system 3 where roughage is ad libitum and concentrate restricted. This feeding regime is focussed on physical appetite and residual efficiency (table 1).

Table 2. Capacity for performance testing in EAAP countries.

Country	Stations	Places		Breeds	
		Number	% for beef	Dairy/ dual-purpose	Beef
Belgium	2	700	43	4	1
C.S.S.R.	9	1500	0	5	-
Denmark	3	1050	20	4	6
F.R. Germany	10	1630	13	7	2
Finland	1	330	0	3	-
France	29	2030	58	6	9
German D. Rep.	6	2000	15	1	2
Great Britain *	0	0	0	-	-
Greece *	0	0	0	-	-
Ireland	3	336	66	1	8
Italy	6	520	48	3	4
Netherlands	3	360	0	2	-
Norway	3	420	0	1	-
Poland	25	3300	0	2	-
Portugal	5	224	55	1	3
Sweden	7	550	24	4	5
Switzerland	1	280	0	3	-
Yugoslavia	3	272	0	3	-

* All performance testing at farm

Table 3. Housing systems in performance testing stations.

Country	Dairy/dp			Beef		
	ind.	group	tied	ind.	group	tied
Belgium	x	x			x	
C.S.S.R.	x	x				
Denmark	x	x	x		x	x
F.R. Germany	x	x	x	x		x
Finland			x			
France	x	x	x	x	x	x
German D. Rep.	x	x		x	x	
Great Britain *					x	
Greece *		x				
Ireland	x	x			x	
Italy		x			x	
Netherlands		x	x			
Norway			x			x
Poland	x					
Portugal	x	x				
Sweden	x		x		x	x
Switzerland		x	x			
Yugoslavia		x				

* All performance testing at farm

Table 4. Feeding systems[1] in performance tests

Country	Dairy/dp				Beef			
	1	2	3	4	1	2	3	4
Belgium		x						
CSSR			x					
Denmark			x				x	
F.R. Germany		x	x				x	
Finland			x					
France	x				x	x	x	x
German D. Rep.			x				x	
Great Britain							x	
Greece	x							
Ireland			x			x		
Italy			x		x		x	
Netherlands			x					
Norway			x				x	
Poland			x					
Portugal			x				x	
Sweden			x				x	
Switzerland			x					

1System 1: concentrate restricted/roughage restricted.
System 2: concentrate ad lib./roughage restricted.
System 3: concentrate restricted/roughage ad lib.
System 4: concentrate ad lib./roughage ad lib.

References

Andersen, B.B., A. de Baerdemaeker, G. Bittante, B. Boinaiti, J.J. Colleau, E. Fimland, J. Jansen, W.H.E. Lewis, R.D. Politiek, G. Seeland, T.J. Teehan & F. Werkmeister, 1981. Performance testing of bulls in AI: Report of a working group of the Commission on Cattle Production. Livest. Prod. Sci., 8: 101-119.

Session I

Comparison of performance test results for beef characteristics with male progeny tests in different environments

METHODS OF DESCRIBING BODY COMPOSITION AND MAINTENANCE REQUIREMENTS OF BULLS TESTED

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Summary

Various techniques for in vivo estimation of body composition are compared on repeatability, reproducibility, predictive value and practicability. It is concluded, that with the present equipment, the method of choise in a performance testing program is ultrasonnic scanning followed by visual assessment and handling.

Different methods for estimation of maintenance requirements (or "non-productive use of energy") are briefly described. For use in a performance testing scheme, a method based on recordings of feed intake and weight gain in successive time periods is proposed. Variation in "non-productive use of energy" due to feeding level and genotype are demonstrated.
Keywords: body composition, maintenance requirement, performance test, cattle.

Introduction

In breeding programmes for a simultaneous improvement of milk and beef, the most important traits are milk production capacity and growth rate. Other traits of importance are carcass quality, feed efficiency and appetite. Carcass quality traits are closely related to body composition. Feed efficiency are related to maintenance requirement.

During growth, not only the weight but also the body composition of the animal continually changes, and so do its maintenance metabolism. In growing cattle maintenance metabolism (or "non-prodictive use of energy") is seldom less than 40 per cent of the total metabolism and usually more (Van Es, 1980). Hence, differencies among animals in maintenance metabolism also results in differencies in feed efficiency.

Therefore, methods for describing body composition and maintenance requirements are important tools in testing and breeding programmes.

Methods of describing body composition

Potential methods

The most accurate methods of estimating the body composition of an animal is to slaughter it and then performe dissection and chemical analysis. However, this is a destructive method, which also suffers from the disadvantages that it is expensive and that only one assessment of body composition can be made on each animal, i.e. this method can neither be used for describing changes in body composition during growth, nor can it be used to describe carcass traits of potential breeding animals.

During a CEC workshop in Copenhagen (December 1981) various techniques for in vivo estimation of body composition in cattle were discussed. Based on the proceeding from this workshop, and on more recent literature various in vivo techniques are summarized in table 1. The different techniqes are compared on: repeatability, reproducibility, predictive value and practicability. Repeatability is defined as the extent to which measurements on the same animal under simular conditions correspond with each other. It is influenced only by measurement errors and time effects. Reproducibility is difined as the relationship between measurements under different conditions. Besides measurements errors and time effects it is also influenced by the person performing the measurements. The predictive value is defined as the relationship betweeen the in vivo measurements and the carcass traits. Practicability includes the pracitically possibilities of the method in a performance testing program, i.e. size and portability of the equipment, time requiared to performe the measurement, limitations on the size of the animal which can be measured etc.

Table 1. Comparison of various in vivo techniqes for describing body composition in cattle.[a]

Method	Repeatability	Reproducibility	Predictive value	Practicability	Reference
Live weight	+ + +	+ + +	+	+ + +	Kempster, 1982
Visual assessment and handling	+ +	+	+ +	+ + +	Kempster, 1982, Jansen et al., 1985
Body dimensions	+ + +	+ + +	+	+ + +	Kempster, 1982
Density	+	+	+	(+)	Miles, 1982
Dilution	+ +	+ +	+	+	Robelin, 1982
Dielectric	.	.	.	+	Miles, 1982
Ultrasonic	+ +	+ +	+ +	+ +	Andersen et al.,1982 Jansen et al., 1985
X-radiography	.	.	.	+	Miles, 1982
Computerised x-ray tomography (CT)	+ + +	+ + +	+ + +	-	Sørensen, 1987
Nuclear magnetic resonance (NMR)	+ + +	+ + +	+ + +	-	Miles, 1982
Potassium (^{40}K)	.	.	+ +	+	Miles, 1982
Neutron activation analysis	.	.	.	+	Miles, 1982
Hormone measurements	+	+	+	+ +	Miles, 1982

a) +: low, ++: medium, +++: high, . : information not available
-: can not be used due to limitations on size of body which can be measured

Experimental results from Denmark

Ultrasonic equipment ("Danscanner") has been used on performance test stations in Denmark since 1976 for prediction of carcass quality. The repeatability and predictive value of the technique has been tested in several experiments, and the precision of predicting a given carcass trait varies widely. Generally, the best predictors of dressing percentage and lean-to-bone ratio are obtained through ultrasonic measurements of muscle areas, while ultrasonic fat measurements are the best predictors of lean and fat percentages in the carcass (Andersen et al., 1982 and Sim, 1983).

The repeatability of the "Danscanner" measurements at the Danish performance testing stations has been calculated by Andersen et al. (1987). The correlations between reapeated measurements (adjusted to constant live weight) were calculated within six months time periods. Correlations between measurements at 9 and 10 months of age range from 0.49 to 0.69 (mean 0.61), between measurements at 9 and 11 months of age were from 0.49 to 0.67 (mean 0.59) and between measurements at 10 and 11 months of age range from 0.50 to 0.72 (mean 0.64).

Andersen et al. (1987) used the correlation between ultrasonically ("Danscanner") measured muscle area and carcass traits on bulls slaughtered immediately after the performance test to describe the predictive value of ultrasonic measurements. The results (table 2) demonstrate that it is possible by ultrasonic measurements to obtain the same precision in prediction of carcass traits as from corresponding muscle areas measured on the sectioned carcasses. It is also shown in table 2 that conformation scoring and body lenght measurements directly on the carcass give the same and/or a poorer description of body composition than muscle area measurements on live animals.

Table 2. Phenotypic correlations between ultrasonic muscle area and carcass quality traits (within year, breed and station and adjusted to constant live weight - n = 243). (Andersen et al., 1987)

	Carcass trait:			
	Dressing percentage	Confor-mation	Lean/ Bone	Muscle area
Ultrasonic muscle area	0.30	0.27	0.36	0.49
Carcass muscle area	0.30	0.27	0.41	-
Carcass conformation	0.27	-	0.33	0.27
Carcass lenght	-0.09	-0.28	-0.05	-0.06

Computed tomography (CT) scanning has been used to discribe body composition of dairy goats (Sørensen, 1987). A total of 41 lactating goats were scanned and subsequently slaughtered, dissected and analysed for chemical composition. The CT-data were condensed by principal component analysis. Based on standard error of estimate (SEE) and on standard error of predicted value (SEP) the "Best" predictor for each of seven compositional traits were selected. The validity of CT-scanning was expressed in the percentage of reduction in SEP when a model based on live weight alone was compared to a model based on live weight plus CT-information. The percentage reduction in SEP was 0 for carcass water and carcass protein, 50.5 for carcass fat, 15.4 for non-carcass water, 26.0 for non-carcass protein, 74.7 for non-carcass fat and 72.3 for total energy content.

Methods of describing maintenance requirements

Potential methods

As pointed out by Van Es (1980) three different approaches can be used to estimate maintenance requirements for energy.

The animals can be fasted for a number of days at the end of which estimates of maintenance metabolism can be derived from heat production and urinary energy loss measured in respiration chamber (method A).

The animals can be fed approximate maintenance ration; from their average daily gain (method B1) or energy balance measured in respiration chamber or by the comparative slaughter technique (method B2) the part of the ration needed for maintenance can be computed.

The third method (the regression approach) derive maintenance requirements from measurements of weight gain or energy balance at two or more feeding levels followed by extrapotation to zero production (method C). Van Es (1980) discussed different regressions models. From the simples form, where maintenance requirements are estimated as the intercept-value from either regression of production on intake or regression of intake on production (model C1 and C2 of Van Es, 1980), to more complex models, where production are divided into energy retained in the body either total (RE) or as protein (RE_p) and fat (RE_f), (from respiration chamber or from comparative slaughtering) and where maintenance requirements are estimated as the partial regression of metabolisable energy (ME) on metabolic weight ($W^{3/4}$). The most complex model (model C9 of Van Es, 1980) includes in addition to the above mentioned factors also factors relating efficiency of ME utilisation to relative rate of protein deposition and to physical activity of the animal (i.e. degree of maturity).

Experimental results from Denmark.

Thorbek (1980) used the regression method and measurements of retained energy (measured in respiration chamber) to estimate maintenance requirement for energy of young calves in different liveweight intervals (from 100 to 275 kg, with intervals of 25 kg, n=176). Maintenance requirement per kg metabolic weight varied from 377 to 486 KJ per day, with no pronounced relation to liveweight.

Based on data from four production experiments with young bulls on individual records of feed consumption, serial slaughtering and complete carcase dissection, Andersen (1980) estimated maintenance requirements using the following basic regression models:

$$NE = b_0 + b_1\,LW^{0.73} + EP; \quad (1)$$

$$NE = b_0 + b_1\,LW^{0.73} + b_2LG + b_3F\text{ per cent} + b_4D\text{ per cent} \quad (2)$$

where EP = energy in product;
NE = net energy consumed per day;
$LW^{0.73}$ = metabolic weight, i.e. the liveweight raised to the power 0.73;
LG = liveweight gain per day;
D per cent = dressing percentage;
F per cent = fat percentage in the carcase.

In experiment 1, 165 male calves of Red Danish evenly distributed in progeny groups from four sires, four feeding levels (ad libitum, 85 per cent, 70 per cent and 55 per cent) and seven slaughter weights (from 180 to 540 kg, with intervals of 60 kg), the maintenance requirement (b_1) was estimated within feeding levels. The results shows an increase in maintenance requirement with increasing feeding intensity (from 282 to 532 KJ per kg metabolic weight and day for 55 per cent intensity and ad libitum, respectively).

Experiment 2 and 3 comprised of 307 and 409 young bulls, respectively, from a comprehensive crossbreeding experiment, where different beef breed were used on Red Danish and Black and White Danish cows. In experiment 2, the bull calves were feed with concentrate ad libitum and three slaughter points were used (300 kg, 12 months and 15 months). In experiment 3, three feeding levels (ad libitum, 85 per cent and 70 per cent) and three slaughter weights (320 kg, 440 kg and 560 kg) were used. In both experiments, maintenance requirement was estimated within sire breed and significant effect of sire breed was found. In accordance with experiment 1, differencies in maintenance requirements between the different feeding intensities in experiment 3 was observed.

The 4th experiment consist of data from the progeny test for beef traits in dual purpose breeds. A total of 300 bull calves evenly distributed on 30 sires, fed with concentrates ad libitum and tested in the period from 4 weeks of age to a liveweight of 340 kg, was included in the analysis. Model 1 was used on recordings from successive 28 days periods, and daily gain in each period was used to describe energy deposition (EP). Maintenance requirements (b_1) was estimated within sire, and a high within breed variation was found. An heritability of 0.31 for the b_1-values was estimated.

Preliminary results from an experiment with 720 young bulls evenly destributed on 30 progeny groups and three slaughter weights (340 kg, 470 kg and 600 kg) also shows variation among progeny groups in maintenance requirement (Jensen, 1987).

Sørensen (1987) used CT-scanning to estimate maintananc requirement of lactating dairy goats (n=4o). The energy balance was estimated from the CT-scanning, and maintenance requirement was calculated as: net energy consumed per day - energy in milk - energy balance. A regression of the estimated maintenance requirements on metabolic weight only explained 11 and 4 per cent of the variation in the estimated maintenance requirements in early and middle lactation, respectively, and the regression coefficients was not significantly different from null. This indicate that maintenance requirements can not be discribed by the metabolic weight alone.

Discussion and conclusion

The review of various in vivo techniques for estimating body composition in the first part of this paper, shows that the "best" prediction is obtained by CT- or NMR-scanning. Unfortunately, these methods can not be used on cattle due to limitation of the size of body which can be scanned. Other drawbacks are the high price of the equipment and that it is unportable. Until these problems are solved, the methods of choise is ultrasonic scanning followed by visual assessment and handling.

Regarding estimation of maintanance requirements, the following have to be noticed; method A and B can not be used on fast growing animals, since these young animals are easily stressed and may show an abnormal behavior under the fasting period (method A) or under the period fed at maintenance level (method B), (Van Es, 1980). This leads to the regresion approach (method C) as the method of choise for estimating maintenance requirements of young growing animals. However, the more complex regression models require measurements of energy deposition. In a performance testing program, measuring the energy balance by means of respiration chamber is almost impossible due to the high price of the equipment and labor consumption, the comparative slaughter technique can not be used on potential breeding bulls, and the CT-scanning method used by Sørensen (1987) can as above mentioned not be used on cattle.

The method used in the 4th experiment of Andersen (1980) could be used in a performance testing scheme, as it only requires recordings of feed intake and weight gain in successive time periods. The method could probably be improved by including ultrasonic measurements to describe energy deposition more precisely than by weight gain alone.

The results from Andersen (1980) and from Jensen (1987) demonstrates that maintenance requirement is influenced by feeding level as well as by genotype. Hence, it is possible to manipulate the "non-productive use of energy", in the short run by change of feeding intensity and in the long run by selection.

References

Andersen, B.B., 1980. Feeding trials describing net requirements for maintenance as dependent on weight, feeding level, sex and genotype. Ann. Zootech. 29: 85-92.

Andersen, B.B., H. Busk, J.P. Chadwick, A. Cuthbertson, G.A.J. Fursey, D.W. Jones, P. Lewin, C.A. Miles & M.G. Owen, 1982. Ultrasonic techniques for describing carcass character istics in live cattle. CEC Report, EUR 7640 EN, 78 pp.

Andersen, B.B., J. Jensen & P. Madsen, 1987. Performance testing of potential AI bulls for beef traits. In: Cattle Production Research, Danish Status and Perspectives. Landhusholdningsselskabets Forlag, Copenhagen. p. 28-38.

Jansen, J., B.B. Andersen, P.L. Bergström, H. Busk, G.W. Lagerweij & J.K. Oldenbroek, 1985. In vivo estimatin of body composition in young bulls for slaughter. 2. The prediction of carcass traits from scores, ultrasonic scanning and body measurements. Livest. Prod. Sci. 12: 221-230.

Jensen,J., 1987. Personal communication.

Kempster, A.J., 1982. Use of in vivo techniques and their limitations for commercial management and selection of cattle for slaughter. In: Andersen, B.B. (Ed.): In vivo estimation of body composition in beef. Report no. 524 National Institute of Animal Science, Copenhagen, p. 127-132.

Miles, C.A., 1982. Other techniques and future possibilities. In: Andersen, B.B. (Ed): In vivo estimation of body composition in beef. Report no. 524 National Institute of Animal Science, Copenhagen, p. 165-191.

Robelin, J., 1982. Measurement of body water in living cattle by dilution technique. In: Andersen, B.B. (Ed): In vivo estimation of body composition in beef. Report no. 524 National Institute of Animal Science, Copenhagen, p. 156-164.

Sim, G., 1983. The use of ultrasound to predict the carcass composition of live cattle - a review. Anim. Br. Abs. 51, 853-875.

Sørensen, M.T., 1987. Computed tomography for in vivo prediction of body composition in livestock. Ph.D. Thesis, The Royal Veterianary and Agricultural University, Copenhagen, 78 pp.

Thorbek, G., 1980. Studies on Protein and Energy Metabolism in Growing calves. Report no. 498 National Institute of Animal Science, Copenhagen, 85 pp.

Van Es, A.J.H., 1980. Net reqiurements for maintenance as dependent on weight, feeding level, sex and genotype, estimated from balance trials. Ann. Zootech. 29: 73-84.

METHODS OF EVALUATION CARCASS COMPOSITION

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Abstract

It is important to introduce evaluation methods for carcass traits in order to avoid negative long–term effects on carcass composition of selection for daily gain only, and to evaluate for traits more closely related to the breeding goal in beef production than is just daily gain. Several methods of evaluation carcass composition are available. Exact measurements of body composition, however, require expensive techniques that are not yet applicable in a practical evaluation procedure. Ultrasonic scanning is the most tested method for in vivo estimation of carcass traits and routinely used in Denmark. Recent results from Sweden and some other countries show that the additional information obtained from scanning measurements does not increase accuracy greatly, compared with what is already gained by means of live weight. For a routinary use it is important to test new and more simple scanning equipments and other evaluation methods such as body measurements, scoring of fleshiness and progeny testing for carcass traits.
Keywords: in vivo, carcass traits, ultrasonic, cattle.

Introduction

With time it has become obvious that evaluation of bulls for growth rate only is not sufficient to improve the efficiency of lean–meat production. The need to include measures on carcass traits in the evaluation procedure in order to balance the negative correlations between daily gain and certain carcass traits has been pointed out often, eg. Andersen (1977). This seems especially important in view of the increasing importance of Holstein in many European cattle populations. Thus Holstein has often been reported to have a higher daily gain but more unfavourable carcass traits than some European Friesian strain, e.g. Philipsson et al. (1981) and Stolzman et al. (1981).

In order to get an early evaluation for carcass traits one must seek for methods to estimate carcass composition on live potential AI bulls. There has been a very rapid technical development in this area and various methods have been described and extensively discussed during the last decades. Especially two CEC workshops have been held on this subject, viz. in Copenhagen (Andersen, 1982) and in Bristol (Lister, 1983).

Some of the "new" techniques such as Computerized Tomography (CT), Nuclear Magnetic Resonance (NMR) and Video Image Analyses (VIA) are promising for use in animal breeding in the sense that they have been shown to measure body composition in live animals with great accuracy. However, the equipments are today expensive, have limited motility and not yet suitable for larger animals such as cattle. The development of these techniques will certainly continue and they may in the future be important tools in the evaluation of carcass composition.

The "classical" method in the field of estimation body composition is the ultrasonic technique. Also more simple methods for predicting slaughter quality have been described, eg. linear body measurements and scoring of conformation type, fleshiness and fat covering.

Progeny testing for carcass traits could be an alternativ to the in vivo methods in a breeding program including slaughter quality.

It will fall out of the frame of this paper to review and discuss all possible methods to evaluate carcass composition. Furthermore there are excellent reviews available in this field, e.g. from the CEC workshops. In this paper, I felt it more important to discuss some of the methods that could be available today for practical application in a breeding program and to underline certain aspects concerning repeatability, accuracy in prediction and costs of the measurements. In addition some recent results, mainly Swedish ones, concerning ultrasonic scanning will be discussed.

The ultrasonic technique

Ultrasonic technique has been used to evaluate carcass traits of live cattle for more than 30 years. During this time period the technique has improved considerably, new more sophisticated equipments have been developed and precision of measuring has increased. Numerous investigations in this field have been reported. For review see eg. Simm (1983) and Kempster et al. (1982).

It is often difficult to make comparisons of the results from different investigations. The studies include various types of cattle, slaughtered under differing conditions and different types of scanning equipment have been used.

Important factors for the value of scanning technique are repeatability of measurements, precision of prediction carcass traits, properties of the equipment and costs for a routinary use in the performance testing.

Repeated measurements

The interpretation of scanning pictures is of particular importance for repeatability of the measurements. Generally, repeated measurements made by the same operator on the same animal show fairly high correlations. Repeatabilities of 0.70−0.97 are often found, e.g. Andersen et al. (1982).

Of more interest are the correlations between interpreters evaluating the same scans. These correlations vary often between 0.6 and 0.9 when measurements are taken at the lumbar region. The intraclass correlations reported by Henningsson et al. (1986) were rather moderate and lower than those reported by other authors, 0.58±0.12 for muscle area and 0.42±0.14 for subcutaneous fat thickness when interpreted by two persons who had earlier been trained together in interpreting scanning pictures. The corresponding figures were 0.35±0.16 for both measurements when interpreted by two persons not earlier trained together. Although it was not possible in this study to separate the influence of interpreter from that of the training method it seems most probable that the differences in intraclass correlations at least partly depend on the preceding training situation. It is thus important that operators and those who evaluate or interpret the scanning pictures are well au fait with animal anatomy, that they be trained continuously in the use of the equipment and that they make regular checks of their results against each other and against carcass measurements. Interpretation of each picture by more than one person could also be recommended in order to increase accuracy still further.

The accuracy of the scanning measurements could also be improved by including several measurements made at certain time intervals in a regression in order to estimate the values at a preferred age (Jensen & Andersen, 1982). The question as to whether improved accuracy achieved by making repeated measurements at certain intervals should be utilized must be weighed against the cost of measuring each animal several times.

Precision of prediction

The quality of an in vivo technique depends lagely on its predictive value. This is measured by the relationship between in vivo traits and carcass traits. The most commonly used measures of precision are correlations between ultrasonic measurements and the carcass traits concerned. A better measure, which also takes account of the variation in the trait to be predicted is the residual standard deviation (r.s.d.), Kempster et al. (1982).

Phenotypic correlations reported in literature vary considerably depending on carcass trait studied, scanning measurement and equipment used. Andersen et al. (1982) reported correlations between muscle area at the lumbar region and dressing percentage of 0.33−0.58. Appel (1980) obtained correlations of 0.2−0.6 between scanning measurements and weight of various carcass cuts. Henningsson et al. (1986) estimated correlations of 0.34−0.48 between muscle area measured prior to slaughter and several carcass traits. Corresponding correlations between muscle area measured at one year of age, which is the end of the performance testing period, and carcass traits were lower, 0.11−0.35. For fat thickness measured by scanning, the correlations were usually low − with some traits negative.

Correlations or residual standard deviations do not necessarily indicate the best combination of prediction. The best way of test is to examine the various combinations of ultrasonic measurements, with live weight, in multiple regression equations for different carcass traits. Precision is then usually expressed as coefficient of determination (R^2). Henningsson et al. (1986), though, used as a measure of predictability the relative importance of different ultrasonic measurements in explaining the variation in the carcass traits, expressed as the reduction in error mean square when one more measurements was included in the multiple regression equation.

Explained variation in carcass traits

Several investigations have examined various combinations of ultrasonic measurements, with live weight, in multiple regression equations for different carcass traits. Generally, ultrasonic measurements show a moderate relationship with carcass traits. However, when data are adjusted for live weight or examined on a percentage basis, the relationships become much weaker. Henningsson et al. (1986) found that the relative importance of live weight measured just prior to slaughter in explaining the overall variation in carcass weight, the amount of lean meat and valuable cuts was high, 71−91%. This could be expected, since these traits constitute a considerable proportion of the live weight. On the other hand, live weight contributed noting or very little to the variation in the proportions of various carcass traits. The relative importance of the muscle area was quite modest, but did reduce the error variance when included in the model, by some 1−18%. The largest reduction in error variance was obtained for valuable cuts and for dressing prcentage. Fat thickness did not help reduce the error variance − except for fat tissue, where it contributed 4−5%.

When data on live weight, muscle area and fat thickness were combined, the contribution of scanning measurements was 7−17% higher in comparison with figures for live weight alone for the amount of fat tissue, dressing percentage and valuable cuts.

When measured at one year of age, live weight contributed only 12−16% to the reduction of error variance in carcass weight, the amount of muscles and valuable cuts when included in the model. Muscle area at one year of age only helped reduce error variance for percentage of valuable cuts, 26%, and to some degree for dressing percentage, 4%. Fat thickness at one year of age explained relatively more of the variation in percentages of the traits than did fat thickness prior to slaughter. A combination of live weight, muscle area and fat thickness recorded at one year of age reduced the error variance for dressing percentage and percentages of muscle and fat tissue by 5−8% and percentage of valuable cuts by 33%, in comparison with live weight alone.

Similar results were reported by Jansen et al. (1985) who found that both carcass value and lean weight were determined primarily by live weight ($R^2 = 0.8$) and that ultrasonic measures explained 3% additional variation in lean weight.

Also Eriksson (1985) reported similar results from the analyses of field data. In that study a combination of live weight, muscle area and fat area recorded 40 days before slaughter increased the degree of explanation (R^2) of the amount of muscles and fat by 6−11% in comparison with live weight alone. The corresponding figures for the percentage of muscle and fat in the carcass were 15−19%.

The additional information obtained by measuring fat thickness (or fat area) is for most carcass traits greater than that obtained from muscle area (Henningsson et al., 1986; Erikson, 1985). Similar results are reported by Andersen (1982) who concluded that measurement of the subcutaneous fat layer gives the best description of carcass fatness and lean tissue content while measurements of muscle area are the best description of dressing percentage and lean/bone ratio. For a routine use of ultrasonic scanning, it is therefore important to include measuring of fat thickness.

The result from the investigations mentioned here and other have shown that a somewhat greater part of the variation in certain important carcass traits can be explained by combining information on live weight, muscle are and fat thickness, than by using live weight only. However, the additional information are rather sparse for most traits. Even small contributions from the scanning measures in explaining the variation in a trait can be useful when no explanation of the variation can be obtained from live weight alone. Such traits, mainly expressing carcass composition, might be of increasing importance in the future when new breeds are introduced that may have a less favourable carcass composition than the European breeds. If the long−term effects on dressing percentage and carcass composition of selection for growth rate are negative, as reported by Andersen (1977), even small contributions from scanning in balancing these could be justified.

The scanning equipment

Several types of scanning equipments have been developed and tested, eg. by Andersen et al. (1982) and Kempster et al. (1981). The two most frequently used "classical" machines might be the "Danscanner" and the "Scanogram". These two equipments were originally built specially for use on animals. No big differences between these equipments have been described (Andersen et al., 1982).

The "classical" machines are delicate equipments and it is necessary to follow some basic rules in order to get reliable results (Busk, 1983). Thus both operators and interpreters must be carefully instructed, they must measure many animals in order to aquire the routine and they must meet regularly to compare their results. Furthermore, service of the equipment is very important. The machines should be brought together often and compared.

These circumstances makes the ultrasonic scanning technique laborious and expensive. It would therefore be important to find and test more simple scanning equipments that are easier to handle. Such machines have also been developed and one, the "Aloka echo camera", is used in Denmark (B. Bech Andersen, personal communication).

Body measurements and scoring

Alternative methods to assess carcass quality on live cattle could be body measurements and scoring of fleshiness and fat covering. Such methods have the advantage to be both simple and cheap. Jansen et al. (1985) found that in vivo scores predicted fleshiness and price per kg of the carcass better than ultrasonic scanning, while body measurements were poorer predictors.

Body measurements and scoring of muscularity and fatness are made routinely at two Swedish performance testing stations testing Friesian bulls. The bulls are slaughtered after performance testing or when the collection of semen is finished and some carcass traits such as carcass weight, dressing percentage and grading are registered. These data will be analysed in the near future to see if it is possible to use in vivo measurements and scoring to predict carcass characteristics.

Progeny testing for carcass data

An alternative to in vivo estimation of body composition at the performance testing is progeny testing for carcass characteristcs. Such methods have already been investigated (see e.g. Maijala, 1974; Liboriussen et al., 1984). A prerequisite for progeny testing is that progenies of the bulls to be tested can be identified, raised for beef production under field conditions and judged in the commercial slaughter routines. The Swedish breeding structure for dual-purpose cattle with a high percentage AI usage ought to be suitable for progeny testing for beef production based on field data. Gravir (1984) suggested groups of at least 50 male progenies to be preferable. The main problems reported with progeny testing under field conditions (Liboriussen et al., 1984; Gravir, 1984) were lost information on slaughter registrations and problems in connecting the identification of the animals at slaughter with that from the production recording. These problems were believed to be solved by introducing improved routines and common computer registrations in production recording and at slaughter. It should be noted when discussing the advantages of progeny testing that only bulls selected for AI can be tested, while their selection in the first step would still have to rely on their performance testing results.

Final remarks

It is not obvious from the results received, whether ultrasonic scanning should be recommended as a way of improving the evaluation of performance tested bulls for carcass traits. The Swedish conclusion today is that the benefit of scanning measurement might be to small in comparison with the expense of routine measuring. It has therefore been decided not to introduce ultrasonic scanning at this stage as a part of the Swedish beef evaluation program, but to follow carefully investigations in this field, especially those going on in Denmark.

Alternative methods will be evaluated. Body measurements and scoring have already been mentioned. Progeny testing accoring to the Norwegian model (Gravir, 1984) will be investigated.

References

Andersen, B.B. 1977. Genetiske undersøgelser vedrørende kvaegets tillvaekst, kropsudvikling og foderudnyttelse. *Rep. No. 448, Natl. Inst. Anim. Sci.*, Copenhagen, 137 pp.

Andersen, B.B. 1982. Potential use of in vivo techniques in a combined milk/beef breeding programme. In: Andersen, B.B. (ed.), In vivo estimation of body composition in beef. *Rep. No. 524, 94–98. Natl. Inst. Anim. Sci.*, Copenhagen.

Andersen, B.B., Busk, H., Chadwick, J.P., Cuthbertson, A., Fursey, G.A.J., Jones, D.W., Lewin, P., Miles. C.A. & Owen, M.G. 1982. Ultrasonic techniques for describing carcass characteristics in live cattle. CEC Report, EUR 7640 EN, 78 pp.

Appel, W. 1980. Die Bestimmung des Schlachtkörperwertes am lebenden Rind mit dem dänischen Ultraschallgerät "Danscanner". Inaugural–Dissertation zur Erlangung des Grades eines Doktors der Agrarwissenschaft an der Christian–Albrechts–Universität Kiel (Schriftenreihe des Institutes für Tierzucht und Tierhaltung der Christian–Albrechts–Universität Kiel; heft 3, 1981).

Busk, H. 1983. Improved Danscanner for cattle pigs and sheep. In: Lister, D. (ed.), In vivo measurements of body composition in meat animals. Proceeding from CEC workshop at Langford, Bristol.

Eriksson, J.–Å., 1985. Samband mellan ryggmuskel– och fettyta på levande djur och slaktkroppsmått. Mimeograph, SHS, S–631 84 Eskilstuna, Sweden.

Gravir, K. 1984. Feltmässig avkomstgranskning for kjøttavdrått. In: Avlsarbeidet med NRF–Norsk Rødt Fe. NRF, Hamar, Norway.

Henningsson, T., Ral, G., Andersson, O., Karlsson, U. & Martinsson, K., 1986. A study on the value of ultrasonic scanning as a method to estimate carcass traits on live cattle. Acta agric. scand. 36, 81–94.

Jansen, J., Andersen, B.B., Bergström, P.L., Busk, H., Lagerweij, G.W. & Oldenbroek, J.K. 1985. In vivo estimation of body composition in young bulls for slaughter. 2. The prediction of carcass traits from scores, ultrasonic scanningand body measurements. *Livest. Prod. Sci. 12,* 231–240.

Jensen, J. & Andersen, B.B. 1982. Analyse af syv års individprøvedata (miljøkorrektion, arvelig variation, sikkerhed og T–, U– og I–tal). *Rep. No. 526. Natl. Inst. Anim. Sci.*, Copenhagen.

Kempster, T., Cuthbertson, A. & Harrington, G. 1982. Carcass evaluation in livestock breeding, production and marketing. Granada, London, UK.

Kempster, A.J., Cuthbertson, A., Jones, D.W. & Owen, M.G. 1981. Prediction of body composition of live cattle using two ultrasonic machines of differing complexity: a report of four separate trails. J. agric. Sci., Camb. 96, 301–307.

Liboriussen, T., Lauritsen, F. & Andersen, B.B., 1984. Analyser vedrørende afkomstprøver for kødproduktion på grundlag af data fra praksis. *Rep. No. 565. Natl. Inst. Anim. Sci.*, Copenhagen, 64 pp.

Lister, D. (ed). 1983. In vivo measurement of body composition in meat animals. Proceeding from CEC workshop at Langford, Bristol.

Maijala, K. 1974. Many–sided progeny testing of bulls. *Ann. Genet, Sél. Anim. 6, 253–266.*

Philipsson, J., Hansson, I. & Henningsson, T. 1981. Growth rate and carcass characteristics of different strains of Friesian cattle. *32nd Ann. Meet. of the European Ass. for Anim. Prod.*, Zagreb, 1981.

Simm, G. 1983. The use of ultrasound to predict the carcass composition of live cattle – a review. *Anim. Breed. Abstr. 51,* 853–875.

Stolzman, M., Jasiorowski, H., Reklewski, Z,. Zarnecki, A. & Kalinowska, G. 1981. Friesian cattle in Poland. Preliminary results of testing different strains. *World Anim. Rev. 38,* 9–15.

PHENOTYPIC AND GENETIC PARAMETERS OF GROWTH TRAITS IN SUCCESSIVE PERIODS

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Summary

The coefficients of heritability, of phenotypic, genetic and environmental correlations concerning the successive weights from 7 to 12 months of age and the corresponding monthly gains were estimated on 734 bulls (83 sires) of the Belgian Blue breed (double-muscled type). The heritabilities of the successive weights ranged from 0.206 to 0.265, of the monthly gains from 0.06 to 0.278. The estimate of the heritability of the overall daily gain (7-12 months) was 0.44. The estimates of the genetic correlations between the weights and subsequent gains were not significantly different from zero. On the other hand, the genetic correlations between the periodic gains were high (median = 0.94) but the phenotypic correlations were low (median = 0.04). The choice of the selection criterion (weight for age or daily gain) and the possible genetic alteration of the growth curve in order to ensure a high daily gain relative to mean weight are discussed. Correlations between performance test results and progeny test results on the farm have also been estimated.
Keywords: performance test, cattle, growth traits, genetic parameters.

Introduction

Performance testing in Central Station is organized in Western Europe since a decade or two. The testing procedures applied in different European countries have been reviewed by Andersen et al. 1981. The main problems raised in practice are : the size of the station, the housing system, the age of the bulls at admission and at the start of the testing period, the length of the testing period, the feeding level, the feed intake recording, the estimation of the body composition, the choice of the selection criteria, the method of genetic evaluation, its repeatability in the farm conditions, the impact of the test results on breeding decisions.

The intent of this paper is to analyze the data collected at the Performance Testing Station of Ciney and to estimate the phenotypic and genetic parameters of the following growth traits : the successive weights and monthly gains from 7 to 12 months.

Material and methods

Heritabilities, phenotypic, genetic and environmental correlations were estimated on 734 performance tested bulls from 83 sires. All these animals belonged to the same breed : the Belgian Blue (double-muscled type). They were reared in station and were fed ad libitum from 5 to 12 months with a concentrate and straw. The testing period started at 7 months and ended at 12 months. The bulls were allotted in groups of five, were kept in loose-housing on straw bedding. Method 3 of Henderson was used to estimate the genetic parameters. The effects in the mixed model were : random effects : sire; fixed effects : year (8 levels), season of the completion of test (6 periods of 2 months), interaction year x season, age at admission (3 levels : below 90 days, between 90 and 150 days, between 150 and 210 days). The Least Squares and Maximum Likelihood Computer Program (LSML76) was used for this analysis (Harvey 1977).

Results

The coefficients of heritability are given in table 1.

Table 1. The coefficients of heritability (h^2) and their standard error (S.E.).

Trait	h^2	(S.E.)	Trait	h^2	(S.E.)
Weight at			Ave. daily gain		
7 months	0.207	(0.106)	7- 8 months	0.250	(0.111)
8 months	0.226	(0.108)	8- 9 months	0.060	(0.090)
9 months	0.206	(0.106)	9-10 months	0.278	(0.114)
10 months	0.235	(0.109)	10-11 months	0.081	(0.092)
11 months	0.214	(0.107)	11-12 months	0.104	(0.095)
12 months	0.265	(0.111)			
			7- 9 months	0.167	(0.102)
			7-10 months	0.434	(0.128)
			7-11 months	0.448	(0.130)
			7-12 months	0.440	(0.129)

The heritabilities of the successive weights increased moderately with age, from 0.207 at 7 months to 0.265 at 12 months. Regarding the heritabilities of the gains during the successive periods, the estimates fluctuated from one period to the next. The heritability estimate of the average daily gain became stabilized around 0.44 when the daily gain was averaged over a period of at least 3 months. The genetic and phenotypic correlations between successive gains are given in table 2.

Table 2. Genetic and phenotypic correlations between periodic gains (above diagonal : genetic; below diagonal : phenotypic) (in parentheses : the standard error).

r_g / r_p	7-8	8-9	9-10	10-11	11-12	7-12
7-8		0.229 (0.599)	1.011 (0.286)	1.071 (0.695)	0.684 (0.522)	0.977 (0.150)
8-9	0.083		1.117 (0.918)	0.145 (0.939)	0.593 (0.926)	0.788 (0.487)
9-10	0.111	0.007		0.925 (0.635)	0.963 (0.514)	1.049 (0.134)
10-11	0.035	0.109	0.034		1.137 (0.934)	0.911 (0.372)
11-12	-0.007	0.035	0.073	0.046		0.817 (0.316)
7-12	0.444	0.443	0.468	0.499	0.435	

The phenotypic correlations between the partial gains were very low (median : 0.04) while the corresponding genetic correlations were large (median : 0.94) but the standard errors are also large. The environmental correlations were low and generally negative (median = -0.12). On the other hand, the genetic correlations between the partial gains and the overall gain (7-12 months) had a central value of 0.91, the phenotypic correlations of 0.44 and the environmental correlations of 0.37. The genetic correlations between the weights at different ages and the subsequent monthly gain had a central value of 0.20. The correlations between initial weight (7 months), final weight (12 months) and overall daily gain (7-12 months) are given in table 3. These correlations are presented with the corresponding correlations estimated on an independent set of data (505 bulls, from 52 sires, entered at one month of age, same station). The heritabilities of these traits are also given in table 3.

The results of these two independent studies are quite comparable : heritability of gain higher than the heritabilities of weights; low or zero correlation between initial weight and subsequent gain; high correlations between initial and final weight, between final weight and overall daily gain but these correlations are between a part and its whole.

Discussion

As the growth performances are significantly affected by year and season, they are to be adjusted for these factors. Each station has probably its own seasonal characteristics and these are expressed through the growth parameters of the animals and their variability.

Table 3. Correlations between initial weight (IW), final weight (FW) and overall daily gain (ADG). Heritabilities in the last column.

Traits		Correlations Phenotypic	Genetic	Heritabilities		
IW x ADG	1	0.144	-0.035 (0.281)	IW	1	0.21
	2	0.122	-0.344 (0.292)		2	0.27
IW x FW	1	0.834	0.695 (0.154)	FW	1	0.26
	2	0.831	0.613 (0.220)		2	0.20
FW x ADG	1	0.659	0.698 (0.146)	ADG	1	0.44
	2	0.651	0.529 (0.237)		2	0.44

1 = Present study   2 = from Hanset et al. (1987).

Heritability estimates quite comparable to those found in this study were reported by Swiger (1961) for monthly growth rate and by Fimland (1973) for bimonthly growth rate. In our data, the daily gain had to be averaged over a period of at least 3 months to reach its maximum of 0.44. Fimland (1973) found a maximum of 0.54 for the heritability of the cumulative gain 90-330 days. The error variance was stabilized with having more than 180 days in test. In our data, the heritability of the final weight was smaller than the heritability of gain (table 3). Perhaps, a longer test period would have been necessary to reach a higher heritability. The heritability estimate found by Fimland (1973) for the final weight was 0.37 against 0.49 for the overall daily gain and the estimates of heritability of cumulative growth rate increased steadily from 0.06 (150 days) to 0.49 (360 days).

Concerning the negative genetic correlations between pre-weaning gain and post-weaning gain found by some authors, such a result could be due to chance, to a real genetic antagonism or to the automatic negative correlation between gains made in adjacent periods because of differences in fill (Koch and Clark 1955). Moreover, as the pre-weaning period and the post-weaning period provide different environments, apparently different sets of genes condition the response of calves in these different environments. As a consequence, selection on pre-weaning gain would be ineffective in improving the genotypes for later gains (Koch and Clark 1955). This is also the opinion of Bogart and Frischknecht (1967) who found no relation between gains made during the nursing period and subsequent gaining ability. They concluded that records on pre-weaning and post-weaning performance are necessary for improving both.

On the other hand, like most authors, Tong (1982) found significant regression coefficients (both linear and quadratic) for on-test daily gain on initial weight and this observation is considered by him as "a consequence of high genetic correlations for growth at different ages". Moreover, like most authors, he found very low estimates of the phenotypic correlation between pre-test daily gain and on-test daily gain (range : -0.15 to 0.02).

In contrast to the phenotypic correlations, the genetic correlations between periodic gains, estimated from our data, are generaly high. The negative sign of several environmental correlation estimates is likely to be ascribed to errors in weighing, differences in fill at the end of the different periods and to cyclic and compensatory growth.

For non overlapping 56 days intervals, Koch et al. (1982) found an average phenotypic correlation of +0.14, an average environmental correlation of -0.03 and an average genetic correlation of +0.77. The genetic correlations tended to decline for more distant gain intervals (e.g. from 0.81 to 0.51 when the distance increases from 0 to 112 days).

High genetic correlations between gains made during successive periods imply that the same growth genes are involved. It was the case in our data for the 5 monthly gains between 7 and 12 months. On the other hand, low or zero genetic correlations between successive gains mean that different genes are involved. We found such a situation between initial weight and subsequent growth. Now, a slow growth rate at an earlier age with consequently a lower initial weight followed by a rapid growth rate, during the fattening period, will ensure a better food conversion ratio and a better income since such a growth pattern provides a high daily gain relative to mean weight (Pasternak and Shalev 1983, Hanset et al. 1987). On the other hand, high genetic correlations throughout the entire growth period would mean that testing for growth could be done at any moment during the growth period.

Performance testing is expected to reveal those genetic differences that are the most profitable in the farm conditions. Would it be preferable to select on average daily gain during the test period, or on weight for age, or on both. If average daily gain is measured during the test period, final weight is a function of birth weight, pre-test and test gain. Tong (1982) has suggested to combine in an index both weight for age and on test daily gain. Hanset et al. (1987) showed that final weight was a poor selection criterion if the goal was to maximize net income during the fattening period. In this connection, daily gain and feed conversion ratio were far better as selection criteria.

For 75 performance-tested bulls, selected for A.I. and then progeny-tested on the farm, the rank correlations between performance test results (IW; FW; ADG; deviations from seasonal means) and progeny test result (weight at 12 months, on the farm W_{12}, progenies of both sexes) were calculated (table 4).

The high correlations between initial weight and final weight, and between daily gain and final weight, all traits measured in station, are part-whole correlations. The correlations between initial weight on the one hand and daily gain (station) and weight on the farm, on the other hand, are not significant. The ranking of sires on the basis of their daily gain in station is apparently closer to the ranking based on weight on farm than the ranking on final weight in station.

Table 4. Rank correlations between performance-test and progeny test results.

	IW(St)	FW(St)	ADG(St)	W_{12}(F)
IW(St)		0.654[3]	-0.149	0.012
FW(St)			0.585[3]	0.243[1]
ADG(St)				0.336[2]

St = Station F = on the farm
(from Hanset and Michaux : unpublished results).

The genetic correlations between the traits measured on station and the trait measured on the farm could be drawn from the regressions of progeny test on performance test. These correlations are : 0.64 for gain and 1.04 for final weight. In other words, the relation between daily gain (station) and weight on farm would have been closer given the heritability of 0.44 for daily gain if the genetic correlation between these two traits had been equal to unity.

References

Andersen, B.B. et al., 1981. Performance testing of bulls in AI : report of a working group of the commission on cattle production. Livest. Prod. Sci. 8 : 101-119.
Bogart, R., W.D. Frischknecht, 1967. Relationship of weights, scores and gains in growing cattle. J. Anim. Sci. 26 : 883 (Abs.).
Fimland, E.A., 1973. Estimates of phenotypic and genetic parameters for growth characteristics of young potential AI bulls. Acta Agric. Scand. 23 : 209-216.
Hanset, R., C. Michaux,and A. Stasse, 1987. Relationships between growth rate, carcass composition, feed intake, feed conversion ratio and income in four biological types of cattle. Génét. Sél. Evol. 19 : 85-107.
Harvey, W.R., 1977. User's guide for LSML76. Ohio State Un.
Koch, R.M. and R.T. Clark, 1955. Genetic and environmental relationship among economic characters in beef cattle. I - Correlation among paternal and maternal half-sibs. J. Anim. Sci. 14 : 775-785.
Koch, R.M., L.V. Cundiff and K.E. Gregory, 1982. Influence of post-weaning gain interval on estimates of heritability and genetic correlations. J. Anim. Sci. 55 : 1310-1318.
Pasternak, H. and B.A. Shalev, 1983. Genetic - economic evaluation of traits in a broiler enterprise : reduction of food intake due to increased growth rate. Brit. Poultry Sci. 24 : 531-536.
Swiger, L.A., 1961. Genetic and environmental influences on gain of beef cattle during various periods of life. J. Anim. Sci. 20 : 183-188.
Tong, A.K.W., 1982. Effects of initial age and weight on test daily gains of station-tested bulls. Can. J. Anim. Sci. 62, 671-678.

RELATIONSHIP BETWEEN PERFORMANCE TEST AND PROGENY TEST FOR VEAL AND BEEF PRODUCTION IN DUTCH RED AND WHITE CATTLE

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Summary

A field trial was conducted to determine genetic parameters in veal and beef production and relationship between performance test and progeny test for veal and beef production. Progeny of 61 performance tested MRY bulls were fattened for veal and beef. With about 325 kg milk replacer per head 1188 progeny were reared in a specialized fattening unit to an average live weight of 226 kg. Mainly with corn silage and concentrates 1168 progeny were fattened in nine different farms to an average live weight of 520 kg in on average 440 days. Heritabilities in veal and beef production traits varied from 0.09 to 0.30 and 0.08 to 0.48 respectively, which makes effective selection possible. Genetic correlation between corresponding traits in veal and beef production varied from 0.50 to 0.79, which indicated selection on veal production will improve beef production and reversed. Selection on daily gain, weight and pelvic height at 365 days in the performance test improves both veal and beef production ability of progeny.

Introduction

In The Netherlands 60 per cent of the new born Dutch Red and White (MRY) calves, not required for replacement in the dairy herd, are reared as veal calves and 40 per cent are grown as beef bulls. To maintain or improve the merit of MRY calves for veal and beef production a beef index, based on the performance test of AI bulls, was introduced (Jansen et al., 1984). Since knowledge of genetic parameters for the beef index of MRY performance tested bulls was limited, a progeny test was conducted of performance tested bulls as veal calves and beef bulls. The objectives of this study were to estimate genetic parameters for veal and beef production characteristics and to establish relationship between performance test, veal and beef production traits.

Material

Performance test

Performance test data were available from 721 purebred MRY bulls, born between September 1981 and October 1985, and reared in two central test stations for at least 245 days. These bulls were progeny of 42 sires. The bulls were tested on a diet with concentrates supplied according to age and roughages supplied ad libitum. The traits measured were daily gain between 120 and 365 days of age and body weight, pelvic height, fleshiness and fat covering at 365 days.

Progeny test

The progeny test for veal and beef production was conducted for 61 performance tested pure bred MRY bulls from AI studs in the eastern and southern part of The Netherlands between April 1984 and March 1985. Within AI areas test inseminations with semen from each bull on heifers in first lactation were performed within a period of two months. From each sire 34 new born male calves of 6 - 13 days of age were purchased. With regard to weight at delivery and type score, two equivalent groups were composed. One was reared for veal and one for beef production. Monthly a progeny group of a reference sire was purchased in both AI areas for the estimation of non-genetic effects. These groups were also allocated in two comparable groups, one for veal and one for beef production. The veal calves were reared in a specialised fattening unit. According to weight at delivery, the calves were allocated among four feeding schemes with different slaughter ages. Equal amounts of milk replacer were supplied (325 kg) to all the individuals during the rearing period. Milk refusals were weighed and recorded. Calves were weighed before slaughter. Carcass weight, fleshiness, meat colour and price per kg were recorded after slaughter. The data of 1188 veal calves were eligible for statistical analysis. The beef bulls were allocated over nine fattening units. Weekly, the delivered progeny was sent to one of these farms. After the adaptation period (60 days) they were kept in groups and fattened with (mainly) corn silage and concentrates for on average 440 days up to on average 520 kg live weight. Bulls were weighed and after slaughter carcass weight, fleshiness, fat covering and price per kg were recorded. The data of 1168 beef bulls were eligible for statistical analysis. The merit of the new born calves for respectively veal and beef production was calculated as carcass value minus costs during the growing period.

Methods

Variance and covariance components were estimated by a Restricted Maximum Likelihood (REML) procedure, using the EM-algorithm described by Schaeffer (1983). The start characteristics, veal and beef production traits and performance test traits were modelled as:

$$\underline{y} = \underline{Xb} + \underline{Zu} + \underline{e}$$

were $\underline{y}$ is a vector of observations, $\underline{b}$ a vector with fixed effects, $\underline{u}$ a vector with effects of sire, $\underline{e}$ a vector with error terms and $\underline{X}$ and $\underline{Z}$ are known incidence matrices of appropriate order.
First and second moments are:

$$E\begin{bmatrix}\underline{y}\\ \underline{u}\\ \underline{e}\end{bmatrix} = \begin{bmatrix}\underline{Xb}\\ \underline{0}\\ \underline{0}\end{bmatrix} \quad \text{var}\begin{bmatrix}\underline{y}\\ \underline{u}\\ \underline{e}\end{bmatrix} = \begin{bmatrix}\underline{ZGZ}'\sigma^2_s + \underline{I}\sigma^2_e & \underline{ZG}\sigma^2_s & \underline{I}\sigma^2_e\\ & \underline{G}\sigma^2_s & \underline{0}\\ \text{symm} & & \underline{I}\sigma^2_e\end{bmatrix}$$

where $\underline{G}$ = matrix of additive genetic relationship, σ^2_s = sire variance and σ^2_e = error variance.

Progeny data were analysed by a sire model with effects of sires of progeny as random effects (62 sires). For arrival and veal production traits two breeding areas: east and south, and four year-seasons:

April - June 1984, July - September 1984, October - December 1984 and January - March 1985 were distinguished. For beef production traits the mentioned breeding areas and in total 49 herd-year-seasons were distinguished

Performance test data were analysed by a sire model with effects of sires of performance tested young bulls as random effects (42 sires). Bulls were tested in two central test stations. Eight year-seasons: Oct.1981-March 1982, April 1982 - Sept. 1982, ..., April 1985 - Sept. 1985 were distinguished.

Sire components of covariance were estimated analogously by summation of traits:

$\sigma_{s_{jk}} = \frac{1}{2}(\sigma^2_{s_{(j+k)}} - \sigma^2_{s_j} - \sigma^2_{s_k})$, where j and k indicate different traits.

For estimation of covariance components between performance test, beef production and veal production traits a multivariate lineair model with unequal design was used. Information on a trait was measured on different animals and in different environments and the design of the two traits was allowed to differ. Analysis was pairwise. The general lineair model is an extension of the univariate model, equation (1):

$$\begin{bmatrix} \underline{y}_1 \\ \underline{y}_2 \end{bmatrix} = \begin{bmatrix} \underline{X}_1 & \underline{0} \\ \underline{0} & \underline{X}_2 \end{bmatrix} \begin{bmatrix} \underline{b}_1 \\ \underline{b}_2 \end{bmatrix} + \begin{bmatrix} \underline{Z}_1 & \underline{0} \\ \underline{0} & \underline{Z}_2 \end{bmatrix} \begin{bmatrix} \underline{u}_1 \\ \underline{u}_2 \end{bmatrix} + \begin{bmatrix} \underline{e}_1 \\ \underline{e}_2 \end{bmatrix} \qquad (2)$$

with the subscript referring to the i^{th} trait.
First and second moments are

$$E\begin{bmatrix} \underline{y} \\ \underline{u} \\ \underline{e} \end{bmatrix} = \begin{bmatrix} \underline{Xb} \\ \underline{0} \\ \underline{0} \end{bmatrix} \quad \text{var}\begin{bmatrix} \underline{y} \\ \underline{u} \\ \underline{e} \end{bmatrix} = \begin{bmatrix} \underline{ZGZ'} + \underline{R} & \underline{ZG} & \underline{R} \\ & \underline{G} & \underline{0} \\ \text{symm} & & \underline{R} \end{bmatrix}$$

with

$$\underline{G} = \begin{bmatrix} \underline{A}_{ii}\,\sigma^2_{s_i} & \underline{A}_{ij}\,\sigma_{s_{ij}} \\ \underline{A}_{ji}\,\sigma_{s_{ij}} & \underline{A}_{jj}\,\sigma^2_{s_j} \end{bmatrix}$$

$$\underline{R} = \begin{bmatrix} \underline{I}\,\sigma^2_{e_i} & \underline{0} \\ \underline{0} & \underline{I}\,\sigma^2_{e_j} \end{bmatrix}$$

$\underline{A}_{ij}$ = matrix of additive genetic relationship sires trait_i x sires trait_j.

Estimation of covariance components is described by Schaeffer (1983); accounting for additive genetic relationship is described by Henderson (1984). The quadratics necessary for estimation are

$$\text{tr}\,(\underline{Q}_i\underline{G}) = \underline{\hat{u}}'\underline{Q}_i\underline{\hat{u}} + \text{tr}(\underline{Q}_i C_{22}),$$

with $\underline{Q}_i = \underline{G}^{-1}\underline{G}_i\underline{G}^{-1}$ (i=1,3) and $\underline{C}_{22}$ is the inverse of the coefficient matrix (random part) and

$$tr(\underline{P}_i\underline{R}) = \hat{\underline{e}}'\underline{P}_i\hat{\underline{e}} + tr(\underline{P}_i\underline{WCW}'),$$

with $\underline{P}_i = \underline{R}^{-1}\underline{R}_i\underline{R}^{-1}$ (i=1,3) and $\underline{W}$ is the coefficient matrix with inverse matrix $\underline{C}$.

Iteration was stopped when change between rounds was smaller than 1 %.

Results

Veal and beef production

Table 1 is a summary of overall means, genetic variation, heritabilities with standard errors and responses to single trait selection based on 50 progeny per sire and a selection intensity of 0.798 (50 %) in sires.

Table 1. Mean values, genetic variation (σ_g), heritabilities (h^2) with standard errors (S_{h^2}) and selection responses for traits at start, veal production and beef production traits.

Trait	Mean	σ_g	h^2	S_{h^2}	SR
Start:					
Weight (kg)	46.0	2.7	0.26	0.08	0.9
Type score (1-10)	7.5	0.6	0.23	0.08	0.2
Price (Dfl.)	626.3	43.5	0.19	0.07	14.4
Veal production:					
Daily gain (g)	1179	31	0.12	0.06	9.7
Feed per kg gain (g)	1741	59	0.27	0.08	21
Carcass weight (kg)	144.3	2.9	0.10	0.05	0.9
Carcass fleshiness (1-5)	3.5	0.23	0.30	0.09	0.08
Meat colour (1-5)	1.4	0.19	0.15	0.06	0.06
Price per kg carcass (Dfl.)	10.17	0.22	0.29	0.08	0.09
Value of the calf (Dfl.)	619	53.6	0.23	0.07	18.4
Beef production:					
Daily gain (g)	1076	30	0.14	0.06	9.6
Carcass weight (kg)	304.1	6.3	0.08	0.05	1.8
Carcass fleshiness (1-5)	2.7	0.23	0.48	0.11	0.09
Carcass fat covering (1-5)	2.6	0.16	0.27	0.08	0.06
Price per kg carcass (Dfl.)	8.22	0.06	0.28	0.08	0.02
Value of the calf (Dfl.)	533	77.3	0.15	0.06	24.9

Weight, type score and price at start may be improved through selection. Heritability estimates for veal and beef production characteristics varied between 0.10 - 0.30 and 0.08 - 0.48, respectively. Value of the calves is mainly determined by carcass characteristics. In veal production, price per kg was calculated from carcass fleshiness and meat colour; in beef production it was from carcass fleshiness and carcass fat covering. In both types of meat production heritability estimates for quantitative traits (e.g. daily gain or weight) are somewhat lower than those for qualitative traits (e.g. fleshiness). Genetic correlations among respectively veal and beef production traits are given by Dijkstra et al. (1987).

Genetic relation between veal and beef production

Genetic correlations between veal and beef production characteristics are presented in Table 2.

Table 2. Genetic correlations between veal and beef production characteristics.

Veal calves	Beef bulls				
	DG	CW	CF	PC	VC
Daily gain (DG)	0.53	0.74	0.14	0.53	0.72
Carcass weight (CW)	0.42	0.64	0.29	0.62	0.65
Carcass fleshiness (CF)	0.69	0.91	0.79	0.82	0.82
Price per kg carcass (PC)	0.25	0.26	0.51	0.50	0.38
Value of the calf (VC)	0.45	0.65	0.37	0.24	0.70

Veal calves differ from beef bulls in feeding regime and age at slaughter. Nevertheless all traits mentioned in Table 2 showed positive relationships. The genetic correlation between corresponding traits in veal and beef production varied between 0.50 and 0.79. Considering the level of the genetic correlations for both kinds of meat production, selection for veal production will improve the genetic ability for beef production (and reversed).

Performance test and relation between performance test and progeny test

Table 3 is a summary of overall means, genetic variation and estimates of heritabilities with standard errors of the performance test data.

Table 3. Mean values, genetic variation (σ_g) and heritabilities (h^2) with standard errors (S_{h^2}) for performance test traits.

Trait	Mean	σ_g	h^2	S_{h^2}
Daily gain (g)	1176	52	0.41	0.12
Weight at 365 days (kg)	417	16	0.40	0.12
Pelvic height at 365 days (cm)	125.3	1.6	0.48	0.14
Fleshiness at 365 days (1-6)	3.3	0.14	0.12	0.08
Fat covering at 365 days (1-6)	1.8	0.10	0.18	0.09

At 365 days, fleshiness and fat covering showed low heritabilities. When considering the heritability estimates, daily gain, weight at 365 days and pelvic height at 365 days are most suitable for selection after performance testing.

A summary of genetic correlations between performance test traits and traits in progeny testing is given in Tabel 4.

Table 4. Genetic correlations between performance test traits and progeny test traits.

Progeny test	Performance test			
	Daily gain	Weight at 365 days	Pelvic height at 365 days	Fleshiness at 365 days
Start				
Weight	0.36	0.49	-0.21	-0.41
Type score	0.31	0.15	0.22	-0.44
Price	0.42	0.42	-0.06	-0.54
Veal production				
Daily gain	0.58	0.47	0.57	-0.50
Feed per kg gain	-0.64	-0.51	-0.10	-0.01
Carcass weight	0.28	0.20	0.77	-0.74
Carcass fleshiness	0.59	0.52	0.07	0.18
Meat colour	0.26	0.16	0.92	-0.01
Price per kg carcass	0.17	0.12	-0.88	0.23
Value of the calf	0.69	0.56	0.57	-0.11
Beef production				
Daily gain	0.66	0.47	0.69	-0.28
Carcass weight	0.61	0.40	0.77	-0.37
Carcass fleshiness	-0.19	0.33	-0.76	0.37
Carcass fat covering	0.13	0.24	-0.15	0.64
Price per kg carcass	-0.05	0.43	-0.72	0.50
Value of the calf	0.70	0.52	0.74	-0.36

Daily gain of the performance test had a genetic correlation with daily gain of veal calves and beef bulls of 0.58 and 0.66 respectively. The figures for live weight and carcass weight were somewhat lower. Fleshiness at 365 days of the performance tested bulls showed small positive correlations with carcass fleshiness in veal and beef production. Selection on weight of performance tested bulls will improve quantitative and qualitative traits in veal and beef. Selection on pelvic height at 365 days and, to a lesser extent, daily gain will improve quantitative traits in veal and beef, but will have none or undesirable effects on qualitative traits.

Discussion and conclusions

Heritability estimates for veal and beef production characteristics indicate that selection for veal and beef production by progeny testing might be effective. Heritabilities presented in Table 1 may be underestimated for the following reasons. First, sires of calves were performance tested and selected with an intensity between 33 and 50 %. This selection is mainly for pelvic height at 365 days and, to a lesser extent, body weight at 365 days. The 61 sires of the calves had on average a significantly higher pelvic height and weight at 365 days compared to their contemporaries. Selection in sires of veal calves and beef bulls will influence sire variance components of progeny downwards. Second, effect of sires is confounded with effect of season. Test inseminations of unproven sires are carried out within a period of two months. Therefore, progeny of a reference sire was purchased all over the year to cancel this confounding. Besides, using a relationship matrix to estimate variance and covariance components will diminish the confounding of sire with season. Oldenbroek and Meijering

(1986) in a similar study with Black and White dairy cattle estimated seasonal effects from progeny data of the reference sire and, after preadjusting data of unproven sires, estimated heritabilities. They found that pr adjustment did not result in higher variances between progeny groups. However, the preadjustment has the disadvantage of introducing of a correlation between residuals within season classes. Therefore a simultaneous adjustment was used in this study.

In The Netherlands, price differences of newborn calves sold for meat production are based on weight and score for type. As can be concluded from Table 1, arrival characteristics can be improved through selection. The correlation with qualitative and quantitative veal and beef production characteristics however, was rather low. Genetic correlations between weight and score for type at start with value of the calf for veal production were 0.14 and 0.19 respectively and with value of the calf for beef production 0.36 and 0.63 respectively. Therefore, selection on start characteristics will have a small effect on the improvement of genetic ability for veal and beef production. Moreover, selection on start characteristics can give rise to an increase of dystocia and stillbirth in the population. In the present situation, prices of calves are mainly determined by supply and demand of newborn calves; price differences don't reflect the merit of the calves for veal and beef production.

Oldenbroek and Meijering (1986) estimated genetic correlations between performance test traits and progeny test traits using the method described by Blanchard et al. (1983). Herein, genetic correlation is a function of the correlation between breeding values and the accuracy of the breeding values estimated. As pointed out by Dijkstra et al. (1987) in some cases, especially in case of low heritabilities, the former method yields overestimated genetic correlations. In the present study genetic correlations between traits in performance and progeny test are estimated by means of a comprehensive REML-algorithm to solve this problem.

This study showed selection on daily gain, weight at 365 days and pelvic height at 365 days to be useful for improvement of veal and beef production characteristics. Fleshiness at 365 days of young AI-bulls in performance testing had a low heritability and small positive correlations with carcass fleshiness of veal calves and beef bulls. Hence, fleshiness at 365 days is less suitable for selection. To study the consequences of selection on veal and beef production based on performance test an index, consisting of daily gain, weight at 365 days and pelvic height at 365 days of a young bull with the same information on 5 half-sibs, was constructed. The breeding objective consisted of value of the calf for veal and beef production. Economic values were discounted by the Geneflow method to the veal calf level according to Brascamp (1978). Economic values, total gain and genetic progress of traits in aggregate genotype are presented in Table 5.

Table 5. Economic values (v), percentages of total gain accounted for by gain in each trait (p) and genetic progress (Δg) of traits in the aggregate genotype for selection by means of performance testing (selection intensity is 1).

traits in aggregate genotype	v	p(%)	Δg(Dfl)
value calf for veal production	1.000	49.8	14.7
value calf for beef production	0.579	50.2	25.6

Standard deviations of index and breeding goal were Dfl. 59.16 and Dfl. 90.51 respectively. The correlation of index and aggregate genotype (accuracy of breeding value) was 0.65. Despite of higher genetic variation in beef production compared to veal production, both types of meat production contribute one half to total gain due to a higher discounted economic value of veal.

Selection for veal and beef production by means of performance testing will decrease the response in selection on milk production caused by a decrease in selection intensity in the dams of the sires. Since relationships between milk and dystocia traits on the one hand and veal and beef production characteristics on the other hand in the MRY-breed are not available, at present optimal breeding plans can not be calculated; before long data sets will be available to estimate these relationships.

References

Blanchard, P.J., Everett, R.W. and Searle, S.E., 1983. Estimation of genetic trends and correlations for Jersey cattle. J.Dairy Sci. 66:1947-1954.

Brascamp, E.W., 1978. Methods on economic optimization of animal breeding plans. Zeist, IVO-report B-134, 117 pp.

Dijkstra, J., Korver, S., Laurijsen, H.A.J., Oldenbroek, J.K., Rooy, J. de and Werf, J. van der, 1987. Possibilities to select on veal and beef production in Dutch Red and White (MRY) dairy cattle. Zeist, IVO-report, in press, Dutch, with English summary and subtitles.

Henderson, C.R., 1984. Estimation of variances and covariances under multiple trait models. J.Dairy Sci., 67:1581-1589.

Jansen, J., Korver, S., Dommerholt, J. Meijering, A. and Oldenbroek, J.K., 1984. A selection index for beef production capacity of performance-tested young bulls in AI in Dutch dual-purpose breeds. Livest. Prod.Sci. 11:381-390.

Oldenbroek, J.K. and Meijering, A., 1986. Breeding for veal production in Black and White dairy cattle. Livest.Prod.Sci. 15:325-336.

Schaeffer, L.R., 1983. Notes on lineair model theory, best lineair unbiased prediction, and variance component estimation. 362 pp.

PERFORMANCE TEST RESULTS IN RELATION WITH PROGENY TESTS UNDER STATION AND FIELD CONDITIONS FOR FLECKVIEH.

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Summary

Performance test data from three Bavarian test stations were analyzed and a comparison with different types of progeny test results conducted. From a total of 3.942 performance tested bulls, 48.6 % were accepted but only 37.2 % of the total finally conducted test matings in AI. Only half of the theoretical possible selection difference for 420 day weight or gain on test was realized.

The comparison of sire-son relationships for 148 pairs with station progeny tests showed genetic correlations from 0.65 - 0.79 for gain and weight. Correlations with carcass traits are also given. Information from contract herds were available from 119 pairs, resulting in genetic correlations of 0.77 - 0.90. The EEC-conformation score had a genetic correlation of 0.52 with the round circumference. A progeny test under field conditions collecting data from slaughter houses for slaughter weight and EEC-grades resulted in 385 sire-son pairs with at least 20 progeny. The genetic correlations for net gain ranged from 0.49 to 0.61 indicating a less favourable conformity, but the herd environment could not be eliminated due to missing information. It is concluded, that performance test results agree with progeny test data for comparable traits under comparable feeding conditions and weight ranges.

Keywords: Cattle, performance test, progeny test, growth traits, carcass traits, genetic parameters

1. Introduction

Performance tests of Fleckvieh bulls at central test stations started in Germany twenty years ago when model-calculations indicated an advantage over progeny testing in situations where differences in carcass quality were of minor importance (Bogner, 1967, Rittler, 1967). In the beginning, the bulls were owned by the individual breeders, which caused problems in acceptance by AI-studs. Therefore, performance testing was incorporated into the breeding schemes in 1970, when the bull calves in Bavaria were bought by the breeding organizations, combining the interests of herdbook-societies and AI-studs on a regional level. These organizations also fund the performance tests with regional differences.

2. Materials and methods

2.1 Performance test data

Bull calves from planned matings are inspected at 3 to 4 weeks of age and should originally arrive at the test station between 5 and 7

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weeks of age. Health programs which differ between stations have prolonged this time period as the report by Hahn (1987) indicated. After a weaning and adjustment-period, the test period runs from the 112th to the 420th day of age. The bulls are group-housed and fed ad-lib with corn silage in combination with an age-dependent concentrate mixture, the composition of which has changed over the years (Hahn, 1987). Feed intake is not recorded, based upon the early EAAP recommendation (Kräusslich, 1974). Evaluation is presently based on a rolling station average using 30 contemporaries from previous test groups.

Selection is practiced in connection with the licensing of AI-bulls at the end of the test period. Besides growth performance and muscularity, physical soundness of the bulls is also evaluated, using an index for milk and beef traits described by Averdunk and Alps (1985). Selection of AI-test bulls is practiced in three stages:

- official licensing by a five-man panel
- acceptance by the AI-stud based on physical appearance and
- final passing of fertility control for AI-service.

Table 1. Selection of performance tested Fleckvieh bulls in Bavaria and selection differentials from 1971 to 1984.

Selection stage Trait	n		420-day-weight mean	s		Gain in test period mean	s	
Bulls tested	3942							
absolute trait			559	44		1308	126	
deviation from contemporaries			+1	40		+2	110	
Bulls accepted at licensing	1914	48.6%						
deviation			+21	31		+57	86	
Selection differential					0.50			0.50
Bulls finishing test matings	1468	37.2%						
deviation			+20	31		+58	86	
Selection differential					0.48			0.51

The selection differentials for 420-day weight and gain during test are given in table 1 for the combined data, where the deviation from the contemporary average is used to eliminate systematic effects. On average 49% of the bulls finishing the test are licensed,with variations between stations from 44 to 54 percent. Approximately 3.8% of the bulls are not accepted by the AI studs due to physical problems. Another 7.6% are eliminated because of fertility problems (libido and semen quality). There is no difference in growth traits between all bulls licensed and those accepted for AI test service, indicating that no antagonistic effects were observable. The losses after completion of the test reduced the selection pressure remarkably:only half of the theoretically possible selection difference could be realized. For all other traits measured during the performance test, about 50-70% of the selection differential for weight and gain are realized, as was shown by Averdunk & Binder (1986).

2.2. Progeny test data

2.2.1 Station test

Station progeny test data were available from two test stations which have comparable management and fattening regimes to the performance test stations. Twelve progeny per sire are fattened to constant age (500 +/-6 days) and evaluated in the slaughter-house of the institute. Besides weights at different ages, carcass data and estimates of lean, bone and lean to bone ratio are available (Alps et al., 1980). Important traits used in prediction of lean and bone content are also given. Traits are expressed as deviations from station-year-season averages and breeding values are calculated, using recent heritability estimates (table 2). Heritabilities for station progeny test results are between 0.50 and 0.70, which could be inflated by some common environment.

2.2.2. Contract field test

In 1979, a pilot study was started in Lower Bavaria, where a random sample of 15 to 18 sons were distributed to contract farms, following examples from Switzerland. There are no regulations regarding final weight or fattening period, but the farmer has to sell the bulls to cooperating slaughter houses. In addition to three weights taken during growth and directly before slaughter through a production recording organization ("Mastprüfring"), the farmer is obligated to deliver individual carcass weights and EEC-grades as of 1983. Recently, the weight of the front feet, the hide and the kidney and channel fat have also been recorded. Data are analyzed by a BLUP-procedure considering slaughter day within farm and age at arrival on the farm as systematic effects (Reinhardt and Dempfle, 1986). Traits and heritabilities used are given in table 3.

2.2.3. Field data from slaughter houses.

Data from slaughter houses have been recorded since 1982, using the lifetime eartag number of the animals in conjunction with the carcass weight and the EEC grades. The eartag number is matched with the calf registry to obtain birth date and parentage. In the beginning of this system, special eartags were used for progenies from test bulls, but they are no longer used because of discrimination reasons. Through the development of this system over the years, data from 60,000 animals have been recorded in 1986. Data are analyzed by a BLUP-procedure, considering the region of origin by slaughter house-season interaction, the EEC-fat-class and an age correction (Schild, 1986).

Since the farm of fattening is not available from the slaughter house, the employed interaction considers the main flow of calves for bullfattening. One point of constant discussion is, what age levels should be eliminated. At present, animals up to 800 days are accepted since some regions would lose too many progeny. Heritabilities for the traits used (table 4) are in the lower range of the literature values, but theavailable information also has to be considered. Traits used are age-corrected net gain, muscularity grade expressed in DM/kg and a value of gain per day of age as a product of net gain and grading. To avoid non-random price fluctuations, constant differences between grades are applied.

For the relationship between performance test and the different progeny test results, the product-moment correlations between breeding values were converted to genetic correlations. Heritabilities used (listed in the respective tables) were from recent analyses of the different data sources.

3. Results

The relationship between performance test data of the sire and the station results of his progeny are given in table 2. For fattening traits, the genetic correlations are in the range 0.6 to 0.8 with the highest value for gain during test, even if the periods were not comparable. The present genetic correlations are somewhat lower than those published earlier for 2/3 of the present data (Averdunk et al., 1980), resulting in higher heritability estimates used here for performance test traits. While the relationship between frame size of the sire and weight of his progeny decreased with increasing age, the reverse was true for the round circumference and tour spiral measures. Since the last two measures are weight-dependent, this tendency would be

Table 2: Genetic correlations between performance test traits of the sire and fattening results from progeny at test stations (n = 148 with 11.3 effective sons).

		Traits from performance test of sire:				
Traits of progeny:	Heritability	420-day weight	Gain in test period	Height at withers	Round circumfer.	Tour spiral
Heritability :		0.35	0.35	0.34	0.33	0.25
Weight at 365 days	0.64	+0.70	+0.69	+0.46	+0.17	+0.56
420 days	0.71	+0.68	+0.64	+0.42	+0.24	+0.57
500 days	0.66	+0.79	+0.75	+0.29	+0.23	+0.68
Gain on test (112-500 days)	0.64	+0.77	+0.80	+0.24	+0.26	+0.65
Net gain	0.69	+0.66	+0.69	+0.24	+0.21	+0.61
Dressing %	0.72	-0.12	+0.06	+0.02	+0.13	+0.02
Est. lean %	0.71	+0.13	+0.19	+0.23	+0.47	+0.26
Est. bone %	0.68	+0.20	+0.24	-0.10	-0.10	+0.18
Lean-bone ratio	0.66	+0.25	+0.32	-0.02	+0.02	+0.25
Pistol cut %	0.70	-0.24	-0.23	+0.20	+0.24	-0.14
Kidney &. channel fat%	0.73	-0.13	-0.08	+0.09	+0.28	-0.05
Feet weight %	0.59	-0.62	-0.63	-0.35	-0.24	-0.61

expected. The correlations for net gain are in comparable magnitude to live weight gain, while the dressing percentage shows no relationship to the performance test data recorded. The correlations with the estimated lean and bone content of the carcass and the lean-bone ratio do not demonstrate severe antagonistic problems. The relationship between the round circumference and lean content (+0.47) requires more detailed investigation, since Burgkart and Völkl (1964) found a phenotypic correlation to the weight of the hindquarter of 0.88.

The negative relationship between weight and the pistol-cut in percent is to be expected because of the change of body proportions with increasing weight (Averdunk, 1974). While the kidney and channel fat has no pronounced tendencies, the weight of the four feet, expressed in percent of the carcass, resulted in a rather high negative relationship with gain and weight.

Table 3 contains the results for the progeny tests on contract farms. While the genetic correlations between the fattening traits show a close relationship between sires and their progeny, the correlations to body measurements are comparable to those of the station test. For dressing percent, higher negative correlations were unexpectedly found for chest girth and the round measurement in comparison to station test results. The EEC grades were available for only 82 sire - progeny pairs. Conformation score had a reasonable heritability, but fat score showed nearly no variation in Fleckvieh and therefore a heritability of 0.01. The conformation score had a high positive relationship with the fattening traits of the sire, but also to his circumference measures. Part of the results could be explained by the fact that, within breeds, conformation scores in practice are not independent from carcass weights. The correlations with the fat score are beyond reality, due to the low heritability, but are given for completeness.

Table 3: Genetic correlations between performance test traits of the sire and fattening results of progeny in contract farms (n = 119 with 11.3 effective sons).

		Traits from performance test of sire:					
Traits of progeny:	Heritability	420-day weight	Gain in test	Height at withers	Chest girth	Round circumf.	Tour spiral
Heritability:		0.35	0.35	0.34	0.36	0.33	0.25
Gain (birth)	0.26	+0.90	+0.86	+0.41	+0.42	+0.43	+0.49
Gain (test)	0.22	+0.89	+0.89	+0.41	+0.50	+0.47	+0.56
Carcass wt.	0.22	+0.82	+0.75	+0.27	+0.24	+0.28	+0.53
Dressing %	0.43	-0.03	-0.11	-0.23	-0.40	-0.21	+0.13
Net gain	0.26	+0.83	+0.77	+0.29	+0.24	+0.31	+0.51
Conformation score 1)	0.22	+0.59	+0.53	+0.04	+0.39	+0.52	+0.65
Fat-score 1)	0.01	-2.56	-2.08	-1.19	-1.04	-0.80	-1.79

1) n = 82 sires with 11.5 effective sons

The highest amount of sire-son pairs is available for the field test, as shown in table 4. Two alternative results are given for age limits for field data, which are at present under discussion. The genetic correlation between the fattening results of sires and their progeny is in the magnitude of 0.50 - 0.60 and do not increase when lower age limits are used; however, the same heritabilities were applied for this subset of the data. The conformation score indicated the same tendency as with the contract farm results, but on a lower level and the value gain per day was highly determined by net gain. It should be mentioned, that the correlations with the circumference measures of the sire (round and tour spiral) have the same magnitude as 420-day weight and gain on test.

Table 4: Genetic correlations between performance test traits of the sire and fattening results of progeny under field conditions

		Traits from performance test of sire:					
Traits of progeny:	Heritability	420-day weight	Gain in test	Height withers	Chest girth	Round circumf.	Tour spiral
Heritability:		0.35	0.35	0.34	0.36	0.33	0.25
a) Age restriction < 800 days							
Carcass wt.	0.11	+0.49	+0.57	+0.39	+0.29	+0.49	+0.60
Net gain	0.12	+0.49	+0.56	+0.38	+0.29	+0.49	+0.60
Conformation score	0.09	+0.12	+0.21	-0.30	+0.13	+0.09	+0.11
Value gain/day	0.12	+0.48	+0.55	+0.35	+0.29	+0.48	+0.59
b) Age restriction < 700 days							
Carcass wt.	0.11	+0.53	+0.61	+0.42	+0.32	+0.51	+0.66
Net gain	0.12	+0.53	+0.59	+0.41	+0.32	+0.51	+0.65
Conformation score	0.09	+0.14	+0.24	-0.28	+0.17	+0.14	+0.16
Value gain/day	0.12	+0.51	+0.57	+0.37	+0.32	+0.50	+0.63

a) n = 385 sires with 58.2 effective sons
b) n = 385 sires with 50.0 effective sons

4. Discussion

The comparison of sires and progeny is always influenced by the fact that comparable traits are rather limited, especially since carcass data and environmental conditions also differ. Another problem involves the reliability of population parameters, which should be free of common environmental effects. Nearly all of the problems mentioned were faced in the data. The population parameters used for the performance and station progeny test data were estimated by Henderson's Method III after pre-correction for systematic effects. For the performance test data, some type of compensatory mating could influence the genetic parameters. The station progeny test data contained a confounding of season and progeny groups, which led to extremely high heritabilities. In contrast to those high values, rather low heritabilities were found for the field data, since the most important source of variation, the fattening farm, is not known. With 50 resp. 58 progeny it is assumed that these progeny are randomly distributed and that no genotype x environment correlation is present. The results of the different data sets showed that for station and contract farms, the genetic correlations for rather comparable fattening traits were in the magnitude of 0.7 to 0.9. While the fattening conditions for these two subsets are in a comparable intensity with the performance test station, the field data showed correlations of only 0.5 to 0.6 under a variety of conditions, which is demonstrated by the age limits applied. Genotype x feeing intensity interactions have been demonstrated in several investigations (e.g. Langholz et al., 1983). Since a subset of the field data in a region with higher intensity showed a higher genetic correlation of gain on test with net gain (r = 0.67 vs. 0.59 for the complete data), there are indications of some effects mentioned above,which at present cannot be specified.

Sire-progeny relationships for beef traits in the literature are not many-fold and have been summarized recently by Parnell et al.(1986). The studies with beef breeds (Kincaid and Carter, 1958; Shelton et al., 1958; Carter, 1970; Smith et al., 1979) found lower relationships than expected, but these tests started after weaning. Comparable results have been reported by Lessel & Francis (1968) and De Roo & Fimland (1983). Problems involved are pre-test environment and the possibility of compensatory growth, differences in test period length, sex and feeding intensity, which all could lead to lower relationships between sire and progeny (Parnell et al., 1986). The review on the value of preweaning growth for selection in cattle (Barlow, 1978) also included valuvaluable information on possible reasons for interactions.

The correlations of fattening traits and body measurements of the sire with carcass traits of his progeny are in the direction, which would be expected from direct measurements. Some tendencies, especially for the round measurement, need further investigation. Unfortunately, data for a comparison of muscularity scores on live and conformation scores on slaughtered animals are rather limited, but are being accumulated for use in the near future. The results available indicate that selection for higher weight in performance tests does not negatively influence the lean content of the carcass and the conformation score, used for payment on the market. This holds only on a within breed basis and the obvious tendency that conformation scores are weight dependent should be watched carefully in the future.

Central performance testing of young bulls is effective to improve fattening traits, as has been shown by the data analyzed. The realized selection differential in our performance test is only half of the theoretical possible. Every possible means should be used to improve the selection efficiency, especially to avoid losses after the test through libido and semen problems or physical appearance. This is especially necessary if the costs of testing are increased through the recording of individual feed intake (Langholz, 1984), which will be more important in the future.

References

Alps, H., P. Matzke & G. Averdunk, 1981. Schätzung des Fleisch- und Knochengewichtes im Schlachtkörper von Jungbullen der Nachkommenprüfung an Stationen. Z. Tierzüchtung u. Züchtungsbiologie 98: 197-209.

Averdunk, G. 1974. Nachkommenprüfung auf Fleischleistung beim Rind. In: 1st World Congress on Genetics applied to Livestock Production. Vol. I, p. 681 - 691, Garsi, Madrid. ISBN 84-400-0727-2.

Averdunk, G. H. Alps, A. Gottschalk & J. Fußeder, 1980. Relationship between performance test traits of the sire and fattening and carcass traits of his progenies. Paper C 3.6, 31. Ann. Meetg., Europ. Ass. of Animal Production, Munich 1981.
Averdunk, G. & H. Alps. 1985. Selection strategies for milk and beef production in German dual purpose breeds. In: Adapting EEC cattle breeding programmes to market realities. p.139 - 162, EEC, Luxembourg. ISBN 92-825-5716-2.
Averdunk, G. & C. Binder.1986. Relationship between performance test results of the sire and direct and indirect calving traits in German Simmental. In: 3rd World Congress on Genetics applied to Livestock Production Vol IX, p. 431-436, Lincoln, USA. ISBN 0-9616828-0-9.
Barlow, R. 1978. Biological ramnifications of selection for preweaning growth in cattle. Anim. Breed. Abstr. 46: 469-494.
Bech Andersen, B., A. de Baerdemaeker, G.Bittante, B. Bonaiti, J.J. Colleau, E. Fimland, J. Jansen, W.H.E. Lewis, R.D. Politiek, G. Seeland, T.J. Teehan & F. Werkmeister, 1981. Performance testing of bulls in AI: Report of a working group of the commission on cattle production. Livest. Prod. Sci. 8, 101-119.
Bogner, H. 1966.Kritische Betrachtung des bayerischen Prüfprogrammes für Bullen der künstlichen Besamung unter besonderer Berücksichtigung der Selektionskriterien Mastleistung, Futterverwertung und quantitativer Schlachtkörperwert. Bayer. Landw. Jahrbuch 43: Sonderh. 2, 5-87.
Burgkart M. & H. Völkl, 1964. Schätzung des Keulengewichtes am lebenden Rind. Züchtungskunde 36, 203-205.
Carter, A.H. 1971. Effectiveness of growth performance selection in cattle. Proc. N.Z. Soc. Anim. Prod., 31: 151-163.
De Roo, G. & E. Fimland. 1983. A genetic analysis of performance and progeny test data for young bulls of Norwegian red cattle and various Friesian crosses. Livest. Prod. Sci., 10: 123-131.
Hahn, R. 1987. Hygienic and fertility aspects of the performance test. Report in seminar on: Performance testing of bulls for efficiency and beef production in dairy and dual purpose cattle. Wageningen.
Kincaid, C.M. & R.C. Carter. 1958. Estimates of genetic and phenotypic parameters in beef cattle. I. Heritability of growth rate estimated from response to sire selection. J. Animal Sci. 17, 675-683.
Kräusslich, H., 1974. General recommendations on procedures for performance and progeny testing for beef characteristics. Livest. Prod. Sci., 1: 33-45.
Langholz, H.-J.. 1984. Erfolgsaussichten einer verstärkten Integration der Fleischleistung in der Besamungszucht. Züchtungskunde 56, 455-466.
Langholz, H.-J., M. Suhren & G. Heveling. 1983. A comparison of progeny testing of Friesian bulls indoors and on pasture. In: Grassland Beef Production. p.113-123, Martinus Nijhoff Publ. ISBN 0-89838-650-0.
Lessells, W.J. & A.L. Francis. 1968. The crossbred progeny test of beef bulls. Expl. Husb. 16: 1-12.
Parnell, P. F.,R.L. Baker & J.L. Foulley. 1986. The efficiency and place of multi-herd animal evaluation procedures for beef cattle. In: 3rd World Congress on Genetics applied to Livestock Production. Vol. IX, p. 373-388. Lincoln/USA. ISBN 0-9616828-0-9.
Rittler, A., F. Werkmeister & D. Fewson. 1966. Untersuchungen über die Prüfung von Bullen auf Mastleistung und Schlachtkörperqualität in zentralen Anstalten. Züchtungskunde 38: 1 - 9.
Reinhardt, F. & L. Dempfle. 1986. Fleischleistungsprüfung mit Vertragsbetrieben. Report at a Seminar in Landshut, 9.-11.6.1986.
Schild, H.-J. 1986. Fleischleistungsprüfung im Feld - Ergebnisse und Auswertung. Report at a Seminar in Landshut, 9.-11.6.1986.

Shelton, M., T.C. Cartwright & W.T. Hardy. 1958. Relationship between performance-tested bulls and the performance of their offspring. Prog. Report Texas Agric. Exp. Stn., Cattle Series No. 137.
Smith, C., D.E. Steane & C. Jordan. 1979. Progeny test results on Hereford bulls weight-recorded on the farm. Anim. Prod., 28: 49-53.

RELATIONSHIP BETWEEN PERFORMANCE TEST AND PROGENY TEST FOR VEAL AND BEEF PRODUCTION IN BLACK AND WHITE DAIRY CATTLE

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Summary

The efficacy of a performance test for growth and slaughter quality of Black and White bulls for improving veal and beef production of progeny was studied in an experiment with offspring of 38 bulls, which were fattened for veal and for beef. Heritabilities for veal and beef production traits indicated possibilities to improve these traits by means of selection. Corresponding traits in veal and beef production had positive genetic correlations. Selection for daily gain and final weight in the performance test may improve the value of offspring for veal and beef production in Black and Whites.

Introduction

Performance testing of young sires is carried out to improve veal and/or beef production. The performance of young sires is measured in standardized rearing conditions. Their progeny will be more intensively fattened as veal calves or as beef bulls.

The efficacy of selection on performance test data may be measured as the regression from the breeding value for veal or beef production on the sires' own performance. Less progeny groups are required to estimate such a regression than to estimate a genetic correlation. The accuracy of these estimations may be improved, through fattening progeny from sires with extreme performances only (Hill and Thompson, 1977). Genetic and phenotypic parameters for quantitative performance and fattening traits are rather well known (Andersen et al., 1981). Using Holstein Friesians in the Dutch Friesian population has mainly a negative effect on the qualitative trait fleshiness in veal and beef production (Oldenbroek, 1982). These two arguments led to an experiment with progeny of 38 Black and White sires with an extreme score for fleshiness in the performance test. The two groups of bulls differed significantly in the performance test for fleshiness (0.66 EUROP-points). Their progeny groups were fattened for veal and beef at the experimental farm 't Gen from 1979 - 1986.

The purpose of this paper is to describe the possibilities for selection on veal and beef production after performance testing. Variances and heritabilities for performance test traits, veal production traits and beef production traits will be described. Genetic correlations between veal and beef production traits will be presented. The regression and correlation coefficients between both types of fattening and performance testing will indicate the response to selection in veal and beef production after performance testing.

Material and methods

Performance and progeny test

Performance test data was available from 587 bulls, born between December 1980 and October 1985, and reared in the central test station of the province of Friesland for at least 245 days. These bulls were progeny of 9 Dutch Friesian and 35 Holstein Friesian sires and of 71 purebred Dutch Friesian dams, 259 dams with 50 % HF-genes, 178 with 75 %, 46 with 88 % and 33 with 100 %. The bulls were tested on a diet with concentrates supplied according to age and hay supplied ad libitum. Their data on daily gain and feed conversion between 120 and 365 days of age and body weight, pelvic height, fleshiness and fat covering at 365 days was available.

Test inseminations with semen of each sire on heifers in first lactation were carried out in the province of Friesland within a period of one month. So, progeny groups could be sampled within a period of 3 - 6 weeks. Every six months, from October 1979 onwards, progeny groups of four sires two with a low score and two with a high score for fleshiness in the performance test were sampled. The extremes had to be found within bulls with the same percentage of HF-genes. Calves to be purchased had to be healthy, single-born males out of second calf cows with a gestation period of 260 - 295 days. They were delivered at the experimental farm between 6 and 13 days of age. Progeny groups (with three exceptions, from which only beef bulls were kept) consisted at least of 32 calves. According to weight at delivery and type score, a progeny group was split up in a group of 16 for veal production and a group of 16 for beef bull production.

The calves for veal production were assigned, according to weight, to four feeding schemes: $\leq$ 36 kg, 37 - 42 kg, 43 - 47 kg and $\geq$ 48 kg. In each scheme the calves were allowed to consume about 300 kg of milk replacer before slaughter. Within a scheme, calves were offered a fixed weighed amount of milk replacer according to age. Refusals were weighed and recorded. The data of 532 veal calves from 35 sires was eligible for statistical analysis.

The calves for beef production were reared up to 10 weeks with milk replacer, concentrates and some roughage. From week 10 until slaughter batch 1 - 5 was fed ad libitum with a complete diet of grass silage, corn silage and concentrates; batch 6 - 10 was fed with concentrates according to weight and corn silage ad libitum. Beef bulls were tied up and fed individually in order to measure feed intake. The beef bulls were slaughtered around 490 kg live weight. For statistical analysis, the data of 621 beef bulls from 38 sires was eligible. The value of calves for veal and beef production was calculated as carcass value minus the costs of fattening.

Analyses

A mixed model was used containing fixed effects for seasonal effects (Oldenbroek and Meijering, 1986) and percentage of HF-genes (0, 50, 75, 88 and 100 %), and random effects for variation between and within sires. A matrix for genetic relationships between sires was included in the model. Components of variance were estimated by REML.

The progeny dataset was analysed with a half-sib model. Fixed effects in the model represented environmental differences between batches of four sires, differences between sires in percentage of HF-genes (0 %, 50 %, more than 50 %) and the corresponding interaction. Random effects represented between sire variation (within the three percentage classes of HF-genes) and within sire variation between offspring.

The heritability estimate $\hat{h}^2$ follows from $\hat{h}^2 = 4\hat{\sigma}_B^2/(\hat{\sigma}_B^2 + \hat{\sigma}_W^2)$, where $\hat{\sigma}_B^2$ and $\hat{\sigma}_W^2$ are the estimates of the between and within components of variance respectively.

The estimate for the genetic correlation $\hat{r}$ between two traits x and y follows from $\hat{r} = \hat{\sigma}_B(x,y)/\hat{\sigma}_B(x)\hat{\sigma}_B(y)$, where $\hat{\sigma}_B(x)$, $\hat{\sigma}_B(y)$ are the estimates of the between components of variance from the analyses of traits x and y respectively and the covariance estimate $\hat{\sigma}_B(x,y)$ may be obtained from an analysis of the sum x+y. The heritability estimate $\hat{h}^2$ may be considerably biased because of selection on fleshiness of sires. An estimate with smaller bias was obtained by using results from the regression from offspring on sires' score for fleshiness (Hill and Thompson, 1977).

Genetic correlations between veal and beef production traits were estimated with a multivariate linear model with unequal design (Dijkstra et al., 1987).

The genetic correlation between a trait x from the performance test of a sire and a trait y observed on his offspring was estimated by using results from the regression of progeny means y on sire observations x (Hill and Thompson, 1977).

Results

Performance test

The performance test traits daily gain, feed per kg gain, final body weight and final pelvic height showed moderate estimates for the heritabilities with acceptable standard errors (Table 1). The estimates for final fleshiness and fat covering scores gave doubts about their usefulness for selection after performance testing.

Table 1. Mean values with genetic standard deviation (σ_g) and heritabilities (h^2) with standard errors (S_{h^2}) for performance test traits.

Trait	Mean	σ_g	h^2	S_{h^2}
Daily gain (g)	1053	48	0.39	0.13
Feed per kg gain (VEVI)	5277	203	0.24	0.11
Final body weight (kg)	383	11	0.21	0.10
Final Pelvic height (cm)	128.9	1.3	0.25	0.11
Final fleshiness (1-5)	1.6	0.1	0.06	0.08
Final fat covering (1-5)	1.5	0.1	0.05	0.07

Veal and beef production

Weight and price at start had low heritability estimates. The estimate for heritability for type score was higher, but will be positively biased because sires were selected on fleshiness (Table 2).

Veal calf traits showed heritabilities between 0.36 (daily gain) and 0.56 (feed per kg gain), but after correction for selection on fleshiness in the sires most of these heritabilities decreased. Only the estimates for carcass weight and meat colour remained constant.

Beef bull traits showed heritabilities between 0.23 (fat covering of the carcass) and 0.87 (fleshiness of the carcass). The heritability estimates for carcass weight, carcass fleshiness, price per kg carcass and value of the calf for beef production decreased through the correction for selection in the sires on fleshiness.

Table 2. Mean values, genetic standard deviations (σ_g), heritabilities (h^2) with standard errors (S_{h^2}) and heritabilities corrected for selection on fleshiness in the sires (h^2_c).

Trait	Mean	σ_g	h^2	S_{h^2}	h^2_c
Start:					
Weight (kg)	41.4	1.5	0.11	0.05	0.11
Type score (1 - 10)	5.1	0.6	0.29	0.09	0.26
Price (Dfl)	380	28	0.16	0.07	0.15
Veal calves:					
Daily gain (g)	1037	50	0.36	0.14	0.28
Feed per kg gain (g)	1840	97	0.56	0.17	0.49
Carcass weight (kg)	129.6	5.8	0.51	0.16	0.50
Carcass fleshiness (1-5)	2.3	0.3	0.51	0.16	0.35
Meat colour (1-5)	1.6	0.4	0.47	0.16	0.46
Price per kg carcass (Dfl)	9.45	0.18	0.51	0.16	0.38
Value of the calf (Dfl)	343	57	0.43	0.15	0.22
Beef bulls:					
Daily gain (g)	1043	56	0.59	0.17	0.58
Feed per kg gain (VEVI)	4730	232	0.59	0.17	0.59
Carcass weight (kg)	269.5	8.6	0.47	0.15	0.39
Carcass fleshiness (1-5)	2.4	0.4	0.87	0.20	0.73
Carcass fat covering (1-5)	2.9	0.2	0.23	0.10	0.22
Price per kg carcass (Dfl)	7.71	0.18	0.66	0.18	0.55
Value of the calf (Dfl)	488	123	0.77	0.19	0.63

Genetic relation between veal and beef production

Table 3 is a summary of genetic correlations between veal calf and beef bull traits. All genetic correlations between corresponding traits were positive.

Table 3. Genetic correlations between veal calf and beef bull traits.

	Veal calves					
Beef bulls	DG	FG	CW	CF	PC	VC
Daily gain (DG)	0.61	-0.37	0.47	0.43	0.32	0.64
Feed per kg gain (FG)	-0.40	0.49	-0.09	-0.32	-0.23	-0.53
Carcass weight (CW)	0.58	-0.35	0.42	0.52	0.31	0.67
Carcass fleshiness (CF)	0.06	-0.17	0.21	0.90	0.54	0.46
Price per kg carcass (PC)	0.04	-0.16	0.19	0.85	0.49	0.40
Value of the calf (VC)	0.46	-0.43	0.29	0.75	0.47	0.71

Relation between performance and progeny test

The relation between performance test traits and the important traits in progeny testing is described in Table 4 through the regression coefficients from progeny traits on performance traits and the correlation between phenotypic value in performance test and breeding value in progeny test. From both parameters it can be deducted that selection on daily gain or body weight in the performance test improves all fattening traits. Selection on fleshiness of performance tested bulls has also a favourable effect on progeny traits, except daily gain in beef production. Selection on pelvic height of bulls has no favourable effect on progeny traits in veal or beef production.

Table 4. Regression coefficients from progeny test traits on performance test traits (b) and the correlation between phenotypic value in the performance test and breeding value in the progeny test (r).

	Performance test traits							
	Daily gain (g)		Fleshiness (1-5)		Body weight (kg)		Pelvic height (cm)	
Progeny traits	b	r	b	r	b	r	b	r
Price at start (Dfl)	0.039	0.20	10.464	0.31	0.158	0.26	-2.304	-0.40
Daily gain veal (g)	0.420*	0.93	22.390*	0.41	0.867*	0.82	3.376	0.34
Fleshiness veal (1-5)	0.002*	0.64	0.165*	0.54	0.003*	0.52	-0.030	-0.48
Value calf veal (Dfl)	0.411*	0.83	37.668*	0.74	0.889*	0.71	0.481	0.04
Daily gain beef (g)	0.286*	0.68	15.402	0.22	0.605*	0.51	2.146	0.13
Fleshiness beef (1-5)	0.002*	0.63	0.174*	0.38	0.005*	0.53	-0.010	-0.12
Value calf beef (Dfl)	0.693*	0.73	56.068*	0.41	1.619*	0.62	2.973	0.12

* Regression coefficient significantly different from zero ($p < 0.05$).

Discussion and conclusions

Heritability and genetic correlation are concepts defined within the framework of a mathematical model. One of the assumptions underlying this model is that the population under study is in equilibrium, i.e. the distribution of genotypic values is stable. This assumption is not met in the data presented in this paper: due to the introduction of HF-genes the characteristics of the population were changing in time.

Therefore the genetic variation is estimated within classes of percentage of HF-genes. Although this approach reduces the problems following from multi-model probability distributions, extrapolation of the results of the analyses bears some risk since the population under study is changing rapidly.

In a former study, Oldenbroek and Meijering (1986) reported unstable heritability estimates for performance test traits of 358 bulls of 41 sires born between April 1980 and October 1983 and tested in the central test station in Friesland. The estimates were very sensitive for the number of sons per sire, which varied widely. For the present analysis 587 sons of 46 sires were available. There was still a large variation in number of sons per sire, but the number of sires with many sons increased considerably and sires were better spread over seasons. These facts led to more stable estimates for heritabilities of performance test traits than in the former study (Oldenbroek and Meijering, 1986). For daily gain and fleshiness heritabilities were similar as in the performance test for MRY (Dijkstra et al., 1987), but in MRY bulls heritabilities for weight and pelvic height at 365 days of age were twice as high. In both breeds the heritability estimate of the score for fleshiness at the end of the performance test is too low to facilitate effective selection. This may be due to limited scoring possibilities for fleshiness in the EUROP-system for bulls of the same age and the same genotype and/or to the intensity of rearing in the performance test, which impedes the expression of genetic capacity for fleshiness.

In the present study it was attempted to use sires with extreme scores for fleshiness. However, finally the difference in fleshiness between the two types of sires was rather low: 0.66 EUROP-points. This difference was associated with significant differences in final body weight (21 kg) and daily gain (55 g/day) in the sires, but not with a difference in pelvic height. Amongst other (dairy) characteristics pelvic height was an important criterion for culling bulls after the performance test. So selection for fleshiness was to some extent selection for weight traits. The selection of the sires influenced the heritability estimates. After correction for this selection in the sires the heritability estimates for daily gain, carcass fleshiness and value of the calves are 50 per cent of those estimated in a former study with Black and White veal calves (Oldenbroek and Meijering, 1986). But in both studies the standard errors of the estimates do not invite to an intense discussion about the source of the differences between the studies. The heritability estimates for veal calf traits in MRY (Dijkstra et al., 1987) are in agreement with those found in the present study. All three studies indicate that veal calf traits can be improved by means of selection. The heritability estimates for beef bull traits in the present study are high in comparison with beef bull traits in MRY (Dijkstra et al., 1987). An explanation might be that Black and Whites have never been selected for this type of beef production. From the present study and from the study in MRY it can be concluded that beef production traits may be improved by means of selection.

Veal production and beef production differ largely in feeding system and in age at slaughter. Despite these differences genetic correlations between corresponding traits in both types of production are positive. The size of these correlations indicates a sire x production-type interaction (except for fleshiness), but the final conclusion might be that selection for veal production improves the genetic ability for beef production (and the reverse). The study in the MRY breed (Dijkstra et al., 1987) yielded similar genetic correlations between corresponding traits in veal and beef production and led to a similar conclusion.

In the former study with Black and Whites (Oldenbroek and Meijering, 1986) no significant relation could be found between breeding values for performance test traits and breeding values for veal production of progeny. The study in the MRY breed (Dijkstra et al., 1987) yielded the conclusion that daily gain, final weight and final pelvic height in the performance test are useful selection traits for improvement of veal and/or beef production. The present study indicates daily gain and final weight as useful performance test traits. Apparently, pelvic height in Black and Whites gives no indication for veal or beef production capacity.

References

Andersen, B.B., De Baerdemaeker, A., Bittante, G., Bonaiti, G., Colleau, G., Fimland, E., Jansen, J., Lewis, W.H.E., Politiek, R.D., Seeland, G., Teehan, T.J. and Werkmeister, F., 1981. Performance testing of bulls in A.I. Report of a working group of the Commission on Cattle Production. Livest.Prod.Sci.,8:101-119.

Dijkstra, J., Korver, S., Oldenbroek, J.K. and Van der Werf, J., 1987. Relationship between performance test and progeny test for veal and beef production in Dutch Red and White cattle. Contr. EAAP-symposium "Performance testing of bulls for efficiency and beef traits in dairy and dual purpose cattle". 27 - 29 April, Wageningen.

Hill, W.G. and Thompson, R., 1977. Design of experiments to estimate offspring-parent regression using selected parents. Animal Production 24, 163-168.

Oldenbroek, J.K., 1982. Meat production of Holstein Friesians in comparison to Dutch Friesians and Dutch Red and Whites. In: G.J. More O'Ferrall (Editor), Beef Production from Different Dairy Breeds and Dairy Breed crosses. Martinus Nijhoff, The Hague, pp. 45-52.

Oldenbroek, J.K. and Meijering, A., 1986. Breeding for veal production in Black and White dairy cattle. Livest.Prod.Sci.,15:325-336.

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RELATIONSHIP BETWEEN PERFORMANCE TEST AND VARIOUS PROGENY TRAITS IN THE SWISS DUAL PURPOSE BREEDS

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Summary

Genetic correlations between performance test and various progeny traits were estimated for 184 Brown Swiss bulls and 231 Red and White bulls. Antagonistic relationships were found between performance test and calving ease (r_g from .20 to .32 for birth weight, stillbirth rate and dystocia rate). A strong positive correlation exists between daily gain on performance test and carcass weight gain on beef progeny test (.88 in Brown Swiss, .70 in Red and White). The relationship with daughters type conformation is also favourable, especially in the Red and White breed. In looking at these correlations within selected groups of bulls, it appears that the relationship with carcass weight gain is far more stable than these with dystocia rate or conformation scores. This allows the conclusion that a more efficient two steps selection could be applied in order to improve the beef traits of the Swiss dual purpose breeds.

Introduction

The two main breeds held in Switzerland, Brown Swiss and Red and White, wich represent together more than 80 % of the total cattle population, both have a dual purpose breeding goal. In accordance with this breeding goal, the A.I. testing scheme includes a performance test in a central station and a progeny test on beef performance in the field, e.g. on specialised fattening farms. Up to now, the selection pressure on daily gain on performance test has been very low, and because of the economic situation, the results of the beef progeny test lacked weight in the final selection of A.I. bulls. There are arguments about the necessity of progeny testing all young bulls on beef production, especially the bulls with higher percentage of American dairy genes.

The main purpose of the present investigation is to establish the relationship between performance test and progeny test results on daily gain. Other traits are also included in the analysis.

Material

Performance test and progeny test results were collected from three batches of young bulls of both the Brown Swiss and the Red and White breed. These bulls were performance tested between 1980/81 and 1982/83 and subsequently used in A.I. The exact number of bulls involved in the computation of correlations is given in table 2. The progeny test on daughters conformation was not yet completed for the third batch of bulls. This fact accounts for the lower number of bulls included in the correlations with conformation traits.

Performance test

All bull calves born from planned matings are raised in a central performance test station. The station in Langnau bei Reiden has a capacity of 250 bulls. The calves enter the station at 60 to 90 days of age. Average daily gain from 120 to 350 days is recorded as growth trait. After the test, approximatively 60 % of the bulls are moved to an A.I. station and used in the progeny testing scheme if semen production and quality are satisfactory. The main culling reasons are feet and legs conformation and type; only few bulls are eliminated based on average daily gain. Buri-Gmünder (1986) gives a detailed survey on test procedure, genetic parameters and estimation of breeding values for the Swiss performance test station.

Progeny test

Each young bull is used for at least 700 first inseminations in contract herds. Calving performance data are recorded from 400 to 500 calvings per bull. Breeding values are computed for the traits mentioned in table 1 separately for 1st and other parities, taking into account sex of calf, year and season effects (Gaillard, 1980).

25 to 30 bull calves are alloted to contract fattening farms for progeny test on beef production. The bulls are slaughtered at 13 to 14 months of age with280 kg carcass weight on average. A BLUP sire evaluation procedure is applied on daily carcass weight gain as main criterion of growth and fattening performance and on various carcass traits recorded in the slaughterhouses (Chavaz, 1986)

Conformation scores and measurements are recorded on the 50 to 55 first freshning daughters of each bull by classifiers of the A.I. Federation and of the herdbook. Part of the traits are also included in the present investigation (table 1). Detailed information on the scoring scheme and sire evaluation procedure is given by Chavaz (1983). Other traits included in the progeny testing scheme (milk yield milking ability, fertility) were not considered in this paper.

Method

Genetic correlations between traits recorded on different animals were derived from the correlations between breeding values as proposed by Mason (1964) and applied by Gaillard (1980) and other authors. The confidence range of the correlations was computed according to an approximation formula (Robertson, 1972; cited Bar-Anam, 1973). In order to account for non additive effects, the correlations were computed within year and within genetic group (crossbreeding level with American Brown Swiss resp. Red Holstein).

Results and discussion

Table 2 contains all correlations between performance test and the considered progeny traits. There exists a significant relationship between performance test and calving performance. With higher daily gain on performance test, increase in birth weight as well as in stillbirth and dystocia rate can be expected. The relationship with birth weight is slightly stronger in the Brown Swiss as in the Red and White population, while the other correlations lie at the same level in both breeds.

The high correlation between performance test and carcass weight gain on progeny test shows that, to a large extent, both traits trace back to the same genetic background. Again, the correlations are slightly higher for the Brown Swiss bulls. The subjective fleshiness score is also positively related to performance test, but the thigh volume, which is corrected to a constant carcass weight, is negatively correlated with performance test. This could be an indication about an antagonism between high growth potential and compact carcass type.

The correlations with conformation traits of the daughters show different patterns in the Brown Swiss and in the Red and White. Chest girth, depth, width and muscling scores seem to be closer related to performance test in the Red and White. Nevertheless, selection on high daily gain on performance test should lead to improved type conformation in both breeds.

In table 3, three correlations (performance test with dystocia rate, carcass weight gain and combined type score) were computed within specific bull groups in order to analyse breed differences and the effects of selection. As with reduced number of bulls the standard error of correlations increases, the results have to be carefully interpreted.

This observation concerns especially the correlation with dystocia rate. Even with the whole material, its confidence range is relatively wide. Within specific bull groups the correlation becomes close to 0 or even negative. This can be explained with the fact that the breeding values for dystocia are not normally distributed and the relationship with performance test may not be linear on the whole variation range. The correlations with the combined type score show larger differences too, especially in the Red and White groups selected on daily gain.

For practical purposes, the correlation between performance test and beef progeny test is the most important one. The estimated values remain consistent from group to group. This shows that the relationship is similar in dual purpose as in more dairy genetic groups. A strong selection on performance test would probably not affect to a large extent the relationship with beef progeny test results. The hypothesis that an optimized two stage selection scheme could be applied in order to improve the beef characters of dual purpose breeds is thus substantiated.

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References

Bar-Anan, R., 1973. Breeding aspects of difficult calving and calf progeny characters. PhD Thesis University of Reading.

Buri-Gmünder, Th., 1986, Analyse der Eigenleistungsprüfungen von KB-Stieren der Station Langnau. Diplomarbeit ETH Zürich.

Chavaz, J., 1982. In den Stierenkatalogen: Ein neues Gesicht für die Nachzuchtbeschreibung. Mitt. SVKB 20: 73 - 76.

Chavaz, J., 1986. Nachzuchtprüfung auf Fleisch: Ergebnisse 1983/84 und 1984/85. Mitt. SVKB 24: 48 - 54.

Gaillard, C., 1980. Populationsanalyse verschiedener Merkmale des Geburtsablaufes beim Simmentaler Fleckvieh. Diss. ETH Zürich Nr. 6624.

Mason, I.L., 1964. Genetic relation between milk and beef characters in dual-purpose cattle breeds. Anim. Prod. 6: 31 - 45.

TABLE 1 : Description of traits included in the investigation

Short name	Trait	Heritability	Size of progeny group
Performance test			
ADGPT	average daily gain (120-350 day)	.40	
Progeny test on calving ease (direct effect)			
GESTLE	gestation length	.55	400-500
BIRTHW	birth weight	.21	400-500
STILLB	stillbirth rate	.03	400-500
DYST	dystocia rate	.07	400-500
Progeny test on beef production			
CARWG	carcass weight gain	.25	25-30
FLESH	carcass fleshiness score	.20	25-30
THVOL	estimated thigh volume	.15	25-30
CCVI	combined carcass value index	.18	25-30
Progeny test on daughters type			
WIHEI	withers height	.55	50-55
CHGIR	chest girth	.40	50-55
LENGTH	length score	.35	50-55
DEPTH	depth score	.35	50-55
WIDTH	width score	.25	50-55
MUSCL	muscling score	.25	50-55
CTYSC	combined type score	.30	50-55

TABLE 2 : Correlations between breeding values (r_{BV}) and estimated genetic correlations (r_g) between performance test and various progeny traits

Correlated trait	Brown Swiss number of bulls	r_{BV}	r_g	conf. range of r_g	Red and White number of bulls	r_{BV}	r_g	conf. range of r_g
GESTLE	184	.102	.162	.018/.300	231	.033	.052	-.078/.180
BIRTHW	184	.178	.286	.147/.414	231	.123	.198	.071/.319
STILLB	184	.159	.285	.146/.413	231	.169	.306	.184/.419
DYST	184	.168	.279	.140/.407	231	.189	.315	.194/.427
CARWG	162	.447	.875	.836/.905	229	.346	.698	.625/.759
FLESH	162	.217	.447	.314/.562	193	.138	.296	.162/.419
THVOL	162	-.099	-.218	-.360/-.066	193	-.177	-.411	-.522/-.286
CCVI	162	.138	.290	.142/.425	193	-.061	-.134	-.270/.007
WIHEI	108	.175	.296	.113/.459	155	.220	.368	.223/.497
CHGIR	108	.155	.270	.085/.437	155	.351	.603	.492/.695
LENGTH	108	.255	.449	.284/.588	155	.238	.412	.272/.535
DEPTH	108	.205	.361	.185/.515	155	.345	.598	.486/.691
WIDTH	108	.091	.167	-.023/.345	155	.263	.474	.342/.588
MUSCL	108	.056	.103	-.088/.286	155	.261	.471	.338/.585
CTYSC	108	.196	.352	.175/.507	155	.381	.671	.574/.749

TABLE 3 : Genetic correlations between performance test and three progeny traits within specific bull groups

Correlated trait	DYST number of bulls	DYST r_g	CARWG number of bulls	CARWG r_g	CTYSC number of bulls	CTYSC r_g
Brown Swiss, distributed acc. to US Brown Swiss blood percentage						
≤ 50 %	114	.456	112	.672	54	.221
> 50 %	70	.024	70	.999	54	.437
Red and White, distributed acc. to Red Holstein blood percentage						
0 % (=Simmental)	60	.560	60	.738	43	.725
> 0 %	171	.255	169	.683	112	.659
≥ 50 %	130	.298	128	.719	85	.658
≥ 75 %	57	.489	55	.508	38	.842
Brown Swiss, distributed acc. to breeding value for ADGPT						
≥ +40 g	47	-.088	47	.865	31	.641
≥ +20 g	70	.307	70	.829	31	.799
≥ 0 g	109	.302	108	.690	66	.609
< 0 g	78	.001	77	.702	43	.463
Red and White, distributed acc. to breeding value for ADGPT						
≥ +40 g	52	.278	51	.999	28	-.167
≥ +20 g	83	.268	82	.627	49	.104
≥ 0 g	133	.552	131	.761	84	.553
< 0 g	105	-.421	105	.296	77	.077

RELATIONSHIP BETWEEN THE MEAT EFFICIENCY OF SIRES AND THAT OF THEIR SONS AT THE TESTING STATIONS

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Summary

We have established positive correlations between quantitative indices of meat efficiency of sires and these of their sons during the fattening period. When evaluating the weight of bulls at rearing stations at 12 months of age and weight gains of their sons during the fattening period we have established correlation r = 0.146; as for the relation between gains of sires during the teststation period, respectively gains from birth and gains of their fattened sons from birth, we have determined r = 0.086, respectively r = 0.081. Moderate correlations were also established between dressing percentage of sons and quantitative indices of their sires at rearing stations (r = 0.118 to 0.189). Similarly as in the case of sires weight at 12 months, moderate correlations between the weight at 3 years of age and the net gain of their fattened sons were established (r = 0.206). The mentioned relation is more significant compared to the sires weight at 12 months of age (r = 0.169). Sires' weight at 3 years of age as well as their dressing percentage have not influenced dressing percentage of the sons. We have not found a correlation between the weight of pelvic and kidney fat in sires at 3 years of age and that of their sons (r = -0.049). Close relationship between indices of the weight gain and the carcass value of sons and the sires' weight at 3 years of age is similar to the case of evaluating sires at 12 months of age. When evaluating relations between sires' gains from birth and indices of the weight gain and carcass value of their sons we have determined somewhat higher correlations at 3 years compared to 12 months of age.
Keywords: sires, meat efficiency, correlation between sires and sons.

Introduction

In our study we have tried to find relationships between the meat efficiency of sires and that of their sons at testing stations respectively indices established during the primary selection of sires at 12 months of age. Data for the evaluation were gained from eleven A.I. stations on the territory of the Gzech socialist Republic during the years 1981 to 1985. Bulls of the Bohemian Pied breed including crossbreds with a small share of the Ayrshire and the Red Holstein breeds (n = 139) were slaughtered at 3 years ± 1,5 months of age. Evaluation of their sons included estimation of net gains, gains from birth, the final body weight at 500 days of age, the weight of half-carcasses and the weight of kidney and pelvic fat.

Results and discussion

The found relationships between indices observed in sires at 3 years of age and those established during the primary selection at 12 months of age present moderate or middle correlations (tables 1 and 2). That confirms the importance of sires selection and its continuity with consecutive life period of the bulls at A.I. stations. Zero or slightly negative correlations were only found between the weight of kidney and pelvic fat, dressing percentage at 3 years of age and the values obtained during the primary selection at 12 months. The mentioned negative correlations between growth rate and dressing percentage have been ascertained by many authors and they are supposed to be related to the different maturity rate of individual types of cattle.

Table 1. Correlation coefficients between indices of bulls at 3 years of age and at primary selection (n= 139).

12 months / 3 years	Weight gain during test-station	Weight gain from birth	Height at withers at 12 months	Body weight at 12 months
Height at withers	0.135	0.254	0.332	0.168
Dept of chest	0.047	0.088	0.096	0.057
Width of chest	0.052	0.197	0.107	0.175
Width of hips	0.128	0.229	0.050	0.141
Width of pelvic region	0.151	0.264	0.124	0.241
Length of croup	0.161	0.175	0.159	0.189
Length of trunk	0.163	0.277	0.246	0.333
Girth of chest	0.126	0.234	0.193	0.245
Circumference of foreshank	0.130	0.158	0.056	0.132

Established correlations between the weight at 3 years of age and the weight gain from birth to primary selection (r = 0.409) are essentially in accordance with results mentioned by Šereda et al. (1979) (r = 0.440) in bulls at 2 years of age. As for the gain during the teststation period, established correlations are different (r = 194, respectively r = 0.552).

Table 2. Correlation coefficients between indices of meat efficiency of bulls at 3 years of age and at primary selection.

12 months / 3 years	Weight gain during testation	Weight gain from birth	Height at withers at 12 months	Body weight at 12 months
Slaughter weight	0.194	0.392	0.235	0.365
Weight of warm carcass	0.262	0.376	0.243	0.433
Weight of kidney and pelvic fat	-0.056	-0.046	-0.001	-0.016
Gain from birth	0.276	0.409	0.314	0.485
Net gain	0.276	0.383	0.164	0.404
Dressing percentage	0.095	0.075	-0.029	0.059

Correlations between the values of growth efficiency at 12 months of age, respectively at 3 years of age and the values of investigated indices of their sons at testing stations of fattening capacity are significant.

Evaluating the body weight of sires at rearing stations at 12 months of age and weight gains of their fattened sons (table 3) we found a correlation of 0.146, which is almost consistent with results of Šereda et al. (1979) (r = 0.131). Correlations between sires' gains during the test-station period, respectively from birth and their fattened sons' gains from birth were lower (0.086, respectively 0.081) compared to results mentioned by Šereda (0.101, respectively 0.130).

Table 3. Correlation coefficients between the rearing of sires and carcass value of their fattened sons.

Sires at 12 months	Weight gain		Height at withers at 12 months	Body weight at 12 months
Fattened sons	during test-station	from birth		
Net gain	0.105	0.118	0.186	0.169
Proportion of kidney fat	0.077	0.095	0.166	0.118
Dressing percentage	0.118	0.187	0.063	0.174
Relative breeding value of net gain	-0.085	-0.096	-0.140	-0.160
Slaughter weight	0.080	0.183	0.074	0.226
Weight gain from birth	0.086	0.081	0.189	0.146
Weight of warm carcass	0.124	0.245	0.094	0.275
Weight of kidney and pelvic fat	0.079	0.120	0.152	0.161

In contrast to the statement of Šereda et al. (1979) that there is no correlation between net gains of sons and the quantitative indices of sires at rearing stations, we have found positive correlations (r = 0.105 to 0.169). This ascertainment corresponds with the finding of Averdunk et al. (1980) mentioning correlations r = 0.311 to 0.379.

Moderate correlations were found between dressing percentage of sons and the quantitative indices of their sires at rearing stations (r = 0.118 to 0.189); Šereda et al. (1979) found correlations approximately at the same level, but the negative ones, whereas Averdunk states zero values of correlation as for body weight of sires at 420 days the positive correlation r = 0.344 as for gains of sires during the testation period (112-420 days).

In our findings weight gains from birth and weight at 12 months of sires were more closely related to net gains, dressing percentage, slaughter weight and weight of half-carcasses of sons than to sires' gain during the teststation period.

Similarly to the case of sires' weight at 12 months we have found moderate correlations between the weight at 3 years of age and net gains of their fattened sons (r = 0.206) (table 4).

Table 4. Correlation coefficients between indices of weight gains and carcass value of sires at 3 years of age and their sons from testing stations of fattening capacity.

Sires at 3 years / Fattened sons	Weight slaughter	Weight warm carcass	Weight kidney and pelvic fat	Gain from birth	Gain net	Dressing percentage
Net gain	0.206	0.189	-0.108	0.271	0.167	-0.018
Proportion of kidney fat	0.110	0.014	-0.025	0.116	0.058	-0.120
Dressing percentage	0.045	0.113	-0.089	0.080	0.072	0.061
Relative breeding value of net gain	-0.042	-0.092	-0.021	-0.123	-0.122	-0.054
Slaughter weight	0.180	0.151	-0.020	0.238	0.246	0.067
Gain from birth	0.219	0.191	-0.100	0.282	0.173	-0.019
Weight of warm carcass	0.179	0.182	-0.060	0.243	0.248	0.086
Weight of kidney and pelvic fat	0.154	0.081	-0.049	0.200	0.135	-0.059

This correlation is more significant compared to the weight of sires at 12 months (r = 0.169). The corresponding level was also established in the case of relations to their sons' gains from birth to the end of the fattening period (r = 0.219), respectively to their slaughter weight (r = 0.180). Body weight of sires at 3 years of age as well as their dressing percentage have not influenced dressing percentage of their sons No significant correlation was found between the weight of kidney and pelvic fat in sires at 3 years and that of their fattened sons (r = -0.049).

Correlation between net gains of sires at 3 years and indices of fattened sons reaches similar values (respectively slightly lower) as in case of sires' gain from birth. It is important that the mentioned correlations are positive in quantitative indices including net gains.

Net gain in the estimated set of sires (n = 392) presents variability s.d. = 37 g); it would be possible to use it for culling 5 - 10% of bulls with the lowest values. Warranty of utilization of sires' net gains at 3 years, respectively their gains from birth for selection purposes needs verification by means of calculating heritability coefficients. Unification of nutrition intensity of sires at all A.I. stations presents another necessary prerequisite for it.

References

Šereda, L., J. Váchal, 1979. Vztahy mezi vlastni výkrmnosti býků v odchovnách a zkouskami jejich potomstva na stanicích kontroly výkrmnosti a jatecné hodnoty. Závěrecná zpráva, Research Institute for Animal Breeding, Praha - Uhrineves.

Averdunk, G., H. Alps, A. Gottschalk, J. Fusseder, 1980. Beziehungen zwischen der Eigenleistungsprüfung des Vaters und der Mastleistung und dem Schlachtkörperwertt seiner Nachkommen. Bayerische Landesanstalt für Tierzucht, 31 Jahrestagung der Europäischen Vereinigung für Tierzucht.

PERFORMANCE TEST RESULTS IN RELATION TO PROGENY TESTS UNDER FIELD CONDITIONS FOR DANISH BREEDS

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Performance testing of bulls prior to their use in AI has been an important element in the breeding plans for Danish dairy and dual purpose cattle breeds since 1975. The performance testing stations are owned and administered by the organisation EGTVED. This organisation covers a wide spectrum within production, breeding, sale and slaughtering of cattle. The economic basis of the activities is annual grants from a fond administering slaughtering fees and other levies as well as income from the performance testing activities. The National Institute of Animal Science is involved in the theoretical planning of testing procedure as well as in the routine testing work, and computation of breeding values.

The performance testing arrangement has met increasing approval from year to year as shown in table 1, and nearly all bulls are now performance tested before they enter an AI-center.

Table 1. Development in number of performance tested bulls per year and breed destribution (Andersen et al. 1987).

Testing year	1975 -76	1976 -77	1977 -78	1978 -79	1979 -80	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86
Total no. of bulls	215	452	510	568	580	508	630	571	675	818	821
Proportion of AI bulls (%)	48	42	51	49	54	69	70	77	81	75	74
Proportion of (%)											
RDM (Red Danish)	35	42	46	40	37	42	35	32	30	33	34
SDM (Black and White Danish)	52	47	40	46	49	44	51	54	53	51	51
DRK (Red and White Danish)	5	4	4	4	3	0	1	2	2	2	2
JER (Danish Jersey)	8	7	10	10	11	14	13	12	15	14	13

However up till 1983 only a part of the AI bulls were performance tested and some other bulls were progeny tested on an central testing station. Only few bulls were both performance tested and progeny tested.

Relations between station results and field results

In the beef industry we are faced with a very wide range of production systems varying from intensive veal production based on bull calves slaughtered at 200 kg live weight to extensive grassland systems based on steers slaughtered at 3 years of age. Progeny of the same sire may often be found in all systems and it makes creation of testing and selection procedures more complicated.

Several studies have been carried out to analyse the genotype x production system interaction and/or the genetic correlation between station performance test results and progeny test results based on field data. The correlations obtained in those investigations varies from 0 (Oldenbroek and Meijering, 1985 - Holland) over 0.3 (Gravir, 1985 - Norway) to 0.9 (Rave, 1973 - Germany). It is important to notice, however, that such results depends on a multiplum of factors (age interval, definition of growth trait, sex, feeding system etc.) In the Dutch experiment t.ex. growth rate of the performance tested bulls is measured from 120-365 days of age, and the feeding based on a roughage diet. Those measures are then correlated to growth rate of progenies fed on a milk replacer diet from 10-150 days of age. From a physiological point of view it may be totally different traits. In the investigations from Norway the growth rate of the performance tested bulls are measured in the age interval 90-360 days, and the following progeny test results is based on carcass weight ajusted to 15 mth's of age. Such a trait is influenced not only of growth capacity but also of variation in birth weight and dressing percentage, and relatively low correlation between performance test and progeny test results should therefore be expected.

A direct measure of the relationship between station performance test results and field progeny test results have not been carried out on Danish data. Hovewer, 32 performance tested sires of the breed Red Danish have also been station progeny tested for beef production, and following correlations between the results from the two testing systems are obtained (table 2).

Table 2. Correlations between testing results from individual performance tests and station progeny tests (32 Red Danish sires).

	Performance test results			
Progeny test results	Growth index	Ultrasonic index	Daily gain	SFU/ kg gain
Total beef index	0.39	-0.08	0.46	0.01
Daily gain	0.38	-0.09	0.45	-0.14
SFU/kg gain	-0.47	0.17	-0.52	0.12
Carcass muscle area	0.02	0.35	-0.01	0.25

Assuming $r_A = 1.0$ the expected correlation between the two measures of breeding values is 0.5 - 0.6. However the results presented in table 2 indicates that the underlying genetic correlations can vary from 0.2 (feed conversion ratio) to 0.8 (growth rate). The testing conditions at the performance test station was feeding with a roughage diet according to age and a testing period from 1 1/2 to 11 mth's of age. The corresponding conditions for the station progeny test was concentrate ad libitum and a testing period from 4 weeks of age to 360 kg live weight. Genetic correlations below 1.0 are therefore expected.

In a breeding experiment designed by Liboriussen et al. 1984, the genetic aspects of progeny testing of young AI bulls for beef production characters by means of information from field data was examined. The work was based on analysis of two different datasets both collected from practice (fielddataset 1 and 2). In addition the results have been compared with corresponding data from the Danish progeny test station "Egtved".

Fielddataset 1 contained information on 866 young bulls distributed on 32 Danish "Black and White" sire groups. The data was collected from AI centers and slaughter plants in 1980 and 1981. Fielddataset 2 originates from a calf-weighing programme and covers the period from 1970 to 1978. The genetic analysis of this material was based on 4138 young bulls distributed on 108 Red Danish and 76 Black and White Danish siregroups. The traits included in the analysis were daily carcass gain and carcass grading score. The following heritabilities were estimated (table 3).

Table 3. Variation in carcass gain and grading score between and within half sib families and estimates of heritabilities (Liboriussen et al. 1984).

Data		s^2(between)	s^2(within)	$h^2 \pm$ SE	
Fielddata 1.	carcass gain	25	3357	0.03	0.04
	grading score	0.031	1.399	0.34	0.11
Fielddata 2.	carcass gain	185	2165	0.32	0.05
	grading score	0.150	1.209	0.44	0.06
Test station	carcass gain	235	1574	0.52	0.06
	grading score	0.068	0.937	0.27	0.05

The main conclusion from the experiment was that young AIbulls can be progeny tested with high accuracy for both carcass gain and carcass grading by collecting field information from the number of male progenies resulting from the test inseminations. However, as a criterion of selection for beef production in a total breeding programme individual performance tests are more competitive (stepwise selection).

The expected as well as the actual, calculated correlations between breeding values estimated from field- and station data respectively are shown in table 4. The "expected correlations" are based on the the assumption that the genetic correlation between results from the two systems is 1.0.

Table 4. Correlations between results from station- and field progeny tests. 59 siregroups (Liboriussen et al. 1984).

	$r_{expected}$	r_{actual}
Carcass gain (station/fielddata 2)	0.58	0.28
Carcass score (station/fielddata 2)	0.54	0.20

The difference between the actual and expected correlations can be due to overestimation of the heritabilities and/or genetic correlations different from 1.0. The first reason seems to be the most important, but the results also indicate that the testing condition at the performance testing stations has to be as close as possible to "common practice" for future production systems.

References

Andersen, B. Bech, J. Jensen & P. Madsen, 1987. Performance testing of potential AI bulls for beef traits. In: Cattle Production Research, Danish Status and Perspectives. Landhusholdningsselskabets Forlag, Copenhagen. (in press)

Gravir, K., 1985. Oversikt over dyremateriale og avlsarbejde med Kjøttproduksjonseigenskaper i Norge. 8 pp.

Liboriussen, T., F. Lauritsen & B. Bech Andersen, 1984. Progeny testing of AI bulls for beef production based on field data. Report no. 565 from the National Institute of Animal Science. 64 pp.

Oldenbroek, J.K. & A. Meijering, 1985. Breeding for veal production in Black and White Dairy Cattle. 17 pp.

Rave, G., 1973. Genotyp-Umwelt-Interaktionen für zwei Prüfmethoden der Nachkommenprüfung auf Fleischleistung beim Rind. Züchtungskunde 45, 22-29.

RELATIONSHIP BETWEEN PERFORMANCE TESTING AND FIELD PROGENY TESTING FOR BEEF PRODUCTION

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Summary

Data on 358 bulls show a genetic correlation between growth rate from 90-360 days of age and carcass weight and carcass value recorded on male progeny of 0.3. This clearly shows that growth rate in the performance test and beef production in terms of weight and value of carcasses are different traits.

Selection based on performance test gives a sample of bulls with significant better beef production potential than with no selection at the early stage.

Introduction

Even though potential AI bulls are performance tested and a certain proportion of bulls is culled because of growth rate this is hardly very efficient with regard to beef production if no further informations on this trait are included in the final selection after the progeny test is finished. One way of overcoming this is to try and measure traits related to carcass quality on live bulls, but so far such methods have not shown to be as good as informations on carcasses.

Progeny testing of bulls for beef production has been included in the breeding program for Norwegian dairy cattle since 1959.

Data

From 1959 to 1971 this progeny test was based on data from special stations. Because of limited station capacity only a small sample of the bulls were progeny tested for this trait, and consequently it had rather little influence on the selection of bulls.

Therefore NRF decided to change to a system based on field data, and this was done in 1971. The farm animal recording system, the cooperative slaughterhouses and NRF cooperate to obtain these carcass data. Until 1985 all the data from slaughtering have been collected by means of special ear tags where date of slaughtering, carcass weight and carcass grade have been written on and then sent to NRF.

With later developments of computing systems there is now a change to a system where all these data are taken directly from electronic scales at the slaughter houses. Based on a direct linkage the carcass data are put together with the cow recording data and are then available for use in the progeny testing of NRF bulls. An extra gain from this method is that the farmers get results about beef production as well as milk production from the cow recording system. This direct recording system works just as well as the special ear tags when only the animals have got the correct identification and are included in the cow recording system.

Table 1 shows how the number of animals with carcass data has varied since 1974. There has been a steady increase until 1984, but mainly because of the change of system there is a small reduction of data the last year. The number of records in 1986 is not available yet.

The old system provides data on male progeny only, but the direct system also includes data of heifers and cows. In the future it will be possible to include heifers in the progeny testing if desirable, and the data will provide informations on trends in carcass weight on older cows.

Table 1. Number of carcass records and size of progeny groups.

Year	Number of carcass records	Size of progeny groups	Number of progeny tested bulls
1974	3 131	15	66
1975	3 877	17	115
1976	2 068	23	109
1977	3 902	20	119
1978	5 451	22	141
1979	7 398	33	112
1980	8 659	47	109
1981	8 601	53	110
1982	6 286	44	104
1983	11 363	30	107
1984	13 608	46	114
1985	10 751	51	117
1986		39	127

Progeny test method

The progeny test is carried out on two traits; carcass weight and carcass value. To obtain the carcass value the grade is used to find the price per kg.

The carcass data may be from animals slaughtered at various ages, and before estimating the breeding values the data are adjusted to an age of 17 months. Then this model is used (Fimland, 1984):

$$\underset{\sim}{Y} = \underset{\sim}{X}\underset{\sim}{\beta} + \underset{\sim}{Z}\underset{\sim}{S} + \underset{\sim}{e}$$

where $\underset{\sim}{Y}$ is the vector of observations.
- $\underset{\sim}{X}$ is an incidence matrix showing progeny in a combined classification of district and slaughter months,
- $\underset{\sim}{\beta}$ is a fixed effect of district and slaughter months jointly,
- $\underset{\sim}{Z}$ is a matrix showing presence of progeny of different young bulls,
- $\underset{\sim}{S}$ is a vector of random effects of young bulls, and
- $\underset{\sim}{e}$ is a vector of residuals.

With more data we hope to be able to take into account herd effects, and we will aim at using data from several years at a time to be able to estimate genetic trends. So far data has been restricted to progeny of test bulls only, but with the new recording method no such limitations will exist.

Relations between performance test and progeny test.

Data on the progeny tested bulls in 1984-86 are used to investigate this question. This is a total of 358 bulls.

Table 2 shows some correlations between traits at the performance test and the breeding values for beef production.

Table 2. Correlations between performance test and progeny test results. 358 bulls.

Progeny test	Performance test		
	Weight at 360 days	Growth rate 90-360 days	Index for growth rate including paternal half brothers
Carcass weight	0.15	0.15	0.16
Carcass value	0.14	0.15	0.16

As shown by these correlations carcass weight and carcass value are almost the same trait because value is almost fully determined by the weight. The correlation between the breeding values is 0.99, and the genetic correlation is 1.00.

The correlations in Table 2 seem small, but the genetic correlations derived from this analysis are not so small. The genetic correlations are obtained by changing the variances to genetic variances by taking into account the accuracy of the traits, which are the heritability of the performance test results and the accuracy of the breeding value for the carcass traits.

This results in genetic correlations of 0.3 which shows that carcass traits and live weight or live growth rate are different traits. With the selection carried out these correlation are probably biased downwards.

In addition it may be argued, that some weaknesses by the model used to obtain the progeny test results lead to smaller correlations than it should be. But even so it is doubtful if the true genetic correlation is above 0.5-0.6, and that shows that use of informations on carcasses is necessary if we want the selection to be successful.

Effect of performance test selection on beef production

In a program with some progeny test for beef production performance test is still of geat importance because selection at that stage determines which bulls are entering AI. The existing data make it possible to get some idea about the effect of this early selection. Table 3 shows the regression coefficients for the effect of performance test index on subsequent progeny test result for carcass weight and carcass value. The bulls entering AI are selected from the best half regarding the performance index. With an index ranging from 1 to and 10 and with a standard deviation on 1.5 this leads to an expected selection differential of 1.2 index units.

Using the results from Table 3 this shows that the performance test selection for growth rate increases the average carcass weight and carcass value of the AI bulls' progeny with 0.6 kg and Nkr. 20.30 respectively. The prices used are from 1986.

Table 3. Average increase in carcass weight and carcass value of the progeny by one unit increase in the bull's performance index.

Carcass weight	0.48 kg/index unit (S.E. = 0.15)
Carcass value	16.90 Nkr/index unit (S.E. = 5.64)

References

Fimland, E., 1984. Progeny testing procedure in Norway. In Bulletin 183, IDF/EAAP Symposium, Prague, 1984, p. 117-132.

DISCUSSION (SESSION I)

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Introduction

At the start of the discussion Bech Andersen summarized the main results about the genetic correlation between performance test and progeny test for beef traits. The following methods to estimate the relationship between performance test and progeny test were distinguished:

1. Correlation between phenotypic value in performance test and breeding value in progeny test.
2. Correlation between breeding value in performance test and breeding value in progeny, weighted by accuracy.
3. Restricted Maximum Likelihood (REML).

The genetic correlation between performance test and progeny test results for live-weight gain and carcass gain reached a level of 0.6-0.7. Thus selection on performance test traits is effective for beef production as long as the fattening system is comparable.

Table 1. Correlation between performance test traits and progeny test results (explanation methods: see text).

Authors	Daily gain/ daily gain	Daily gain/ carcass weight	Daily gain/ carcass value	Method of estimation
Hanset et al.	0.64			1
Averdunk et al.:				
- station	0.80			2
- contract herds	0.89			2
- field data		0.57	0.56	2
Dijkstra et al.:				
- veal	0.58	0.28		3
- beef	0.66	0.61		3
Chavaz:				
- Brown Swiss		0.88		2
- Red and White		0.70		2
Oldenbroek et al.:				
- veal	0.93			1
- beef	0.68			1
Steine		0.15	0.15	1

Veal calves/beef bull production

Progeny test results of veal and beef bull production are genetically related to a substantial level as is demonstrated by Oldenbroek et al. for Dutch Black and White and by Dijkstra et al. for Red and White Cattle (Table 2).

Table 2. Genetic correlation between veal calf/beef bull production based on progeny tests.

	Dutch Friesian	Red and White
Daily gain	0.61	0.53
Carcass weight	0.42	0.64
Carcass fleshiness	0.90	0.79
Carcass price per kg	0.49	0.50

Selection strategy

In the discussion on selection strategies it is clear that a first step of selection based on performance test is effective (h^2 about 0.4, genetic correlation about 0.6) with practically no loss in dairy traits. With an additional progeny test on beef traits, a second selection step is possible. The accuracy of the progeny test can be higher, but the results are available later and selection on beef traits competes with the selection on dairy traits. An optimal combination of performance and progeny test, as proposed by Steine, and discussed later by Niebel et al. is a possible solution.

Performance test methods and accuracy of test

Different aspects are discussed, but not always a firm conclusion or recommendation could be derived. Variation is dependent on breeds, production systems, structure of and investment in AI breeding schemes.

- Age at beginning and end of test.
  In dairy breeds, with bucket feeding of calves, it is recommended to raise the bull calves from about 4 weeks at the station. In the pretest period, quarantaine and more uniformity in raising conditions are possible. In beef breeds, with a suckling period, the pretest period is much longer e.g. Hanset et al.
  A number of countries are decreasing the end of test from 12 months of age to 11 months. This especially to get the young AI bulls trained and tested for fertility traits. In Bavaria, the end of test in the Fleckvieh is at 14 months. In this later maturing breed, it is expected that they demonstrate more accurately the beef traits at an older age. A compromise of both aspects is the result of this part of discussion.

- Feeding systems
  There are differences in feeding systems and energy density of the ratio. Sometimes complete diets are fed ad libitum. Restricted feeding is not supported because in many production systems animals are kept in groups and they get ad libitum roughage. A system of feeding concentrates restricted to age and a high quality roughage at libitum can be seen as a good solution.

Maintenance requirement, residual energy intake.

Feed conversion is an economically important trait, but it can only be calculated when feed intake is measured. Genetic variation is demonstrated e.g. Madsen h^2=0.3, Van der Werf et al. h^2=0.21. Maintenance requirement can be derived from a regression approach (Madsen h^2=0.31). In the experiment of Korver et al. feed intake characteristics had a heritability of about 0.5 and the calculated residual energy intake a heritability of 0.25.

A general recommendation to measure feed intake is not given, but this area of research has promising aspects.

Estimation of lean meat production capacity and conformation traits

Henningson has discussed methods to score fleshiness and fat covering. This can be a cheap method, but the accuracy and classified variation are very important. Bech Anderson remarked that in the data of Oldenbroek et al. a small genetic variation in fleshiness scores was found e.g. mean 1.6 and σ_g 0.1. In that case a low h^2 (0.06) and low predictive value can be expected. To his opinion, a more accurate ultrasonic measurement is necessary to demonstrate sufficient variation in fleshiness. It may be remarked, that in the young Holstein Friesians bulls of 1 year kept under a restricted concentrated feeding level and hay ad libitum, not much variation can be seen (low level of fleshiness). In the Dutch Red and White bulls a higher level of fleshiness is demonstrated (3.3 points) and there is also not much variation σ_G 0.14 and a low h^2 of 0.12. The use of a danscanner is doubtful in the hands of not danish specialists. In general, it is worthwhile to increase accuracy of measurements. The EAAP working group on assessment of carcass traits (H. de Boer) is planning to work on recommendations for optimal carcass assessment procedures as part of performance test procedures. De Boer had made a short note on selection for performance test which is added to this discussion.

SOME NOTES ON SELECTION FOR BEEF TRAITS (Mr. H. de Boer)

The goal to increase lean production potential may be completed with a requirement on saleability; a similar meat yield has a higher value/kg if muscles are thicker and fatness more optimal.

In performance testing with appropriate feeding system the main quantitative and qualititative data of interest are
- estimated carcass weight
- estimated muscle weight
- a measure of muscle thickness.

The main determinant of carcass and muscle weight is live weight; it is difficult to find additional measures to obtain a more accurate estimate. However, it seems questionable whether it pays to pursue very great precision, in view of other factors limiting the strength of conclusions.

It seems worthwhile to understand why muscle thickness is important as a criterion. No doubt it has a rather low value as a (co-)predictor of carcass composition, which is mainly influenced by fatness. Still, there is a systematic relation by its effect on the muscle/bone ratio; though limited in ultimate effect on composition, it is very consistent. Moreover thickly muscled carcasses sell better, because consumers do not behave rationally in covering their protein needs. Different from some 10 years ago visual/tactile assessment of muscling (fleshiness) and fatness seems to be accepted as a respectable method everywhere. This emphasizes questions of standardisation, reproducibility and also of interpretation. To these aspects, the following comments are:

- Standardization of scorings can only be realised via parallel carcass scoring according to carcass standards; it seems however that this is not effected in many cases. To avoid deviations in the longterm, precautions are necessary (standard series of slides).
- Reproducibility of scorings can be checked rather easily by independent parallel scorings or repeated scoring after some time. It seems that checks of this kind are not much applied.
- Correct interpretation of assessed muscling in terms of potential muscling may be difficult without accounting for fatness. If fat has developed, this indicates that potential muscling has been developed to full extent. In case no fat has developed, this is not necessarily so, and differences in potential muscling between animals may become obscured.

It seems that lower heritabilities for fleshiness assessed in live animals at the end of the performance test, compared to carcass fleshiness of progeny, may be due to two factors, alone or in combination:

a. less accurate scoring in the live animal.
b. insufficient development of potential muscularity in performance tested bulls (feeding level).

The last complication also applies in case a measure of muscle thickness is applied, e.g. Danscan muscle area, or round circumference.

In addition to the lean weight for age criterion in performance testing it seems relevant to improve and to compare the various parameters of muscle thickness, primarily because of the importance of the trait by itself for carcass yield. It seems relevant to take account of carcass fatness in selection only if, under prevailing commercial conditions of beef production, this has proven to give serious difficulties not surmountable by adapted management.

Session 2

Comparison of performance test results for efficiency traits with female progeny tests in different environments

AN AUTOMATED SYSTEM OF RECORDING FOOD INTAKE BY INDIVIDUAL ANIMALS HOUSED IN GROUPS AND FED SILAGE AD LIBITUM

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Summary

Rationing systems for cattle and genetic selection criteria cannot be made more precise until we have a more complete understanding of the factors which control forage intake. In order to collect information on forage intake and feeding behaviour from a large number of cattle kept under farm conditions we have developed a system in which cattle are identified from collar-borne transponders as they eat from weighed blocks of silage. Data are collected and pre-processed by a micro-computer which also controls the allocation of compound feed from dispensers. The microcomputer is programmed in 'C', a high level language, using a comprehensive software development system; the program is easily portable to other computers. Information on the timing and size of meals is transferred on floppy disc to a mainframe computer for sorting, statistical analysis and graphical output.
Keywords: Computerised data collection, Cattle, Feed intake.

Introduction

During the last thirty years there has been a phenomenal increase in our knowledge of the nutritional physiology of ruminant animals. As a consequence the Agricultural and Food Research Council (AFRC, 1965, 1980) published texts that synthesise this and other knowledge into a system for feeding ruminant farm animals. The system condenses the nutrient requirements of a particular class of stock, and dietary ways of meeting those requirements, into a form applicable to the average animal in a specified group in commercial enterprises.

Central to the applicability of any diet is the prediction of feed dry matter intake (DMI), which in effect sets the nutrient concentration to meet a given need. Many of the available prediction equations have been derived from data obtained in experiments made for other reasons and often from cows that were fed mixtures of forages (MAFF, 1984; Bines & Forbes, 1980). The time interval over which the experimental data have been reported and the change in breed or genetic constitution may reduce the relevance of such equations (e.g. Vadiveloo & Holmes, 1979) to present day feeding systems and feeds. Further problems include the effect of level of feeding or the proportion of concentrates or compound feeds and their interaction with forage quality on forage DMI (Thomas, 1980).

All of the prediction equations recommended for use on commercial farms include the live weight of the animal and this is taken to be positively related to DMI. It is generally accepted that the larger the cow the more she will eat; it is also now accepted that the fatter the cow the less she will eat (Garnsworthy & Topps, 1980; Land & Leaver, 1980) though this aspect has not yet been incorporated into prediction equations.

Direct measurements of silage DMI, when variable amounts of concentrated feeds are given, have been made either on cows kept in individual stalls, or on group-housed cows with restricted access to their own feeder by electronically controlled gates. Because of the high labour demand DMIs are often recorded by difference between the filled weight of the feeder and the weight after several days of access. Thus it is not possible to record the number and size of individual meals or how they vary with dietary constituents, the pattern of feeding over 24h periods, the repeatability of these characteristics, the social dominance order and competitive effects.

The system described below was developed to provide information on these aspects of dairy cow nutrition. It consists of equipment to identify cows automatically when they are feeding, to weigh the blocks of silage to which the cows have access and to control the dispensation of compound feeds to individually-identified cows from out-of-parlour feeders. The monitoring and control of this equipment, and the storage of relevant data, are performed by a micro-computer.

Methods

It is convenient to describe the experimental methods in terms of the hardware and software employed.

Hardware

The system described is designed to house approximately fifteen cattle, allowing silage to be fed *ad libitum*, with a controlled compound allocation via out-of-parlour feeders. Figure 1 is a diagram of the layout of the yard.

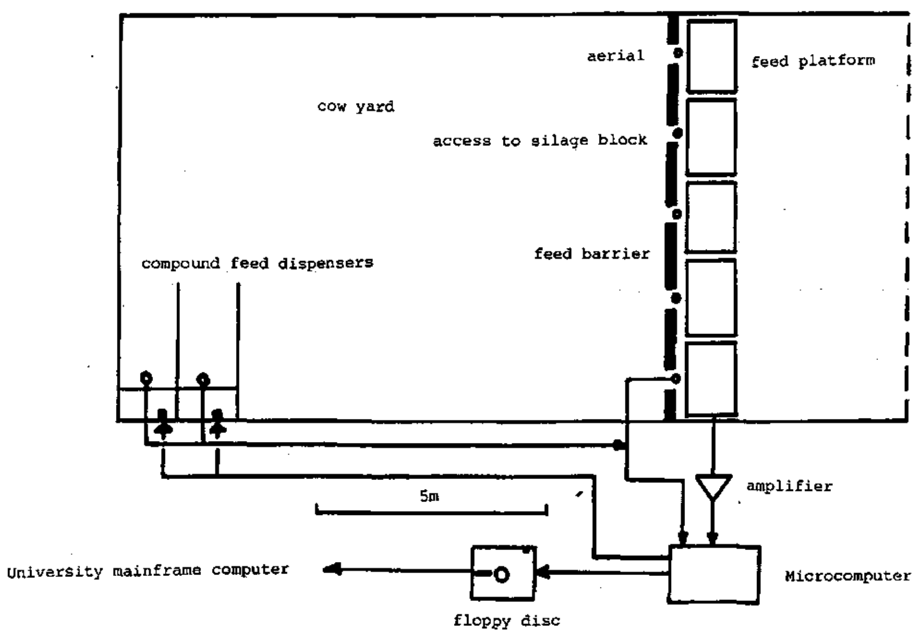

Fig. 1. Diagram of the layout of the yard and equipment used to monitor feeding behaviour of cattle.

Silage blocks of approximately 500kg are cut using a conventional block-cutter and placed on each of five load platforms. These load platforms consist of four compression-type load cells, the output of which is input via a signal conditioner to a microcomputer.

Cattle have continuous access to the silage on the load platforms via a feed barrier with one access point per platform. Each access point is fitted with an aerial loop which energises an active transponder on the collar of any cow that feeds at that particular platform. The activated transponder transmits the identity of the cow to the microcomputer. This identification system is based on that developed at the National Institute of Agricultural Engineering (Brindle, 1976).

Divisions projecting about 0.75m at right angles to the feed barrier reduce the problem of aggressive replacement of a feeding cow by another. They also cause sufficient delay during a rapid replacement of one cow by another to enable a reliable weight to be obtained for the finish of one meal and the start of the next.

Accuracy was assessed by simulating meals using suitable weights up to 10 kg; the mean error was ±0.15kg per meal which is equivalent to approximately 2.25kg per day for a typical cow.

Compound allocation is controlled by two out-of-parlour feeders which have been modified to operate via the same identification system and are controlled by the main recording software. All data of concentrates dispensed and all meals of silage taken by individual cattle in the group are stored on floppy disc, giving a complete picture of the feeding behaviour of each animal.

The computer hardware used is based on a standard "bus" to minimise the need for the design, construction and commissioning of hardware (Hoyle 1985). For this work the system chosen (Minstrel, Hotel Microsystems Ltd., London) was based upon the "S100 bus", now standardised as "IEEE 696".

Software

The language "C" was chosen as it provides all features associated with modern high-level languages and is "portable" to other types of computer.

A program in the "C" language consists of a main segment which calls functions that perform specific tasks. In this application the main segment scans the keyboard for operator instructions and at regular intervals (typically 1 second) calls functions to interrogate the cow identification system, to weigh the blocks of silage and to put data into a file on floppy disc when required. Three files are produced: one stores the silage meal data, a second records the times at which cows enter the compound feed dispensers while a third is for messages generated automatically or by the operator. A fourth file is used to store current system parameters such as the identification numbers and daily compound feed allocations of cows currently in the system, calibration factors for the load platforms and the weight dispenses by each out-of-parlour feeder at each "drop". This information is thereby automatically available to the program after a restart. Most of the information which is accessed by more than one function is stored in permanently defined "global" storage.

The following features are provided:

calibration of load platforms; set or reset the clock; read the tag numbers of cows currently identified; interactively set or reset the date; automatically increment the date at midnight; interactively set or reset various system parameters; close files, either automatically at midnight or interactively when the data disc is nearly full; open new data files; actuate a "drop" of feed from a dispenser; interpret an operator instruction and call the appropriate function; get or save the system parameters from the parameter file automatically at midnight or when the program is restarted, or under operator control; check that a cow identified by the system is on the current list; list the identities and current allocation of compound feed for all cows, or a particular cow, on the screen; determine whether a meal or silage has just started or finished; put a list of options on the screen; allow the operator to type a message which is put into a disc file along with messages generated automatically by other functions; allocate a new day's compound feed ration to each cow at a specified time of day.

Software - data reduction and analysis

Data files are uploaded to an Amdahl 5860 mainframe computer using a microcomputer that is linked with the University network. The Amdahl has a huge on-line storage capacity with facilities for unlimited off-line storage. The massive amounts of data generated by the feed monitoring system can, therefore, be stored for an indefinite period and be accessed either immediately or relatively quickly.

Each day's data file is sorted according to cow, using the Statistical Analysis System (SAS, SAS Institute Inc., Carey, North Caroline). The sorted data are then scanned by means of a program written in FORTRAN to determine which consecutive meals should be merged according to a minimum intermeal interval which can be specified when the program is run. SAS is then used again for calculation of summary statistics and for preparation of graphical output. At any stage files from different days can be merged in order to examine periods of greater than one day.

Although it is essential for our use of the data-collection system that we have access to these powerful tools, simpler analyses could be performed using the microcomputer on the farm site.

Results and Discussion

Although this is a description of the system for recording feeding by cattle it is appropriate to present some examples of the results which are being obtained in order to illustrate the extent to which the aims of the project are being met.

Figure 2 shows the distribution of meals throughout a 24h period for one cow. The mean number of meals for all 12 cows over a period of 110 days was 15.7 per cow per day with a mean daily intake of 45.7kg silage for the twelve cows over a week in mid lactation.

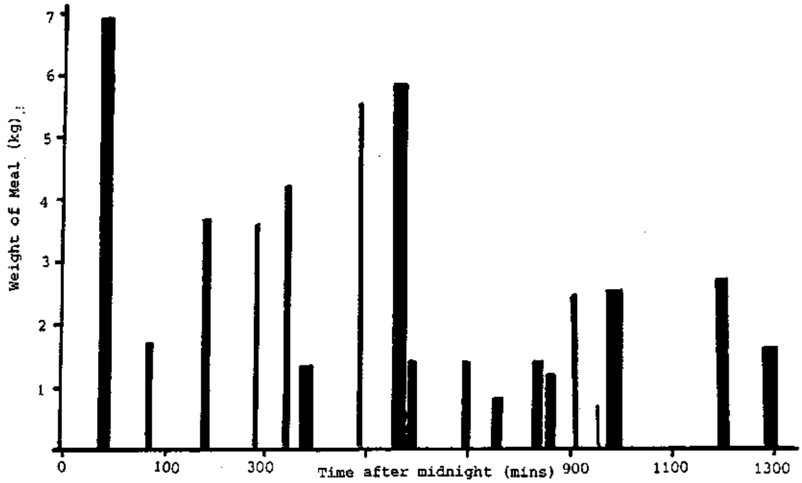

Fig. 2. An example of a 24h meal pattern of a cow recorded by the system described in this paper. The height of each bar represents the weight eaten while the width is the duration.

The ability to control automatically the times at which cows can get allocations of compound feed will make it easy to investigate the effects of different patterns of allocation within the day or the effects of feeding different amounts on different days. Monitoring the times at which cows approach the compound feeders should help in determining the optimum interval between feeds and the number of cows which can use a feeder without undue competition. The relationship between the timing and size of voluntary meals of silage and dispensation of compound feed will also be relatively simple to determine; we already have the data to achieve this. In the current studies some cows are given an allocation of one compound feed dispensed by one out-of-parlour feeder, while others have access to a compound of different composition from the other feeder.

In conclusion, the system described enables continuous monitoring of the feeding behaviour of any number of cattle kept in conditions which do not differ, as far as the animals are concerned, from those on many commercial farms. The long-term storage of the data on a mainframe computer allows them to be processed by fast and powerful software, including sorting, condensing, statistical analysis and graphical output.

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References

Agricultural Research Council. 1965. The Nutrient Requirements of Ruminant Livestock. Slough, Commonwealth Agricultural Bureaux.

Agricultural Research Council. 1980. The Nutrient Requirements of Ruminant Livestock. Slough, Commonwealth Agricultural Bureaux, pp 351.

Bines, J.A. & J.M. Forbes. 1980. Towards more precise prediction of the feed intake of milking cows. Animal Production, 30: 475-476 (Abstract).

Brindle, J.E. 1976. Automatic dairy cow identification. Journal of Agricultural Engineering Research, 21: 41-48.

Garnsworthy, P.C. & J.H. Topps. 1982. The effect of body condition of dairy cows at calving on their food intake and performance when given complete diets. Animal Production, 35: 113-119.

Hoyle, B.S. 1985. Microprocessor application development using standardised hardware. Journal of Microcomputer Applications, 8: 245-253.

Land, C. & J.D. Leaver. 1980. The effect of body condition at calving on the milk production and feed intake of dairy cows. Animal Production, 30: 449.

M.A.F.F. 1984. Energy Allowances and Feeding Systems for Ruminants. Reference Book 483, London, H.M.S.O. 85 pp.

Thomas, C. 1980. Conserved forages. In "Feeding Strategies for Dairy Cows", ed. W.H. Broster, C.L. Johnson & J.C. Tayler, London, Agricultural Research Council. pp 8.1-8.14.

Vadiveloo, J. & W. Holmes. 1979. The prediction of the voluntary feed intake of dairy cows. Journal of Agricultural Science, 93: 553-562.

AUTOMATIC RECORDING OF ROUGHAGE INTAKE UNDER LOOSE HOUSING CONDITIONS

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Summary

The paper gives a short description of the development of an automatic roughage intake monitoring system for dairy cows. The main points to consider for running tests on such a system are mentioned. Several items affecting the accuracy of the total installation are discussed. An outlook is given on the scientific topics related with the intake measurement.
Keywords: Dairy cows, feed intake, automatic monitoring

Introduction

The system of keeping dairy cows has changed during the last years. More and more there is a trend towards loose housing for milking cows. This development can not only be observed in commercial farms also research operations changed the housing system of cows. The measurement of the roughage intake of individual dairy cows is even in a tie stall barn a very labour intensive job. In a loose housing barn this measurement requires a lot of technical installations. Due to this there is little data available on roughage intake for every individual cow over the whole lactation in a freestall operation.

So there is a situation that the research farms are in need of a simple equipment for determining the roughage intake on a low cost and a low labour basis. For that reason the Institute for Animal Breeding and Animal Husbandry of the University of Kiel developed the technical equipment to measure roughage intake in free stall operations. The equipment is installed on "Karkendamm" the dairy research farm of the institute and works now for 15 month. In this paper there will be presented a short description of the installation and a report of the problems which arose during the development and the test period of the feeding apparatus.

Development of the feeding apparatus

Design of the hardware of the system

The equipment has to be designed in a way that it fits for the normal work in a barn. For our operation that means, that the feedstuff has to be filled into the feeding containers by a mixing waggon and the containers have to be big enough, so that one has to dispense the feedstuff only twice a day.

The feeding containers are made from flexible plastic and they have a length of 170 cm, so that the ratio of animals per feeding place is about 2 : 1. This Container is attached with lever arms to a load cell on each side. This electronical load cells measure the weight of the feeding container permanantly. For removing the rest of the silage out of the container it is possible to tip it over.

At every feeding place there is installed a small microcomputer for the calculation of the feed intake. On the one hand this computer is hooked up to the load cells of the feeding container and on the other hand there is a connection to the identification antenna. The 28 small computers in the barn are hooked up to a host computer in the office by a ring line. The computer at the feeding place has the function to identify the animal, to calculate the amount of intake from the weight change of the feeding container and to send the complete intake process of the specific cow to the main computer.

The host computer has the function to sum up the several intake processes on a per cow basis, on a per feeding place basis and on a total basis. Furthermore it has to store the information on a floppy disk when one day is completed.

Necessary software to operate the system

For the operation of the system it was necessary to develop several software packages. The program for the identifikation and the calculation of the feeding process is installed in the small computers at every feeding place. The software for the communication between the host computer and the computer at the feeding places is installed partly at the host and partly in the feeding place. For maintaining the output of the small computers there is a program on the host computer. This program has also the function to initialize the small computers at the startup of the system.

Problems in software development

The most critical point at the software development was to program the feedingplace computer. It was very difficult to have good results for the intake processes because of the heavy weight changes at the load cells while the cow is eating. To eliminate this weight changes the programm calculates a moving average of the weight from the last 32 values. The weight changes caused by the eating of the cow are calculated from this averages. But this method of calculating the intake process does not fit if the cow is immidiately followed by another one. In that situation it is more suitable to determine the amount of intake from the actual weight on the load cells.

Beside of that the feedingplace computer has to realize wether there takes place a filling or removing of feedstuff at the container. For that reason in the program there is an upper value for the weight change during a given time intervall. If the weight change of the load cells is bigger than that value the feedingplace computer sends a message to the host that there has been a filling in or removing of silage.

Another critical point is to determine at which time the cow disappears from the feeding place if no other cow follows immidiately. At the time the cow leaves the place the computer gets another identification but it can not be seen that the cow diappears. The time the cow leaves the feeding place is calculated from two different sources. The first is a timeout factor. That means that you don't get a new identification for a given period of time. The second is the stability of the weight on the load cells for a given period of time. If both values are true it is assumed that the cow has left the place and the final calculation of the intake process takes place.

Accuracy of the system

The accuracy of the system depends upon three factors. At first there is to mention the quality of the load cells. There is a large variety of load cells on the market. For the system at the research operation cheap load cells were chosen. The tests of the accuracy of the load cells have shown that they are accurat enough. When filling the feeding containers with roughage, the deviation between the amount of roughage the feeding system reports and the true value was about 40 kg per ton. If one compares the reported amount of silage eaten by the cows per place one finds a deviation of three to four percent.

It is very difficult to find out how accurat the calculation of the individual intake process under practical feeding conditions is. If one makes an attempt to do so, the situation is, that one has to weigh back about 40 kg of silage from the feeding container, just to find out wether the reported amount of 200 g is true. But by extensive laboratory tests it can be shown that the weighings are reliable as soon as the amount of eaten silage is greater than 100 g. For that reason the system considers an amount less than 100 g as no intake.

The second important point for the accuracy of the results is the quality of the identification. For a system without feeding gates at the headlocks it is extremely important to have an identifikation rate of 100 percent. By observation during several days it was prooved that every cow is identified as soon as it enters the feeding place. To assure that, it is important that one has a very quick identifikation system. The identification of the feeding apparatus has a rate of ten identifications per second. In comparison to a commercial system this is much faster, for example a normal commercial antenna identifies at a rate of one identification process every two seconds. Another important point concerning identification is the possible distance between the antenna and the responder. For the normal commercial identification the range is about 10 to 15 cm. To have a reliable identification at the feeding place for roughage the distance has to be increased to a range of 20 to 22 cm. As soon as all the points mentioned above are considered it is possible to operate such a system without gates at the headlocks.

The third point where it is possible to loose information is the communication between the computer at the feeding place and the host computer. Under practical conditions it could be observed, that the communication is extremely reliable. The rate of lost intake processes is below one percent. To control the communication every feeding place computer reports to the host whenever it was not able to deliver the results of the intake calculation to the host. From the host computer it is possible to get a list of the number of lost intake processes for every feeding place. If the computer at the feeding place breaks down the host computer reports the number of unsuccessful tries to reach that specific feeding place so that it is easy to see wether every computer in the barn is working properly or not.

Output of the feeding system

The information which the host computer gets from the feeding place is the number of the feeding place, the number of the responder of the cow the amount of silage the cow has eaten and the number of minutes the cow has occupied the place. The host computer adds on the actual time when the message is received. Beside of that the host recieves evry filling and emtying of the feeding containers. After receiving the message the host computer connects the barn number of the cow to the number of the responder and he sums up the received intake to an intake per day. The total eating time of every animal and the number of visits are also reported on a daily base. The same calculations are done for every feeding place and as a grand total.

As an option it is possible to record every single intake process on a floppy disk with the informations mentioned above. With that information it is possible to find out at which time and how long every cow has been at a feeding place and how much roughage the cow has eaten during her visit. At the research farm we store that information but this option produces a lot of records. For example if one controls 60 cows that way there is an output of 3000 records per day and 60.000 characters have to be stored.

From the research farm the datas are transfered to the mainframe for further scientific analyses.

Current research projekts based on the roughage monitoring system

Up to now there are three projekts dealing with the roughage intake of dairy cows. The first is to determine the variation of roughage and total intake between individual cows and between different breeds. Also the most important parameters which effect the intake of the cows will be analysed. After that it is planned to calculate the energie balance for every animal to find out how efficient the used feeding strategy is. It has to be calculated wether there are considerable differences in the utilisation of the feedstuff.

The second trial deals with the relationship between the concentration of metabolites and enzymes analysed from blood and milk samples and the energie balance of the animal.

The third projekt is an attempt to estimate the intake only from the information that is optained from the identifikation process namely from the number of vists, the daytime of the visits and the length of the intake process. Beside of this information other specific parameters of the cow may be included. The plan is to develop a cheap system for controlling the roughage intake just by identifying the cows at the headlocks.

Conclusions

The most important things which should be considered in the development of automatic monitoring system for roughage intake of loosed housed dairy cows have been pointed out in this paper. With the example of the feeding apparatus which is installed at the dairy research farm "Karkendamm" of the Institute for Animal Breeding and Animal Husbandry of the University of Kiel it is shown that the automatic recording of intake in loosed housed cattle is possible with a reasenable technical equipment. If some similar monitoring system is available from commercial dealers at reasonable prices there will be the opportunity of measuring the intake capacity much easier in dairy herds and also in performance testing stations.

RELATIONSHIP BETWEEN APPETITE AND EFFICIENCY OF THE BULL AND HIS FEMALE PROGENY DURING GROWTH AND LACTATION

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Summary

Improvement of feed efficiency and appetite has a great potential importance in cattle breeding. Based on Danish experiments is it shown that those traits has a significant genetic variation in growing bulls. No interaction if found between genotype and concentrate/roughage ratio in the diet, but the daily energy intake has a great influence on the genetic correlation between appetite/daily gain and daily gain/feed utilization. Feed efficiency of performance tested bulls has very little influence on the daughters milk production index. The design of a comprehensive "life-cycle" experiment is described. The purpose is to investigate the genetic variation in appetite and efficiency in growth and lactation as well as the genetic relationships between such traits measured on young bulls, heifers and lactating cows.

Introduction

The most important cost factor in the dairy/beef industry is the consumption of food, and therefore the question about individual genetic controlled differences in feed efficiency has been discussed in many years. Efficiant AI breeding programmes combined with a heavy import of Holstein-Friesian genes have increased the milk production capacity of the dairy cow at a rate of 1% per annum or more, and several investigations have shown that selection for higher milk yield automatically improves the feed efficiency. T.ex Mason et al. (1957) has analysed data from the old Danish progeny test stations for milk production, and found a genetic correlation between FCM-yield and feed efficiency on 0.95. Such strong relationship is confirmed in subsequent experiments (Freeman, 1975), but the cows were fed according to requirements for maintenance and yield and it will automatically lead to a high correlation. In an experiment with ad libitum feeding, Gibson (1986) has shown that for every 10% genetic increase in milk yield, the efficiency of conversion of food to milk was increased by 7.3%. However, it is also discussed by Gibson (1986) that the correlated response in efficiency may be reduced when the milk yield attain a higher level.

The quota limitations on milk production has not so far had any measureable impact on the breeding schemes, but on a long view the consequences can be a movement from "maximal yield breeding" to "efficiency breeding" (Andersen, 1985). Consequently a direct selection for feed efficiency could be of importance if possible. An other trait of potential importance is appetite, as further increase in milk production capacity in the dairy breeds will require larger feed intake and larger rumen capacity to reduce energy undersupply in the first part of lactation. It means that direct selection for both feed efficiency and appetite could be of importance in modern breeding programmes.

Significant genetic variation in both traits are demonstrated, but the necessary registrations will be difficult to carry out in a great scale in practice. In addition both appetite and efficiency are traits of a very complex nature which results from many underlaying biological components. Therefore the biological effect of a genetic improvement/changing can be difficult to predict. It means that much research work has to be done before it is possible eventually to recommend incorporation of appetite and efficiency as a direct breeding goal in the breeding schemes.

Theoretically testing and selection for appetite and efficiency can be included in the young bull selection (performance testing stations), bull dam selection (bull dam stations) or proven bull selection (field test of daughter groups). The experimental activities in Denmark is concentrated on the first two alternatives.

Contribution from Danish experiments

Genetic variation in appetite and efficiency in young bulls

In order to examine the genetic variation in appetite and feed efficiency, 10 years of data of performance tested bulls were analysed. The data consisted of 5337 bulls. From 1975 to 1980 the bulls were fed with concentrate on a high level (according to age but nearly ad libitum), and since 1981 with a restricted amount of concentrate and on a roughage diet mixture ad libitum. The results are presented in table 1 (and the data was not adjusted for gene import and heterosis).

Table 1. Genetic parameters on growth, feed intake and feed utilization calculated on data from restrictive feeding and ad libitum feeding respectively (Andersen et al., 1987).

		h^2	genetic SD
Restrictive feeding	DG	0.52	53
n = 1856	AP	0.28	0.03
no. of siregroups = 159	FU	0.48	0.18
Ad. lib. feeding	DG	0.57	65
n = 3481	AP	0.39	0.20
no. of siregroups = 215	FU	0.33	0.15

	Genetic correlations		
	DG/FU	DG/AP	FU/AP
Restrictive feeding	-0.99	0.71	-0.63
Ad. lib feeding	-0.76	0.77	-0.17

DG = liveweight gain in grammes per day.
AP = feed intake in Scand. Feed units per day.
FU = feed utilization in Scand. feed units per kg gain.

Change from restrictive to ad libitum feeding has lead to an increase in genetic variation in daily gain and to a reduction in the heritability of feed efficiency. As expected the genetic variation in daily feed intake is drastically influenced. The feeding system also affect the genetic correlations between daily gain and feed utilization and between daily gain and appetite.

Corresponding analysis have been made on data from the progeny test station for beef production. The feeding regime was concentrate ad libitum and the test period from 1 1/2 mt´s to 360 kg liveweight. The results presented in table 2 confirm the results from the performance test data.

Table 2. Genetic parameters on growth, feed intake and feed utilization calculated on progeny test data (Stockvisch, 1982)

	h^2	genetic SD
DG	0.46	66
AP	0.73	0.20
FU	0.33	0.15

Genetic correlations		
DG/FU	DG/AP	FU/AP
-0.40	0.62	0.47

DG = liveweight in grammes per day (1 1/2 mt´s - 360 kg).
AP = feed intake in kg drymatter/day.
FU = feed utilization in kg drymatter/kg gain.

Stokvisch (1982) also compared the effect of selection on indices containing growth rate (DG), growth rate + feed utilization (DG + FU) and growth rate + feed utilization + appetite (DG + FU + AP) respectively. The results indicated that the highest accuracy and the highest total economic responce was reached by selecting on an index containing all traits, when only beef production was concerned (table 3). In dual purpose breeds, however a high appetite might be valuable in itself as high appetite is of importance for the milk production. A closer study of these relations has therefore to be done in order to make a correct decision by which relative weight of appetite and feed utilization should be included in the selection of performance tested bulls.

Table 3. Genetic superiority by selection for various indices (i=1), (Stokvisch, 1982).

	Indices		
	DG	DG + FU	DG + FU + AP
DG (gr/days)	49.6	38.6	39.9
FU (kg DM/kg gain)	-0.05	-0.08	-0.10
AP (kg DM/day)	0.11	0.02	0.01

In order to evaluate the effect of genotype x feeding regime interaction, male progeny of 24 Holstein-Friesian sires were tested on four different diets. Each progeny group consisted of 24 young bulls assigned at random to four concentrate levels (100, 75, 50, 25 %). Roughage was given ad libitum and the indiviual feed intake was registated. Preliminary results from the experiment demonstrates that the effect of siregroup, year and diet on daily feed intake, feed conversion and growth rate are strongly significant, but no interaction between genotype and roughage/ concentrate ratio in the diet can be seen (table 4).

Table 4. Effect of genotype, energy level in diet and interaction on ˋed intake (AP), feed utilization (FU) and daily gain (DG).

		Level of significans		
Effect of	DF	AP	FU	DG
Year	3	0.0001	0.0001	0.0166
Sire (year)	20	0.0284	0.0090	0.0004
Diet (year)	16	0.0001	0.0001	0.0001
Sire x diet	76	0.3708	0.9933	0.9965

However feeding intensity and energy level have a great influence on the gentic correlations between appetite/daily gain and daily gain/feed efficiency (table 1 and 2) and therefore the feeding regime can be of importance when the relationship between appetite and efficiency of the bull and his female progeny has to be examined.

Performance test results of bulls related to progeny test results of daughters.

As shown in table 5 only the correlation between height of the performance tested bulls and height of the tested daughters is on an important level. Feed efficiency of the tested bull has no or very little influence on the daughters milk production index.

Table 5. Correlations between test results of bulls and progeny test results of their daughters.

	Individual performance test results			
Progeny test results (daughters)	Growth index	Ultrasonic index	SFU/ kg gain	Height
	Red Danish - n = 90:			
Butterfat-index	0.24	0.10	-0.14	0.17
Height	0.35	-0.22	-0.34	0.42
	Black and White Danish - n = 217:			
Butterfat- index	-0.02	-0.16	0.01	0.06
Height	0.12	-0.15	-0.11	0.49

In 1984 a comprehensive "lifecycle" efficiency experiment was started in Denmark with the purpose to investigate the genetic variation in appetite and feed utilization in growth and lactation, as well as the genetic relationships between those traits measured on young bulls, heifers and lactating cows respectively.

The experiment is based on progenies from 56 AI sires performance tested for growth, muscularity, appetite and efficiency. Male and female calves from the national test insemination programme are brought to the experimental stations at an age of 3-4 weeks. Half of each male progeny siregroups are tested on a concentrate diet ad libitum and the other half on a roughage diet ad libitum. The test period is from 1 1/2 to 11 mt´s of age, the feed intake is individually recorded and after the test all bulls are slaughtered and dissected into lean, fat and bone. The female progeny siregroups are divided into three subgroups each on three calves. The test period is from 1 1/2 mt´s of age to 300 kg live weight. The feeding regime for the three subgroups are low energy diet, medium energy diet and high energy diet fed ad libitum, and the expected average daily gain 500 grammes, 650 grammes and 800 grammes respectively. The feed intake is individually recorded. Six heifers from each of the siregroups are then tested in 250 days of lactation. Daily feed intake and milk yield are recorded and the energy mobilization is followed by regularly weighings and ultrasonic measurements. At the end of 250 days lactation the cows are slaughtered and dissected into lean, fat and bone. The outline of the experiment is summarized in table 6.

Table 6. Outline of a Danish "lifecycle" efficiency experiment. Male/ female halfsibs on test stations.

No. of siregroups	Male progenies (1 1/2 - 11 mt´s	Female progenies Rearing heifers (1 1/2 mt´s - 300 kg´s)	Female progenies Lactating cows (250 days)
56	a. (224) b. (224)	c. (168) d. (168) e. (168)	f. (336)

no. of animals in brackets.

a. Young bulls tested on a concentrate diet ad libitum.
b. Young bulls tested on a roughage diet ad libitum.
c. Heifers tested on a low energy diet ad libitum (500 g/day).
d. Heifers tested on a medium energy diet ad libitum (650 g/day).
e. Heifers tested on a high energy diet ad libitum (800 g/day).
f. Lactating cows tested on a high energy diet ad libitum.

The first 700 animals have started in the experiment and 65 cows are lactating. According to the plan, the experiment is finished in 1991 and no preliminary results are calculated.

References

Andersen, B. Bech, 1985. Consequences of the milk quotas for the breeding goals. a) Improving milk and beef production potential within the pure bred dairy/dual purpose cattle population. Proc. CEC Seminar Bruxelles EUR 10057 EN 191-199.

Andersen, B. Bech, Jensen, J. & Madsen, P., 1987. Performance testing of potential AI bulls for beef traits. In: Cattle Production Research. Danish Status and Perspectives. Landhusholdningsselskabets Forlag, Copenhagen 28-38.

Freeman, A.E., 1975. Genetic variation in nutrition of dairy cattle. In: Effect of genetic variance on nutritional requirements of animals. National Academy of Science. Washington DC. 19-46.

Gibson, J.P., 1986. Efficiency and performance of genetically high and low milk producing British Friesian and Jersey Cattle. Anim. Prod. 42, 161-182.

Mason, I.L., Robertson, A. & Gejlstad, B., 1957. The genetic connection between body size, milk production and efficiency in dairy cattle. J. Dairy Res. 24, 135-143.

Stockvisch, P., 1982. Relations between growth, feed intake and feed efficiency. National Institute of Animal Science, Copenhagen, 38 pp.

PERFORMANCE TEST RESULTS OF YOUNG BULLS IN RELATION TO FEED INTAKE AND EFFICIENCY OF FEMALE PROGENY

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Summary

Performance testing of young AI-bulls gives the possibility to select on feed intake in a breeding program. A selection experiment is going on for two generations in five years (five batches). Young performance tested bulls were selected on roughage intake. The weighted standardized selection differential applied was 2.54 in sires and dams were random. Data of progenies were recorded on young growing, pregnant and lactating heifers for intake, growth and milk yield. Data were partly available on one generation and included 202 young heifers and 127 pregnant and lactating heifers. Genetic parameters were estimated only for young heifers by paternal half-sib analyses. Feed intake characteristics had a heritability of about 0.50. Residual energy intake, energy intake adjusted for growth and metabolic weight, had a heritability of 0.25. Standardized selection responses for roughage intake in young, pregnant and lactating heifers were 0.28, 0.12 and 0.04. Roughage intake of lactating heifers adjusted for milk yield resulted in a standardized selection response of 0.13.
Keywords: feed intake, performance test, heritability, selection.

Introduction

Dairy farming has evolved into a specialized system for producing as much milk per cow as possible, without attention to nutritional inputs. Freeman (1975) concluded that selection for higher milk production automatically improves feed efficiency. This conclusion was based on results of the Beltsville trials (Hooven et al., 1972). They defined efficiency as the ratio of fat-corrected milk to energy intake. Because concentrates were fed according to milk production, the correlation between efficiency and fat-corrected milk might be expected to be high. Cows with high milk yields received relatively more concentrates; cows with lower milk yields received relatively more roughage. They reported a genetic correlation of 0.93, based on 305 daughter-dam pairs. Heritability was 0.56 for feed efficiency and 0.56 for fat-corrected milk. The value for fat-corrected milk is rather high compared to other literature sources. Huizinga et al. (1986) have shown that daughter-dam estimates were higher generally than paternal half-sib analyses.

Besides feed efficiency, feed intake is an important trait. In the first part of lactation, intake of nutrients, especially energy and protein, does not meet requirements of the high yielding dairy cow. This negative energy balance could be reduced by increasing density of the diet by a higher proportion of concentrates. There are limitations to the density of the feed because approximately 30% of the dry matter should be long roughage to enable the rumen to function normally. Gravert (1984) showed results of 32 sets of monozygous twins with 96 lactations. Cows were fed a mixed ration of roughage and concentrates ad libitum. Heritability of energy intake during the initial 20 weeks of lactation was 0.16 and its genetic correlation with milk production was only 0.12. Results suggested that selection on milk yield would not automatically increase feed intake of dairy cows in the first part of lactation. In circumstances with feeding concentrates according to milk yield this genetic correlation was 0.86 on a total lactation basis (Hooven et al., 1972).

Performance testing of young AI-bulls gives a possibility for selection on feed intake in a breeding program. In 1982/1983 a selection experiment on feed intake started with the following objectives :

- To estimate the relationship between young performance tested potential A.I. bulls and female progeny during growth and lactation for traits feed intake, residual feed intake and efficiency on an ad libitum feeding system without feeding concentrates according to production.
- To study relationship between feed intake and efficiency traits of young (growing), pregnant and lactating cows.

This selection experiment will be carried out during two generations and has in total 5 batches. A batch is defined as the group of animals in one year. At this moment we have only data available of partly 1 generation and this includes 3 batches of young heifers and 2 batches of lactating animals. The numbers of lactating animals are small so we will pay most attention to the preliminary results of young heifers.

This paper was focussed on the analysis of feed intake, residual feed intake, efficiency and production characteristics:

- Estimation of direct and correlated responses of the divergent selection for roughage intake of young potential A.I. bulls.
- Estimation of genetic parameters on basis of progeny groups of young heifers.

Material

The sires had been tested in a central station on a diet with concentrates supplied according to age and roughage (hay) ad libitum. Data are normally gathered on daily gain, feed intake and thereby on feed conversion between 120 and 365 days age and fleshiness at 365 days.

Young performance tested bulls were chosen for this selection experiment on the basis of their feed intake performance. For the 5 batches of this selection experiment 38 sires were selected in two groups, one each with a high or a low feed intake. Contrasts for roughage dry matter intake between the two sire groups varied between a proportion of 25 and 40 of the average of all the sires. Sires were used in more than one year to eliminate year effects. Sires varied in proportion of Holstein Friesian genes from 0 to 100. Inseminations with semen of each sire were randomly carried out on dairy cows of the experimental unit of the Agricultural University. These cows also varied in proportion of Holstein Friesian genes. The selection experiment is more extensively described by Korver & Vos (1986).

The three available batches of 202 young heifers for the analysis originated from 24 sires. The phenotypic selection differential applied between 12 sires with a high feed intake and 12 sires with a low feed intake was 2.76 phenotypic standard deviation units (S/σ_p) dry matter roughage intake. When weighted for number of progenies per sire, the "effective" selection differential was 2.54 units phenotypic standard deviation. For analysis, two batches of pregnant and lactating heifers were available, consisting of a total 127 animals. Weighted selection differential was 2.42 standardized phenotypic standard deviations dry matter roughage intake.

The individual feed intake of the young heifers, and thereby feed conversion, was measured at 44, 48, 52 and 60 weeks of age. Body weight was recorded at start and finish of each measuring week. The diet consisted ad libitum roughage (hay) and no concentrates.

Body weights of pregnant and lactating heifers were recorded monthly and milk production (including components) weekly. Feed intake was measured individually during weeks 35 and 36 of pregnancy and eight weeks during the first 15 weeks of lactation. The diet was ad libitum roughage (grass silage) and 1 kg per day concentrates during pregnancy per day. During lactation, cows were offered a fixed amount of 6 kg concentrates, independent of milk production level, and ad libitum roughage. Energy and crude protein content of the diet were analyzed weekly.

Methods

The following model was used to estimate parameters for the different traits:

$$y_{ijklm} = g_i + cr_j + js_k + s_l + e_{ijklm}$$, where

y_{ijklm} = observation
g_i = effect of selection group i (i=1,2)
cr_j = effect of crossbred group j (j=1,4;j=0%, >0-40%, >40-60% or >60% Holstein Friesian genes)
js_k = effect of year-season k (k=1,12 or 1,8)
s_l = random effect of sire l

Year-season classes were defined as four periods per year according to birth (young heifers) or calving (lactating cows). Periods for each group were : December - January, February, March, and April - May. For sires $E(s_k)=0$ and $var(s_k)$ was σ^2_s; for errors $E(e_{ijklm})=0$ and $var(e_{ijklm})$ was σ^2_e. Relationships among sires were included. Sire variance components were estimated by an univariate REML algorithm described by Meyer (1986). The selection groups could have a downward effect on the estimate of variance component. Covariance components were obtained from a multitrait equal design REML algorithm (Meyer, 1986) by analyzing two traits simultaneously. Iteration was stopped when change between rounds was smaller than 1%.

The model was adapted for calculation of residual feed intake as defined by Koch et al. (1963). In young heifers residual feed intake was energy intake adjusted for daily gain and metabolic weight. These two covariables were added to the model. This trait reflects differences between animals in using metabolizable energy for maintenance and growth. For lactating heifers, metabolic weight and fat protein corrected milk (Korver, 1982) were added as covariables.

Results and discussion

Young heifers

Heritability of feed intake of young heifers at an age of 44-60 weeks was 0.55 from half-sib analysis (table 1). This estimate was adjusted for proportion of Holstein Friesian genes of the heifers and year-season. Adjustment of roughage intake for differences in metabolic weight changed heritability of dry matter intake from 0.55 to 0.17. Residual energy intake, ME intake adjusted for growth and metabolic weight (maintenance requirement), had a heritability of 0.25. This reflects genetic differences between animals in efficiency of using metabolizable energy for growth and maintenance. Andersen (1980) showed within breed variation in maintenance requirements of beef bulls and calculated a heritability of 0.31 on a limited data set.

Table 1. Overall mean, contrasts between selection group (Low - High), standardized selection response (R/σ_p) and heritability (h^2) (s.e.) of traits of 202 young heifers.

	Mean	Contrast	R/σ_p	h^2
Roughage intake (kg dm/day)	6.42	-0.17	-.28	.55(.26)
Roughage intake (g dm/day.$W^{3/4}$)	88.9	-1.7	-.24	.17(.21)
Energy intake (ME kJ/day)	62030	-1678	-.28	.58(.27)
Daily gain (g/day)	638	-53	-.63	.31(.22)
Average live weight (kg)	301.0	-3.0	-.16	.53(.26)
Feed conversion (ME kJ/g)	101.0	+6.7	+.40	.43(.24)
Fleshiness at week 60	7.1	-0.17	-.24	.51(.26)
Fatness at week 60	5.7	-0.17	-.22	.55(.27)
Residual intake (ME kJ/day)	62030	-331	-.07	.25(.27)

The observed contrast between two selection groups for roughage intake was 0.17 kg dry matter intake per day in the period of 44-60 weeks. This contrast was most expressed in week 60. Contrasts in the different weeks of measurements were : week 44, 0.02: week 48, 0.15: week 52, 0.24: and week 60, 0.29. The standardized phenotypic selection response (R/σ_p) was 0.28 units phenotypic standard deviation, compared with the standardized weighted selection differential of 2.54 in the sires while the dams of the young heifers were random. This computes to a heritability of 0.22, assuming that roughage intake of the young potential A.I.bull and the young heifer are the same trait. This assumption is questionable because of differences such as age of measuring of animals, sex and feeding regime. Heifers were measured at 310 to 420 days of age and young bulls were measured at 120 to 365 days of age. Van der Werf et al. (1987) analyzed data of the performance test stations and estimated a heritability of 0.29 for roughage intake of young sires. This calculation was based half-sib groups.

Heritability of daily gain was 0.31. This figure corresponds with several literature sources (e.g. Andersen et al. 1981). The correlated standardized response was 0.63. Heritability of feed conversion was 0.42 and the genetic correlation between feed conversion and daily gain was-0.72 (table 2). Comparable results were found for young performance tested bulls (van der Werf et al., 1987). Roughage intake and body weight had a genetic correlation of 0.99. This was higher than the genetic correlation of performance testing bulls at 120 to 365 days of age (0.54).

Table 2. Phenotypic (above diagonal) and genetic (below diagonal) correlations between feed intake and efficiency traits of young heifers (age 40-60 weeks).

Trait	1	2	3	4
1 Roughage intake		.58(.05)	.25(.07)	.35(.07)
2 Body weight	.99(--)		.08(.08)	.28(.07)
3 Daily gain	.19(.50)	.27(.49)		-.76(.03)
4 Feed conversion	.54(.36)	.38(.42)	-.72(.26)	

Table 3 shows Best Linear Unbiased Estimates for feed intake and efficiency characteristics of young heifers, depending on the proportion Holstein Friesian (HF) genes.
This proportion had a clear influence on feed intake and daily gain. A higher proportion of HF genes in the heifers resulted in a higher feed intake and daily gain.

Table 3. Best Linear unbiased estimates of feed intake and efficiency traits of young heifers (age 40-60 weeks) with different proportion of Holstein Friesian genes.

	Proportion Holstein Friesian genes			
	0%	>0-40%	40-60%	>60%
Roughage intake (kg dm/day)	6.29	6.39	6.47	6.52
Roughage intake (g dm/day.$W^{3/4}$)	89.7	88.1	88.2	89.0
Energy intake (ME kJ/day)	60750	61780	62590	62870
Daily gain (g/day)	611	641	657	641
Feed conversion (ME kJ/day)	103.2	100.0	99.0	102.0
Body weight (kg)	289.3	302.0	306.4	306.3
Residual intake (ME kJ/day)	63239	61583	61362	61936

Lactating heifers

Preliminary results of pregnant and lactating heifers are in table 4. Roughage dry matter intake per day was significantly lower for progenies of sires with a low roughage intake than for progenies of sires with a high roughage intake. The selection response, as a proportion of the phenotypic standard deviation, was 0.12 during pregnancy. The value for young heifers was 0.28. This response decreased from pregnancy to lactation from 0.12 to 0.05. One reason for the observed differences for feed intake between pregnancy and lactation could be the physiological status and milk production of the animal. Growth and lactation are different biological processes. Progenies of "low" sires produced more milk than progenies of "high" sires despite of the comparable pedigree breeding values of the sires as young AI bulls.
Adjusting the values of roughage intake by milk yield in the first 15 weeks resulted in a response of 0.13 as a proportion of the phenotypic standard deviation. The adjusted contrast was 0.11 kg dry matter intake of roughage per day. This result was comparable to the pregnancy period.

Table 4. Overall mean, contrasts between selection groups (Low-High) and standardized selection response (R/σ_p) for traits of pregnant and lactating heifers.

	mean	contrast	R/σ_p
Pregnant heifers weeks 35 + 36			
Body weight (kg)	523.0	-11.7	-.36
Roughage intake (kg dm/day)	8.30	-0.12	-.12
Energy intake (ME kJ/day)	85840	-1310	-.12
Lactating heifers weeks 1 to 15			
Body weight (kg)	482.8	-12.3	-.40
Roughage intake (kg dm/day)	9.34	-0.04	-.05
Energy intake (ME kJ/day)	159817	50	+.01
Residual intake (ME kJ/day)	159817	469	+.06
Milk (kg/day)	17.9	0.5	+.23
Fat %	4.17	0.00	---
Protein %	2.93	0.00	---
Fat Protein Corr. Milk (kg/day)	17.7	0.4	+.20
Feed conversion (FPCM/ME)*1000	.189	0.006	+.24

References

Andersen, B.B., 1980. Feeding trials describing net requirement for maintenance as dependent on weight, feeding level, sex and genotype. Ann. Zootechn. 29: 85-92.

Andersen, B.B., A. de Baerdemaeker, G. Bittante, B. Bonaiti, J.J. Colleau, E. Fimland, J. Jansen, W.M.E. Lewis, R.D. Politiek, G. Seeland, T.J. Teehan & F. Werkmeister, 1981. Performance testing of young bulls in AI: report of a working group of the commission on cattle production. Livest. Prod. Sci. 8: 101-119.

Freeman, A.E., 1975. Genetic variation in nutrition of dairy cattle. In: The effect of genetic variation on nutrition of animals. National Academy of Science. Washington: 19-46.

Gravert, H.O., 1985. Genetic factors controlling feed efficiency in dairy cows. Livest. Prod. Sci. 12: 87-99.

Hooven, N.W., R.H. Miller & J.W. Smith, 1972. Relationships among whole- and part-lactation gross feed efficiency, feed consumption and milk yield. J. Dairy Sci. 55: 1113-1122.

Huizinga, H.A., S. Korver, B.T. MacDaniel & R.D. Politiek, 1986. Maternal effects due to cytoplasmic inheritance in dairy cattle. Influence on milk production and reproduction. Livest. Prod. Sci. 15:11-26.

Koch, R.M., L.A. Swiger, D. Chambers & K.E. Gregory, 1963. Efficiency of feed use in beef cattle. J. Anim. Sci. 22:480-494.

Korver, S.,1982. Feed intake and production in dairy breeds dependent on the ration. PhD. thesis, Agr. University, Wageningen, The Netherlands.

Korver, S. & H. Vos, 1986. Selection on feed intake in dairy cattle. 3rd World Congress on Genetics applied to Livestock Production. Lincoln, Nebraska. pp. 285-290.

Meyer, K., 1986. Restricted Maximum Likelihood to estimategenetic parameters in practice. 3rd World Congress on Genetics Applied to Livestock Production. Lincoln, Nebraska. 454-459.

Van der Werf, J.H.J., A. Veldhuizen & S. Korver, 1987. Relationship between young AI-bulls characteristics and milk yields. EAAP-seminar no. 34, Wageningen, The Netherlands.

RELATIONSHIP FOR GROWTH AND INTAKE BETWEEN YOUNG BULLS AND DAUGHTERS

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Summary

In winter 1984/85 a field test was carried out, where the cattle owners measured during 4 consecutive days feed consumption of 1001 heifers of 44 Finnish Ayrshire sires. Among those sires 34 had been on feed consumption control during their performance test. Measuring stage in farms was 60-150 days after calving (average 101 days). Test period was in the same week than milk recording and milk production was on average 20.4 kg/d. Live weight at first calving ranged from 304 kg to 614 kg and heifers' dry matter intake ranged from 0.5 kg/d to 22.8 kg/d with an average of 15.1 kg/d which is equivalent with 3.3 kg per one hundred kg live weight. Heritabilities and their standard errors for feed intake and milk production were .07 (.053) and .14 (.066) respectively and the genetic correlation was .60 (.266). There were differences in daily feed consumption between the sire groups but relations to the sires' own feed consumption data were weak.

Introduction

Feed intake and feed conversion efficiency are very variable traits as well in milk as beef production. Many studies have found that these traits are inheritable with reasonably high heritabilities (Gravert, 1984). So the selection for feed intake or feed efficiency could be profitable although measuring is laborious and expensive. Therefore most breeders consider it more profitable not to include these traits in a breeding program.

In Finland there is only one performance test station for bulls and none for progeny testing. In winter 1984, a field test was carried out to measure feed consumption during the first lactation. The main purpose of this study was to look at the possibilities of collecting this kind of data from farms and to estimate genetic parameters in the Finnish Ayrshire population.

Material and methods

About 1700 farmers were asked to participate in the test. 1841 heifers of 44 young bulls, used in A.I. during 1980-1981, were available at these farms. Heifers had calved between 15th August and 15th December 1984. So it would be possible to get information of their feed consumption during 4 consecutive days in the period from 60 up to 150 days after calving. The owners weighted the feed on these four consecutive days. The test period was arranged in the same week as the milk recording day. Live weight was estimated by measuring at first calving. The traditional feeding system in Finnish dairy herds is feeding according to production level and live weight. Owners had got instructions to feed their heifers just as they usually did.

We gathered records of about 1300 heifers' feed consumptions from which 299 were eliminated for different reasons. Main reason (242 heifers) was over- (>130%) or underfeeding (<70%) compared to the norms; 0.4 f.v./1 kg FCM and 4.0 f.v. * live weight $^{.75}/500^{.75}$.

Therefore the size of the test material was 1001 heifers. Feed consumption was measured between 60-150 days after calving with an average of 101 days (range 60-150 d, s.d. 15.9) and calving age was about 26 months (22-35, s.d 2.4).

Proportions of grass, hay, and concentrates intake in dry matter were 37.6, 21.6, and 38.5% respectively and the consumption rate roughage: concentrate was 59:41. The quality of roughage, hay and grass silage was reasonable.

Phenotypic correlations were calculated both by regression of the sire on daughter and regression of sire on daughters mean. Genotypic correlations and heritabilities were calculated by regression of sire on daughter for FCM, dry matter intake and live weight in the heifer material. Only the sire was included in a model. Stepwise regression analysis was used in order to study the non-genetic factors affecting the intake of the heifers.

Results and discussion

Bulls in performance test

During 1979-1980 an experiment, which measured in addition to the standard procedure feed consumption, was carried out at the performance test station in a two-week period with bulls of 5, 7 and 9 months of age. Therefore total consumption during the performance test (from 3 to 12 months) was not obtained. 34 of the 44 sires with daughters took part in this consumption control.

Table 1. Growth and feed intake results of 34 Finnish Ayrshire bulls in a performance test station at different ages (mean, s.d.).

Age	5 month		7 month		9 month	
Live weight, kg	148	16.7	207	19.5	283	23.8
Feed intake, kg/d	4.3	.41	6.1	.61	8.2	.61
Hay, kg/d	1.8	.34	2.7	.53	3.9	.56
Growth rate, g/d	863	191	1209	128	1272	146

Table 1 presents growth results which are averages of three months of age; 4-6, 6-8 and 8-10 months. Growth rate of the whole test period (3-12 months) was 1115 g/d. Average hay consumption was at different ages 42, 45 and 47% of average dry matter consumed. At the station was during the testing time (1979-1980) a pneumonia epidemic and growth rate was clearly hampered.

Table 2. Phenotypic correlations between dry matter intake at different ages, live weight and growth rate of 34 Finnish Ayrshire bulls in a performance test.

	Intake			Live weight				Growth rate			
Age - month	5	7	9	5	7	9	12	5	7	9	3-12
Intake hay 5	.95	.54	.47	.63	.61	.63	.48	.54	-	-	.35
7	.54	.97	.51	.51	.52	.55	-	.40	-	-	-
9	.47	.49	.97	-	-	-	-	.46	-	-	-

Only statistical significant correlations ($p < .05$) given.

The phenotypic correlations between the growth rate of the whole period and weights at 5, 7, 9 and 12 months of age were significant; .46, .58, .64 and .91 respectively. Lampinen (1987) found similar results in Ayrshire material (1977-1985) with 1408 bulls and 60 sires. Heritabilities for growth rate and the weights at 3, 6, 9, 11 and 12 months were in that study .52 (.11), .25 (.07), .25 (.07), .49 (.10), .50 (.10) and .50 (.10) respectively. The material (34 bulls) was to small for genotypic calculations.

In table 2 correlations between intake and live weight were quite high. The size of an animal and/or the size of his digestive traćt will determine the dry matter intake. But still there were poor and good consumers with the same weight and many bulls seem to grow respite of 'underfeeding' and vice versa. Repeatability of feed intake from one age to another was weak.

Heifers in farms

Table 3. Milk production (FCM), live weight (LW) and feed intake (DMI) of 1002 Finnish Ayrshire heifers.

	Mean	S.D.	Range
FCM, kg	20.4	3.6	10.8 - 31.6
Fat %	4.4	.54	2.5 - 6.9
Protein %	3.1	.23	2.4 - 3.9
DMI, kg/d	15.1	1.9	9.5 - 22.8
DMI/.01*LW	5.3	.4	2.0 - 4.1
LW, kg	457	42	304 - 614

Feed consumption in feed units was .62 f.v./FCM kg (.41-.91). The number of cows per herd was 16 and their milk production varies from 3699 to 9791 kg FCM with an average of 6174 kg FCM. In 1984 the production level in milk recording was very similar, 12.8 cows per herd and 6032 kg milk in average.

Mostly, the test period (60 ... 150 days after calving) is responsible for the range in the milk production (table 3). Most important factors affecting the dry matter intake (DMI) of a heifer were milk (FCM) and live weight (LW). According to Lehtinen (1986) regression equation was:
DMI = 4.48 + .26 (.014) * FCM + .01 (.001) * LW.(R**R = .35).

This is in good agreement with the correlations of table 4.

Table 4. Heritabilities (diagonal), phenotypic (above) and genotypic correlations for dry matter (DMI), milk production (FCM), and live weight of 1002 Ayrshire heifers (mean s.e.).

	DMI		LW		FCM	
DMI	.07	.053	.38		.54	
LW	.75	.139	.42	.114	.25	
FCM	.60	.266	.38	.217	.14	.066

Sire - offspring

Phenotypic correlations between sire and his offsprings' feed intake were statistically non significant, -.01, -.33 and -.19 for 5, 7 and 9 months of age respectively. There was only a significant correlation between sires' feed consumption at 5 months of age and offsprings' live weight: .44.

Sire's final weight (12 months) was significantly correlated with his offsprings' feed intake (.33).

Possibilities to estimate a cows' feed intake in milk production on the basis of her sires feed consumption in the performance test seems to be insufficient. But the material is small and circumstances at the performance test station were not ideal for any kind of test.

When and how long time has to be to control feed intake are very important questions. According to Leukkunen (1985) control period should not be more than four days. Leukkunen admits that information collected on farms is never so precise and therefore in practice the period should be more than four days. But if the period is to long it will be hard to find herds to start a test. Another possibility is to concentrate on a performance test where feed intake for beef production is measured.

References

Gravert, H.O., 1984. Genetic factors controlling feed efficiency in dairy cows. 35th EAAP-meeting, The Hague. 6N4.4.

Lampinen, A., 1987. Growth rate and its evaluation among dairy A.I. bulls. Manuscript, Helsinki University, Dept. of Animal Breeding.

Lethinen, R., 1986. Dry matter intake of a cow and factors affecting on it. Manuscript, Helsinki University, Dept. of Animal Science.

Leukkunen, A., 1985. Four days' feed consumption as a predictor for a whole lactation period. Manuscript.

PERFORMANCE TEST RESULTS OF THE BULL AND FEMALE PROGENY REGARDING CALVING RESULTS, GROWTH AND MUSCLING.

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Summary

The genetic relationship between station performance test results and the direct and indirect calving results were investigated using data from the Fleckvieh population in Bavaria. For the direct effect antagonistic relationships were found between growth of the sire and the calving results of the calves the sire produced. The calving ease scores of the daughters were in most cases not unfavorably correlated with the performance test results of the sire, since larger sires produce also larger daughters. For the different parity groups, the correlations varied to a certain extent, partially due to very low heritability estimates for some calving traits. Several body measurements showed the same tendency as 420-day-weight or gain during the test period.

The genetic correlation between performance test results of the sire and measurements and classification scores of their daughters were calculated for the data from 1980 to 1986 using 208 sire-progeny groups. For withers height a genetic correlation of +0.90 was found, showing a good agreement. Chest girth and muscularity score showed a less pronounced correlation (+0.62 resp. +0.34). Since the daughters are classified 3 to 5 month after calving, the evaluation of muscularity may be influenced by the stage of lactation. The genetic correlations between the body measurements of the sire and the daughters were in most cases as expected.
Keywords: Cattle, performance test, dystocia, female growth, genetic parameters, antagonism

1. Introduction

The Fleckvieh breed is in Southern Germany and in parts of Austria and Switzerland the dominant breed, which is selected as a meat-pronounced dual purpose breed. Selection programs are applied to improve beef and dairy traits through performance and progeny testing. Recording of calving performance is incorporated in the dairy-recording system, where the farmer answers questions about the birth process of heifers and cows in 28-day intervals. The antagonistic effects between growth of the sire and calving performance of his calves' respective daughters have been investigated (Binder, 1986). In the routine progeny testing program of AI-bulls, 50 daughters are classified three to four months after calving by coworkers of the institute. Evaluation of physical soundness and scoring of stature, form, muscularity and udder is conducted. Body measurements are also recorded, which are used to estimate live weight. The relationships between the performance test of the sire and calving traits as well as classification traits are presented in this study. Population parameters used are described in more detail by Averdunk & Binder (1986).

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2. Material and methods

2.1 Calving traits.

Calving performance data are recorded for survival and calving assistance separately and also for gestation length. Survival includes the following scores: surviving, stillborn, dead within 48 hours p.p., and dead after 48 hours p.p. Calving assistance is recorded as no help, one person, two or more persons helping, veterinary assistance and operation (caesarean or embryotomy).

Data from 2.458 mil. calvings during 1972 - 1980 were used to estimate genetic parameters for direct, indirect and maternal effects. The traits were analyzed as all-or-none traits, separately for parities 1, 2 and all others, using mixed-model procedures (Harvey, 1977) and the following systematic effects: sex of calf, year, season, region and calving age as a covariate with linear and quadratic terms. Heritability estimates for direct and indirect effects were derived, using the above model and the terminology of Willham (1963). The covariance between the direct and the maternal component was derived from the regression of daughters records upon paternal records, which were weighted by the inverse of the variance due to differing numbers of observations, as proposed by Rutzmoser (1977). Heritabilities for maternal components were also derived.

Genetic correlations between the performance test result of the bull and his paternal and indirect calving records were derived from the product-moment correlations between breeding values, which were computed after correction for systematic effects, by applying the heritabilities from the whole data set. A minimum of 20 calving records per parity was required to be included in the analysis, which led to the structure in table 1. Approximate standard errors for genetic correlations were calculated using the formula from Robertson (1972), quoted by Bar-anan(1973).

Table 1: Number of sires and progenies for genetic correlations between performance test and calving traits.

	paternal		indirect	
Parity	no.sires	no.calvings	no.sires	no.daughters
1	650	41.4	509	60.5
2	747	48.7	413	46.5
3 or more	750	92.7	316	63.4

2.2 Measurements and scores of daughters.

Classification data with comparable information were available for 1981 to 1986, including 58,910 daughters from 1,962 sires. Scores for stature and conformation or muscularity on a 9-point scale and measurements of height at withers, chest girth and body length (withers to hooks) were analyzed. Effects for sires within classifiers, year-season, age of calving and evaluation date after calving as covariates were fit using mixed model techniques (Harvey, 1977). The traits were then corrected for the systematic effects and the phenotypic correlations with the performance test traits were calculated using 208 sires with an average of 43.97 daughters. The genetic correlations were derived from the product-moment correlations, using the population parameters.

3. Results

Heritablities used and the genetic correlations between performance test results of the sire and the paternal calving data are given in table 2 for some selected trait combinations. In general there is an antagonistic effect between higher weight or gain of the sire and the calving ease of the calves produced. The relationship between sire performance traits and the surviving rate of his calves ranged from no relationship to -.36, with the highest correlation usually occurring for third and later parities. Also, there seems to be no weight independent body measurement which could be used as a restriction criterion. The results between parities seem to vary, but are within the limits of their standard-errors; some deviations for the second parity are caused by very low heritabilities for the direct calving trait. There is also no divergent relationship for external width measurements, except the rather uniform tendency that broader animals lead to decreasing gestation length.

Table 2: Genetic correlations between performance traits of the sire and calving records of his calves (paternal or direct effect)

			Trait of the calves of the sire: Surviving rate	Death rate	Assistance >= 2 men	Veterinary support	Gestation length
		Parity:	Heritability:				
Trait of		1	.04	.03	.09	.05	.41
sire:		2	.03	.03	.09	.01	.41
	Heritability	3+	.02	.02	.10	.01	.39
420 day		1	-.13	+.24	+.19	+.34	-.00
weight	.35	2	+.03	+.01	+.21	+.62	+.03
		3+	-.36	+.30	+.13	+.39	+.00
Gain		1	-.17	+.29	+.16	+.24	+.01
112-420	.35	2	-.04	+.02	+.17	+.51	+.01
days		3+	-.31	+.16	+.08	+.28	-.03
Withers		1	-.10	+.10	+.31	+.27	-.00
height	.34	2	-.09	+.04	+.19	+.18	+.01
		3+	-.30	+.16	+.22	+.22	-.02
Round		1	-.04	+.12	+.05	+.08	-.10
circum-	.33	2	+.03	+.05	+.02	+.34	-.04
ference		3+	-.23	+.21	+.10	+.22	-.10
Chest		1	-.14	+.13	+.13	+.01	-.11
width	.28	2	+.17	-.08	+.27	+.52	-.07
		3+	-.15	+.15	+.12	+.14	-.14
Hip		1	-.12	+.17	-.04	+.24	-.20
width	.16	2	-.10	+.16	+.29	+.53	-.12
		3+	-.36	+.12	+.32	+.30	-.16

SE (r(g)) = 0.07 to 0.25

The genetic correlations for the indirect effects (daughters calving performance) are given in table 3, which also contains the heritabilities used. These results are less uniform, compared with those in table 2, and were partially affected by very low heritabilities for the indirect calving traits (especially parity 2). Since the correlations between direct and maternal effects of the calving traits were in most cases negative (Binder, 1986), the signs of the genetic correlations with the performance test data are also reversed. The antagonistic tendencies are less pronounced, if at all observable, since selection for higher weight leads to larger body dimensions of the daughters. The correlation of the indirect calving traits with hip width indicate that a broader hip does not automatically lead to a wider pelvic opening. Internal pelvic dimensions provide more accurate information (Holzer 1983), but they are also complicated to collect.

Table 3: Genetic correlations between performance test traits of the sire and calving records of his daughters (indirect effect)

			Traits of daughters				
			Surviving rate	Death rate	Assistance >= two men	Veterinary support	Gestation length
		Parity:		Heritability:			
Trait of		1	.03	.03	.09	.04	.13
sire:		2	.01	.02	.09	.01	.13
Heritability:		3+	.02	.02	.14	.02	.15
420-day		1	+.06	-.11	+.04	+.08	-.02
weight	.35	2	-.06	+.08	+.10	-.24	-.02
		3+	+.38	-.41	+.00	-.20	+.02
Gain		1	+.04	-.06	+.08	+.01	-.02
112-420	.35	2	-.11	+.22	+.10	-.40	-.05
days		3+	+.19	-.41	-.01	-.31	-.03
Withers		1	-.04	-.03	+.04	+.03	+.02
height	.34	2	-.22	+.25	-.02	+.40	+.14
		3+	+.08	-.10	+.14	+.01	+.12
Round		1	+.09	-.08	-.05	+.10	-.02
circum-	.33	2	+.02	+.10	-.02	+.00	-.00
ference		3+	+.25	-.07	+.03	+.04	+.12
Chest		1	-.14	-.00	+.26	+.24	+.00
width	.28	2	+.76	-.44	+.14	+.31	-.17
		3+	+.83	-.90	+.18	+.01	-.22
Hip		1	-.22	+.14	+.14	-.07	+.03
width	.16	2	+.22	-.10	+.17	+.66	-.03
		3+	+.09	-.58	+.40	+.32	+.31

SE (r(g)) = 0.09 to 0.45.

For the comparison of the daughters' evaluation with their sire's performance test, the heritabilities for the data from 1980 to 1986 were also used for the test station results (table 4). A subjective conformation or muscling score also is included. These recent estimates were somewhat lower than those from the combined data, used in table 3. Height at withers of the sire at 14 months resulted in the highest genetic correlation with the same trait of the daughters at 31 months of age. Since the stature score is closely related to height, it is not surprising that the correlation is of the same magnitude. Chest girth had a genetic correlation of +.62, which is reasonable, considering that the daughters are measured shortly after peak lactation. De Roo & Fimland (1983) found this correlation to be +.56 using Norwegian Red Cattle and Friesian sires from three other countries. Their genetic correlation for height at withers was also lower than in this study (+.79 vs. +.90). The highest relationship for gain on test was with chest girth, as was expected, but the relationship (+.29) is rather low. The relationship between growth and chest girth for the De Roo & Fimland study was +.40.

Table 4: Genetic correlations between performance test traits of the sire and scores and measurements of daughters. (208 sires with 43.97 daughters).

		Traits of daughters:				
		Stature score	Muscularity sc.	Withers height	Chest girth	Body length
Trait of sire:	Heritability:	Heritability: .36	.29	.38	.35	.41
Gain on test	.32	+.10	+.15	+.11	+.29	+.17
Withers height	.30	+.85	-.13	+.90	+.26	+.52
Chest girth	.33	+.11	+.33	+.11	+.62	-.01
Round circumf.	.19	+.28	-.04	+.32	+.22	+.10
Tour spiral	.23	+.30	+.11	+.30	+.48	+.20
Chest width	.34	-.15	+.35	-.13	+.25	-.11
Hip width	.25	-.27	+.16	-.25	+.06	-.14
Muscularity score	.37	-.28	+.34	-.33	+.22	-.22

While the muscularity score of sire and daughters had a genetic correlation of +.34, some antagonistic effects of this score with size were obvious. The round circumference of the sire was not related to the muscularity score of the daughters, but the tour-spiral was found to have a positive relationship to chest girth and body length, which should be expected since it is the best measurement of body dimensions. It is also worth mentioning that chest width had a higher positive relationship with daughter's muscularity score than to hip width. The cross-relationship with milk production might explain some of these results, but further investigation is necessary.

4. Discussion

The relationships between performance test traits of bulls and the direct and indirect components of calving ease were investigated on a rather large sample of sires under field conditions. For this study, only the calving results from test matings were used to avoid the effect of disassortative matings, which are frequently used by producers trying to avoid dystocia problems. One disadvantage of this requirement is that the number of progeny per parity is small (on average 40-90), which affects the estimates of the genetic relationships. Also, a quantitative trait like birth weight was not available.

The results indicate that unfavorable genetic correlations between growth and calving ease were more pronounced for direct effects than for indirect effects.This antagonistic effect between paternal calving traits and performance traits of the sire was also found in an earlier study with part of the data (Osterkorn et al. 1977). Similarly, Gaillard's (1980) analyses indicated positive correlations for direct effects between production traits (height at withers, chest girth and growth rate) and calving performance traits (calving difficulty and birth weight) for heifers and cows. The investigated external body measurements showed no pronounced, weight independent relationship with calving ease and a multiple regression approach did not, in contrast to the results of Hässig et al. (1980), increase the correlations. However, these authors had the measurements from the heifers themselves.

The report of an E.E.C./E.A.A.P. working group suggested three possible breeding strategies, the choice of which naturally depends on each particular production system and seriousness of the problem (Philipsson et al., 1979). The methods included: 1) differential use of bulls on heifers vs. cows, 2) selection of bulls for calf effects and 3) selection for dam effects. Hanset (1981) has shown, that the rate of total progress for calving ease depends upon the ratio of the genetic variance of the maternal to the direct component and the correlation between both. Since the variance for the maternal component is only slightly less than the direct component and the correlation between both is between -0.25 and -0.40 for the traits shown here, an index for improvement of calving ease should be used, according to the results of Hanset (1981).

Calving ease should be included in a selection index of AI-bulls to be applied for the different sources of information for beef traits in the Fleckvieh breed (Averdunk 1984). Studies of the economic weight for calving ease should also consider the side-effects of calving difficulties, including a higher culling rate after the first parity, a higher insemination index, a longer calving interval and a lower milk yield, as recent investigations with Holstein-Friesians from the United States and with Fleckvieh in Bavaria have shown (Djemali, 1985; Sauerer et al., 1987). As with most secondary traits, inclusion of calving ease in the selection program calls for larger progeny groups in the active population. Daughter groups of 120 to 150 may result in breeding values with higher precision, which are also required for maternal fertility and stayability.

Selection based on the results of performance tests of bulls is also increasing the size of the adult animal, which is to some extent demonstrated with the comparison of measures on daughters after calving. The antagonistic relationship between growth and body size of the sire, and surviving rate and calving scores of his calves is reasonable given that Simmental calves larger at birth tend to also be larger at later ages (Burfening et al., 1981). While size showed a very close relationship, the correlations between measures of weight were less pronounced. One reason for this result can be that the evaluation time three to five months after calving is rather unfavourable to estimate the real weight of an animal. On the other hand, the 420-day weight may be correlated to a lesser degree with adult weights, as compared to longer testing periods. Flatnitzer et al. (1969) found lower correlations between first calved cows and their male half sibs for weight and gain compared with heifers. Also an increase of the relationship was found with increasing age of the male half sibs. Without further investigations on muscularity-scores and chest girth, the results should not be interpreted as genotype x sex or genotype x age interactions.

References

Averdunk, G., 1984. Progeny testing in the Federal Republic of Germany. In: IDF-Bulletin, Document 183 p. 59-79 ISSN 0250-5118.
Averdunk, G. & C. Binder,1986. Relationship between performance test results of the sire and direct and indirect calving traits in German Simmental. In: 3rd World Congress on Genetics applied to Livestock Production Vol IX, p. 431-436 ISBN 0-9616828-0-9.
Bar- anan, R.,1973. Breeding aspects of difficult calving and calf progeny characters. Ph. D. Thesis, University of Reading.
Binder, C.,1986. Merkmalsantagonismus zwischen Mastleistung und Körpermaßen von Bullen und dem Abkalbeverhalten ihrer Töchter. Diss.TU Berlin
Burfening, P.J., D.D. Kress, R.L. Friedrich & D. Vaniman, 1981. Calving ease and growth rate of Simmental sired calves. III. Direct and maternal effects. J. of Anim. Sci. 53: 1210-1216.
De Roo, G. & E. Fimland, 1983. A genetic analysis of performance and progeny test data for young bulls of Norwegian red cattle and various Friesian crosses. Livest. Prod. Sci., 10: 123-131.
Djemali, M., 1985. The economic importance of dystocia in dairy cattle and the development of an ordered categorical analysis procedure to evaluate sires for calving ease. Diss. Iowa State Univ., Ames.
Flatnitzer, F., G. Averdunk & H. Bogner, 1969. Gewichtsermittlung weiblicher Tiere im Feld im Vergleich zur Stationsprüfung über männliche Tiere zur Zuchtwertschätzung von Vätern auf Zuwachsleistung. Bayer. Landw. Jahrbuch 46: 828-853.
Gaillard, C.,1980. Populationsanalyse verschiedener Merkmale des Geburtsverlaufes beim Simmentaler Fleckvieh. Diss. ETH Zürich.
Hässig, H. und W. Schlote, 1980. Beziehungen zwischen dem Geburtsverlauf und Hilfsmerkmalen bei Fleckviehfärsen. Züchtungskunde, 52, 4-15.
Hanset, R., 1981. Selection problems when antagonistic effects exist between production characteristics and calving difficulties. Livest. Prod. Sci. 8: 291-305
Harvey, W.R., 1977. User's Guide for LSLM76 (Mixed Model Least-Squares and Maximum Likelihood Computer Progam). Ohio State University.
Holzer, A., 1983. Populationsanalysen für Merkmale der inneren Beckenöffnung, ihre Beziehung zum Geburtsverlauf und zu Körpermerkmalen bei primiparen Fleckviehrindern. Diss. LMU München.
Osterkorn, K., H. Kräusslich, G. Averdunk & A. Gottschalk. 1977. Beziehungen zwischen den Eigenleistungsergebnissen von Prüfbullen und den Abkalbeergebnissen aus dem Testeinsatz. In: Calving problems and early viability of the calf. Martinus Nijhoff Verlag, Den Haag.
Phillipsson, J., J.L. Foulley, J. Lederer, T. Liboriussen & A. Osinga. 1979. Sire evaluation standards and breeding strategies for limiting dystocia and stillbirth. Livest. Prod. Sci. 6: 111-127.
Rutzmoser, K., 1977. Genetische Korrelationen zwischen Milch- und Fleischleistung beim bayerischen Fleckvieh. Diss. Weihenstephan.
Willham, R.L. (1963): The covariance between relatives for characters composed of components contributed by related individuals. Biometrics 19: 18 - 27
Sauerer, G., G.Averdunk & P. Matzke. 1987. Einfluß von Schwergeburten auf die nachfolgende Fruchtbarkeit und Leistung. Report, XII. Annual meeting 'Physiologie und Pathologie der Fortpflanzung', 12./13. 3. 1987 in Rosenheim.

DISCUSSION (SESSION II)

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Genetic improvement of feed intake capacity and feed efficiency has a great potential importance in dairy cattle breeding. Testing and selection for these traits can theoretically be included in the bull dam selection (at bull dam stations), in the young bul selection (at performance testing stations) or in the proven bull selection (field test of daughter groups).

In session II Jackson et al. and Junge et al. described an automatic roughage intake monitoring system for dairy cows tested under experimental farm conditions. Practical problems concerning price, robustness, weighing back procedures, length of test periods and the use in practice were discussed. It was suggested that the techniques would be available for practice (individual breeders and test stations) within a short time.

A Finnish paper (Haapa) indicated a bad relationship between performance test results and daughters' feed intake (one day control). From Holland and Denmark extensive breeding experiments dealing with this topic were described. Averdunk et al. showed an unfavourable direct correlation between growth of sire and calving results of calves and a favourable indirect correlation to calving ease as a trait of the daughters.

An important genetic variation in feed intake and feed efficiency of growing bulls was demonstrated at the seminar. The relative importance of intake capacity and efficiency as well as the genetic relationshsip between the traits measured on growing animals and lactating animals are under investigation in Norway, Holland and Denmark, and results will be presented within the next three years.

Session 3

Fertility traits and value of metabolic and immunological parameters of performance tested bulls for predicting traits of progenies

HYGIENIC AND FERTILITY ASPECTS OF THE PERFORMANCE TEST

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Summary

The probands for performance tests come out of different herds with all kinds of hygienic problems. To ensure reliable results the hygienic regulations must therefore be very severe. Furthermore, the tested bulls shall go in the A. I. stud, which also asks for a high hygienic standard. The hygienic regulations are reported.

Since 15 years a certain percentage of the tested bulls does not fulfill the breeding soundness conditions, which are necessary for an A. I. bull. This percentage is higher compared to the corresponding percentage of the auction- bulls.

Introduction

Organization

The central breeding organization VFR is operating the performance test station Brandhof since 1971. The Brandhof is one of three test stations in Bavaria. Until 1986 2,021 male calves (Simmental and Gelbvieh) have been tested.

Animals

The young bulls enter the test station at an average age of 60 days and an average weight of 106 kg. The test period starts with the 112th day and ends with the 420th day.

Housing

The bulls are kept in groups in boxes with straw. To each box belongs a paved run without a roof. The feed is offered partly outside, partly inside the stable. During the last 4 - 6 weeks of the test period the bulls are kept in a stanchion barn. Enough place, a good barn climate and optimal light are ensured; furthermore behaviourial disorder (ethopathies) as well as damages by construction errors (technopathies) should be avoided.

Feeding

Since 10 years the feeding is carried out according to Table 1.
The amounts are weighed resp. fed exactly. For concentrates a special mixture is used. Since 1983 the following ingredients are used: 6 % minerals, 23.5 % each coarse soya bean meal, winter wheat, winter barley and oats. Thereby the share of raw protein was lowered (185 g of raw protein/660 stu).
The mineral has a wide Ca : P-relation (6.5 : 1).

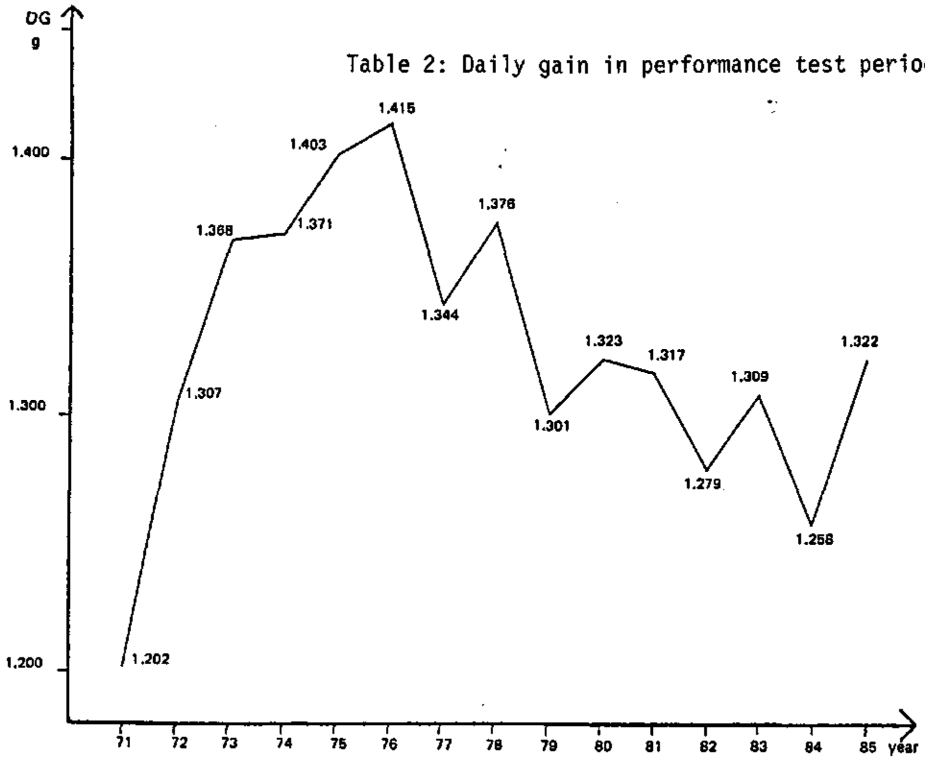
Table 1. Feeding schedule.

Age period (= weight period)	Concentrates kg	Grass cobs kg	Hay kg	Straw kg	Corn silage
to 111th day (up to appr. 150 kg)	up to 3.0 (ø 2.5)	-	1	-	ad lib
112th to 224th day (ca. 150 - 300 kg)	3.0	-	1	1	ad lib
225th to 420th day (ca. 300 - 580 kg)	3.0	2	-	2	ad lib

Daily gain

The daily gain over the years was 1,312 g in average; the excessive gain (above 1,400 g) was reduced to 1,300 g and less as shown in Table 2.

Table 2: Daily gain in performance test period.



Hygienic aspects

The probands are coming out of different herds with all kinds of hygienic problems and risks. Therefore it is necessary to establish a very strict hygienic program. The bull calves are delivered in 6 groups per year, consisting of 15 - 20 animals per batch. According to the A. I. breeding program about one third of the young test bulls necessary for replacement should come out of the performance station and about two thirds out of auction sales. Since 15 years a certain percentage of the performance tested bulls don't fulfill the requirements for good libido and semen quality. This percentage is always higher compared to the auction bulls. Useless bulls are slaughtered. This causes not only genetic but also financial losses.

Results and discussion

1. Hygienic aspects

The hygienic conditions for the calves are very severe and costly.

Table 3. Hygienic conditions (tests and treatments) for the calves.

1. Origin-herd
   free of: tuberculosis, brucellosis, leucosis
   in future: unsuspectable for BHV_1 (IBR-IPV-IBP)
2. Calves
2.1. First treatment (immidiate)
   Blood: BHV_1
   Vacc.: Bovigripp (5 ml s.c.)
   Pasteurella (2 ml nasal)
   BVD
   Inducer (1 ml oral and 2 ml s.c.)
2.2. Second treatment (4 weeks later)
   Blood: BHV_1
   Vacc.: Bovigripp (5 ml s.c.)
   Pasteurella (2 ml nasal)

These conditions have the aim to keep up a healthy herd in the performance test station. After all, the performance test should be finished as effective as possible according to the genetic value. There is also the risk to pick up all kinds of diseases existing in the country. Every calf is coming out of a single herd; every herd has its individual hygienic problems. The mentioned conditions for the calves are developed out of our experiences in the past 15 years and are generally proven. Nevertheless, it is essential that you permanently contact specialists in the virus-laboratories for new problems and adapt the regulations to the new epidemical situation. It also should be mentioned that you never can prevent all the diseases, especially in the cold-humid period, when the calves come out of their individual environment, where they had been kept very carefully by the breeder. But the different vaccinations prevent more severe diseases. The so-called colds after transport can be treated easily and successfully by a consequent veterinarian treatment.

Finally, the selected bulls definitely should go into the A. I. stud. The hygienic standards of the A. I. station (Table 4) are high and regulated by different laws of the state government. The performance test station must therefore be considered as a hygienic prestep of the A. I. station and all the mentioned private regulations for the performance test station must finally follow the laws for the A. I. station.

Table 4. Hygienic standards for the performance tested bulls.

1. Two weeks before licencing
   Blood: BHV_1, leucosis
2. First Tests - A. I. station
   Blood: BHV_1, brucellosis, leucosis, leptospirosis
   Praeputial-flushing: trichomoniasis, vibriosis
   Tuberculosis
   Vacc.: food and mouth
   Vitamins
   Antihelmintica
3. Second Tests - A. I. station (2 - 3 weeks later)
   Repeat: BHV_1, praeputial-flushing, excrement-tests

2. Fertility aspects

The BVN is buying the positive tested bulls after licencing from the VFR-Company at a standard price of DM 6,000.--. Therefore we have the situation of buy and sell and the guarantee conditions for breeding soundness, are described in Table 5. Useless bulls are returned after the so-called guarantee period and slaughtered.

Table 5. Guarantee regulations for breeding soundness edited by the Bavarian cattle breeding society and the Bavarian associations of the A. I. Organizations (1. Jan. 1986)

Breeding ability		guarantee period
Libido, propulsus, ejaculation		6 weeks
Semen quality - fresh		12 weeks
volume	$\geq$2 ml	
density	$\geq$600 000 sperms/mm^3	
path. sperms	$\leq$20 %	
progr. motility	$\geq$70 %	
Semen quality - frozen (since 1987)		
progr. motility	50 % ($\geq$2/3 of all samples)	
Fertility		16 weeks

Regarding the fertility aspects the results of three investigation periods are described (KANTOR et al 1977, RÖHRMOSER 1979 and HAHN 1987).

Table 6. Number of bulls without useful breeding soundness (+); comparison of performance tested bulls and bulls from auction sales.

Investigation period	Perform. tested bulls			Auction sale		
	n	+	+%	n	+	+%
1 KANTOR et al (1971-1974)	134	26	19.4	274	41	15.0
KANTOR et al (1975-1976)	86	31	36.1	231	57	24.7
2 RÖHRMOSER (1975-1977)	121	42	34.7	332	72	21.6
3 HAHN (1978-1986)	470	116	24.7	1152	209	18.1
ø 1 + 2 + 3	811	215	26.5	1989	379	19.1

Table 6 shows:

In the average of these three investigation periods the performance tested bulls had a worse breeding soundness than the bulls from auction sale; that means 26.5 % of the performance tested bulls did not fulfill the guarantee conditions compared to 19.1 % of the auction bulls.

The highest differences were registered in the investigations of RÖHRMOSER and KANTOR b; these differences were statistically significant. Exactly in these periods we have had the highest daily gain (compare Table 2). According to these bad results the feeding intensity was lowered. Furthermore, grass cobs, hay and straw were fed and a special composition for the concentrates was used. The aim was to obtain more an optimum than a maximum of daily gain. So the daily gain was lower in the following years. It is also remarkable that in investigation 1 (KANTOR a) the daily gain of the performance tested bulls was lower than these of the auction bulls.

Regarding the libido we observed that generally the auction bulls showed a better libido. The reason could be the group-housing of the performance tested bulls during the test period. We changed the housing, which means one month before the licencing all performance tested bulls were taken out of the group and were then kept separately.

Up to 1976 we always had very dramatic outbreaks of bronchopneumonia and enteritis.

The testicles of all slaughtered bulls were histologically checked. The results were irreparable damages in the tissues, which causes a bad semen production. It was assumed that these damages in addition to negative nutrition effects could be a further reason for the worse breeding soundness of the performance tested bulls in investigations 1 and 2. After 1976 we therefore developed the already mentioned hygienic program and tried to prevent diseases by prophylactic vaccinations.

If you compare investigations 1 resp. 2 with 3 it is obvious that the breeding soundness improved as well for the performance tested bulls as for the auction bulls. The explanation could be that also the specialized bull breeders improved their management. Or had we really succeeded in improving fertility by a stronger selection between the bull-lines for increase male fertility?

Summarized it is assumed that a lower feeding intensity, a better housing and a good prophylactic hygienic program may be the reasons for the improved breeding soundness in the third investigation period.

References

Hahn, R., 1987.
Berechnungen zum Einfluß der Eigenleistungsprüfung auf die Fruchtbarkeit (unveröffentlicht).

Kantor, H., G. Averdunk, R. Hahn und E. Schwarz, 1977.
Einflüsse der Eigenleistungsprüfung auf Deckverhalten, Samenqualität und Befruchtungsvermögen von Jungbullen.
Bayer. Landw. Jahrbuch, 54., 2.

Kraus, H., 1981.
10 Jahre Eigenleistungsprüfung auf Fleischleistung beim Rind (unveröffentlicht).

Röhrmoser, G., 1979.
Auswirkungen der Eigenleistungsprüfung auf Deckverhalten, Spermaqualität und Befruchtungsvermögen von Prüfbullen.
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IMMUNOLOGICAL TRAITS IN YOUNG BULLS IN RELATIONSHIP WITH HEALTH STATUS OF PROGENIES

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Summary

Relations between immunological traits in young bulls and the resistance to mastitis of their daughters are studied in Norwegian red cattle. There are no significant correlations but so far the data set is very limited. With new generation of bulls it will be possible to get more accurate informations on these relations. The results indicate that some relations exist, and The BoLA system seems very promising.

Introduction

Diseases cause large economic losses in milk production. If possible, disease resistance should therefore be included in breeding programs.

In Norway we have a disease recording program where all diseases treated by a veterinary surgeon in milk recorded herds are recorded (Solbu, 1983). Information is used to progeny test bulls for different diseases. The bulls' progeny tests for mastitis and ketosis are included to calculate the bulls' total breeding value (Fimland, 1984; Fimland and Gravir, 1984). These total breeding values are the selection criteria for the bulls.

Most dairy cattle diseases in Norway are sex limited to the cow and they have low heritabilities (Solbu, 1984 a). Effective evaluation for these traits results mainly through progeny testing.

In many cases the disease frequencies increase with the age of the cow (Solbu, 1983). To wait for final progeny tests will therefore increase generation intervals and the breeding values estimated for diseases might be biased because of selection.

If disease resistance could be measured in the animals' lives and on both sexes, the effficiency of selection could be increased. It is therefore of interest to find marker traits linked to diasese resistance that can be used in selection. In many countries this would be the only possibility to select for disease resistance since diseases are not recorded.

Mastitis is the disease that causes the largest economic losses. This disease is, at least to some extent, of an infectious nature. It would therefore be natural to look for connections between resistancy to mastitis and different immunological traits. An experiment has been designed to investigate this possibility.

Materials and Methods

The immunological system is very complex (see for example Bier et al., 1981). Many different traits can therefore be studied and one has to choose among traits when setting up experiments.

In the present study the following traits were studied: the bovine MHC (BoLA) antibody response to human serum albumin (HSA) and to the synthetic polypeptide (T,G)-A--1, serum levels of complement, the C_3 compound of complement and serum levels of lysozyme and of IgM.

All the immunoological traits were measured on young bulls in performance test stations. The animals used for the experiments and the different experimental procedures have been described by Lie and Solbu (1983), Lie et al. (1983), Lie et al. (1986) and Syed et al. (1986).

The progeny test for mastitis has been described by Solbu (1984 b) and Fimland (1984).

Possible connections between the different immunological traits and mastitis have been studied by using analysis of variance. The bull's progeny test result for mastitis was regarded as a dependant variable with the different immunological traits as independant variables. Separate analyses were performed for the different immunological traits and appropriate models according to earlier findings (Lie and Solbu, 1983; Lie et al., 1983; Lie et al., 1986; Syed et al., 1986) were used in the different analyses. So far, 39 bulls are progeny tested for mastitis and have antibody responses to HSA and (T,G)-A--L. The same 39 bulls also have measurements of complement levels, C_3 levels, lysozyme levels and IgM levels. The different BoLa-types represent different alleles at the Class I MHC-locus in cattle. Thirteen different internationally "workshop approved" alleles were recognized in the tested bulls (see Lie et al., 1986). The frequency of the BoLA alleles differ very much and some of the alleles are rare in the bulls tested. A complete analysis including all different alleles and all different combinations of alleles can only be performed when a large number of animals are both BoLA-tested and progeny tested for mastitis. So far 110 bulls are both BoLA typed and progeny tested and that is not enough for a combined total analyses. The effect of the different BoLA alleles was therefore analyzed in separate analyses, one of each allele and the bulls were grouped according to whether they had the allele in question or not.

Results and discussion

The main preliminary results are summarized in Table 1. The table shows the different immunological traits studied, whether the traits have a significant association with mastitis and in what direction the association exists. (An increase in resistance to mastitis with an increased level of the immunological trait is recorded as + and the opposite as -).

Table 1. Association between different immunological traits measured on young bulls and the resistance to mastitis in their daughters.

Immunological trait	Significant level p≅	Direction of association
Lysozyme	n.s.	
Complement	0.10	+
C_3	n.s.	
HSA	0.20	+
(T,G)-A--L	0.15	-
IgM	n.s.	
BoLA	*	+ - *

* Some of the BoLA alleles had significant association to mastitis resistance, some positive and some negative. See text for further explanation.

Lysozyme

No significant connection between lysozyme level and mastitis frequency was found. However, Lie and Solbu (1983) discovered a "lysozyme gene" in the Norwegian dairy cattle population with a frequency of about 6%. Only four of the 39 progeny tested bulls had this "lysozyme gene". The data are limited. Further investigations should be undertaken.

Complement and C_3

There is a tendency that increased complement levels in the bulls increases the resistance to mastitis, while no association was found between C_3 levels and mastitis resistance.

HSA and (T,G)-A--L

Neither for HSA nor for (T,G)-A--L were strong significant associations to mastitis resistance found. However, the relationship between the two traits was negative. Increased response to HSA followed increased resistance wile decreased response to (T,G)-A--L followed increased resistance.

IgM

No correlation beteen IgM and mastitis resistance was found.

BoLA

Five of the BoLA alleles had a relationship with mastitis resistance with significant level $p \leq 0.20$. Four of these five alleles had negative associations with mastitis resistance. That means that daughters of bulls carrying this allele are more susceptible to mastitis than daughters of other bulls, wile the opposite was the case for one allele. Two of these five alleles are carried by very few bullls in this material (one and four bulls respectively). Some of the "workshop recognized" BoLA alleles represented in the Norwegian red cattle population were not found in the bulls that were both BoLA typed and progeny tested for mastitis.

The presented results are not very conclusive and that might discourage further research in this area. However, these results are based on a very limited amount of data. To get more conclusive results further research is necessary. In Norway this work will be carried on and as new bulls are progeny tested for mastitis more information will be available.

The immunological system is a very complex system. It has many times been shown that selection for different immune responses is possible (see for example Biozzi et al., 1982). However, high immune responses are not always correlated to high resistance to all infectious diseases (Biozzi et al., 1982). So the seemingly antagonistic results for antibody responses to HSA and T,G)-A--L should not be surprising.

Mastitis is a very complex disease. It may have many different causes and many different agents might be involved in "common" dairy cattle mastitis. To be resistant to mastitis cows should, therefore, have a good "general" immune system and this might not be measured with any of the immunological measurements used in this work. With a more specific infectious disease than mastitis, stronger connection with different immunological traits might be expected. Such diseases are, however, not common in Norway, so Norwegian field data cannot be used to verify this.

Conclusions

There is some evidence that immunological traits measured on young bulls are connected to mastitis resistance in the bulls' daughters. However, more research is needed to get conclusive results.

If a strong connection is established between mastitis resistance (or resistance to any other important disease) and immunological traits measured on bulls, this can be used in selection for disease resistance. However, since the animals' immunological system is so complex and they are living in environments with many immunological challenges, one should be cautious when genetically manipulating the animals' immune system. A change might give better resistance against one disease but make the cows more susceptible to others. If selection is initiated for a given immunological trait, one must be certain that this selection does not negatively influence other traits.

References

Bier, O.G., W.D. Da Silva, D. Gøtze & I. Mota, 1981. Fundamentals of immunology. Springer-Verlag, New York Inc., 442 pp.

Biozzi, G., D. Mouton, A.M. Heumann & Y. Bouthillier, 1982. Genetic regulation of immunoresponsiveness in relation to resistance against infectious diseases. 2nd World Congress on Genetics Applied to Livestock Production, Madrid 4-8 Oct., 1982, V, 150-174.

Fimland, E. 1984. Progeny testing procedures in Norway. IDF/EAAP Symposium on "Progeny testing methods in dairy cattle", Prague, Sept. 14-16, 1984, p. 117-132.

Fimland, E. & K. Gravir, 1984. The selection criterion of Norwegian Red Bulls. IDF/EAAP Symposium on "Progeny testing methods in dairy cattle", Prague, Sept. 14-16, 1984, p. 219-226.

Lie, Ø. and H. Solbu, 1983. Evidence for a major gene regulating serum lysozyme activity in cattle. Zeitschrift für Tierzuchtung und Züchtungsbiologie 100: 134-138.

Lie, Ø., H. Solbu, H.J. Larsen & R.L. Spooner, 1986. Possible association of antibody responses to human serum albumin and (T,G)-A--L with the bovine major histocompatibility complex (BoLA). Veterinarian Immunology Immunopathology 11: 33-350.

Lie, Ø., M. Syed & H. Solbu, 1083. The genetic influence on serum haemolytic complement levels in cattle. Animal Blood Groups Biochemical Genetic 14: 51-57.

Solbu, H. 1983. Diesease recording in Norwegian dairy cattle. I. Disease incidences and non-genetic effects on mastitis, ketosis and milk fever. Zeitschrift für Tierzüchtung und Züchtungsbiologie 100: 139-157.

Solbu, H. 1984a. Diesease recording in Norwegian dairy cattle. II. Heritability estimates and progeny testing for mastitis, ketosis and "all diseases". Zeitschrift für tierzüchtung und züchtungsbiologie 101: 51-58.

Solbu, H. 1984b. Progeny testing for health and fertility. IDF/EAAP symposium on "Progeny testing methods in dairy cattle", Prague, Sept. 14-16, 1984, p. 117-191.

Syed, M., Ø. Lie & H. Solbu, 1986. Serum complement component C_3 levels in cattle: Genetic influence and association with total haemolytic activity. Acta Veterinaria Scandinavica 27: 250-256.

USE OF HORMONES AND METABOLITES IN PREDICTION OF DAIRY MERIT OF PROGENY

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Summary

In the search for possible predictors of dairy merit, the regulation of traits involved in milk production might be the key. Among these, feed intake, the partioning of nutrients between tissues and the ability to mobilize energy from body tissues, shows genetic variation and may find expression even in young bull calves. The traits are under hormonal control. Insulin, growth hormone and thyroxine are the key hormones involved.

Simulating the lactational stress of a cow during the energy deficit period on young animals has been able to show differences between selected lines. A current experiment is used to illustrate how the preparation of animals, the metabolic challenge tests and blood sampling is carried out in practice. There is need for serial blood sampling and analysis for many hormones and metabolites in each sample. The interpretation of the results is briefly discussed.
Keywords: Hormones, selection, metabolism, cattle.

Introduction

The genetic progress in milk production by means of traditional breeding plans is limited by some biological facts, namely that milk production is solely expressed in the adult female, and that the reproductive rate of females is low compared to that of bulls. Dairy merit of bulls must therefore be assessed by progeny testing. This means a generation interval of about 7 years, despite the bulls are fertile when they are one year old. If dairy merit of bulls could be measured while the bulls are staying at the performance test station, a substantial increase in yearly genetic progress is possible, when utilizing nucleus breeding plans (Christensen & Liboriussen, 1986).

The purpose of this paper is to review parts of metabolic regulation associated with milk production and to present an experiment designed to evaluate various measures of metabolic and endocrine fitness in young animals.

Traits affecting milk production

Milk yield is affected by a number of traits, each showing genetic variation, but some are only expressed in the lactating cow (table 1).

Table 1. Traits affecting milk yield, their expression and the genetic influence.

Trait	Expression: Adult female	Young female	Young male	Genetic variation
Feed intake	+	+	+	+ +
Digestion & absorbtion	+	+	+	?
Maintenance	+	+	+	+
Partitioning	+	?	?	+ +
Mobilisation	+	?	?	+ +
Milk synthesis				
Mammary size	+	(+)	-	+ +
Cell efficiency	+	-	-	0

Among the traits mentioned, feed intake can be measured on bull calves and possess genetic variation. But it remains to be verified whether feed intake in lactating cows and in growing bull calves is the same trait. Digestion and absorbtion of energy seems to be unaffected by selection for milk yield (i.e. Davey et al., 1983) even if there may be genetic variation in the trait. In a dairy merit selection experiment, Davey et al. (1983), found no line differences in ability of cows to metabolise dietary energy, nor in their heat production. Maintenance requirements may therefore represent a smaller component of variation in total efficiency.

Partitioning of the absorbed nutrients between body tissues and mammary gland is heavily influenced by selection (Davey et al., 1983). The partitioning of nutrients can favour the mammary gland and at the same time mobilize energy from body tissues, thus causing a weight loss. A fuller discussion is given by Bauman et al. (1985).

The mammary gland synthesis capacity is determined by the number of secretory cells and the efficiency of the single cell. Across species, little variation is found in efficiency of the secretory cell. Total number of secretory cells, also expressed as size of udder, shows large genetic variation. Indirect measures of mammary gland size are not easy to suggest for young bull calves (Sejrsen, 1986).

Hormonal regulation

All the traits affecting milk yield are to a greater or lesser extent under hormonal regulation and the secretion of hormones are also affected by genes. A change in secretion of the hormones through selection therefore must be a reflection of a change of the genome. The endocrine system regulate and coordinate the interaction between the traits affecting milk production (fig. 1).

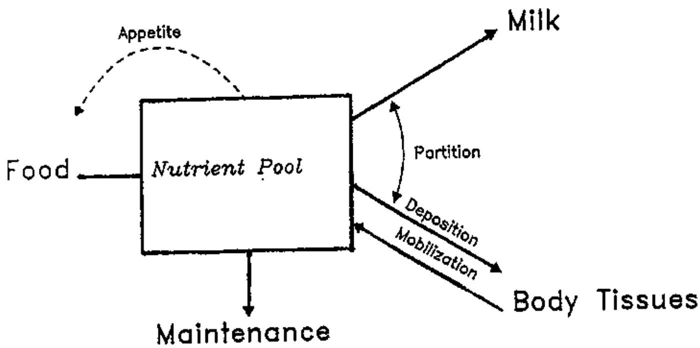

Figure 1. The partitioning of nutrients between tissues (mod. after Bines & Hart, 1982)

Glucose and fat metabolism is regulated by insulin. A high level of insulin favours deposition of body fat. Hart et al. (1978) found decreased levels of insulin in lactating dairy cows, compared to lactating beef cows. The experiment was repeated, but with equal energy balance in the two groups of cows and no difference was found in insulin (Hart, 1981).

Growth hormone injected to lactating cows increased milk yield by changing the partitioning of nutrients towards mobilization (e.g. Eppard et al., 1985). Differences in growth hormone level in cows due to selection is shown by Flux et al. (1984).

Among the other hormones known to affect milk production just a few should be named here: Thyroxine, glucagon, prolactin, placental lactogen, somatomedin etc.

Testing metabolism in calves

Thyroxine, which is known to affect milk yield in cows, was measured in AI-bulls by Joakimsen et al. (1971). The genetic correlation of thyroxine degradation rate to milk yield in the offspring was $r_g = 0.42$. These results were confirmed by Sørensen et al. (1981), but they did not recommend selection based on thyroxine measures until more was known about possible detrimental effects. The necessity of using radioactive compounds in live animals raises further ethical and veterinary questions.

At the peak of lactation, while the cows are mobilising energy from body tissues, genetic differences are seen most clearly. A simulation of this metabolic stress on the young animal could possibly be a measure of metabolic fitness related to milk production capacity.

Sejrsen et al. (1984) fasted Red Danish calves from lines selected for high and low dairy merit. Blood was sampled during ad. lib feeding, fasting and after refeeding. Differences between lines in plasma urea and free fatty acids (FFA) was most pronounced by the end of the fast. Differences in insulin response to fasting and thyroxine response to refeeding approached significance.

Intravenous infusions of hormones or metabolites are precise ways to challenge metabolism. Land et al. (1983) infused propionate into dairy (Friesian) and beef (Hereford x Friesian) calves. Insulin response was 3 to 4 fold greater in beef calves compared to dairy calves.

Non genetic sources of variation in hormones and metabolites

Investigations on the relationships between circulating levels of hormones and dairy merit have often given conflicting or disappointing results. This may arise from lack of control over, or knowledge about confounding environmental factors (Sejrsen & Løvendahl, 1986).

Environmental and management factors, known to affect metabolites and hormones are feeding regime, composition of diet, condition of animals, confinement, day length and temperature. Pituitary hormones, e.g. growth hormone are released episodically to the blood stream, giving a randomly peaking pattern.

The influence from environmental and random sources of variation must be minimized by carefully planned and controlled experiments as discussed by Trenkle (1978). Physiological challenges can help in amplifying genetic differences above experimental noise as shown by Land (1981).

Statistical methods based on the split-plot designs (Gill & Hafs, 1971), or subsampling methods (O'Sullivan et al. 1984), are useful in planning and evaluation of repeated measures and serial blood sampling.

Practical design of metabolic challenge test experiment

In a current experiment a number of metabolic challenge tests are evaluated. Sixty female and male calves from lines selected for high and low dairy merit are experimental animals. The difference in milk yield between the two lines is about 20%.

Each animal is tested between 3 and 4 months of age and again between 9 and 10 months of age. The testing procedure (fig. 2) is the same at both ages and for both sexes. It comprises four days for standardizing feed intake and two days with frequent blood sampling around the metabolic challenges. To minimize stress due to blood sampling, calves are fitted with a jugular vein catheter the day before sampling begins.

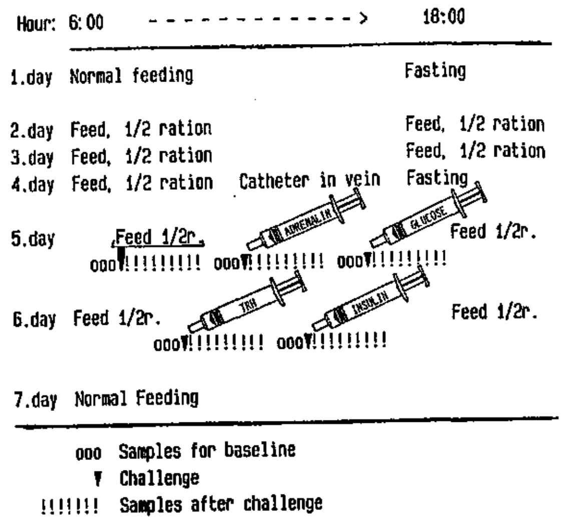

Figure 2. Testing procedure.

Blood is drawn at short precise intervals and cooled off immediately and plasma isolated and frozen (20 C) until analysed. Glucose, urea and FFA are determined by a photometric method. Growth hormone, insulin and thyroxine are determined by radio immuno assay (RIA).

Preliminary results

The project was started in January 1985 and the last blood will be sampled in June 1988. Metabolites have been determined in a good part of the plasma samples, but we have just started analysing for hormones. Below in fig. 3 the concentration of FFA during days 5 and 6 are plotted versus the time of day they were drawn.

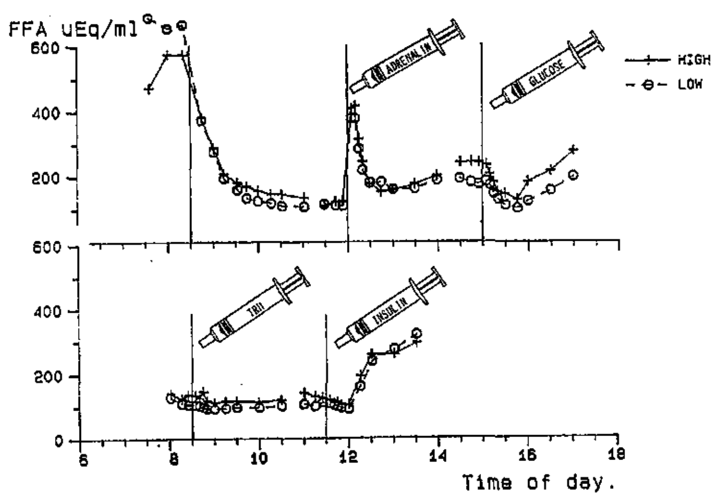

Figure 3. Plasma free fatty acids in bull calves age 3-4 months on the days 5 and 6. See fig. 2.

The short fasting period initiales a mobilisation of fatty acids. After the meal FFA drops, but gives a spike after adrenalin injection. This reaction is short and FFA starts raising slowly. The glucose load stops mobilisation immediately but after 1/2 hour the glucose is used up and FFA raises again. FFA does not respond to thyrotropin releasing hormone. Insulin raises FFA in much the same way as do fasting.

Differences between lines are small during most of the time. But what kind of differences are to be expected? How is the response measured? Simple concentrations as shown here are of little value. Alternatives may be: baseline, largest response, retention times or degradation constants. The choice between these must be done according to their predictive value, statistical robustness to missing values and to their biological meaningfulness.

Selection on metabolic fitness test?

Before any selection can be based on these tests, we need genetic parameters and a simpler and cheaper testing procedure. Likewise the laboratory function must be standardised and evaluated critically.

During these experiments we aquire knowledge about the interaction between genetics and endocrinology. This may help us avoid increasing frequencies of metabolic diseases in our selection schemes.

References

Bauman, D.E., McCutcheon, S.N., Steinhour, W.D., Eppard, P.J., Sechen, S.J., 1985. Sources of variation and prospects for improvement of productive efficiency in the dairy cow: A review. J. Anim. Sci. 60, 583-592.

Bines, J.A. & Hart, I.C., 1982. Metabolic limits to milk production, especially roles of growth hormone and insulin. J. Dairy Sci. 65, 1375-1389.

Christensen, L.G. & Liboriussen, T., 1986. Embryo transfer in the genetic improvement of dairy cattle. Ch. 4, 37-46 in: Exploiting new technologies in animal breeding; Genetic developments. ed. Smith, C., King, J.W.B. & McKay, J.C., Oxford University Press, Oxford.

Davey, A.N.F., Grainger, C., MacKenzie D.D.S., Flux, D.S., Wilson, G.G., Brookes, I.M. & Holmes, C.W., 1983. Nutritional and physiological studies of differences between Friesian cows of high and low genetic merit.

Eppard, P.J., Bauman, D.E. & McCutcheon, S.N., 1985. Effect of dose of bovine growth hormone on lactation of dairy cows. J. Dairy Sci. 68, 1109-1115.

Flux, D.S., Mackenzie, D.D.S. & Wilson, G.F., 1984. Plasma metabolite and hormone concentrations in Friesian cows of differing genetic merit measured at two feeding levels. Anim. Prod. 38, 377-384.

Gill, J.L. & Hafs, H.D., 1971. Analysis of repeated measurements of animals. J. Anim. Sci. 33, 331-336.

Hart, I.C., Bines, J.A., Morant, S.V. & Ridley, J.L., 1978. Endocrine control of energy metabolism in the cow: Comparison of the levels of hormones (prolactin, growth hormone, insulin and thyroxine) and metabolites in the plasma of high- and low-yielding cattle at various stages of lactation. J. Endocr. 77, 333-345.

Hart, I.C., 1981. Recent investigations into the physiology of beef and dairy cattle. EEC scientific workshop, Edinburgh. 10 pp.

Joakimsen, Ø., Steenberg, K., Lien, H. & Theodorsen, L., 1971. Genetic relationship between thyroxine degradation and fat-corrected milk yield in cattle. Acta Agric. Scand. 21, 121-124.

Land, R.B., 1981. Physiological criteria and genetic selection. Livest. Prod. Sci. 8, 203-213.

Land, R.B., Carr, W.R., Hart, I.C., Osmond, T.J. & Tilakaratne, N., 1983. Physiological attributes as possible selection criteria for milk production. 3. Plasma hormone concentrations and metabolite and hormonal responses to changes in energy equilibium. Anim. Prod. 37, 165-178.

O'Sullivan, F., Whitney, P., Hinshelwood, M.M. & Hauser, E.R., 1984. The analysis of repeated measures experiments in endocrinology. J. Anim. Sci. 59, 1070-1079.

Sejrsen, K., 1986. Endocrine mechanisms underlying genetic variation in growth in ruminants. 3rd World Congr. Gen. Appl. Livest. Prod., Lincoln, Nebraska, USA. XI, 261-270.

Sejrsen, K., Larsen, F. & Andersen, B.B., 1984. Use of plasma hormone and metabolite levels to predict breeding value of young bulls for butter fat production. Anim. Prod. 39, 335-344.

Sejrsen, K., Løvendahl, P., 1986. Criteria identifying genetic merit for milk production. Ch. 16:142-152 in: Exploiting new technologies in animal breeding; Genetic developments. Smith, C., King, J.W.B. & McKay, J.C. (eds.). Oxford University Press, Oxford.

Sørensen, M.T., Kruse V. & Andersen, B.B., 1981. Thyroxine degradation rate in young bulls of danish dual-purpose breeds. Genetic relationship to weight gain, feed conversion and breeding value for butterfat production. Livest. Prod. Sci. 8, 399-406.

Trenkle, A., 1978. Relation of hormonal variations to nutritional studies and metabolism of ruminants. J. Dairy Sci. 61, 281-293.

SUITABILITY OF THE EFFECTIVE THYROXIN RATIO AND OF THE TRIIODOTHYRONINE CONTENT AS AUXILIARY TRAITS IN THE SELECTION FOR GROWTH

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Summary

The thyroid activity of 2 795 young bulls aged 3, 6 and 9 months was investigated by monitoring the effective thyroxin ratio (ETR) and the T_3-content of the animals. The repeatability was low because of the long time interval between the investigations. Also the heritability coefficients of the traits were in the low range and exceeded .1 only in one case. The phenotypic correlations between the thyroid traits and growth hardly reached the significance limit. Because of the high standard error the genetic correlation coefficients permitted no unequivocal conclusions. In their present form, the investigated thyroid traits are not suitable as auxiliary traits of the selection for growth.
Keywords: effective thyroxin ratio, triiodothyronine, genetic and phenotypic correlation, heritability, repeatability, growth, cattle

Introduction

The use of metabolic parameters for indirect estimation of the genetic predisposition to economically important performance traits could help enhance the efficiency of selection measures in breeding programs.

In particular, it promises to be successful where sex-limited traits preclude selection by phenotypic performance, and progeny testing decisively prolongs the generation interval. Both these circumstances hold for the selection of bulls for the improvement of milk performance in dairy and dual purpose breeds. Advantages can be expected also for the selection for growth though to a lesser extent, because the growth traits are not sex-limited and can be measured at a relatively early time. However, knowledge of the relationships with both trait complexes is necessary in order to estimate potential effects on growth if such traits are being used for improvement of milk performance.

It is under these aspects that the thyroid activity of young bulls has been investigated. As parameters are used the effective thyroxin ratio (ETR) and the triiodothyronine content (T_3).

Material and Method

The investigations were carried out on 2 795 young bulls from two performance testing stations. The standardized feeding conditions in these stations were suited most to maintain the influence of feeding on thyroid activity at a uniform level.

Blood for measuring the thyroid activity was drawn from the young bulls at the age of 3, 6 and 9 months.

The day of investigation had a considerable effect on the variance of the thyroid traits. This effect has been eliminated and comparability of the traits over the farms and periods of investigation has been achieved through a correction by means of the herdmate average. The growth traits studied were submitted to a similar correction procedure in order to exclude seasonal effects.

Results

Means and coefficients of variation

Table 1 lists the means and coefficients of variation of the thyroid criteria separately for the two stations. Both traits differ between the stations. Whereas the ETR shows but little differences, the latter are considerable for the T_3-content but are getting less at the later blood withdrawals.

Table 1. Means and coefficients of variation of thyroid traits.

	station 1			station 2		
	n	$\bar{x}$	s%	n	$\bar{x}$	s%
1. Blood withdrawal						
ETR	545	.94	6.5	709	.96	6.6
T_3-content (ng/ml)	495	1.74	34.3	661	1.32	34.6
2. Blood withdrawal						
ETR	799	.95	5.5	923	.94	5.8
T_3-content (ng/ml)	686	1.86	22.6	895	1.57	27.0
3. Blood withdrawal						
ETR	728	.97	6.1	841	.93	5.6
T_3-content (ng/ml)	660	1.86	23.8	833	1.77	25.0

Since blood was withdrawn at a fixed age, the alterrations also revealed age-related influences. The ETR shows only differences with age, which revealed an opposite tendency in the two stations. In contrast, the T_3-content increased in both stations with the age of the animals. However, the age-related increase was lower in station 1, so that the differences between the stations decreased with age and were no longer significant at the age of 9 months. Contrary to the ETR, the T_3-content exhibited a very high variation, with coefficients of variation rangig from 23 to 35 %.

Repeatability and heritability

The repeatability was estimated within the stations (Table 2). The estimated coefficients of repeatability are all very low. It has to be assumed that the low values were due to the long time interval between the investigations. Osmond et al. (1981) have demonstrated for the T_3-content at a 3-day interval between the investigations a coefficient of repeatability .382, whereas the long-term repeatability between 6 and 16 weeks of age also amounted to only .1. Thus, it appears impossible to obtain, over a long period of time, a trait value that is characteristic of the animal.

Table 2. Coefficients of repeatability of thyroid traits within the stations.

		E T R		T_3-content	
	n	w	s_w	w	s_w
Station 1	1949	.106	.028	.087	.023
Station 2	1694	.049	.024	.091	.026

Owing to the low repeatability one could also expect low heritability coefficients, which could be confirmed (Table 3). The majority of the estimates were below .1. Flach (1983) found a similarly low value ($\hat{h}^2$ = .14) for T_3-content. Thus, the thyroid traits have much lower heritabilities than the growth traits and are already for this reason not suitable as early selection criteria. On an average of the three investigations there occurred, as expected, an increase in heritability, without reaching a magnitude relevant for breeding, however.

Table 3. Estimated heritability coefficients of the ETR and the T_3-content.

	n	$\hat{h}^2$	$s_{\hat{h}^2}$
1. Blood withdrawal			
ETR	1253	.187	.086
T_3-content	1155	.055	.074
2. Blood withdrawal			
ETR	1720	.087	.057
T_3-content	1579	.066	.058
3. Blood withdrawal			
ETR	1568	.084	.061
T_3-content	1492	.085	.063
average			
ETR	1678	.180	.071
T_3-content	1573	.174	.072

Relations between the thyroid traits and the traits of growth

In order to characterize the relations between the traits of thyroid activity and the traits of growth, phenotypic and genetic correlations have been used (Table 4). The phenotypic correlations are all in a very low range with changing signs between the blood withdrawals. The significance threshold is reached only once. Also the average trait values from the three blood withdrawals did not reveal any closer relationship with the daily gain.

The genetic correlations exhibit absolutely higher values in comparison to the phenotypic ones. Between the ETR and the daily gain they change from positive values in the first blood removal to negative values in the third withdrawal. The high standard errors suggest possible random fluctuations, so that no strict causal relationship can be inferred. The genetic correlations between the T_3-content and the daily gain are around zero in the first two blood withdrawals, while in the third one a negative estimate occurred with high standard error.

Bobek (1980) found a higher phenotypic correlation of $r = .484$ between the T_3-content in calves and their daily gain.

Table 4. Phenotypic and genetic correlations between the thyroid traits and the daily gain from day 85 to 365.

	n	r_p	s_{r_p}	r_g	s_{r_g}
1. Blood withdrawal					
ETR	920	.032	.033	.428	.440
T_3-content	859	.082*	.034	.000	.000
2. Blood withdrawal					
ETR	1334	-.001	.028	.186	.335
T_3-content	1230	.057	.028	.000	.000
3. Blood withdrawal					
ETR	1306	-.019	.028	-.473	.514
T_3-content	1238	-.015	.029	-.608	.554
average					
ETR	1316	.002	.028	.138	.293
T_3-content	1241	.038	.029	-.334	.571

* Level of significance $P \leq .05$

Discussion

Thus, we could not reach in our investigations the more close relationships, reported in the literature, of other thyroid traits with growth, such as the thyroxin content (Graf and Grosser, 1979) or the thyroxin degradation rate (Tang Sørensen et al., 1981).

Hence we have to conclude that the investigated thyroid traits in their present form cannot be used as auxiliary means of selection for growth. Nevertheless, a causal relationship between the thyroid functions and growth is undisputed, so that further investigations to find appropriate criteria accounting for further hormones and metabolic parameters should not entirely be denied.

References

Bobek, S., M. Kacinska & P. Zapletal, 1980. Thyroxine and triiodothyronine concentrations in the serum of bullcalves and its dependence. Zbl. Vet. Med. A, 27:697-701

Flach, D., 1983. Untersuchungen über die Verwendbarkeit der Schilddrüsenhormone, des Insulins, der Kreatin-Kinase, der Glutamat-Dehydrogenase und der Glutathion-Reduktase im Blutserum als Hilfskriterien der Zuchtwertschätzung beim Rind. Dissertation Gießen, Justus-Liebig-Universität

Graf, F. & I. Grosser, 1979. Thyroxinwerte von Jungbullen im Bezug zur Eigenleistung und Töchterleistung. Zbl. Vet. Med. A, 26:682-686

Osmond, T.J., W.R. Carr, C.J.M. Hinks & R.B. Land, 1981. Physiological attributes as possible selection criteria for milk production. 2. Plasma insulin, triiodothyronine and thyroxine in bulls, Anim. Prod. 32:159-163

Tang Sørensen, M., V. Kruse & B. Bech Andersen, 1981. Thyroxine degradation rate in young bulls of Danish dual-purpose breeds, genetic relationship to weight gain, feed conversion and breeding value for butterfat production. Livestock Prod. Sci. 8:399-406

STRESS TEST FOR BULLS IN WAITING - METABOLIC REACTIONS IN RELATIONSHIP TO FERTILITY OF HER PROGENY

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Summary

In conducting a stress test on bulls in waiting the aim was to discern wether on the basis of metabolic reactions to an insufficient energy supply, one can select the daughters in respect to metabolic stability and fertility. A total of 54 bulls in waiting in three tests. were exposed to metabolic stress of insufficient energy supply. An increase in variation especially of enzymes could be observed. The bulls metabolic reactions are not comparable to the cows metabolic stress occuring during high lactation. Cows have an increased basal metabolic rate to maintain the level of milk production, whereas the energy consumption rate in bulls is clearly reduced. In all tests linear correlations, r= -.30 to r= -.80, between the metabolic reactions of the bulls and their daughters reproductive performance (breeding value for days open) could be measured. For only 7 bulls and three parameters repeatabilities could be estimated for the metabolic reactions between the different tests. The intra-class correlations were .60 for Y-GT, .24 for GPT and .88 for glucose. These parameters appear suitable for an estimation of female fertiliy on the basis of the bulls metabolic reactions. The multiple regression analysis showed a multiple correlation with the breeding value (days open) of r1= -.47; r2= -. 87; and r3= -. 69 in the three tests.
Keywords: Stress test. fertility, performance test bulls

Introduction

Investigations made by DEPKE (1981) and GRAF (1981) discovered significantly elevated blood parameters in some daughter groups. Thus one can conclude that reaction to metabolic stress is genetically determined. Initial investigations, with waiting bulls which were exposed to a specific metabolic stress, revealed differing metabolic reactions among the bulls (ROEVER, 1983; FEDDERSEN et al.. 1984). A correlation between the inability of the bulls to regulate their metabolism and a reduced fertility in the daughters was indicated. Therefore the goal of this study was to develop a metabolic stress test in bulls to permit selection for physical conditions and female fertility.

Material and methods

At two A.I. stations, 54 waiting bulls with an age of 3.7 to 5.0 years were available for the physical constitution test. Three experiments were divided into a control period and a period of insufficient energy supply, whereby each of these periods was subdivided into an adaption period of three to four weeks, to allow the rumen to get used to the feed, and a measuring periods of three weeks. During the control period the bulls received a ration which covered their maintenance needs. During the stress period, with energy undersupply, the bulls were fed barley straw ad lib. 0.5 kg of soya grain extract and small portions of minerals.

Blood samples were taken during the measuring period twice weekly at the same time and in the same sequence by puncturing the jugular vein to exclude the influence of daily fluctuations. At the end of the experimental periods, six blood samples per bull were available and 2 blood samples out of the control period. Blood levels of the following substances were determined: γ-Glutamyl-Transferase (γ-GT), Aspartat-Aminotransferase (GOT), Alanin-Aminotransferase (GPT), Glucose (GLu), D-(-)-3-Hydroxybutyrat (β-HB), triglycerides (Trigly) and urea (Harnst). In periods 1 and 3 urea analysis was restricted to samples taken during the stress period.

With the Least-Squares-Maximum-Likelihood-Programm (HARVEY, 1976) the following models were applied:

Model A: $y_{ijklmn} = u + d_i + s_{ij} + p_k + t_{l:k} + g_{m:k2} + e_{ijklmn}$

wherby

y_{ijklmn}= observation value for the jth bull; u= least-squares-mean; d_i= fixed effect of the series (i=1,2,3); s_{ij}=random effect of the bull (j) within the series; p_k= fixed effect of the test period (k=1,2); $t_{l:k}$= fixed effect of the measuring day (l) within the test period (k), $g_{m:k2}$= fixed effect of the loss of weight (m) within the test period (k=2), e_{ijklmn}= random residual error.

Model B: $y_{ijk} = u + s_i + d_j + e_{ijk}$

The repeatability of the reactions in response to stress could be estimated for 7 bulls that were examined in both tests 1 and 2. For this purpose, model B had to be simplified due to the limited amount of data material available.

Results

Influence of stress

Insufficient energy supply during the stress period caused a reaction in the bulls' metabolic parameters, which can be determined from the difference between the stress value minus the control value. The differences in reactions appear more revealing than the absolute rate of the stress value because of the genetic determination of the regulation capability, the influence of age on the standard value and the high individual differences between the base values. The extent of these reactions can be calculated with the fixed effect "test period" and the application of model A ($R = P_2 - P_1$) as depicted in table 1.

The results show that stress had a signifikant influence on all parameters expect on γ-GT in test 1. Since GPT shows the highest rate of activity in the skeletal muscle system (KELLER, 1971) a loss of activity can be attributed to reduced energy turnover which can then conceal any increase in the liver. In contrast to experiments with lactating cows or starving calves (TILKARATNE et al., 1980; BLUM et al., 1981; a highly significant decrease of B-HB could be observed in all tests. This is mainly a results of feeding, since during the stress period the bulls were almost exclusively fed with straw, and a decrease in the butyrate

Table 1. The bulls reactions to stress (estimated value from the difference: stress value - control value, and standard error of the difference).

parameter	u_1	R_1 [1)]	s_{R_1} [2)]	u_2	R_2	s_{R_2}	u_3	R_3	s_{R_3}
Y-GT	14.9	.02	.14	13.5	1.02	.06	13.7	.38	.08
GOT	31.5	.98	.24	28.6	-1.22	.20	24.7	2.96	.22
GPT	17.8	-1.14	.14	16.5	-2.22	.18	11.7	1.93	.24
glucose	61.0	-5.33	.58	62.9	-3.42	.54	62.1	.92	.30
ß-HB	1.65	.20	.04	2.04	-1.07	.04	1.40	- .15	.02
trigly-cerides	12.2	-4.76	.30	13.2	-2.03	.24	15.4	-5.10	.28
urea	-	-	-	14.9	-3.54	.26	-	-	-

1) reactions in test 1: $P_{\text{stress value}} - P_{\text{control value}}$ 2) standard error

concentration in the rumen was to be expected (ORTH et al., 1961). The result is a considerable reduction in the synthesis of B-HB in the rumen wall, such that an increase in ketone bodies in the caused by fat reduction, cannot be detected. The decreased concentration of tryglycerides in the stress period suggests a removal of lipoproteins released from the liver (HENRICSON et al., 1975;) which, in the case of protein deficiency, can become even greater (KAUFMANN, 1984). The simultaneously low urea concentration during the stress period confirms this assumption. the subsequent stress on the liver is revealed above all in the third test in which the triglyceride level has decreased most and in which, as a consequence, the strongest reactions of enzymic activities can be detected.

The repeatability of blood parameters:

The repeated measure within the test period indicated considerable stability of the parameters. During the stress period, repeatability was often greater than during the control period. this suggests a stabilization of the parameters during the energy deficiency period. In 7 bulls that participated at station 1 in two subsequent tests, it was possible to check the repeatability of the reactions between the test series. The bulls were under the same conditions in both test series but these tests were seperated by exactly one year. The repeatabilities were estimated as intra-class correlations (ICC) with model B and are given in table 2. Glucose and Y-GT show a high repeatability, whereas for GPT a large standard error was found. Because of negative variance components the ICC could not be estimated for GOT, B-HB and the triglycerides.

The bulls metabolic reactions and their daughters fertility:

The breeding value of the bulls' days open (DO) served as the fertility parameter. Days open is the period between the first insemination and the subsequent conception within a given service period. Since 8 bulls from test 2 had no daughters or less than 10 lactating daughters with

Table 2. Repeatabilities (ICC) in the reactions of 7 bulls from two tests, and their standard errors.

parameter	ICC	s_{ICC}
Y-GT	.60	.27
GOT	-[1)]	-
GPT	.27	.39
glucose	.88	.10
ß-HB	-	-
triglycerides	-	-

1) negative variance components

fertility results, these bulls were excluded from subsequent analyses. The correlations between the bulls reactions and the fertility results of their daughters are shown in table 3. The results from the bulls tested by ROEVER (1983) have been included. The results reveal similar and in part significant correlations for Y-GT and GPT. Surprisingly, the daughters were found to have better fertility when the bulls show a greater reaction in enzymic activity. Only GOT in test 2 shows a deviation from this observation. In contrast, the reactions of the metabolic concentrations of bulls are not entirely clear. From test to test, different but barely significant correlations with daughters fertility can be observed.

Table 3. Correlations between the bulls enzymic and metabolic reactions and their breeding value for days open (DO).

parameter	R[1)]	test 1	test 2	test 3
number of bulls	20	20	11	14
average nummber of daughters	69	46	35	78
Y-GT	- .50*	- .28	- .83***	- .48
GOT	- .16	- .35	.32	- .25
GPT	- .24	- .43*	- .40	- .31
glucose	.19	- .19	.11	- .44
ß-HB	-[2)]	.30	.25	- .31
triglycerides	-	- .38	- .03	- .06
urea	.12	-	- .12	-
P .05	.43	.43	.58	.51

1) Roever (1983); 2) not examined

As previously shown in table 3 the reactions of some blood parameters have a close relationship to female fertility when the bulls have been under stress. By means of multiple correlation, the joint influence of the metabolic concentration and enzymic activities investigated here can be singled out. The combination of the standardized reactions of the bulls provided an optimal source of information concerning the fertility (DO) of the female offspring. When considering several metabolic parameters together, the multiple correlations were $r_M = .70 - .90$ (table 4) which implies $R^2 = .50 - .80$, therefore the enzymes have a especially high percentage of the variance explained.

Table 4. Results of the multiple regression analysis (dependent variable: breeding value days open (DO)).

test 1		test 2		test 3	
var[1]	r_m	var	r_m	var	r_m
GPT	.42	Y-GT	.83	Y-GT	.48
ß-HB	.53	GOT	.86	ß-HB	.60
triglycerides	.66	GPT	.89	GPT	.73
Y-GT	.68	ß-HB	.90	glucose	.75
glucose	.69	glucose	.90	GOT	.78
GOT	.70	urea	.91	triglycerides	.79
R^2	.49		.83		.62

[1] sequence of independent variables included

Discussion

The result of this paper was to develop on the basis of a more extensive data. base the possibility for selecting female fertility using the metabolic regulation capacity which is both genetically determined and measurable. Also it appears that a relationship between the blood parameters and the reproduction characteristics exists. The results show that stress from an insufficient energy supply in bulls cannot be compared to the metabolic stress ocuring in cows during the prime lactation period. Whereas in the case of lactating cows an increased basal metabolic rate, which maintains the level of milk performance, can be observed, the energy consumption rate in bulls is reduced ("saving metabolism"). On the basis of these experimental stresses, insights into the metabilic regulation capacity and the relationship to fertility are however to be expected (ROEVER, 1983; FEDDERSEN et al., 1984).

In these experiments the conditions mentioned above are met mainly by the enzymes Y-GT and GPT since their activities
- show partly a good repeatability between test periods (table 2).
- show in all tests a high and similar correlation to the daughters fertility (table 3) and
- contribute thereby in all test series when taken together, can explain the biggest share of the variance in female fertility (table 4).

On account of the high repeatability between the test periods, glucose appears to be an additional, suitable parameter for estimation metabilic stress capacity. Therefore only the parameters Y-GT, GPT and glucose were taken into consideration in a further, multiple regression analysis. Significant correlations of r = -.47 in test 1, r = -. 87 in test 2 and r = -. 69 in test 3 resulted between the combination of Y-GT, GPT and glucose and the breeding value DO. These correlations indicate that with an insufficient metabolic regulation for the bulls, a deterioration in the fertility of the daughters is to be expected. Thus, it may be concluded that insufficient metabolic regulation capacity is inherited from the bulls to their daughters and results in reduced fertility.

In conclusion the following can be stated:

1. The stress test for bulls (FEDDERSEN, 1986) as introduced and modified during the tests by ROEVER (1983) permits, on the basis of the metabolic reactions it causes, a differentiation between metabolically

stable and unstable animals. Overall, stress should be increased by a further ration reduction during the period of insufficient energy supply so as to better distinguish differences between bulls.

2. Above all, the blood parameters Y-GT, GPT and glucose should be investigated. Further for their use as predictors for female reproduction.

3. The previous results of these stress tests can at present be applied in addition to bull fertility in order to provide more information for an assessment of the offspring's reproductive performance and constitution. In this connection, bulls whose values lie more than one standard deviation below the average (metabolically unstable) should be investigated closer.

4. As a future preliminary test for young bulls stress test could provide the possibility to identify poor fertility transmitters and exclude them from further breeding. In breeding programmes, the stress test could be carried out during or after the performance test.

Further studies should develop a standardized test procedure and help to explain the connections between the bulls' and cows metabolic reactions. Only then will it be possible to give a final assessment of stress tests with bulls.

References

Blum, J.W., P. Kunz, C. Bachmann, J. P. Colombo, 1981. Metabolic effects of fasting in steers. Research in Veterinary Science 31:127-129

Depke, W., 1981. Untersuchungen zur Konstition und Fruchtbarkeit an ausgewählten Nachkommengruppen des Deutschen Schwarzbunten Milchrindes anhand von Blutserumuntersuchungen. Diss. met. vet., Hannover.

Feddersen, E., G. Roever, E. Kalm, N. Mäckle, 1984. Entwicklung eines Testverfahrens für Bullen zur Selektion auf Stoffwechselbelastbarkeit bei Kühen. 35. Jahrestagung der EVT. 6.-9. August 1984, den Haag, Kommission für Rinderproduktion.

Feddersen, E., 1986. Untersuchungen zur Fruchtbarkeit und Konstitution in der Rinderzucht in Schleswig-Holstein. Diss. agr., Kiel

Graf, F., 1981. Genetische Einflüsse auf Enzymaktivitäten und Metabolitenkonzentration im Blut als Belastbarkeitskriterien für Milchkühe Habil. schrift, Ludwig-Maximilian-Universität, München.

Harvey, W. R., 1976. User's Guide for LSML 76 (Mixed Model Least Squares and Maximum Likelihood Computer Program) Polykopie, Ohio State University.

Henricson, B., G. Jonson, B. Pehrson, 1975. "Lipid pattern", glucose concentration and Ketone body level in the blood of cattle. Zbl.Vet. Med. 24:90

Kaufmann, E., 1984. Anmerkungen zu Wechselwirkungen zwischen Energie- und Eiweißstoffwechel, Persönliche Mitteilung.

Keller, P., 1971. Serumenzyme beim Rind: Organanalysen und Normalwerte Schweizer Archiv für Tierheilkunde, Heft 5, Bd. 113:615-626

Orth, A., W. Kaufmann, 1961. Die Verdauung im Pansen und ihre Bedeutung für die Fütterung der Wiederkäuer. Verlag Paul Parey

Roever, G., 1983. Untersuchungen über die Zusammenhänge zwischen Stoffwechselbelastungen und Fruchtbarkeit am schwarzbunten Rind. Diss. agr. Kiel

Tilakaratne, N., J. C. Alliston, W. R. Carr, R. B. Land, T. J. Osmond 1980. Physiological attributes as possible selection criteria for milk production. Anim. Prod. 30:327-340

METABOLITES, ENZYMES AND HORMONES IN FATTENING SIMMENTAL BULLS: HERITABILITIES, FACTOR ANALYSIS AND RELATIONSHIPS TO PERFORMANCE TRAITS

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Summary

In 593 male progeny of 41 Simmental AI-bulls the blood values of thyroxine, triiodothyronine, glucose, urea, and the liver-specific enzymes GLDH, SDH, ASAT and ICDH are analysed at the age of 2, 5 and 7 months. All blood values were genetically influenced, the heritabilities ranging from 0.14 (SDH) to 0.65 (thyroxine). In the factor analysis 3 factors could be extracted: factor I was high loaded by all liver-specific enzymes, factor II by thyroid hormones and factor III by some blood values dependent on age. Only low correlations between blood values and production and fertility traits could be found.
Key words: blood values, fattening bulls, Simmental cattle, heritabilities, performance traits.

Introduction

In former works significant relationships between some blood values and production traits could be found in lactating Simmental cows (Graf, 1981). As they proofed to be influenced genetically, now the experiment was repeated in male animals. There is some incidence, that blood values of bulls are connected with performance in male and in female animals of Simmental breed (Graf, 1979, Schwab, 1986), as it was found in other breeds by several authors (good reviews are given by Schwab, 1986 and by Reinecke & Seeland, 1985).

Material and Methods

For our analyses 41 progeny groups of Simmental-AI-bulls were available; the average number of the male progeny per group was 14, making a total number of 593 fattening bulls. They were kept under equal housing and feeding conditions (maize silage) in 12 farms.
During the fattening period blood samples were collected at the age of approximately 2 months (80 kg live weight), 5 months (170 kg) and 7 months (265 kg).
The blood samples were analysed for the values of thyroxine (T4), triiodothyronine (T3), thyroxine binding capacity (TBI), glucose, urea and for the activities of the enzymes SDH, ASAT, ICDH.

Results and discussion

Heritabilities

Genetic differences in some blood values are depending on age, especially in T4: older animals differ more genetically than younger animals. The heritabilities shown in table 1 were estimated from mean values of each animal.

Table 1. Heritabilities of blood values

	h^2	s_{h^2}
T4	0.649	0.163
T3	0.175	0.063
TBI	0.281	0.085
Glucose	0.241	0.077
Urea	0.283	0.086
GLDH	0.138	0.055
SDH	0.136	0.055
ASAT	0.027	0.032
ICDH	0.165	0.061

Factor analysis

The factor analysis allowed to extract 3 factors (Table 2). Factor I is explained as "liver factor", factor II as "thyroid factor" and factor III as "age factor" due to the fact, that ASAT, ICDH, glucose and urea were found to be age-dependent.

Table 2. Factor analysis: Factor-loading

	Factor I	Factor II	Factor III
T4		0.798	
T3		0.743	
TBI		-0.636	
Glucose			-0.658
Urea			0.504
GLDH	0.826		
SDH	0.836		
ASAT	0.576		0.519
ICDH	0.525		0.632

The most important result of the factor analysis is, that the so called "liver-specific enzymes", which are normally used in clinical diagnosis of liver diseases, are liver-specific in healthy fattening bulls too and therefore can be used for testing their liver-stability.

Relationships to performance

For each sire the breeding values for blood parameters are correlated with the breeding values of performance traits. The correlations are low and only in few cases significant. Neverthless the signs of the correlation coefficients are of interest: T4 is positively correlated with daily gain ($r = + 0.21$), carcass weight ($r = + 0.15$), butterfat ($r = + 0.21$), but negatively with the non-return-rate 90 of lactating cows ($r = -0.40$). The correlation coefficients of T3 to all mentioned traits have reverse signs, a surprising finding, if one considers the results of the factor analysis. The fact, that T4 is only the precursor of the more efficient T3 may be one of the reasons for this phenomenon.
Glucose values are negatively correlated with weight gain and with milk yield. For the explanation the insulin and glucagon levels might be of great interest; they are the objective of current investigations.
The positive correlations of liver-specific enzymes to fattening and to milk production traits are to be expected as well as the negative correlations to non-return-rates (resp. positive to days open) in lactating cows: The load of the main metabolic organ, the liver, leads to a desintegration of liver cell membranes and might, in addition, cause a faster cell turnover and lead to an efflux of liver cell enzymes into the blood. The activity of liver cell enzymes is therefore an indicator of liver-stability. Lactating cows with genetic predisposition for livercell desintegration tend to fertility difficulties. But it should be stressed, that the correlations are low ($r < 0.1$) and not significant.

Conclusions

None of the blood parameters can be used as a selection criterion, but they can help us in better understanding the genetics of the physiological background of performance. Especially the liver-stability seems to be involved in all production and fertility traits. A connection of those parameters with a hormone profile (thyroid hormones, insulin, glucagon and growth hormone) and additional with a challenge (fasting, injection of glucose etc.), as proposed by Tilakaratne et al., 1980, Feddersen et al., 1984, Schwab, 1986, Graf & Kräußlich, 1986, might be more helpful. But up to now routine-measurements of insulin, glucagon, somatotropin and of their receptors are very difficult and very expensive, especially in connection with an experimental challenge in bulls. However, corresponding research work is in progress.

References

Feddersen, E.G., G. Roever, E. Kalm & N. Mäckle, 1984. Entwicklung eines Testverfahrens für Bullen zur Selektion auf Stoffwechselbelastbarkeit bei Kühen. 37th Annual Meeting of EAAP, 6.-9. August 1984, Den Haag.

Graf, F. & I. Grosser, 1979. Thyroxinwerte von Jungbullen im Bezug zur Eigenleistung und Töchterleistung. Zbl. Vet. Med. A, 26: 682-686.

Graf, F., 1981. Genetische Einflüsse auf Enzymaktivitäten und Metabolitenkonzentrationen im Blut als Belastbarkeitskriterien für Milchkühe. Habil.-Schrift, München.

Graf, F. & H. Kräußlich, 1986. Vergleichende Untersuchungen zur Stoffwechselstabilität des Zweinutzungsrindes (DFV) und des Milchrindes (HF). III. Internationales Symposium zur Rinderzucht. Leipzig, 26.-27.6. 1986.

Reinecke, P. & G. Seeland, 1985. Untersuchungen zur Eignung der Schilddrüsenaktivität als Frühselektionskriterium für Merkmale des Wachstums und der Milchleistung beim Rind Diss. agr., Berlin.

Schwab, M., Das Verhalten von einigen Metaboliten, Enzymen sowie Insulin und Wachstumshormon bei männlichen Rindern mit unterschiedlichem Milchzuchtwert. Diss. agr. München.

Tilakaratne, N., J.C. Allistone, W.R. Carr, R.B. Land & T.J. Osmond, 1980. Physiological attributes as possible selektion criteria for milk production. Anim. Prod. 30: 327-340.

HERITABILITY OF SOME BLOOD VARIABLES AND RELATIONSHIP WITH THE PERFORMANCE TRAITS OF ITALIAN SIMMENTAL YOUNG BULLS.

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Summary

Blood samples were taken from 345 Simmental young bulls, sons of 21 sires, at 3, 6, 9, 12 months of age and at slaughtering. Averages of plasma concentration at 6, 9 and 12 months were used. Among the 15 blood components considered, Lactic Dehydrogenase (LDH) and Alkaline Phosphatase (AP) showed medium-high heritabilities (.39 and .61, respectively), high genetic correlations with daily gain (-.52 and -.55) and moderate genetic correlation with trimmed fat percentage on carcass (-.13 and -.30). AP presented also a moderate genetic correlation with lean meat percentage on carcass (.29). The concentration of these two enzymes at 6 months of age presented the same pattern of correlations with production traits at maturity.
Keywords:performance-test, blood components, genetic correlation.

Introduction

Highly heritable traits can be measured on young bulls during performance test in order to rank the animals by their genetic value. Some important beef production traits cannot be measured in vivo (i.e. dressing percentage, carcass composition), and direct selection does not rely on objective criteria. Therefore, it is necessary to rely on estimates or on indirect selection for correlated traits. Preliminary experimental results on the correlations between some blood components and production traits and on their heritability (h^2) will be presented.

Material and methods

345 Simmental young bulls from 21 sires were tested in 4 subsequent batches in the performance station of the Italian Simmental Breeders Association (A.N.A.P.R.I.) from 1984 to 1986 as described in a previous paper (Spanghero, 1985). Blood samples were taken from jugular vein of fasted animals at 3, 6, 9, 12 months of age and at slaughter age (15-19 months). For each sample were quantified the Packed Cell Volume (PCV) and the following plasmatic components: Glucose (Gl), Total Protein (TP), Albumin (Ab), Globulin (Gb), Urea (Ur), Creatinine (Cr), Inorganic Phosphate (P), Calcium (Ca), Magnesium (Mg), Potassium (K), Glutamic Oxaloacetic Transaminase (GOT), Glutamic Pyruvic Transaminase (GPT), Lactic Dehydrogenase (LDH) and Alkaline Phosphatase (AP) (Bonsembiante & Bittante, 1980). At the end of the trial, Daily Gain (DG) and some slaughtering and jointing parameters were computed. Among these, Lean Meat percentage on carcass (LM%), trimmed bone on carcass (B%), trimmed fat on carcass (F%) and the ratio Lean Meat/trimmed bone (M/B) are considered. Data were analysed by implementing the following univariate mixed model:

$$y_{ijk} = \mu + b_i + s_{(i)j} + e_{(i)jk}$$

where y is the dependent variable, b is the fixed effect of the batch of young bulls on trial (1 i 4), s is the random effect of the sire nested within batch (1 j 6) and e is the random residual. Heritabilities and genetic and phenotypic correlations were computed from variance component estimates obtained by the REML algorithm in the VARCOMP procedure by SAS Institute (SAS Institute Inc., 1985).

Results and discussion

Heritabilities of blood components, defined as average of 2^{nd}, 3^{rd} and 4^{th} sampling, are reported in table 1 together with results published by other authors (Peterson, Nash & Shelford, 1982; Rowlands et al., 1974; Rowlands et al., 1983).

Table 1. Heritabilities of some blood components from literature and from the present trial.

	Rowlands et al., 1974	Peterson, Nash & Shelford, 1982	Rowlands et al., 1983	Present trial
Animals	242 fattening calves	545 lactating cows	428 fattening bullocks	345 young bulls
Genetic type	Hereford x Friesian	Holstein Friesian	British Friesian	Italian Simmental
Sire groups	12	29	72	21
Heritability				
PCV	.50	-	-	.24
Gl	.18	.02	.41	.16
TP	-	.20	-	.20
Ab	.10	.19	.38	.02
Gb	.00	.06	.65	.30
Ur	.00	.17	.29	.07
Cr	-	.44	-	.18
P	.18	.10	.49	.01
Ca	.19	.00	.16	.00
Mg	.21	-	.33	.21
K	.40	.23	.82	.00
GOT	-	.17	-	.12
GPT	-	-	-	.15
LDH	-	-	-	.39
AP	-	.52	-	.61

PCV, TP, Gb, and Mg showed a moderate heritability, within the range .20-.30, and only LDH and AP showed a medium-high heritability, .39 and .61 respectively. Differences among estimates by other authors and among these and our results are generally large. It is worth noting that the few heritability estimates for enzymes available in literature are in agreement with the estimates from the presente trial (Adam et al., 1985;

Gondesen, 1980). In this preliminary work we discuss only correlations among those traits which presented an heritability level of at least .15. Phenotypic correlations are presented in table 2 and genetic correlations are in table 3.

The analysed variables did not show fairly high phenotypic relationships with the performance traits, and all the correlation coefficients laid within the range -.13 and +.18. Among blood components with moderate heritability, PCV presented a medium positive genetic correlation with DG (.41) and with F% (.46), and a negative correlation with B% (-.39), while Gb showed a genetic correlation of some importance (.30) only with LM%. More interesting is the pattern of genetic correlations with production traits of LDH and AP: both enzymes did not show substantial genetic correlation with B% and M/B, but they showed

Table 2. Phenotypic correlations between average concentrations of some blood constituents at 6, 9 and 12 months of age and some productive parameters.

	DG	LM%	B%	F%	M/B
PCV	.063	-.121	-.019	.176	-.024
Gl	.042	.062	-.116	.000	.118
TP	.057	-.020	.013	.046	-.018
Gb	-.004	.046	.042	-.040	-.021
Cr	.053	.084	-.134	-.126	.134
Mg	.075	-.032	-.001	.006	-.024
GPT	-.018	-.075	.121	.021	-.094
LDH	-.029	-.031	.007	-.014	-.004
AP	-.114	.087	.011	-.119	.020

Table 3. Genetic correlations between average concentrations of some blood constituents at 6, 9 and 12 months of age and some productive parameters.

	DG	LM%	B%	F%	M/B
PCV	.412	-.045	-.394	.461	.241
Gl	-.534	-.169	-.208	.107	.007
TP	.170	.039	.267	.219	-.203
Gb	.046	.296	.085	-.194	.037
Cr	.176	.171	.187	-.160	-.030
Mg	.412	-.263	.198	.049	-.344
GPT	-.464	.401	.392	-.648	-.222
LDH	-.515	-.013	-.084	-.128	-.016
AP	-.553	.287	.069	-.299	.074

medium negative correlation with DG (-.52 and -.55, respectively) and a moderate negative one with F% (-.13 and -.30). Finally, AP presented a medium positive genetic correlation with LM% (.29). The high heritabilities and genetic correlations with the production traits showed by LDH and AP, as average of their concentrations at 6, 9 and 12 months of age, suggested the usage of the plasma level of these enzymes at early ages as indicators for growth capacity and carcass composition at maturity. LDH and AP did not show substantial genetic variability at 3 months of age while at 6 months they showed noticeable heritabilities (.29 and .66, respectively) and genetic correlations with DG (-.48 and -.50) and with F% (-.36 and -.29).

Conclusions

These preliminary results indicate that LDH and AP plasma concentrations in young bulls could be used as objective criteria for evaluating carcass composition in live animals at the end of performance test. Also, AP and LDH concentrations at early ages could be used as indicators of growth potential and carcass traits at maturity for calves before entering performance test. However, these results need to be confirmed by implementing Multiple Trait Analysis in order to obtain more relyable correlation estimates and to be verified on larger data sets.

References

Adam, F., Fruhling, S., Gravert, H.O. & Pabst, K., 1985. Genetic determination of liver-specific enzymes and their reliability for predicting milk yield of cows. Anim. Breed. Abstr., 53: 612 (Abstr. 4781).

Bonsembiante, M. & Bittante, G., 1980. Profilo metabolico di manze gravide allevate con razioni caratterizzate da un livello nutritivo moderato o basso. Zoot. Nutr. Anim., 6: 297-309.

Gondesen., F., 1980. Estimates of heritability of blood parameters (glucose, total bilirubin, total cholesterol, GOT and phosphorus) in dairy cattle. Anim. Breed. Abstr., 48: 784 (Abstr. 6599).

Peterson, R.G., Nash, T.E. & Shelford, J.A., 1982. Heritabilities and genetic correlations for serum and production traits of lactating Holstein. J. Dairy Sci., 65: 1556-1561

Rowlands, G.J., Payne, J.M., Dew, S.M. & Manston, R., 1974. Individuality and heritability of the blood composition of calves with particular reference to the selection of stock with improved growth potential. J. Agric. Sci., 82: 473-481

Rowlands, G.J., Manston, R., Kathryn, J.B. & Brookes. P.A., 1983. A genetic analysis of the concentrations of blood metabolities and their relationships with age and live-weight gain in young British Friesian bulls. Livest. Prod. Sci., 10: 1-16

SAS Institute Inc., 1985. SAS® User's Guide: Statistics, Version 5 Edition. Cary, Nc: SAS Institute Inc., 956 .

Spanghero, M., 1985. Nuovi risultati delle prove di progenie per l'attitudine alla produzione della carne dei tori pezzati rossi. La Pezzata Rossa, 11: 17-29.

GENERAL DISCUSSION (SESSION III)

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The discussion was focussed on three points of interest:

1. Parameters related to the sexual and reproductive performance of young bulls.
2. The use of a stressing procedure to get indicators of physiological reactions of the animal.
3. Possibilities for selection on disease resistance.

Sexual and reproductive performance traits as libido, semen quality and semen quantity, are often used as culling criteria of young bulls. We loose on selection intensity and it is difficult to determine correlations with field performance for fertility. Standards are usually determined by AI-studs including the rate of dilution.

With respect to metabolic parameters and stressing procedures it was discussed which test would be useful and which animal we need to select. If we use metabolic parameters as measure of animal response to a fasting stress to predict, for example, the fertility of a bull's daughter, we would like to have "stable" animals. According to German research liver stability seems to be involved in all production and fertility traits. For high producing cows the load of the liver produce a disturbtion of the liver cells giving the cow a higher liver cells turnover. The level of liver cell enzymes in the blood is an indication of liver stability. Experiments were presented with different challenge tests as fasting, adding adrenalin, etc. General questions that were arised:

- What do we want to simulate with a given stressing procedure?
- What is the predictive value of the stressing procedure of young bulls for the metabolic status of e.g. the high producing cow?
- What kind of reaction is preferable of a stressed animal?

Selection for disease resistance can be supported by measuring specific parameters related to immunological responses. The effectiveness of this approach depends on the trait you are dealing with. Field tests e.g. for mastitis showed low heritabilities but selection experiments with challenge tests in other species have shown reasonable responses. Preliminary results of research in Norway showed a small positive relationship between several immunological traits and mastitis. A problem may be the way of characterizing mastitis.

Research is in progress oriented to study the possibility to measure hormonal parameters of young bulls and to quantify their importance as predictors of breeding values to support selection decisions.

Session 4

Estimation of breeding values of performance tested bulls

ESTIMATION OF BREEDING VALUES FOR GROWTH IN PERFORMANCE TEST IN NORWAY

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Summary

The method of utilizing the performance test data in Norway is described. The accuracy of the breeding value for growth at the performance test stations is discussed.

Introduction

In Norway the performance testing of potential AI bulls has been a part of the breeding program since 1957.

From 1972 two stations are used for this purpose and they have a total capacity of 400 bulls per year.

With a dual purpose breed this performance test has an important role to play both in providing data for selection and in giving a standardized environment for the young bulls.

Test period

The test period used to start at three months of age and last until 12 months of age. In 1986 the length of the test period was changed from 270 to 240 days by ending the test at 11 months of age. The reason for this is that the twelvth month normally is used to test the bulls' ability to produce semen, and it has been shown that this testing affects the growth rate, Fimland (1973) and Kirkeeide (1985).

The data also show that a test period of 240 days is sufficient for the purpose.

Traits

From 1972 the selection criterion has been average daily growth in the test period. The bulls are fed concentrates according to age and roughage (mostly grass silage) ad libitum. With this feeding regime and selection for growth rate the intension is to improve the animals' ability to grow fast on a diet with a high percentage of roughage.

Table 1 shows genetic and phenotypic parameters estimated from data for the years 1972-1984, a total of 4320 tested bulls with 144 sires.

The results in Table 1 shows that there are high genetic correlations between all these traits. This demonstrates clearly that selection for one trait or for combinations of traits will lead to increased size of the whole body. It also shows that selection with some restriction on the final weight may be little effective.

Table 1. Genetic and phenotypic parameters for some traits recorded at the performance test stations 1972-1984.
Genetic correlations above the diagonal, heritabilities on the diagonal and phenotypic correlations below the diagonal.

	Daily growth	Weight 90 d.	Weight 360 d.	Heart girth	Height at rump
Daily growth	0.39	0.51	0.96	0.82	0.45
Weight, 90 d.	0.14	0.24	0.74	0.62	0.64
Weight, 360 d.	0.89	0.57	0.43	0.85	0.57
Heart girth	0.61	0.45	0.71	0.34	0.46
Height at rump	0.33	0.40	0.46	0.37	0.60

Standard errors of heritabilities: 0.04-0.08
Standard errors of genetic correlation: 0.03-0.09

Breeding value

The breeding value is calculated using only growth rate. The result of the bull itself is combined with results on the bull's paternal half brothers. Until now we have used a heritability of 0.55 according to the findings of Fimland (1973), but it will be changed to 0.40.

Before entering the computation of breeding values the growth rate is expressed as deviation from the mean of the group of contemporary bulls at the station. Consequently the number of contemporaries may affect the accuracy of the breeding values. The breeding values are presented as an index ranging from 1 to 10, the performance index. Selection of young bulls is done four times a year and within each group the maximum age difference is about 3 months. This may also affect the accuracy of the breeding value, especially if there is some variation in feed quality within this period. The two Norwegian stations are of different size and consequently the groups of contemporaries are of differenty size too. The biggest station has a capacity of 250 bulls while the smaller one has a capacity of 150 bulls.

In order to see if the group size affects the accuracy of the performance index we have estimated the correlations between performance index and progeny test result for beef production within performance test stations and for bulls tested in small and big groups.

The results are shown in Table 2.

Table 2. Correlations between performance index and progeny test results for beef production.

		Number of bulls	Performance index - progeny test
Station	Small	120	0.13
	Big	238	0.17
Group size	≤50	233	0.13
	>50	125	0.19

As long as the progeny test is equally accurate for all bulls these correlations show that there is an effect on the accuracy of the performance index of group size.

Future breeding value

The existing breeding values are probably quite useful because there are only two test stations and the groups are never at the absolute minimum size. However, it will be possible to improve the breeding values by using a BLUP procedure with the relationship matrix included. That will make it possible to connect the two stations because the bulls at the different stations have the same sires.

In this way the performance index would be more accurate, but as long as we are just selecting the best half of the bulls it is not likely to have much effect on the selection response achieved.

References

Fimland, E., 1973. Estimates of phenotypic and genetic parameters for growth characteristics of young potential AI bulls. Acta Agric. Scand. 23: 209-216.

Kirkeeide, E.B., 1985. Fenotypetest av oksar i NRF-avlen. Thesis at the Agric. Univ. of Norway, 58 p.

ESTIMATION OF BREEDING VALUES FOR BEEF PRODUCTION TRAITS ON SWEDISH DUAL-PURPOSE CATTLE

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Abstract

A Mixed Model procedure has been applied to the Swedish performance testing of dual-purpose bulls and was officially introduced in the evaluation for growth rate from January 1987. The model include fixed effects of test station, year and season of birth and breed of the bulls tested and the random genetic effects of sire, maternal grandsire and each individual bull. Due to large variation in year-season effects in daily gain at most stations, breeding values are estimated using the deviations of daily gain of the single bulls from a rolling station average. Breeding values will be related to the average breeding value of a rolling base of the latest 4 years and presented as relative breeding values.
Keywords: growth rate, performance testing, breeding value, BLUP.

Introduction

Performance testing has become an important tool in many countries in the evaluation of bulls for beef production traits, particularly growth rate. The estimation of breeding values for bulls has generally been done by comparing their performance with a rolling average of contemporaries. Changes in breeding structure, new breeding goals and improved breeding programs have modified the assumptions that were necessary for the old procedures to work satisfactorily. Theoretically better evaluation methods have been developed and at the same time computer facilities have made it possible to handle vast quantities of data. Henderson's Mixed Model or the Best Linear Unbiased Prediction (BLUP) procedure (Henderson, 1973), has become a standard method in animal breeding and is widely used in many countries for evaluating the genetic merit of individuals for many traits. Due to the great flexibility of this method it is possible to find evaluation procedures that suit different types of environmental conditions.

The aim of this paper is to describe the application of a Mixed Model procedure to the Swedish performance testing of dual-purpose bulls.

General structure of the performance testing

The Swedish performance testing scheme has been described by Henningsson (1986a), and others. The testing of dual-purpose bulls is today carried out at seven stations with a total capacity of 500-550 bulls tested annually. The stations are run by the AI cooperatives under supervision of The Swedish Association for Livestock Breeding and Production (SHS). Bulls are evaluated for daily gain between 2 and 12 months of age. The evaluation has been done from 1963 until now by using a Contemporary Comparison method. Daily gain of a single bull was compared with the average growth rate of other bulls which were tested contemporarily at the station. A relative breeding value, T, for daily gain on test was then calculated according to the formula:

$T = h^2(R-100)+100$

where

h^2 = heritability for growth rate = 0.4

R = relative growth rate, i.e. growth rate of the young bull as a percentage of that of its contemporary group.

The need for a new evaluation method

Data from the performance testing have been analysed by Henningsson (1986 a,b,c). The main results from these analyses can be summarized as follows:

Non genetic factors, such as test station, year and season of birth and interactions between these, were found to have a significant influence on daily gain. In order to obtain good estimates of the breeding value for growth rate, pre-adjustment should be made for some of these effects. However, difficulties arise when seeking generalized adjustment factors, due to the occurence of interactions.

The contemporary groups did not as a rule adjust satisfactorily for seasonal effects, due to the limited number of bulls and sires tested within a reasonable period of time.

Furthermore, the intensive use of sires over a short period of time, which has been increasingly pronounced during recent years, gave rise to contemporary groups, consisting of only few progeny groups, though large. In such circumstances the genetic level of the contemporary groups would fluctuate, which would affect the estimates of breeding values of the young bulls. It seemed difficult to deal with these circumstances by the Contemporary Comparison method, but could be solved with a Mixed Model procedure.

Introduction of a Mixed Model procedure

In the application of a Mixed Model procedure reported by Henningsson (1986d) the following linear model was used for the evaluation within breed of performance tested bulls born 1967-82.

$$Y_{ijkl} = t_i + g_j + s_{jk} + p_{ijkl} + \epsilon_{ijkl} \qquad \text{Model 1}$$

where

Y_{ijkl} = an observed daily gain on test

t_i = fixed effect of ith station-year-season of birth

g_i = fixed effect of jth sire group

s_{jk} = random additive genetic sire effect

p_{ijkl} = random additive genetic effect of each individual bull

ϵ_{ijkl} = a random error associated with each individual bull's record.

For a detailed description of the model and the solutions, see Henningsson (1986d).

Growth rate records were pre-adjusted for the average effects of month of birth by using adjustment factors described by Henningsson (1986c). Each year was then divided into two seasons, viz. December-May and June-November. In this way, months with similar effects on daily gain were combined in the same season. It would have been possible to form more than two seasons per year, but then the number of records per station-year-season subclass would have been small.

Groups were formed for sires to account for genetic trends over time. The grouping was based on year of birth of the sires. Three to five consecutive years were brought together in order to get approximately 50 sires in each group.

Predicted sire transmitting abilities, PD, for growth rates measured on the sons of any sire, were expressed by $(g_j + s_{jk})$.

The estimated breeding values for bulls, EBV, were obtained in the following way:

$$EBV_{ijkl} = g_j + s_{jk} + p_{ijkl}$$

For practical purposes, EBVs were converted into relative breeding values (RBV) in the following way:

$$RBV = \frac{EBV + \overline{ADG}}{\overline{ADG}} \times 100$$

where $\overline{ADG}$ is the average daily gain on test.

Test for disconnectedness between test station–year–season subclasses were made as described by Eriksson et al. (1978). All subclasses were found to have sires in common and were thus connected.

Results

The results obtained could be summarized as follows: (For details see Henningsson, 1986d).

Heritability estimates for daily gain on test varied between 0.29 and 0.38 for the two main dual–purpose breeds, Swedish Red and White (SRB) and Swedish Friesian (SLB), respectively.

Correlations within year between breeding values by the Mixed Model procedure and breeding values by the Contemporary Comparison method were 0.88 for SRB and 0.83 for SLB. This shows, assuming that BLUP gives accurate breeding values, that it would be possible to improve the accuracy of selection for daily gain by 12–17% by using the Mixed Model procedure.

Andersen et al. (1984) reported slightly higher correlations (0.89–0.93) between breeding values by BLUP and T–values from the Danish performance testing of dual–purpose bulls.

Annual genetic trend in growth rate of performance–tested bulls was positive, though fairly small. Weighted by their use in AI, the trend was estimated to 1–3 g/day. The modest genetic improvement was expected in view of the low selection intensity after performance tesing, where on average only 20% of the bulls tested for daily gain were culled due to low growth rate.

Application of a modified BLUP procedure

In a following up study on essentially the same data, viz. bulls performance tested 1967–85 Eriksson (1986) applied the following modified model for across breed evaluation:

$$Y_{ijkl} = t_i + r_j + s_{jk} + \tfrac{1}{2}s'_{jk} + p_{ijkl} + \epsilon_{ijkl} \qquad \text{Model 2}$$

where in addition to Modell 1

r_j = fixed effect of jth breed
s_{jk} = a random additive genetic effect of the kth maternal grandsire (MGS)

The inverse of the additive relationship matrix was computed according to Henderson (1975) and considered sires and MGS of the bulls. MGS with less than 4 maternal grand sons and no sons were treated as unknown. Precorrection of daily gain for the effect of month of birth was done as described by Henningsson (1986c).

Grouping was not included in this model in order to avoid possible problems with obvious under or overestimations of group effects.

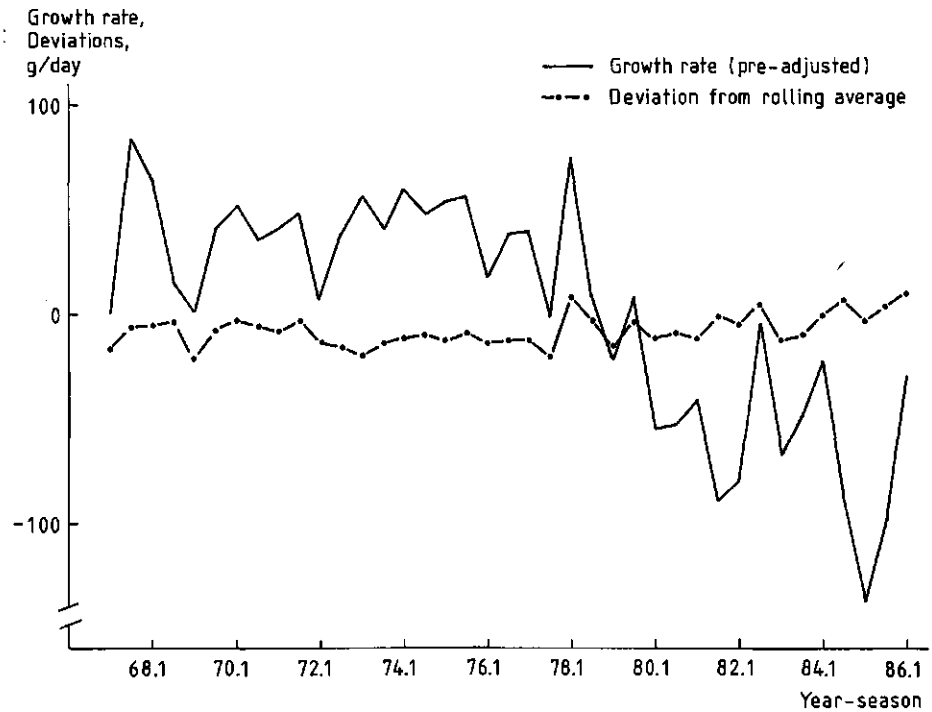

Fig. 1. Year–season effect on daily gain and on the deviation in daily gain from a rolling average in one test station (Eriksson, 1986)

Eriksson (1986) especially pointed out the large variation in daily gain expressed as year–season effects that existed in most stations, particularly between adjacent seasons. As an example the year–season effect on daily gain in one of the largest test stations is shown in Fig. 1. Such large variations were also described by Henningsson (1986a,b). This large variation in growth rate is unacceptable regarding the evaluation of the bulls. Especially problems arise at the border between two seasons. In the extremes there could be a difference of 100 grams in daily gain between two consecutive seasons, which could cause an incorrect difference in estimated breeding values between bulls of 3–4%. To overcome this problem Eriksson (1986) suggested that breeding values for daily gain should be estimated using the deviations of daily gain of the single bulls from a rolling station average. This rolling station average was calculated for each single bulls as the average daily gain during a 5 months period with month of birth of the single bulls in the middle of this period. The year–season effect estimated on deviations in daily gain from the rolling average is shown in Fig. 1 for the same test station as mentioned before. It can be seen that the differences between year–seasons is less but still there are some variation left. This is especially the case for the last season which might be explained by the fact that only few bulls are included.

Breeding values calculated from deviations as described above showed a slightly lower variance than did breeding values estimated from daily gain. The difference between the two types of breeding values had a standard deviation of 0.45 T–units which is rather much, Table 1. The correlation between the two types of breeding values was 0.98–0.99.

Table 1. Means and standard deviations for breeding values calculated from daily gain and from deviations from rolling station averages (Eriksson, 1986)

Breed	No of bulls	Breeding value	Mean	S.D.
SRB	5.760	Daily gain	100.24	2.56
		Deviation	100.20	2.49
		Difference	0.05	0.43
SLB	2.145	Daily gain	100.26	2.65
		Deviation	100.32	2.58
		Difference	-0.06	0.45

An alternative for the evaluation could be the application of an animal model. This has however not been considered so far. An animal model would be more expensive to run and furthermore, the correlation turned out to be good between breeding value of the sires in their performance testing and that of their sons.

The Mixed Model described here (Model 2) was officially introduced in the evaluation of performance tested dual–purpose bulls in Sweden from January 1987.

Daily gain will be evaluated as deviation from a rolling station average as described above. Included in the rolling averages will be bulls from 8 months of age. Breeding value will be estimated for bulls from 10 months of age.

Live weight at one year of age for all bulls included in the evaluation procedure will be estimated from their live weight, registered during the preceding 2 months by means of a linear regression.

Daily gain on test will be pre–adjusted multiplicatively for the effect of month of birth by means of adjustment factors given by Henningsson (1986c), for the effect of breed by additive adjustment factors given by Eriksson (1986) and to 60 days of age at start of test by a coefficient of regression of –1 g/day.

Breeding values will be related to the average estimated breeding value ($\overline{EBV}$) of a rolling base of performance tested bulls which finished their test during the latest 4 years. This base will be moved one year in September each year.

The breeding values will be presented as relative breeding values (RBV). (In Sweden they might be called T–values as before). The RBV:s will have a natural variation and average daily gain within breed for bulls tested the latest 4 years will be used as a base.

The relative breeding value of the bulls will then be computed as follows:

$$RBV = \frac{s_{jk} + \frac{1}{2}s'_{jk} + p_{ijkl} - \overline{EBV} + \overline{ADG}}{\overline{ADG}} \times 100$$

where in addition to Model 2

$\underline{RBV}$ = relative breeding value (T−value)
$\underline{EBV}$ = average estimated breeding value of the base years.
$\overline{ADG}$ = average daily gain within breed of bulls tested during the base years.

References

Andersen, B.B., Løvendahl, P., Madsen, P., Jensen, J., Klastrup, S. & Sørensen, Sv.E. 1984. Avelsstationerne for kødproduktion 1983/84. Rep. No. 676, 43−50. Natl. Inst. Anim. Sci., Copenhagen.

Eriksson, J.−Å., Wilton, J.W. & Henningsson, T. 1978. Estimating breeding values for rate of gain of beef bulls in Sweden. Report no. 23, Department of Animal Breeding ad Genetics, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Eriksson, J.−Å. 1986. Individprövning av mjölkrastjurar, förslag till avelsvärdesberäkning (Performance testing of dairy bulls, suggestions for breeding value calculations). Mimeo. SHS, S−631 84 Eskilstuna, Sweden.

Henderson, C.R. 1973. Sire evaluation and genetic trend. In: Proc. Anim. Breed. Genet. Symp. in honour of Dr J.L. Lush. Amer. Soc. Anim. Sci., Amer. Dairy Sci. Ass.

Henderson, C.R. 1975. Inverse of a matrix of relationships due to sires and maternal grandsires. J. Dairy Sci. 58, 1917−1921.

Henningsson, T. 1986a. Studies on performance testing for growth rate of dual purpose bulls. I. General introduction and effects of breed and non−genetic factors. Acta Agric. scand. 36. 3−17.

Henningsson, T. 1986b. Studies on performance testing for growth rate of dual purpose bulls. II. Genetic parameters and optimal size of the contemporary groups. Acta Agric. scand. 36, 18−29.

Henningsson, T. 1986c. Studies on performance testing for growth rate of dual purpose bulls. III. Investigation of adjustment factors and inclusion of extrapolated records for daily gain. Acta Agric. scand. 36, 30−40.

Henningsson, T. 1986d. Studies on performance testing for growth rate of dual−purpose bulls. IV. Application of the Best Linear Unbiased Prediction (BLUP) method for evaluation of growth rate and estimation of the genetic trend. Acta Agric. scand. 36, 49−59.

ESTIMATION OF BREEDING VALUES FOR MEAT PRODUCTION IN GERMANY

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Summary

The level of performance test for growth and carcass traits in cattle the Federal Republic of Germany are described. Breeding value estimation differs by breed and region. Procedures, including deviation from rolling base and BLUP were carried out. A reduced animal model for estimating breeding values from this data of individual performance testing, data from stations and field data are presented.
Keywords: Germany, performance test, rolling base, reduced animal model.

Introduction

In the Federal Republic of Germany, dual-purpose cattle prevail with different level of importance given to milk and meat production. Therefore the breeding value estimation of growth and carcass traits is not separated from the milk production.

The performance tests and the breeding values estimation are implemented by the "Verordnung über die Körung von Bullen" (BGBl. I p. 1477, 20 August 1979) on recommendation of the "Arbeitsgemeinschaft Deutsche Rinderzüchter" (ADR, 9 November 1983). The interpretation of these laws apply to the federal countries and breeding organisations.

Performance testing of bulls

In the FRG there exists individual (IPT) and progeny performance testing (PPT). The IPT is performed at stations or in field tests for potential future A.I. bulls. At stations, gain and sometimes feed intake are recorded from bulls of planned mates. The test regimes (duration, feeding and housing) are different for station and breed. At the moment, there are ten IPT-stations with a total capacity of 1541 places (72 - 280 places per station). The test period varies between 218 (112-330 live days) and 360 days (60-420)(Holm, 1986).

The IPT on field tests includes the measurement of live weight at auction. The calculations of daily gains require the assumption of a mean birth weight of the different breeds. In the last year 14996 dual-purpose and 505 beef bulls were tested on the field (ADR, 1986). The criterium for percentage lean by IPT is the subjective grade for muscularity.

The PPT (females and males) is carried out for test bulls on different test regimes: station and simple and controlled field tests. Besides growth and feed intake, carcass traits are recorded. There are seven stations with 1523 places (125-540). The age at the beginning of the test period varied between 28 and 113 living days. The end of the test period lies between 245 and 520 live days or is reached at a given live weight (350-450 kg)(Holm, 1986).

The organisation of the field test (PPT) depends on the breed and region. For example, there is the simple field test in Bavaria (Fleckvieh and Gelbvieh breeds) and the controlled field test in Hohenlohe-

Franken (Fleckvieh breed). The first alternative makes it possible to registrate the carcass traits of 17000 young bulls a year. This allows the testing of 430 test bulls (40 males/test bull). In the second case, 90 progeny per year are analyzed (15 males/test bull).

Estimation of breeding values

The Index

For the registration in herdbook it is necessary to calculate an index with the following informations:

- the breeding values for milk yield of the ancestors
- the breeding value for meat production
- the subjective valuation of the appearance
- the evaluation of the sperm production (only Angler breed)

The index is computed without consideration of phenotypic and genetic correlations (base index). The coefficients of the index are standardized to reach a given value for the standard deviation in each partial breeding value and depends on the breed and region. The total standard deviation must total 36 points.

Partial breeding value for meat production

The partial breeding value (lean) consists of the information of the individual, progeny and sib records. For consideration of different traits (daily gain, feed efficiency, carcass traits) a subindex is constructed with inclusion of the genetic and phenotypic correlations.

The estimation of the partial breeding values makes use of the deviations from individual records or progenies averages and a rolling average, which is at least the mean of 30 tested bulls. The deviations are multiplied with the heritability (IPT) or with the factor $2n/(n+k)$ (PPT), where n describes the number of progeny and k is corresponding to $(4-h^2)/h^2$.

An alternative to the above mentioned principle is the best linear unbiased prediction (BLUP). The mixed model which produces BLUP is applied to single traits by individually tested bulls (Wenzler, 1986) on station and progeny test on the field (Schild, 1986)in Baden-Württemberg and Bavaria respectively. The sire-model used in Baden-Württemberg considers the fixed effects of station-year-season and the genetic groups of the sires. Wenzler (1980) analysed the correlation between the breeding values of bulls with the "split and compare" method. The author shows that the relationships between both breeding values were higher with the BLUP-method (Baden-Württemberg) than with the simple deviations (Table 1).

A reduced animal model for prediction breeding values

In the station of the Angler breeding organisation in Süderbrarup (Schleswig-Holstein) all potential future A.I. bulls are individually tested for growth capacity. At the Institut for animal breeding in Kiel a model was developed which permits the prediction of breeding values for daily gain of this station. The analysis of the data show that 20% of the bulls have less than five half-sibs. The application of a simple sire-model shows that the prediction of breeding values for these bulls was very inaccurate. Therefore, additionally information was taken into account. This new information was the relationships on the mother's side and the performance of individually tested sires (if it exists).

Table 1. Correlation between sire-breeding values estimated on two groups of sons (Wenzler, 1980).

Method *	Number of sires	Correlation
I	70	.37
II	70	.53
III	70	.61

* I = sums of deviations
II = contemporary comparison
III = BLUP of breeding values

A total of 912 self performance results were evaluated over six years. Nearly 48% of the bulls have half sibs on the mother's side. The individual performance records were available from 31 sires (total number of sires = 126).

For the prediction of breeding values, a reduced animal model (RAM) was choosen under consideration of all the relationships. In spite of the limited computer capacity (a inversion in core of a 300 x 300 matrix was possible) the results were obtained by the inversion of the coefficient matrix of the mixed-model-equations (MME). This allows simultaneous estimation of the components of variance by restricted maximum likelihood (REML) and calculation of the accuracy of the prediction for each breeding value.

Table 2. Means of the ratio of the variance of prediction error and residual variance (PEV/σ_e^2) for different groups of bulls dependent on the number of paternal half-sibs (Mendizabal, 1986).

Group	Number of half-sibs	Number of animals	PEV/σ_e^2	
			RAM	sire-model
A	$\leq$ 3	85	.343	.423
B	$\leq$ 20	310	.334	.411
C	$\leq$ 60	557	.323	.397
All animals		912	.314	.385

Following computation a comparison was made between RAM and the sire-model. The accuracy of the estimates were expressed as the variance of the prediction error (PEV). The average PEV was lower with RAM compared to the sire-model (Table 2). The order of rank from bulls within years was alterated slightly between these two unbiased methods, but in individual cases the change was very evident. The inclusion of the relationships on the mother's side caused a lot of small differences in the rank of order. However, the sequence of bulls was strongly influenced by the performance of their sires (Table 3). In the future, this factor gains in significance with an increased number of tested sires.

The estimation of components of variance and breeding values required five iterations with a CPU-time of about one minute per iteration. The expense is minimal compared to the gain on informations:

-the estimation of components of variance by REML
-the increased accuracy of the estimation
-the calculation of the accuracy of each breeding value.

Table 3. Number (n) of changes in the rank of order within years* (Mendizabal, 1986).

Size of the change of rank	Cause		
	Relationships on the mother's side n	Self performance of the father n	Both information n
> 30	6	6	14
> 25	8	10	20
> 20	23	14	40
> 15	43	19	75
> 10	98	27	146
> 5	202	41	294

* Average number of bulls per year = 152

The prediction of breeding values for station and field data

The same method (RAM) was applied to predict comparable breeding values for station and field tested bulls. Therefore the model was extended in order to make allowance for genetic correlated traits (station or field). Each bull has an observation either on station or on field. The number of station observations was not sufficient to obtain a satisfying estimation of the correlation between the two traits. If exact values for this correlations are available, the estimation of comparable breeding values for all animals is possible.

References

Arbeitsgemeinschaft Deutsche Rinderzüchter e.V, 1986. Rinderproduktion in der Bundesrepublik Deutschland. Edition 1986. Bonn.

Bundesgesetzblatt, 1979. Verordnung über die Körung von Bullen vom 20. August:1477-1482.

Holm, E., 1986. Umfang und Bedeutung der Fleischleistungsprüfung von Zweinutzungsrindern in der Bundesrepublik Deutschland. Diplomarbeit Kiel

Mendizabal, F.J., 1986. Entwicklung eines Zuchtwertschätzmodells für die Fleischleistung beim Rind. Diss.agr. Kiel.

Schild, H.J., 1986. Nachkommenprüfung auf Fleischleistung im Feld. Der Tierzüchter 38:112-114.

Wenzler, J.G., 1980. Populationsparameter- und Zuchtwertschätzung für die Eigenleistungsprüfung von Fleckviehbullen auf Fleischleistung. Diss.agr. Hohenheim.

Wenzler, J.G., 1986. Eigenleistungsprüfung mit der BLUP-Methode. Der Tierzüchter 38:418-419.

ESTIMATION OF BREEDING VALUES IN DENMARK FOR BEEF TRAITS ON DANISH DAIRY- AND DUAL-PURPOSE CATTLE

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Summary

The testing scheme for performance test for beef traits on dairy- and dual-purpose cattle breeds in Denmark are briefly described. Systematic environmental factors affecting the performance test results as well as the currently used least squares method for estimating breeding values for daily gain and carcass quality are discussed. Futhermore, possible improvements of the evaluation procedure by using a BLUP-procedure with a full animal additive genetic mixed model, and by taking the effects of gene importations (additive genetic effects and heterosis) into account.
Keywords: Performance test, cattle, BLUP, animal model, heterosis.

Introduction

Selection on basis of performance test results is particularly useful for traits of moderate to high heritability. Selection can be carried out at the same time as the animal reaches breeding age. It will reduce the generation interval, and in addition no semen collection, test inseminations or progeny tests for dairy traits have to be carried out for bulls culled on poor breeding value for beef traits. The most important traits for testing and selection in performance tests are growth rate and carcass quality, but also other traits can be of potential importance i.e. feed eficiency, physiological parameters, resistance to diseases etc.

Actual traits for selection

Growth rate in young animals is largely a function of appetite (physically and/or physiologically regulated), the residual efficiency of the animal (maintenance requirement, heat loss related to growth and the efficiency of the digestive tract), and the tissue growth capacity.

Carcass quality includes the traits dressing percentage, fatness, muscle-to-bone ratio and conformation. Indirect prediction of body composition in live animals can be made by a subjective scoring system, or by an objective ultrasonic measurement of fat thickness and muscle area in the loin region.

Testing scheme

Potential breeding bulls of the breeds RDM (Red Danish), SDM (Black and White Danish), DRK (Red and White Danish) and DJ (Danish Jersey) are tested in the age interval from 42 to 336 days. The bulls are feed with restricted amounts of milk and concentrates and a complete diet mixture ad libitum, weighed every four weeks, and each day their feed comsumption is recorded. The health is controlled and all veterinary treatments recorded. At an age of 9 1/2, 10 and 10 1/2 months the area of bulls M. longissimus dorsi LD area is measured by means of ultrasonic equipment.

Collection and analysis of data as well as the publication of testing results is done by the National Institute of Animal Science.

Breed characterization

Total means per breed for the most important traits based on 10 years data are given in table 1.

Table 1. Breed averages for the most important traits recorded on performance test stations. (Andersen et al., 1987).

Breed	RDM	SDM	DJ	DRK
No.	1811	2391	526	120
Weight at 42 days, kg	62	64	37	63
Weight at 336 days, kg	418	436	292	437
Daily gain, g	1211	1263	867	1272
Total feed intake, SFU	1605	1660	1158	1566
Feed efficiency SFU/kg gain	4.52	4.47	4.55	4.20
LD area at 400 kg, cm^2	61.8	59.8	-	64.7
No. of diseases	2.45	2.34	1.50	3.52

Systematic environmental factors

The factors influencing growth rate and feed efficiency have been investigated by Jensen and Andersen (1982) and more recently by Andersen et al. (1987), using the following fixed model:

$$Y_{ijklmn} = ST_i + BY_j + BM_k + (ST \times BY \times BM)_{ijk} + B_l + S_{m:l} + b \times a_{ijklmn} + e_{ijklmn} \quad (1)$$

Where Y_{ijklmn} is the observed value for the n^{th} animal after the m^{th} sire from breed l, born in month k of year j and tested at station i, b is the regression on age (a) at arrival at the station, and e is the random residual.

Based on analysis of data from the first 10 years of performance testing (Andersen et al., 1987), no general environmental trend (year-effect) was found, but some variation from year to year appeares. General station effects on daily gain and feed intake were significant. These effects are due to differences in the housing system, variations in the feed stuffs available and perhaps some differences in the management of animals. Seasons have a general effect on growth rate. Calves born in the autumn have had a 3-4 per cent higher daily gain than calves born during spring, with other periods being intermediate. However, the three main effects mentioned above are not mutually independent as the three-way interaction were significant for daily gain and feed efficiency ($P<0.0001$). It is mainly the differences between stations and the effect of season that varies from year to year and from station to station. This is problably due to unsystematic variation in quality of available feed and effects of epidemic diseases that affect the stations from time to time.

For muscle area, measured by ultrasonic, Jensen and Andersen (1982) and Andersen et al. (1987) used the following fixed model:

$$Y_{ilkjm} = ST_i + M_{i:l} + A_k + b_k x\ w(A_k) + B_j + S_{m:j} + e_{ilkjm} \qquad (2)$$

where Y_{ilkjm} is the m^{th} measurement, taken on station (ST) i, on day of measurement (M) l, at age-group (A) k. The regression b_k x $w(A_k)$ is the individual regression within age group on the live weight of the animal at day of measuring. B refers to breed and S are sire groups within breed.

The ultrasonic measurements are carried out at a fixed age, and hence variation in weight at measurement appear. Due to carry over effects from daily gain, station effects on muscle area have been present, but after correction to constant weight these differences were removed. (Jensen and Andersen, 1982).

An important uncontrolled factor on ultrasonic measurements has been the effect of day of measurement. In model (2) effect of "day of measurement" has been highly significant ($P<0.0001$). The causes of this effect are unknown. The use of the ultrasonic equipment is complicated and involves several tasks, which can contribute to error. Even though intensive investigations have been carried out, it has not been possible to identify single sources of variation (Busk, Personal communication).

<u>Prediction of breeding values</u>

After the test, relative breeding values for daily gain (T-index) and for muscle area (U-index) are calculated. A total performance test index (I-index) is calculated as the sum of T- and U-index deviations from 100.

The T-index is calculated as:

$$\text{T-index} = h^2 \times ((P_x \times 100 / \overline{P}) - 100) + 100$$

where h^2 = coefficient of heritability for daily gain = 0.6.
P_x = average daily gain for the bull.
$\overline{P}$ = breed average at the station.

The U-index is calculated as:

$$\text{U-index} = h^2 \times ((U_x \times 100 / \overline{U}) - 100) + 100$$

where h^2 = coefficient of heritability for ultrasonic muscle area: 0.40 in RDM and 0.45 in SDM and DRK.
U_x = ultrasonic muscle area adjusted to constant liveweight.
$\overline{U}$ = breed average at the station.

The procedure used for estimating the breedstation averages ($\overline{P}$ and $\overline{U}$) has undergone some development during the decade the performance test stations have been operating.

In the first years a simple rolling station breed average was used. Over the years use of bull sires became more and more concentrated on fewer bulls and further those bulls were used within a short time period. This influenced the rolling station average and biased the predictions of breeding values. Hence the procedure was changed, so that the environmental level in a specific station-year-season was estimated by least squares techniques on data from all bulls tested within the last four years, using model (1) and (2) for growth rate and ultrasonic measurements, respectively. Consequently, the breeding values are expressed relative to a rolling genetic base consisting of the bulls tested in the last four years.

Further improvement of the evaluation procedure

The procedure for estimating breeding values used at present gives unbiased predictions but the predicted breeding values will not have minimum prediction error variance, because the least square procedure does not take into account that the sire effect is random. Further more, this method does not utilize information from relatives. An increase in accuracy could be obtained by using a full Animal additive genetic Mixed Model (AMM). This procedure takes the random nature of the genetic effects into account and utilizes all the information in the data.

An other possible improvement of the evaluation procedure would be to take into account the effect of gene importation, which has had a great impact on the Danish cattle breeds during the last decade (Madsen, 1985). Possible effects of this gene importation could be additive genetic differences between the involved breeds/populations and heterosis.

To investigate the effects of using an AMM procedure and to take into account the effects of gene importation Andersen et al. (1987) used the following mixed model:

$$Y_{ijkl} = SYS_i + b_1 \times a_{ijkl} + B_j + BYS_{ijkl} + b_2 \times d \qquad (3)$$
$$+ b_3 \times p(ABK) + b_4 \times p(HF) + \sum_{m=5}^{10} b_m \times P\,(0_m) + animal_{ijkl} + e_{ijkl}$$

where Y_{ijkl} is the l^{th} observation on an animal belonging to breed j and recorded in station-year-season i, b_1 is the regression on age(a) at arrival at the test station. The regression b_2 is the regression on the expected proportion of heterosis due to dominance effects. Heterosis was defined as general or average heterosis across all present breed combinations. The regressions b_3-b_{10} were the regression on the proportion of imported genes of different origin in each individual. Out of the 7 different origins of imported genes only 2 were of importance. Those were American Brown Swiss (ABK) and Holstein-Friesian (HF) from North America. Regressions on the proportion of native Danish genes in each individual was removed from the model as a constraint. The regressions on the proportion of imported genes estimate the additive genetic differences between the native Danish populations and the imported breeds/populations. Further included in the model was effect of animal and the additive relationship matrix based on sire and maternal grandsire. Bull dams were unknown and assumed unrelated. In order to account for a possible trend in the population of bull dams the breed-year-station (BYS) was included into the model. The heritabilities used in the computations were those shown in table 3, estimated in a model taking the effects of the gene import into account.

The BLUP solutions for the breeding values were relative to a base population without gene importation. To convert to absolute breeding values additive genetic effects from the gene importation must be added.

The most important gene importations have been from ABK to RDM and from HF to SDM, and only those will be discussed here, together with the general heterosis effects. Additive effects were significant for all analysed traits, and the estimated effects are shown in table 2.

Table 2. Estimates of additive genetic differences between RDM and ABK and between SDM and HF and general heterosis effects. (Andersen et al., 1987).

	ABK-RDM		HF-SDM		Heterosis effect	
	Abs.	%	Abs.	%	Abs.	%
Weight at 42 days, kg	4.4	7	1.7	3	-0.4	-0.7
Weight at 336 days, kg	49.9	12	5.3	1	5.9	1.4
Daily gain,g	155	13	11	1	21	1.7
Total feed intake, SFU	116	7	6	0	-1.2	-0.1
Feed efficiency, SFU/kg gain	-0.27	-6	0.01	0	-0.07	-1.5
LD area at 400 kg, cm^2	-1.9	-3	-4.7	-8	0.7	1.1
No. of diseases	-0.13	-5	-0.32	-14	-0.46	-18.8

Large additive genetic differences was detected between RDM and ABK. ABK has a 155 g higher daily growth rate during the test period than RDM, resulting in ABK having a 49.9 kg higher live weight at 11 months of age than RDM. ABK has a slightly smaller muscle area than RDM.

Only small genetic differences in growth rate was found between SDM and HF. The importation of genes from HF to SDM has led to a considerable deterioration of carcass quality, here estimated at 8 per cent.

Heterosis effects was significant for most traits, although generally small as expected for growth traits. The estimate of heterosis for growth rate was 1-2 per cent, and for muscle area 1 per cent. For disease frequency a larger advantageous heterosis was estimated.

Gene importation has increased genetic variation in the Danish dual purpose cattle population. Andersen et al. (1987) estimated genetic variances in models with and without parameters to account for the effects of gene importation. As showen in table 3, the estimated h^2 was biased upwards when gene importation was not taking into account.

Table 3. Heritability and phenotypic and genetic standard deviation, estimated with and without correction for effect of immigration. (Andersen et al., 1987)

	With correction			Without correction		
	h^2	Phenotypic SD	Genetic SD	h^2	Phenotypic SD	Genetic SD
Weight at 42 days, kg	0.12	7.30	2.55	0.15	7.32	2.81
Weight at 336 days, kg	0.39	26.1	16.3	0.58	26.8	20.5
Daily gain 42-336 days, g	0.40	79.4	50.3	0.60	81.8	63.2
Total feed intake, SFU	0.26	72.6	37.2	0.37	73.8	44.7
Feed efficiency, SFU/kg gain	0.31	0.27	0.15	0.40	0.27	0.17
LD area at 400 kg, cm^2	0.34	4.39	2.54	0.47	4.49	3.08
No. of disease, total	0.13	1.65	0.59	0.14	1.65	0.61

Heritability estimates from models that took the effects of gene importation into account were well in accordance with results from the litterature e.g. Andersen (1977), de Roo and Fimland (1983) and with earlier analysis of parts of the performance test data (Jensen & Andersen, 1984).

Andersen et al. (1987) calculated a correlation across breeds of 0.86 between breeding values for daily gain predicted by the AMM-procedure and by the present used least squares-procedure. The fact that the correlations are less than 1.0 can be due to several reasons, the AMM-procedure using model (3) accounts more efficiently for fixed effects, it takes account of additive effects and heterosis caused by the immigration, and it utilizes information from all relatives. If the AMM-breeding values are assumed to be the "true breeding values", then 7 per cent of the deviation from unit correlation are due to heterosis and 21 per cent are due to additive effects. The residual 72 per cent is due to a more efficient estimation procedure.

Further improvements in accuracy could be obtained by use of a multitrait procedure, but some computational problems still need to be solved before this can be put into practical use.

References

Andersen, B. B., 1977. Genetic investigations on growth, body development and feed utilization in dual purpose cattle. Report no. 448 National Institute of Animal Science, Copenhagen. 137 pp.

Andersen, B.B., J. Jensen & P. Madsen, 1987. Performance testing of potential AI bulls for beef traits. In: Cattle Production Research, Danish Status and Perspectives. Landhusholdningsselskabet Forlag, Copenhagen. 28-38.

Busk, H., 1986. Personal communication.

de Roo, G. and E. A. Fimland, 1983. A genetic analysis of performance and progeny test data for young bulls of Norwegian Red Cattle and various Friesian crosses. Livest. Prod. Sci. 10, 123-131.

Jensen, J. & B. B. Andersen, 1982. Analysis of seven years data from performance test stations (adjustement for effect of environment, genetic variation, selection indices and their accuracy). Report no. 526 National Institute of Animal Science, Copenhagen. 112 pp.

Jensen, J. & B. B. Andersen, 1984. Performance testing of future A.I. bulls for growth rate, feed efficiency and muscularity. Genetic parameters, adjustment for systematic environmental factors, selection indices. Livest. Prod. Sci. 11(1984):475-490.

Madsen, P., 1985. Breeding strategies for milk and beef production in dual purpose breeds. Proc. CEC Seminar Bruxelles EUR 10057 EN. 117-126.

BEEF INDEX IN GREAT BRITAIN

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Summary

The British beef industry has a considerable dairy component. The pedigree beef breed structure is poor for making genetic change. A beef selection index has been developed and could be used in dairy selection programmes, particularly MOET schemes. The Beef Index objective is "to maximise the financial margin between the value of saleable meat and the cost of feed, taking into account the cost of calving difficulties" and uses a minimum of four, and up to seven, measured traits. Details of parameters are given, together with a discussion of the methodology of the contemporary comparison systems used and predicted responses from use of the index.
Keywords : beef, selection index, contemporary comparisons.

Introduction

Beef production in Britain is around one million tonnes each year, of which about two thirds come from the dairy industry in the form of cull dairy cows and dairy-bred calves; the remainder coming from the beef herd. About a third of the 4.0 million dairy cows and heifers are crossbred to beef bulls and most of the calves are reared for beef, although some of the heifers are reared as suckler herd replacements. The influence of the Holstein has had a detrimental effect on beef production efficiency and carcase merit in Britain. The beef suckler herd is 1.3 million cows. Most suckler herd matings are by natural service whereas for the dairy herd about half are by natural service (mainly heifers), the remainder being by AI.

Pedigree Recording

The pedigree beef herd in Britain has undergone some dramatic changes over the last twenty years, particularly with reference to breed substitution. However, small herd size is a structural deficiency in terms of potential genetic change (see Table 1). Beef pedigree recording in Britain is by the Meat and Livestock Commission (MLC). Pedigree recording is based on weight recording at about 100 day intervals, with 200-day weight indicating performance to weaning and 400-day weight providing an estimate of subsequent growth. MLC also operated performance test centres with a total annual capacity of around 500 bulls. These were closed in 1986 in favour of on-farm performance testing which is expanding rapidly. In 1985/86 about 1,100 cattle were tested in about 100 on-farm performance tests and in 1987 at least 1,500 bulls will be tested.

Table 1. Structure of pedigree beef herds recorded by MLC; Autumn 1986.

Breeds	Total herd	Cows per herd*				Average per herd
		1-20	21-40	41-60	60+	
Aberdeen-Angus	33	52	27	15	6	26
Blonde d'Aquitaine	24	83	13	4	-	12
Charolais	193	81	14	3	2	15
Devon	13	30	46	8	16	29
Hereford	88	40	41	12	7	28
Limousin	171	80	17	2	1	14
Simmental	259	90	9	1	1	10
South Devon	42	38	36	22	4	32
Sussex	18	56	22	6	16	31
Welsh Black	13	23	16	46	15	54

* Figures show % of herds in category

Beef Index

MLC beef breeding services have been reviewed recently and a beef selection index has been developed. The index could be used with suitable modification for performance testing dairy bulls before subsequent progeny testing for milk. Recent developments in embryo transfer would allow dual testing without any material reduction in the intensity of selection for milk production (Steane & Swanson, 1985). In addition, the authors point out that any MOET dairy scheme could use a beef index on all animals and probably could justify the recording of individual feed intake.

The objective of the Beef Index is "to maximise the financial margin between the value of saleable meat and the cost of feed, taking into account the cost of calving difficulties". After much discussion, measured traits have been limited to seven, four of which are now compulsory before an index score can be calculated. The compulsory traits are - calving difficulty score (on a 5-point scale as a trait of the calf), 200-day weight, 400-day weight, and a muscling score on a 15 point scale based on the proposals of De Boer *et al* (1974). The other three traits which can be added to the minimum data are - birth weight, fat thickness, and daily feed intake.

Gestation length was not included as a measured trait since it is difficult to ascertain in field recording and is, therefore, subject to error.

Index Parameters

The parameters are summarised in Table 2. It should be noted that for certain parameters there are different preferred values for different breed types (see Table 3). For the muscular breed types (C and D) the relationship between muscling score and leanness has been increased. However, the heritability of fatness has been reduced for those breeds where fat thickness is low and, therefore, difficult to measure accurately.

Table 2. Heritabilities and correlations used in the MLC Beef Index (heritabilities on diagonal, genetic above, phenotypic below).

	Measured						
	birth weight 1	200-day weight 2	400-day weight 3	feed 4	fat 5	muscling score 6	calving score 7
1	**.40**	.40	.40	.10	-.07	.20	.50
2	.36	**.25**	.60	.50	0	.20	.20
3	.35	.72	**.40**	.70	.30	.25	.10
4	.10	.42	.63	**.40**	.15	.20	0
5	-.27	.32	.23	.37	**.30***	0	0
6	.10	.25	.25	.10	-.10	**.20+**	.10
7	.33	.20	.10	0	0	.10	**.10**

	Objective		
	total feed 8	saleable meat 9	calving difficulty 10
1	.10	.35	.50
2	.50	.60	.20
3	.70	.70	.10
4	.90	.50	0
5	.15	-.20	0
6	.10	.30#	.10
7	0	.10	.90
8	**.50**	.50	0
9		**.40**	0
10			**.10**

* .10 for C and D type
+ .30 for C and D type
# .20 for B type

Table 3. *Breed index groups.*

A	B	C	D
Aberdeen-Angus	Devon	Belgian Blue	Charolais
Beef Shorthorn	Hereford	Blonde d'Aquitaine	Chianina
Murray Grey	Lincoln Red	Limousin	Gelbvieh
	Sussex	South Devon	Simmental
	Welsh Black		

Responses

The relative accuracies of indices involving different numbers of traits have been calculated for all four index designs developed so far (Table 4). It should be noted that, particularly for the continental-type breeds, the value of feed intake is high although it is not very often measured in on-farm tests. For the breed types A and B, fat thickness is very influential on accuracy, as might be expected.

Table 4. Relative accuracies (%)

	Index type			
	A	B	C	D
All measured traits	100	100	100	100
excluding birth weight	98	100	100	100
" fat thickness	82	83	88	96
" feed intake	95	94	87	86
" fat & feed	66	65	72	74
" fat & birth weight	82	81	84	95
" feed & birth weight	93	94	87	86
" fat, feed & birth weight	65	59	65	71

The predicted changes both for measured traits and for the selection objective are shown in Tables 5 and 6. Calving difficulty will tend to remain at the present level, feed intake will increase marginally with a substantial increase in the weight of saleable meat. It should be noted that for the "C" type index, fat thickness has been held constant, whereas for "D" the response is predicted as zero.

Table 5. Predicted responses (genetic standard deviations per standard deviation of index).

	Index type			
	A	B	C	D
Birth weight	.07	.18	.19	.19
200-day weight	.27	.30	.24	.22
400-day weight	.25	.27	.34	.32
Feed intake	.12	.09	.07	.03
Fat thickness	-.27	-.26	0	0
Muscling score	.09	.04	.19	.18
Total feed	.14	.12	.10	.06
Saleable meat	.36	.37	.31	.29
Calving difficulty	-.08	-.00	-.03	-.03

Table 6. Economic response (contribution per £ progress).

	Index type			
	A	B	C	D
Feed	-0.26	-0.22	-0.23	-0.14
Saleable meat	1.16	1.22	1.19	1.10
Calving difficulty	-0.10	0	0.04	0.04

Environmental Corrections

A universal problem in testing is the calculation of contemporary comparisons in order to estimate breeding values. The herd structure of most breeds in Britain militates against the use of techniques such as BLUP. In addition, the use of AI in many breeds is low and many small herds use a single bull.

In the MLC scheme the measured traits are treated in the following way. Weights are obtained by linear regression using at least 3 weights to predict either the 200 or 400-day weight (with maximum permitted intervals between the weighings). Moving averages of a contemporary group are calculated firstly by updating the corrections for parity and sex, and then using these corrections on the animals concerned. Contemporaries are defined as those animals born within 50 days of the subject animal. Each record is then weighted by p^d where p is the fixed parameter (usually 0.98 or 0.97) and d is the difference in days of age between the contemporary animal and the subject animal. Before an animal can be indexed the sum total of these weights must be at least 5.0. Where this is so, the deviation of the subject animal from the contemporary comparison is calculated. This is then divided by the standard deviation which is itself an exponentially smoothed deviation combining both the group and the breed standard deviations in proportions according to the numbers involved in the test. The record which is carried with the animal from then on is the deviation in standard deviation units. Using standardised deviations tends to dissuade any attempts either to adjust records or to include extremely poor animals in an effort to obtain good index scores on other animals. The effect of the introduction of poor animals alters the mean and also the variance - the latter effect tends to be relatively greater than the effect on the mean, resulting, in cases so far, in a reduction in score for the above average animals. Indexes are calculated using the standardised deviations, and scores take into account the relative accuracy of the index as indicated by the measured traits available.

At present, genetic differences between herds are assumed to be zero. It is anticipated that over the next three to five years BLUP systems will be developed for a new MLC computing facility. This will allow adjustment for between herd differences. By this time, multitrait systems should be well developed and will be used.

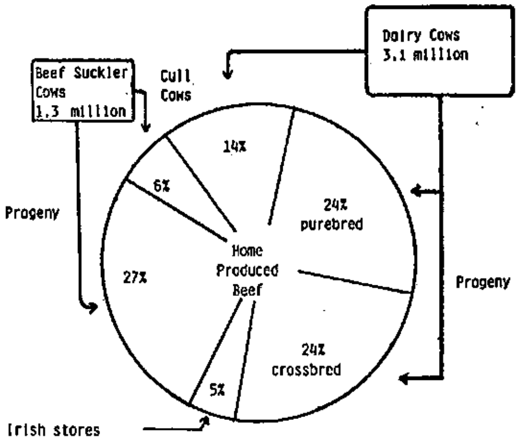

Fig. 1. Sources of home produced beef.

References

De Boer, H., B.L. Dumont, R.W. Pomeroy & J.H. Weniger, 1974. Manual on E.A.A.P. reference methods for the assessment of carcass characteristics in cattle. Livestock Production Science 1:151-164.

Steane, D.E. & G.J.T. Swanson, 1985. Consequences of milk quotas for the breeding goals : improving milk and beef production in the dairy beef crossing systems in the U.K. Adapting EEC Cattle Breeding Programmes to market realities, Brussels. p. 235-244.

RELATIONSHIP BETWEEN YOUNG BULL PERFORMANCE AND DAIRY PERFORMANCE OF PROGENY

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Summary

Genetic relationships between test performance of young bulls and dairy performance of female progeny were estimated for Dutch Black and White cattle. Performance test data for 7 traits was available for 751 young bulls: growth rate, feed conversion, fleshiness, fatness, weight, pelvic height and roughage intake. 145 of those bulls had a known progeny test for dairy performance.

Genetic correlations between performance traits and milk yield were low and varied from -0.14 to 0.18. Correlations of performance traits with fat % and protein % varied from -0.13 to 0.22 and -0.12 to 0.17 respectively. Correlations with fat yield and protein yield varied from -0.21 to 0.30 and -0.20 to 0.26 respectively. Correlations were more negative with feed conversion and most positive with growth and weight. Fleshiness, fatness, pelvic height and roughage intake during performance test of young bulls showed low correlations with dairy performance of progeny.

Introduction

In European dual purpose and dairy breeds beef production results from culling of dairy cows and raising of calves that originate from the dairy herds. The calves can be reared either in a specialized veal production system or as beef bulls. Performance testing of young bulls, as is done in The Netherlands, was set up to enable consideration of beef producing ability in the breeding program of those dual purpose and dairy breeds. Young bulls can be selected on a 'beef index' consisting of the traits: growth rate, fleshiness, feed conversion and birth weight (Jansen et al,1984).

The contribution of performance testing of young bulls to dual purpose breeding programs depends upon the genetic relationships between the traits measured in the performance test and production traits measured on progeny groups. The main part of the genetic gain (in monetary units) results from dairy traits. For a total optimization of breeding programs relationships between performance test and dairy performance of progeny are important as well.

Estimates concerning the correlation between performances of young bulls and milk production of progeny are scarce (Pirchner 1986). Differences between breeds have been pointed out before (More O'Ferral ,1982). Between breeds a negative correlation can be observed for beef production traits and dairy traits. Although 'within breed' genetic relationships are scarce, it was concluded that the economic merit of selection on beef traits is high in dual purpose cattle (More O'Ferral,1982,1985).

Pirchner(1986) mentions correlations between meat proportion and meat growth with dairy performance being negative (-0.26 and -0.38). Other performance traits such as growth and body weight may not be negatively correlated with dairy traits. In this paper, genetic relationships between traits measured on young bulls during performance test and traits for dairy performance, as measured using female progeny, will be estimated.

Materials

Data of young bull performance of Dutch Black and White Cattle were collected at the Terwispel test station. The bulls had been tested in a central station on a diet with concentrates supplied according to age. Roughage was fed ad libitum. From September 1979 through November 1985 751 bulls were recorded for eight traits: pelvic height, fleshiness, fatness and body weight were determined on live animals at the end of the testing period (365 days of age). Roughage intake and total energy intake were recorded during the test period which varied from 235 up to 265 days depending upon the age of arrival. Growth rate and feed conversion were calculated subsequently. The bulls that were tested were more or less influenced by the introduction of Holstein genes. Breed composition varied from 100% FH (purebred Dutch Black and White) to 100%HF (purebred Holstein). Five genetic groups were distinguished: 0%, 1-50%, 51-75%, 76-87%, 88-100%. Distribution of 751 young bulls over genetic groups was 102, 83, 211, 278 and 77 respectively.

Milk performance data were taken from progeny of young bulls that were tested for performance in Terwispel since 1979. For 145 of those bulls about 18.922 progeny records were available from the period September 1983 through September 1986. 305 days records were taken for the traits: kilogram milk, % fat, % protein, kg fat and kg protein. Records were adjusted for age, days open and lactation length according to Wilmink (1987). Incomplete records were extrapolated to 305 days when lactations had been longer than 120 days (Wilmink, 1987). Progeny records were only taken from the test period of young bulls. In addition to records from progeny of young bulls, records of other herdmates were used as well for an accurate estimation of herd-year-season effects. Herdmate records were used only from bulls with a minimum of 10 daughters in 6 herd-year-seasons (total 451 sires with about 97000 records).

Method

First, performance test data and progeny test data were analysed separately to determine variances and covariances. For each dataset a multivariate sire model was used. Variance components were estimated by a REML method using an EM algorithm. Relationships between animals were considered. Traits were measured on the same animal for all traits. In the algorithm a transformation to canonical scale was used reducing a multivariate analysis to t univariate analysis (Meyer,1985) were t is the number of traits considered.

For performance data a genetic group effect and a year season effect were considered. Two covariables were used in the model; length of test period (days) and concentrates intake(kg). Two seasons were distinguished per year.

For the analysis of (co)variance among dairy traits, a multivariate sire model was used with herd year seasons and genetic groups as fixed effects. Genetic groups were determined by the %HF blood of of the progeny. The same classification was used as for performance test data.

For the analysis of correlations between performance test traits and traits measured on progeny, analysis was pairwise. A bivariate model can be considered for two traits, the first being measured on young bulls, the second on their progeny.

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \quad (1)$$

in which the i-th subscript refers to the i-th trait and
y_i is a vector of n_i observations
b_i is a vector of p_i fixed effects
u_i is a vector of s_i random effects
X_i and Z_i are design matrices for fixed and random effects respectively.

Records for different traits are measured on different environments and the environmental correlation can be expected to be equal to zero. u_1 refers to breeding values for the first trait and u_2 to sire effects for the second. For each trait u_i has length equal to n_j young bulls with progeny (n_j=145) plus n_b ancestors (n_b=30). To estimate $\hat{u}_1$, information on half sibs with no progeny can be incorporated in the prediction of the sires of young bulls. Genetic correlations can be estimated from $\hat{u}_1$ and $\hat{u}_2$. Since relationships between bulls existed u_1^* and u_2^* were used rather than u_1 and u_2. $u_i^* = u_i L^{-1}$ and $L^{-1}L^{-t} = A^{-1}$ so u_i^* is a vector of uncorrelated random deviates with $var(u_i^*) = I\sigma^2 g_i$ (Quaas,1984).

Solutions for u^* were obtained by a sire model. For the first trait, solutions for young bulls were obtained by solving from the sire model solutions:

$$\hat{u}_1^* \text{ young bulls} = \frac{1}{\sqrt{.75}} \frac{1}{1+4/3\alpha} (y - X\hat{b} - .5\hat{u}_s) \quad (2)$$

To increase the accuracy of estimates of (2), information on correlated traits was used as well. Estimation was on a canonical scale after a transformation of the observations per animal. α refers to σ^2_e / σ^2_g on a canonical scale. Solutions to (2) are approximations of solutions for u^*_1 from a (reduced) multiple trait animal model.

Components of variance were estimated by a method according to Blanchard(1982);

$$\hat{\sigma}g_i = u_i^{*\prime} u_i^* / \sum^k b_{ik} \quad \text{and} \quad \hat{\sigma}g_{ij} = u_i^{*\prime} u_j^* / \sum^k b_{ik} b_{jk}$$

for variances and covariances respectively. b_{ik} stands for the accuracy of breeding value for the k-th animal on the i-th trait. This method gives a reasonable approximation of variance component estimates when random effects are uncorrelated and residual covariance equals zero (Taylor, 1982).

Results and discussion

Performance data were analyzed for 57 sires having 751 sons in test. Table 1 shows means, phenotypic and genetic standard deviations for the eight traits considered.

Table 1. Performance test traits. Means, genetic and phenotypic standard deviations and heritabilities.

Trait	Mean	σ_g	σ_p	h^2
Growth rate(g/d)	1053	44.7	74.7	.36
Feed conversion(VEM*/kg)	5291	181	399	.21
Fleshiness(1-18)	4.82	0.44	1.00	.19
Fatness(1-18)	4.28	0.27	0.55	.13
Body Weight at 365 d.(kg)	384.4	11.4	24.5	.22
Pelvic Height(cm)	128.5	1.43	2.57	.31
Roughage intake(kVEM*)	661.9	44.5	83.1	.29

* 1 VEM=6.904 kJ net energy

Heritability figures for fatness and fleshiness was relatively low. Oldenbroek et al (1986) found in similar material that fleshines, measured on life bulls, are poor predictors of fleshiness of their progeny. Heritabilities were somewhat higher than Oldenbroek et al probably due to a greater percentage of FH bulls in the data. GLS estimates of the genetic group effects were linearly decreasing with the percentage of HF genes for the traits fleshiness, fatness. For roughage intake and feed conversion group solutions were not linearly related to breed HF%.

Table 2. Genetic (below diagonal) and phenotypic (above diagonal) correlations between performance test traits.

	1	2	3	4	5	6	7
1 Growth rate	***	-.67	.35	.25	.80	.29	.37
2 Feedconversion	-.72	***	-.24	-.06	-.35	.02	.44
3 Fleshiness	.29	-.38	***	.36	.37	-.04	.13
4 Fatness	.56	-.09	-.54	***	.30	.09	.22
5 Weight 365 d	.84	-.55	.39	.38	***	.49	.52
6 Pelvic Height	-.11	.50	-.49	.32	-.02	***	.37
7 Roughage Intake	.57	.15	-.03	.68	.56	.48	***

Table 3 shows the results of 18,922 dairy records considered for 145 young (random) bulls and about 97,000 from 451 proven (fixed) bulls.

Table 3. Dairy performance traits. Means, genetic and phenotypic standard deviations and heritabilities.

Trait	Mean	σ_g	σ_p	h^2
Milk yield 305d (kg)	5182	426	665	.41
Fat 305 days(%)	4.39	0.32	0.36	.79
Protein 305 days(%)	3.38	0.13	0.17	.63
Fat yield 305d (kg)	226.8	21.2	52.4	.56
Protein yield 305d (kg)	174.9	13.5	20.6	.43

Genetic group solutions were consistently increasing with HF% for milk yield, fat yield and protein yield. Heritabilities were high which might be the result of residual breed effects affecting the random sire component. Half of the progeny belonged to the second genetic group(1-50%HF). Wilmink and De Graaf (1986) also found high genetic variances when mixed breeds were analyzed. Heterosis effects might play a role as well although it was shown not to be of great importance in milk production traits (Scholte Coerne,1986).

Table 4 shows the estimated genetic correlations between performance test traits and dairy traits for progeny. Progeny test were available for 145 young bulls descending from 30 sires.

Table 4. Relations between performance test traits and dairy traits.

	Milk kg	Fat%	Prot%	Fat kg	Prot kg
Growth Rate	.03	.22	.17	.21	.12
Feed Conversion	-.14	-.13	-.12	-.21	-.20
Fleshiness	.03	0	.08	.02	.06
Fatness	-.03	.12	.02	.08	0
Weight 365 d	.18	.19	.15	.31	.26
Pelvic Height(cm)	-.09	0	0	-.06	-.09
Roughage intake	-.10	.11	.06	.02	-.06

Relationships between growth and weight of young bulls and milk yield and milk composition of progeny were positive. Correlation of feed conversion with dairy traits was negative. Other traits as fleshiness, fatness, pelvic height and roughage intake showed low correlations with dairy performance of daughters. Korver et al. (1987) also found low relations between roughage intake of young bulls and roughage intake of progeny. They concluded that those traits were not equal for reasons of physiology as well as feeding strategy. Feed conversion based on total energy intake showed a more significant relationship with milk production.

A selection bias might occur since only a selected group was allowed to have progeny. Considering selection practice for own performance this might influence correlations of pelvic height with yield traits downward. Alternatively a REML method might account for some selection bias. REML estimates were considered with a sire model for each trait. Estimates for correlations were effectively based on 30 sires of young bulls only, which was considered too low. A REML method based on an animal model for performance traits gives computational difficulty. Furthermore, it was considered to be more important to estimate breeding values on young bulls accurately using information on correlated traits. Minimum accuracy of those estimates varied from 0.3 to 0.5 based on correlations in Table 2.

The implications of breeding programs were not exactly determined. From our results it can be expected that selection on young bull performance will not greatly reduce variance for dairy traits. Apart from a decrease in selection intensity, selection based upon own performance will not greatly reduce genetic gain from milk production traits.

References

Blanchard, P.J., R.W.Everett and S.R.Searle, (1982). Estimation of genetic trend and correlations for Jersey cattle. J.Dai.Sc 66:1947-1954.

Jansen, J., S. Korver, J. Dommerholt, A. Meijering & J.K. Oldenbroek, 1984. A selection index for beef production capacity of performance tested young bulls in AI:in Dutch dual purpose breeds. Livest. Prod. Sci., 11:381-390.

Korver, S., H. Vos and J.H.J.van der Werf,1987. Performance test results of young bulls in relation with feed intake and efficiency of female progeny. EAAP seminar no. 34, Wageningen

Meyer, K., 1985. Maximum Likelihood estimation of variance components for a multiple trait mixed model with equal design matrices. Biometrics 41:153-165.

Meyer, K., 1986. Restricted Maximum Likelihood to estimate genetic parameters-in practice. 3rd WC on Genetics Appl. to Livest. Lincoln vol. XII:454-459.

More O'Ferral, G.J. (editor), 1982. Beef production from different dairy breeds and dairy beef crosses. CEC Seminar, Dublin 1981. Martinus Nijhof Publ. The Hague.

More O'Ferral, G.J., 1985. Conclusions of CEC seminar. In: Krausslich and Lutterbach(ed). Adapting EEC cattle breeding programs to market realities. CEC seminar Brussels 1985.

Schaeffer, L.R., J.W. Wilton & R. Thompson, 1978. Simultaneous estimation of variance and covariance components from multitrait mixed model equations. Biometrics 34: 199-208.

Oldenbroek, J.K. and A. Meijering, 1986. Breeding for veal production in Black and White dairy cattle. Livest. Prod. Sci. 15: 325-336.

Pirchner, F., 1986. Evaluation of industry breeding programs for dairy cattle milk and meat production. 3rd WC on Genetics Appl. to Livest. Lincoln. vol IX:153-164.

Quaas, R.L., 1984. Linear Prediction. In: Blup School Hand book,AGBU, Univ. New England, Armidale, pp.1-76.

Schulte-Coerne, H. and D. Boie 1986. Heterosis in crosses between European and American dairy breeds. 37-th Ann. Meetings of the EAAP, Vol 1:GC1-9, Budapest.

Taylor, J.F., 1982. Assumptions required to approximate estimates of genetic (co)variances by the method of Calo et al. In: Genet. Res. 1982-1983, pg. 356. Rep. Eastern Artif. Insem. Coop., Dept. of Animal Breeding, Cornell University, Ithaca, N.Y.

Wilmink, H., 1987. Studies on test day and lactation milk, fat and protein yield of dairy cows. PhD Thesis. Agricultural University, Wageningen.

Wilmink, H. and F. de Graaf. Genetische parameters voor 305- dagen produkties. Projekt F100, Dutch Royal Syndicat Arnhem

GENERAL DISCUSSION (SESSION IV)

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The correlations between milk and beef traits was discussed with quite a range being quoted. In general, the Danes felt that the average effect was virtually zero with muscling being -0.2 and growth being +0.2, although it was pointed out that the relative economic values would be important in drawing any conclusions for breeding schemes. The general consensus was that there was a valuable correlation between growth and yields of protein/fat although it was not clear whether adverse relationships with muscling were due to a direct relationship with milk or simply due to the 'type' selection exercised by breeders. It was pointed out that Niebel uses -0.5 in his modelling of dual purpose breeding options but the general opinion was that this was too high an adverse relationship.

The Chairman then raised the problems of differences in variance and the normal assumption of homogeneity. He pointed out that changes in variance were more likely to be environmental rather than genetic and thus the British performance testing schemes took a simplistic (although partially erroneous) approach by assuming that such changes were non-genetic. Dutch workers pointed out that other evidence analysing data by different yield groups showed that heritabilities were similar in different sections, except for highest yield group. Variances were not similar, which indicated that changes in variance should not be assumed to be genetic but might be proportional. It was also pointed out that the Dutch work reported that the variance for milk was quite high and discussions on reasons for such high variances might give some indication of the reasons for the high heritabilities quoted.

The problems of compensatory matings for size was raised and how such matings could be taken into account in an animal model. This was likely to be particularly important in testing dual purpose breeds. A similar effect would occur with imported bulls being mated to those cows which were considered to be best providing assortative matings which, again, were almost impossible to take into account in BLUP systems or, indeed, in any other system.

There was further discussion on multitrait BLUP and on indexing for "dual purpose ability", and whilst there were some reservations on the knowledge of the parameters needed, such practices are under active discussion, for example in Denmark.

Session 5

Implications of performance test results for breeding programmes

THE IMPORTANCE AND THE USE OF BEEF IN THE BREEDING GOAL OF DAIRY AND DUAL-PURPOSE BREEDS IN WESTERN EUROPE

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Summary

In all countries of Western Europe extensive beef production with specialized beef cattle is of minor importance. Beef production with dairy and dual-purpose breeds prevails. Milk quota reduces the number of cows and of calves required to produce beef. Therefore a high genetic potential for beef production of our dairy and dual-purpose cattle is desirable. New technologies like embryo transfer, sex-determination and improved twin rates, however, can reduce the significance of beef performance in the future. Nevertheless it is to be expected that specialized dairy and dual-purpose breeds will produce most of beef.

In beef production the performance traits to be considered are daily gain, food conversion rate, growth capacity and muscle content. Milk, beef and secondary traits are involved in the breeding goal of the dairy and dual-purpose breeds. For high genetic success each trait competes for available selection pressure.

Based on model calculations several suggestions are made for improved genetic gain in the use of beef in the breeding goal. A main point is to extend the individual beef performance test of young bulls on station by larger test capacities for increased selection intensity. The same applies to longer test periods in order to decrease the genotype-environmental interactions. The introduction of additional progeny testing of bulls for beef improves the accuracy of estimated breeding values. In the second selection step of bulls, however, the selection for beef is limited by the need to select for dairy and secondary traits. Finally, the model calculations suggest that use of nucleus MOET-Test Herd schemes are superior to conventional schemes with respect to the increase of the genetic gain in beef.
Keywords: Beef, dairy and dual-purpose cattle, breeding goal, model calculations

Introduction

Under the European circumstances of intensive cattle production, the selection for beef in addition to milk can increase the overall merit of genetic improvement. This situation is quite different to that of the United States, Canada or Australia where the dominant goal is milk production based on low-cost concentrates. In the last 20 years the proportion of specialized dairy breeds is increased considerably in Europe. Today, in agriculture over-production prevails. This is especially true for the submarket of milk. After introduction of the milk quota allocation HENZE et al. (1980) and ZEDDIES (1985) have shown decreased economic weights for dairy traits and increased weighting of beef performance. In this contribution the importance and the use of beef traits in the bree-

ding goal of dairy and dual-purpose breeds in Western Europe is investigated on the basis of model calculations. In particular the following points are considered:
- emphasis on milk and beef,
- parameters for model calculations,
- influence of breeding goal on breeding schemes,
- efficiency for different forms of beef performance tests,
- superiority in genetic improvement of conventional and nucleus MOET-Test Herd schemes dependent on breeding goal for milk and beef,
- conclusions.

Emphasis on milk and beef

The inclusion of milk, beef and secondary traits in the breeding objective requires relative weighting of the traits. The relative weights of the traits balance the genetic gain between milk and beef performance and influence both the importance of the single traits in the breeding objective and in the estimated total breeding value. Between the different cattle populations used in Europe for milk and beef there is a wide range of economic weighting for milk and beef traits. The items which lead to a preference of beef versus dairy traits are:
- A high price of concentrates leads to an early maturity and a high fat content in the carcass.
- Increased milk yield reduces the potential number of fattening calves and increases the importance of genetic improvement in beef production.
- The discounted expressions of beef traits are increased in the dual-purpose breeds due to a lower number of terminal crosses with beef breeds.
- The standardized and discounted expressions influence the marginal change in profit of milk and beef characteristics. Short investment period and high interest rates favour beef relative to dairy traits.

On the other hand new technologies like embryo transfer in combination with sex-determination and improved twin rate favour milk traits heavily versus beef traits.

Parameters for model calculation

In recent years the situation in most Western Europe countries has changed by the milk quota allocation, but is still characterized by overproduction in milk. To demonstrate the possible effects of different weighting of milk and beef five situations for economic weights are summarized in Table 1. For comparison all weights refer to real prices of 1985.

The first set of weights was derived by ADELHELM et al. (1972), where micro economic conditions are assumed. The economic weights of beef traits are obtained for single farms by a Linear Programming Model. The relatively high weight of milk yield against beef traits results from unlimited milk production based on high milk prices in the late sixties.

In a comprehensive work by HENZE and ZEDDIES (1979), HENZE et al. (1980), ZEDDIES et al. (1981) the economic weights of the most important dairy and beef traits are derived by means of Linear Programming and the so called "regional equilibrium model" for the second and third economic situation. The second situation assumes micro economic conditions, which is the individual farm situation. From an additional macro economic or na-

Table 1. Economic weights and monetary genetic variation of individual farm situation and of milk quota situation.

Performance/ Trait	Unit	Gen. var.	Economic situation									
			I Individual farm		II Individual farm		III Pre-milk quota		IV Milk quota		V (II-III)	
		σ_A	v[1] (DM)	$v \cdot \sigma_A$ (%)	v[1] (DM)	$v \cdot \sigma_A$ (%)	v[1] (DM)	$v \cdot \sigma_A$ (%)	v[1] (DM)	$v \cdot \sigma_A$ (%)	v[1] (DM)	$v \cdot \sigma_A$ (%)
Milk:				42		36		28		14		28
Milk yield FCM	kg	400	0.50		0.36		0.25		0.14		0.30	
Beef:				37		40		45		63		27
Food convers.rate	MJ/ kg	1.5	-26.0		-16.5		-16.5		-17.0		-16.5	
Daily gain	g	60	0.58		0.87		0.87		2.15		0.87	
Growth capacity	kg	35	0.68		0.30		0.30		0.07		0.30	
Muscle content of shrunk live weight	‰	5	6.75		6.75		6.75		6		6	
Secondary:				21		24		27		23		45
Milking speed	g/ min	200	.09		.09		.09		.06		.06	
Calving difficulty, direct	% class	30	-.8		-.8		-.8		-.8		-.8	
Calving difficulty, maternal	% class	30	-.8		-.8		-.8		-.8		-.8	
Calving interval (Days open)	days	10	-0.65		-0.84		-0.84		-0.77		-3	
Productive life	day	183	-		-		-		-		.123	
Mastitis	‰	60	-		-		-		-		-1.4	

1) Economic weight

tional point of view the third situation anticipates milk quota allocation and therefore is called "pre-milk quota situation". The most important result for the second individual farm and the pre-milk quota situation is the reduction of the economic value of milk yield. Therefore a relative high weighting of beef traits must be assumed compared with the first economic situation.

In several contributions the effects and consequences of the milk quota allocation are analyzed with respect to the concerned farmers and breeders (e.g. KÖHNE, 1984; ZEDDIES and DOLUSCHITZ, 1984; STEINHAUSER, 1985). These investigations confirm that the economic weight of milk yield is considerably reduced due to the quota allocation. Therefore, ZEDDIES (1985) has presented new calculations about economic weights. These preliminary calculations are based on isolated regional equilibrium models. In situation IV the decrease of the weight of milk compared with pre-milk quota situation can be explained by the decrease of saved opportunity costs and by considering higher veterinarian and finance costs of high yield cows. On the other hand the weight of daily gain is remarkably increased because of the high increase of costs for buildings and labour.

In situation V the economic weights correspond with the weights of milk and beef in situation II and III. In situation V additional secondary traits and economic weights are introduced, which are drawn from the work by FEWSON and NIEBEL (1986).

In the breeding objective the percentage of monetary genetic variation of beef is considerably increased from economic situation I to IV. In situation V the monetary genetic variation of milk and beef is about the same while nearly half of the percentage variation is accounted for by secondary traits.

In the model calculations a dual purpose cattle population is assumed where the dairy index includes milk yield and milking speed. The breeding objective for beef is composed of daily gain, food conversion rate, growth capacity and muscle proportion of shrunk live weight. Frame score and muscle score are used as auxiliary traits in the selection index.

In Table 2 the phenotypic and genetic parameters are summarized used in model calculations. The population parameters are estimates mainly obtained from dual-purpose cattle populations. More detailed information about the applied parameters can be obtained from GRASER et al. (1985) and FEWSON and NIEBEL (1985, 1986).

In Table 3 all sources of information for the different selection groups are summarized, which are used in the conventional and the MOET-Test Herd breeding schemes. In the conventional schemes the selection groups of cows to breed sires, cows to breed cows, test sires and proven sires are distinguished. For the nucleus MOET-Test Herd scheme only the two groups of nucleus cows and sires must be defined.

In the conventional breeding schemes the waiting bull system is used. This is characterized by the fact that young bulls from planned matings are tested on beef performance in station. The bulls are selected and used in A.I. to produce test daughters for half a year. At the same time a limited number of semen doses is sampled and deep frozen to secure the use as bull sires, if the bull does not survive the waiting period. After a second selection stage bulls with highest breeding values are used as bull sires and bulls with second best breeding values as cow sires. In the active breeding population all cows are milk recorded and 90 % are artificially inseminated. The rest of the cows is mated with proven cow sires. Further details about the assumed breeding plan can be obtained from AVERDUNK and ALPS (1985) and GRASER et al. (1985). The most important parameters of population structure, biological coefficients, the cost factors and investment parameters are listed in Table 4. The parameters are needed to establish the conventional and the nucleus MOET breeding schemes.

Table 2. Heritabilities and correlations for the selection traits and economic traits used in the model calculations.

Trait	Heritabilities (diagonal) and Correlations (r_p = above and r_A = below diagonal)																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Milk yield FCM	.25	.10	-	-	-	.10	.10	.25	.25	-.35	-.35	-.40	-	.00	.00	.10	-.10	-	.00	.00	-	-.20
2. Daily gain field,bulls	.10	.15	-	-	-	.80	.95	.30	.30	.20	.20	.25	-	.00	.00	.10	-.10	-	.00	.00	-	.00
3. Food conversion rate	-.10	-.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Growth capacity	.30	.40	-.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Muscle content	-.50	.30	-.30	.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Daily gain, cows	.10	.80	-.55	.30	.25	.10	.80	.25	.40	.30	.15	.30	-	.00	.00	.10	-.10	-	.00	.00	-	.00
7. Daily gain station	.10	.95	-.80	.40	.30	.80	.40	.40	.30	.30	.30	.25	-	.00	.00	.10	-.10	-	.00	.00	-	.00
8. Frame score, cows	.25	.30	-.30	.80	.00	.25	.40	.30	.80	.00	.00	.00	-	.00	.00	.15	-.10	-	.00	.00	-	.00
9. Frame score station	.25	.30	-.30	.80	.00	.40	.30	.80	.40	.00	.00	.00	-	.00	.00	.15	-.10	-	.00	.00	-	.00
10. Muscl.sc.f., bulls	-.35	.20	-.20	.00	.70	.30	.30	.00	.00	.15	.80	.80	-	.00	.00	.30	.20	-	.00	.00	-	.00
11. Muscl.sc.f., cows	-.35	.20	-.20	.00	.70	.15	.30	.00	.00	.80	.30	.80	-	.00	.00	.25	.20	-	.00	.00	-	.00
12. Ultras.meas. stat.	-.40	.25	-.25	.00	.80	.30	.25	.00	.00	.80	.80	.35	-	.00	.00	.30	.25	-	.00	.00	-	.00
13. Days open (calv.int.)	.40	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-	-	-	-	-	-	-	-	-	-
14. Non-return, male	-.40	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.60	.01	.10	.00	.00	-	.20	.00	-	-.10
15. Non-return, female	-.40	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.70	.10	.01	-.10	-.20	-	.20	.00	-	-.10
16. Calv.diff.,dir.	.10	.10	-.10	.20	.40	.10	.10	.15	.15	.30	.25	.30	.20	.00	-.10	.10	-.20	-	.00	.00	-	.00
17. Calv.diff.,mat.	-.10	-.10	.10	-.10	.30	-.10	-.10	-.10	-.10	.20	.20	.25	.30	.00	-.20	-.20	.10	-	.00	.00	-	.00
18. Productive life	-.20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-	-	-	-	-
19. Stayability 36/48	-.20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.20	.20	.20	.00	.00	.80	.05	.00	-	-.10
20. Milking speed	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.25	-	-.10
21. Mastitis	.30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10	-.10	-.10	.00	.00	-.20	-.10	.10	-	-
22. Cell count	.30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10	-.10	-.10	.00	.00	-.20	-.10	.10	.80	.05

Table 3: Sources of information [1)] for the different selection groups in the conventional and the MOET breeding schemes

Trait	Conventional Scheme				MOET-Test Herd Scheme	
	Cows to breed sires	Cows to breed cows	Test sires	Proven sires	Cows	Sires
Milk:						
Milk yield FCM	I,kPHS	I,kPHS	-	kP	I,D+1,nFS,mPHS	D+1,nFS,mPHS
Beef:						
Daily gain	I	I	I	I , 20P	nFS,mPHS,S	I[2)]
Frame score	I	I	I	I	nFS,mPHS,S	I[2)]
Muscling score	I	-	I	I	nFS,mPHS,S	I[2)]
Ultrasonic measurement/Carcass evaluation score	-	-	-	20P	-	-
Secondary:						
Non-return, male	S+8k	-	I+8k	I+8k	S+6k	I+6k
Non-return, female	I+1,2kPHS	I+1,2kPHS	-	kP	I+1,2kPHS	kPHS
Calving difficulty, direct	-	-	kPHS	kPHS	kPHS	kP
Calving difficulty, maternal	I+kPHS	I+kPHS	-	kP	I,D+1,kPHS	kPHS
Stayability 36/48	kPHS	kPHS	-	kP	kPHS	kPHS
Milking speed	I+40PHS	40PHS	-	40P	I,D,kPHS	D,kPHS
Cell count	I+kPHS	I+kPHS	-	kP	I,D,kPHS	D,kPHS

1) I = individual; S = sire; D = dam; P = progeny; PHS = paternal half-sib; FS = full-sib; k,m,n = variable number of sib and progenies; + = repeated records

2) Test and selection within full-sib family

Table 4: Parameters of population structure, biological coefficients and investment parameters

Parameter	Scheme: Conventional	Scheme: MOET-Test Herd
Population structure		
- Total population size (breeding and commercial cows)	1 000 000	500 000
- Proportion of active breeding population (nucleus), %	40	(0.2)
- Proportion of test matings (commercial cows), %	30	(3.8)
- Number of test matings for first lactation record	5	6
- Capacity for performance test of young bulls in station	1 123	260
- Proportion of young bulls selected on beef performance	.50	.30
- Number of daughters per test bull	50	50
- Number of sires to breed sires (cows)	10 (15)	4
- Herd size	20	50
Biological coefficients		
- Survival rate of bulls after performance test in station, %	90	90
- Proportion of bulls usable for AI, %	95	90
- Age at first calving, years (milk)	2.5	2.3 (2.0)
- Calving interval, years	1.04	1.07
- Number of inseminations required per pregnancy	1.7	1.6
- Number of deep freezable doses of semen per sire	-	45 000
- Survival rate of bulls during waiting period	70	-
- Productive life of proven bulls, years	2.8	-
- Survival rate of embryos, %	-	70
- Rearing rate of females till first calving, %	70	70
- Survival rate of cows during one lactation, %	80	80
- Number of deep freezable doses of semen per sire and year	8 000	15 000
Cost factors in DM		
- Fixed costs in total population per cow and year	3.75	1.00
- Costs of milk recording attributed to breeding per cow and year (test herds)	30	(40)
- Costs for beef performance test in station per bull	1 000	1 000
- Costs for waiting bull system per bull and year	4 000	-
- Costs for production of one dose of semen	1.5	1.0
- Costs of the storage of one semen dose per year	.03	.03
Investment parameters		
- Investment period, years	25	25
- Interest rate for return, %	6	6
- Interest rate for costs, %	4	4

Influence of breeding goal on breeding schemes

The breeding response for economic situation I to IV was calculated by NIEBEL (1986) and is summarized in Table 5. In these model calculations

Table 5. Breeding response for different economic situations where young bulls are tested for beef performance in station (NIEBEL, 1986).

Criterion	Economic situation I Individ. farm	II Individ. farm	III Pre-milk quota	IV Milk quota
Genetic gain per cow and year, DM	48.0	34.3	24.7	23.4
Profit per cow and year, DM	233.1	171.3	133.5	172.4
Return per cow and year, DM	256.0	194.3	156.5	195.3
Costs per cow and year, DM	23.0	23.0	23.0	23.0
Genetic gain per year:				
- Milk yield FCM, kg	81.7	74.4	62.9	30.3
- Food conversion rate, MJ/kg	- 0.12	- 0.13	- 0.15	- 0.16
- Daily gain, g	5.1	5.8	6.4	7.2
- Growth capacity, kg	3.5	3.3	3.3	2.7
- Muscle content of shrunk live weight, ‰	- 0.36	- 0.25	- 0.12	0.04
- Milking speed, g/kg	14	15	14	6
- Calving difficulty, direct, % class	.09	.10	.10	.09
- Calving difficulty, maternal, % class	- .11	- .11	- .12	- .10
- Calving interval, day	0.53	0.46	0.35	0.12

only young bulls are tested for beef performance in station and no progeny test for beef is assumed. The results show a noticeable genetic gain of milk yield and an increased genetic gain of the beef traits is obvious due to decreasing economic weighting of milk against beef in the sequence of economic situation I to IV. In a comprehensive study about breeding strategies for milk and beef production CUNNINGHAM and MULVIHILL (1985) obtained similar results due to the reduced economic weight of milk in the quota system.

The influence of the economic weights in situation I to IV and of the method of beef performance test on the breeding response is demonstrated in Table 6. The genetic gain of the single traits and the profit of the different breeding schemes show that economic weighting and in addition the test method for beef influence the breeding response of milk and beef traits considerably. For all test methods of beef the profit-cost ratio is higehst in economic situation I, due to the high economic weight of milk yield. Besides, the introduction of beef performance tests increases the profit-cost ratio. This shows us that beef recording is more cost effective than milk recording. CUNNINGHAM and MOIOLI (1981) and GRASER et al. (1985) got nearly the same results.

In all economic situations and breeding schemes the genetic gain of milk and beef traits, except of muscle content, is satisfactory. A positive genetic gain of muscle content is only obtained in situation IV, when

Table 6. Effect of economic situation and of method of beef performance test of bulls on breeding response.

Test method for beef	Criterion	Economic situation I Indiv. farm	II Indiv. farm	III Pre-milk quota	IV Milk quota
No test	Genetic gain per cow and year, DM	47.4	33.4	23.5	12.3
	Profit/cost ratio	12.6	8.5	6.0	2.2
	Genetic gain per year				
	- Milk yield FCM, kg	116.6	85.9	80.1	73.6
	- Food conversion rate, MJ/kg	- .07	- .07	- .07	- .07
	- Daily gain, g	2.5	2.6	2.8	2.8
	- Growth capacity, kg	3.8	3.8	4.0	3.9
	- Muscle content of shrunk live weight, ‰	- .53	- .52	- .49	- .47
Performance test of bulls and cows	Genetic gain per cow and year, DM	48.0	34.3	24.7	23.4
	Profit/cost ratio	13.3	9.5	7.1	7.8
	Genetic gain per year				
	- Milk yield FCM, kg	81.7	74.4	62.9	30.3
	- Food conversion rate, MJ/kg	- .12	- .13	- .15	- .16
	- Daily gain, g	5.1	5.8	6.4	7.2
	- Growth capacity, kg	3.5	3.3	3.3	2.7
	- Muscle content of shrunk live weight, ‰	- .36	- .25	- .12	.04
Performance test of bulls and cows + progeny test of bulls	Genetic gain per cow and year, DM	48.7	35.4	26.6	29.6
	Profit/cost ratio	13.7	10.0	7.8	10.0
	Genetic gain per year				
	- Milk yield FCM, kg	78.4	69.5	57.2	26.9
	- Food conversion rate, MJ/kg	- .15	- .17	- .19	- .21
	- Daily gain, g	6.8	7.8	8.7	9.8
	- Growth capacity, kg	3.7	3.6	3.5	3.0
	- Muscle content of shrunk live weight, ‰	- .30	- .18	- .04	.14

assuming performance or progeny test for beef. This can be explained by the antagonistic relations between lean meat and milk and the negative correlated response of lean meat due to the high selection pressure for milk (PIRCHNER, 1986).

The effect of the economic situation and the testing capacity of beef performance on the proportion of selected young bulls and the genetic gain is analyzed in Table 7. The genetic gain is related to the starting point of economic situation I to IV in Table 5. In all breeding schemes the lowest number of selected bulls is 1 out of 4. The optimal selection rate of young bulls after beef performance test increases from situation I to IV with relatively high economic weighting of the beef traits. For the optimized genetic gain an increase of the number of test places is also advantageous independent of the economic situation.

Table 7. Effect of economic situation and the testing capacity of beef performance test on the proportion of selected young bulls and the relative genetic gain.

Number of test places	Economic situation I Individual farm	II Individual farm	III Pre-milk quota	IV Milk quota
	Number of young bulls selected			
200	1 : 4	1 : 6	1 : 8	1 : 15
400	1 : 8	1 : 10	1 : 15	1 : 15
800	1 : 10	1 : 15	1 : 15	1 : 15
1600	1 : 15	1 : 15	1 : 15	1 : 15
	Relative genetic gain, %			
200	104	106	110	123
400	107	111	116	127
800	110	114	119	127
1600	112	115	120	125

Efficiency for different forms of beef performance tests

In most cattle populations of Western Europe the potential for genetic improvement of beef is underdeveloped in accordance with performance testing for beef. In the work by GRASER et al. (1985) planning calculations for the further development of beef performance tests have been conducted for dual purpose cattle. From this work the essential results are extracted and summarized in Table 8. The figures shown in the table are slightly modified to obtain comparable results for the breeding schemes. These are due to deviating population parameters used in the model calculations.

The calculations refer to different procedures of the beef performance test of sires. As a reference basis the performance testing in stations of young bulls has been chosen up to 330 days of age (I-330D). Keeping the end of the station test at 330 days, the improvement of the estimation procedure for breeding values and the introduction of ultrasonic measurements (I-330DD) results in a limited increase of the genetic gain. Only the prolongation of the testing period to 420 days (I-420D) can achieve an effective increase of genetic gain and breeding profit. The calculations consider also a cheap performance test and in the field (I-field), which refers to young bulls reared in the herd of the breeder to be sold as breeding animals.

For progeny testing 4 different forms are distinguished. Firstly, in controlled fattening farms (P-CFF) it was assumed that frame and muscling were visually scored. Secondly the test environment for the progeny test in uncontrolled fattening farms (P-field) with male progeny is equivalent to the production environment. In this testing method for the scoring of carcass quality the carcass classification of the beef trading industry was used as a beef performance test. Thirdly the cattle breeding technician can measure length and breast girth of heifers to estimate the weight in addition to scoring of frame and muscling (P-heifer).

Table 8. Breeding response for different forms of beef performance tests in the pre-milk quota situation (modified after GRASER et al., 1985).

Beef performance test [1)]			Genet.gain	Profit	Milk	Beef			
I	P_1	P_2	rel. (%)	rel. (%)	Milk yield FCM (kg)	Food conv. rate (MJ/kg)	Daily gain (g)	Growth capacity (kg)	Muscle cont. shrunk live weight (‰)
330D	-	-	100	100	65	-.09	4.2	3.3	-.28
330DD	-	-	101	103	64	-.09	4.5	3.3	-.24
420D	-	-	108	116	57	-.14	6.0	3.2	-.17
330D	CFF	-	116	126	55	-.17	7.6	3.7	-.11
330DD	CFF	-	116	127	55	-.18	7.7	3.7	-.09
420D	CFF	-	119	133	53	-.18	8.2	3.6	-.08
420D	Field	-	116	128	55	-.17	7.6	3.4	-.11
420D	Heifer	-	117	128	55	-.17	7.9	3.8	-.10
330DD	Field	-	112	120	56	-.15	6.8	3.5	-.13
420D	CFF	Heifer	120	133	53	-.18	8.2	3.6	-.08
420D	Field	Heifer	116	129	55	-.17	7.6	3.6	-.10
Field	-	-	98	96	68	-.08	3.6	3.2	-.33
Field	Stat	-	113	118	56	-.15	7.1	3.6	-.13
Field	Stat	Heifer	113	119	56	-.16	7.2	3.7	-.12

1) I = performance test; P_1 = first progeny test; P_2 = second progeny test

Finally the progeny test in station (P-stat) offers favourable testing conditions. The disadvantage of this testing method is the high cost per proven adult sire.

Generally, the introduction of a progeny test allows an important improvement of the breeding response. A second progeny test for beef performance achieves no clear increase of the breeding response. This is due to the small increase of the reliability of estimated breeding values with the second progeny test for beef performance.

Superiority in genetic improvement of conventional and nucleus MOET-Test Herd schemes dependent on breeding goal for milk and beef

In the preceding model calculations only conventional breeding schemes have been investigated. The introduction of the nucleus Multiple Ovulation Embryo Transfer scheme (MOET) by NICHOLAS and SMITH (1983) shows considerable effects in the genetic improvement of dairy cattle populations. In Table 6, 9 and 10 conventional breeding schemes can be compared with

Table 9. Effect of the inclusion of secondary traits in the breeding objective and the selection process for conventional breeding schemes (FEWSON and NIEBEL, 1986)

Criterion	Secondary traits in breeding objective		
	No	Yes	Yes
	Secondary traits in selection process		
	No	No	Yes
Genetic gain per cow and year, DM	31.6	24.0	25.6
Profit per cow and year, DM	203.7	158.7	164.7
Return per cow and year, DM	237.5	192.5	201.5
Costs per cow and year, DM	33.8	33.8	36.9
Genetic gain per cow and year:			
- Milk yield FCM, kg	72.4	58.9	53.5
- Food conversion rate, MJ/kg	- .17	- .18	- .18
- Daily gain, g	7.9	8.8	8.6
- Growth capacity, kg	3.8	3.9	3.9
- Muscle content of shrunk live weight, ‰	- .15	- .11	- .13
- Milking speed, g/min	.0	.0	1.4
- Calving difficulty, direct, % class	1.1	.9	1.1
- Calving difficulty, maternal, % class	- .8	- 1.0	- 1.8
- Days open, day	.68	.48	.34
- Productive life, day	- 6.2	- 4.4	- .9
- Mastitis, ‰	3.1	2.2	.6

MOET-Test Herd schemes in Table 10 dependent on breeding goal for milk and beef. For the model calculations of the conventional and the MOET schemes the parameters are described in Tables 1 to 4. More detailed information about the conventional schemes can be obtained by FEWSON and NIEBEL (1986). In these schemes the breeding goal is oriented towards milk and beef. Also enormous efforts are made in the genetic improvement of secondary traits which can be derived from high weights of secondary traits due to economic situation V in Table 1.

Table 10. Comparison between a conventional breeding scheme and MOET-Test Herd schemes dependent on breeding goal for milk and beef.

Criterion	Breeding scheme				
	Conventional	MOET-Test Herd			
	Breeding objective				
	Milk and beef	Milk		Milk and beef	
	Analysis				
	base	base	opt.	base	opt.
Number of sires per year	10	4	4	4	4
Number of donors in nucleus per year	-	64	192	64	192
Number of calves per donor	-	8	8	8	8
Number of progenies per test sire	200	50	50	50	50
Generation interval, year	5.28	3.91	3.91	4.16	4.16
Genetic gain per cow and year, DM	26.7	23.3	26.9	34.1	37.2
Profit per cow and year, DM	178.2	146.5	164.5	263.1	277.7
Return per cow and year, DM	205.8	153.7	188.0	271.0	303.0
Costs per cow and year, DM	27.6	7.2	23.5	7.9	25.3
Genetic gain per year:					
- Milk yield FCM, kg	55.9	88.1	100.6	66.3	73.3
- Food conversion rate, MJ/kg	- .17	- .03	- .03	- .28	- .31
- Daily gain, g	8.1	1.2	1.3	13.2	14.2
- Growth capacity, kg	4.0	1.8	2.1	5.2	5.6
- Muscle content of shrunk live weight, ‰	- .19	- .82	- .96	- .10	- .10
- Milking speed, g/min	1.0	2.0	2.3	1.3	1.5
- Calving difficulty, direct, % class	1.2	- 1.6	- 1.9	1.7	1.9
- Calving difficulty, maternal, % class	- 2.0	- 1.7	- 2.1	- 2.0	- 2.2
- Days open, day	.32	.65	.71	.53	.59
- Productive life, day	.8	- 4.3	- 4.9	- 2.0	- 2.3
- Mastitis, ‰	- .1	2.4	2.7	1.2	1.3

For a satisfactory genetic gain of dairy and secondary traits all MOET schemes incorporate test herds in Table 10. In the breeding objective of the MOET scheme which is oriented on milk, all beef traits have zero economic weights. For high genetic gain the advantage of the MOET schemes is a relative short generation interval. The generation interval is reduced by 1.1 years in the assumed adult nucleus MOET scheme with the breeding objective for milk and beef compared to the conventional scheme.

From Tables 6, 9 and 10 the potential of conventional and nucleus MOET schemes for genetic improvement of beef can be derived with respect to the breeding goal of dairy and dual purpose breeds. The most important points are summarized as follows:
- If beef performance is economically unimportant a higher genetic gain in milk yield can be derived with the conventional scheme compared to the nucleus MOET scheme.
- Usually, in the breeding goal of the cattle populations in Western Europe, milk, beef and secondary traits are included. Secondary traits have low heritability coefficients and are antagonistic correlated to milk and beef. Further genetic deterioration of secondary traits must be tolerated if nucleus MOET schemes does not include test herds.
- High economic importance of beef in the breeding goal favours nucleus MOET breeding schemes because of high heritability coefficients and accurate estimates of breeding values of the beef traits.
- By introducing the young bull breeding system and by only using heifers for planned matings a high genetic gain in beef could also be obtained with the conventional breeding scheme.

Conclusions

In dairy and dual-purpose cattle breeding many traits are of economic importance for the breeding goal in Western Europe. The genetic improvement and the economic evaluation of the traits are oriented towards the distant future. BAKKER (1979) enumerated several points, which influence the derived economic weights: structural changes in cattle populations, improvement in the efficiency of production, economic aspects and future trends of supply and demand functions, strategie studies and sustained research political decision making, structural changes in farm management and developments in agricultural labour force, capital investments and market structure developments. This tells us that for estimation of economic values the animal breeder needs support from economists, market scientists, politicans as well as nutritionists.

In the agriculture of Western Europe and specifically in the EEC-market over-production prevails and this most for milk. But also for the submarkets of beef and grain over-production is the rule. The economic evaluations of HENZE et al. (1980) and ZEDDIES (1985) show increased economic weights of beef traits and a reduced economic weight of milk yield with the introduction of milk quota allocation in most of Western Europe. To increase the efficiency of breeding work in use of beef in the breeding goal of dual-purpose breeds the following suggestions can be made:
- extension of beef performance tests for a higher accuracy of estimated breeding values,
- enlarged test capacity of young bulls on beef performance in station with an extended period and an increase of the selection intensity,
- introduction of the young bull breeding system with only use of heifers for planned matings in the conventional breeding scheme,
- use of nucleus MOET-Test Herd scheme with high potential for genetic improvement in beef, where the reduced possibilities for genetic gain can be tolerated in secondary traits.

References

Adelhelm, R., E. Böckenhoff, T. Bischoff, D. Fewson & A. Rittler, 1972. Die Leistungsmerkmale beim Rind - wirtschaftliche Bedeutung und Selektionswürdigkeit. Teil A: Die wirtschaftliche Bedeutung der Leistungsmerkmale. Hohenheimer Arbeiten, Tier. Prod., Heft 64.

Averdunk, G. & H. Alps, 1985. Adapting EEC cattle breeding programmes to market realities. Selection strategies for milk and beef production in dairy beef crossing systems. EEC-Seminar, Brussels, June, 1985, Rep. EUR 10057 EN.

BAKKER, J.J., 1979. Long rate studies on cattle production in Europe. EAAP 30th Ann. Meeting, Harrogate, England.

Cunningham, E.P. & B. Moioli, 1982. Economic and genetic optimisation of dual-purpose bull testing and selection. Dublin pp. 279-292. Martinus Nijhoff.

Cunningham, E.P. & M. Mulvihill, 1985. Breeding strategies for milk and beef production: Biological and economic optimisation of milk and beef production. EAAP 36th Ann. Meeting, Greece.

Fewson, D. & E. Niebel, 1985. Secondary traits in breeding plans of dual-purpose cattle populations. EAAP 36th Ann. Meeting, Greece.

Fewson, D. & E. Niebel, 1986. Selektionsmöglichkeiten auf indirekte Leistungsmerkmale in Rinderzuchtplänen. III. Int. Symp. z. Rinderzucht, Leipzig, DDR. Vol. 1, 188-210.

Graser, H.-U., E. Niebel & D. Fewson, 1985. Model calculations for the optimal planning of beef performance tests using a german dual-purpose cattle population as an example. Livest. Prod. Sci. 13:229-250.

Henze, A. & J. Zeddies, 1979. Nutzen-Kosten-Untersuchung über Angebotskontingentierung in der Landwirtschaft, dargestellt am Beispiel des Milchmarktes. Reihe A, Landwirtschaft - Angewandte Wissenschaft, H. 217, Münster-Hiltrup.

Henze, A., J. Zeddies, D. Fewson & E. Niebel, 1980. Leistungsprüfungen in der Tierzucht. Nutzen-Kosten-Untersuchung über Leistungsprüfungen in der tierischen Erzeugung, dargestellt am Beispiel der Milchleistungsprüfung beim Rind. Reihe A, Landwirtschaft - Angewandte Wissenschaft, H. 234, Münster-Hiltrup.

Köhne, M., 1984. Veränderte Marktordnungen in ihrer Auswirkung auf die Betriebszweige der Rinderproduktion. Züchtgskde. 56:422-430.

Nicholas, F.W. & C. Smith, 1983. Increased rates of genetic change in dairy cattle by embryo transfer and splitting. Anim. Prod. 36:341-353.

Niebel, E., 1986. Economic evaluation of breeding objectives for milk and beef production in temperate zones. 3rd World Congr. on Gen. Appl. to Livest. Prod., Lincoln, USA. Vol. IX, 18-32.

Pirchner, F., 1986. Evaluation of Industry Breeding Programs for Dairy Cattle. Milk and Meat Production. 3rd World Congr. on Gen. Appl. to Livest. Prod., Lincoln, USA.

Steinhauser, H., 1985. Ökonomische Probleme der Rindviehhaltung. Kraftfutter 67:10-18.

Zeddies, J., 1985. Die wirtschaftliche Bedeutung der Leistungsmerkmale beim Rind nach der Milchkontingentierung. Polykopie Hohenheim.

Zeddies, J. & R. Doluschitz, 1984. Milchquoten - einzelbetriebliche Auswirkungen und Anpassungsmöglichkeiten. Agra-Europe 20/84.

Zeddies, J., H. Waibel & W. Zickgraf, 1981. Nutzen züchterischer Fortschritte im strukturellen Wandel der Produktions- und Absatzbedingungen. Polykopie Hohenheim.

FUTURE MARKETING AND ECONOMIC DEVELOPMENTS FOR BEEF WITH REFERENCE TO BEEF FROM DAIRY AND DUAL-PURPOSE BREEDS

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Summary

In past years, the EC situation was characterised by a surplus of beef and veal as a result of increased production and contraction in demand. The exports of beef and veal to non member contries increased permanently, to restrict surplus. After three years of application of the quota system, additional measures are outlined to reduce dairy herd. The production of beef bulls is a good alternative for the farmer. Profitability of beef production is expected to increase slightly. Veal production is expected to decrease in the next years and even profitability will not increase.
The improved economic situation has a positive effect on consumption, but the consumer attitude limits the consumption increase to about 0,5 %. The export of beef and veal have to continue and have to be further stimulated by export refunds.

Introduction

Beef production developments in the EC are highly dependent of dairy herd. Dairy quotas and the increasing beef surplus results in lower producer prices. On the other hand the evolution of consumption and trade with third countries give relative market prospects. In a first point a broad perspective on the EC evolution of beef supplies and demand is given. In the second part the effect of the dairy quotas on beef and veal production are analysed. The final section of the paper presents future market developments.

EC beef supplies and demand

From the cattle numbers, the relative importance of the beef and dairy cattle in every member state is not very clear. Evenhow a general indication on the kind of beef produced emerges from the census figures.

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Table 1. EC-cattle numbers : December census 1986

	% cows and heifers	from which % Friesian	% calves	% other cattle	Total cattle
Germany	50.6	40	34.9	14.5	15232
France	46.8	57	25.7	27.5	22158
Italy	52.2	49	28.4	19.4	8866
Netherland	64.5	63	32.1	3.4	4922
BLEU	53.2	23	26.2	20.6	3146
U.K.	38.4	90	28.4	33.2	12476
Ireland	34.4	80	24.0	41.6	5626
Denmark	55.0	52	39.0	6.0	2490
Ellas	39.6	15	32.2	28.2	761
EUR-10	47.5		29.1	23.4	75677

Milk cows are dominating in the Netherlands and Denmark; the more the Friesian type cows represent more than 50 % of the dairy herd.In Belgium the dairy herd is also very important, but with 23 % the Friesian type cows are quite low and the main type is dual purpose cattle. The share of young calves is the highest in Germany, Netherlands, Denmark and Greece."The other cattle" which is in fact slaughtering cattle is higher than the EC-average in Ireland, United Kingdom, France and Greece.

Beef/veal producers fall into three main categories, corresponding to the three categories of animals reared

- derived products of milk production : cull cows and young calves;
- extensive beef production : suckler herds and grass-reared adult cattle;
- intensive beef production: young male cattle fattened on cereal based feedingstuffs (maize sillage) in special production units.

In past years, the Community had abundant supplies of beef/veal as a result of fairly steady production, import commitments entered into and intervention stocks. The evolution in beef production is characterised by two regular patterns. First, a general trend indicates an increase of about 2 % per year. Second, a cyclical mouvement of about five years gives a variation of about 20 % between peak and depth. Market price for adult cattle shows an opposite mouvement. After the peak in 1984, beef production declined by 2,1 % in 1985 and further 1,2 % in 1986, compared with the previous year.

Table 2. EC-beef balance   1000 tons

	1983	1984	1985	1986[1]
Net Production	6924	7507	7410	7300
Stock change	177	388	55	- 100
Imports	384	383	395	390
Exports	500	694	733	690
Consumption	6631	6808	7017	7100
Rate of Self.Suf.	104.6	110.8	105.3	103.0

[1] estimated

The average slaughter weight of adult cattle is regularly increasing. In keeping with the trend recorded in recent years, the average slaughter weight of calves shows a sharp rise during last years.

The imports of beef and veal from non member countries are quite constant at about 400.000 tons per year. Many of these imports enter the Community on special terms.

The exports of beef and veal to non member countries increased permanently and rose to 805.000 tons in 1985. EC-beef exports are concentrated in three regions. The Middle East/North Africa accounts for 55 % of EC-exports of beef and veal; Eastern Europe accounts for another 20 % and the European Meditarean countries about 10 %. The supply surplus of beef results in an increasing export at supported prices.

Consumption of beef and veal in 1983 was about 5 % down on the 1980 figure. In 1985 consumption has reached again the level of 1980, mostly due to the price decrease on the beef market. The share of beef and veal in total meat consumption has declined from 37 % in 1960 to 27 % in 1985.

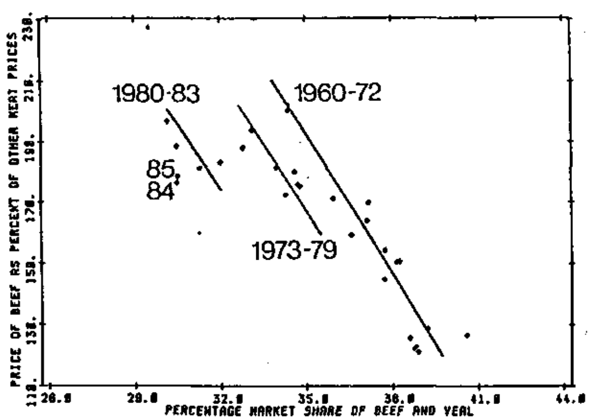

Fig. 1. EEC beef demand
Source : Brian Revel: Market situation and outlook for beef and sheep meat, 1985

Figure 1 shows the relationship between the market share of beef and its price, relative to that of other meats. A mouvement up or down the line implies that consumption for beef has changed due to relative price mouvements. A shift in the curve to the left indicates a decline in beef demand due to factors other than price relation. For any given price of beef relative to that of other meats, the market share will be smaller than before the shift occurred. Beef demand contracted in 1973 and again in 1980. The 1984 and 1985 relationship shows the improvements in beef consumption resulting from lower relative beef prices.

In order to support the market, the Community has continued to apply a number of measures. During 1983-1986, the direct buying-in by public intervention agencies reached about 500.000 tons yearly, representing about 7 % of Community beef production. Counting public stocks of intervention meat, more meat is abailable than is consumed. The self-sufficiency rate was about 105 % in 1985 and 103 % in 1986.

Effect of dairy quotas on beef and veal production

The introduction of milk quotas and the reduction in the dairy herd which followed, was the main reason for the boost in beef supplies in 1984 and 1985. The beef market reacted to the high supply of beef by a sharp fall in prices, which adversely affected all parts of the beef/veal sector. After three years of application of the quota system, immidiate actions are prepared to avoid the continuing high level of butter and skimmed milk powder purchases into intervention and to bring the quota system back into line, with its original objectives of reestablishing market balance in the milk sector. To achieve these objective steps are outlined to a further reduce in reference quantities of 9,5 % during 1987/88 and 1988/89 compared to current levels.

The application of the additional levy system in the milk sector will result in a decrease of 4 % of the dairy herd to 1990. In addition, further milk yield improvements, results in a run-down in dairy cow numbers of about 1 % per year. However the push out from the dairy herd will be lower in practice, by the previous reduction in the number of heifers for breeding. This means that more calves are becoming available, for veal or beef production.

The production of beef bulls is a good alternative for the farmer, to compensate for the drop in milk cows. Crossbreeding with bulls of beef breeds in dairy populations is intensified in most countries of the Community. The decrease of dairy-derived beef production at the one hand and the increased bull beef production at the other hand results in an expected decrease in production of about 3 % in 1990. It means that the rate of self-sufficiency moves to about 100 %. The average slaughter weight and the quality of beef produced will be higher.

The profitability of the beef production is expected to increase slightly. The supply is still larger than demand in the medium term and the market prices for adult cattle are expected to recover slightly. At het production side, prices of young calves will increase, while the higher availability of maize sillage and concentrates results in lower feed costs. It means after all, that the profitability do not allow new investments and only permits the replacement of milk cows by dairy-beef crosses and beef type dual purpose breeds. In this way, the existing feed, labour and investment is valorised most efficiently.

Veal production is expected to decrease in the next years. The reduction in cow numbers means that less young calves are available. At the other hand, the improvement of milk yield makes that more cow calves are used for veal production. The drop in production will be compensated partly by the further increase of the average slaughter weight of calves. Not only a rise in veal price is expected, but also a price increase of young calves, so that profitability will not increase. The more, price of milk powder has a tendency to increase taking into account the restriction on the intervention of skimmed milk powder. In the competition between beef and veal producers for young calves, the beef producer can pay a higher price, because the part of the young calve related to total production costs is smaller.

Future market developments

The EC market situation is likely to be one of persistent structural surplus in medium term. After the analysis of production aspects, two other components determine market situation:the demand recovers slowly, the export depends of the level of restitution.

Consumption of beef and veal is a function of population growth, economic growth, price changes, tastes and preferences. Population growth slowed down to 0,1 % at this moment and for the next decade it is even expected that the Community population is rather decreasing at a rate of 0,1 %.

The economic and employment situation improves and is a major factor affecting overall consumption levels. However, recent research makes clear that meat consumption is becoming less responsive to changes in income. Income elasticity for beef is still positive and is at a further consumption increase of about 0,5 % per year. Veal is a luxery product and means that consumption increases relatively more than income.

Price is the most important factor contributing to the changes in market shares for meat. The sharp fall of prices for protein-rich products used in animal feed has stimulated pig-and poultry meat production. Prices of both substitutes have declined relative to the price of beef and makes that the market share of beef is further under pressure. Also the market share of veal is decreasing. Research on consumer attitudes to meat cuts indicates that health, nutrition and dietary concerns have a negative influence on beef consumption. White meats have the image of being leaner and lighter. Veal is perceived as lean, but is associated with growth promoters.

The EC is the first exporter for beef in 1986. Also in the next years the EC-countries have to continue to export large volumes of beef to third countries. The weakening of the dollar has increased the cost of export refunds. However it is evident that exports are necessary to recuce the persistent stocks. The export opportunities in beef depend largely upon the institutional arrangements for export refunds. At the other hand, the Community goes on to import large but constant quantities of beef on the basis of bilateral and multilateral agreements.

References

CEE,1985. Adapting EEC cattle breeding programmes to market realities. Breeding strategies to optimize beef and milk production from EEC dairy and dual purpose cattle population. Seminar held in Brussels on 4 and 5 June 1985.

CEE,1986. The situation of the agricultural markets. Report 1986, Com 86, 700 final, Brussels, December 1986, 254-271.

Meester, G. & Stryker, D., 1985. Het Europese landbouwbeleid voorbij de scheidslijn van zelfvoorziening. 'sGravenhage, Staatsuitgeverij, 98-105.

Probst, F.W. 1986. Die Märkte fur Schlachtvieh und Fleisch. Agrarwirtschaft, Dezember 1986, Heft 12, 426-440.

Revel, B. 1985. Market Situation and outlook for beef and sheep meat. in: Proceedings of Meat International, London, July 1985, 44-72.

Van der Giessen, L.B., 1985. De gevolgen van de beschikking superheffing voor de rund- en kalfsvleesproduktie. in: Economische en structurele gevolgen van de superheffing. LEI-med. N° 336, oktober 1985, 71-75.

von Massow, V.H., 1984. Einfuhrbegünstigungen und Ausfuhrpolitik der EG bei Rindfleisch. Kieler Wissenschaftsverlag, Vauk, 1984, 181.

- -Results from different countries and different testing systems show that performance testing leads to the expected improvements of growth in the progeny in comparable conditions (e.g. age interval, feeding intensity). The same rate of improvement does not necessarily occur under other conditions.
- -Results indicate that performance test procedures, particularly with regard to the intensity of feeding and the length of the test period, should be orientated towards the prevailing conditions under which progeny have to perform.
- -Recording of feed intake in performance testing is essential to evaluate the efficiency of growth and to quantify non-productive intake. Recent developments in electronics make it feasible to automatically record roughage intake under ad-lib feeding conditions.
- -Control of appetite could be recorded under ad-lib testing conditions. Research is in progress regarding the relationships between appetite, feed efficiency and other parameters of performance tested bulls and their female progeny during growth and milk production.
- -Physiological and immunological parameters of the bulls at the end of the test (in connection with a challenge) may provide indications with regard to metabolic stability in productions and diseases.
- -The estimation of fleshiness of the live animal using subjective scoring systems, ultrasound or other measurements, should be encouraged in view of the indications that this will benefit changes in muscling, meat to bone ratio, dressing per cent and fat deposition.
- -Systematic environmental and genetic effects upon the performance test results have to be eliminated using appropriate statistical methods and models (e.g. BLUP). Additional measurements should be included if they reduce prediction errors.
- -Growth and muscularity traits should be combined in a selection index, including information from relatives (e.g. sire's progeny test).

Further research needs:

- -Genetic correlations between physical and physiological appetite of sires and their daughters.
- -Genetic parameters between components of efficiency (growth, maintenance and residual efficiency).
- -Physiological importance of fat and lean deposition and mobilization in males and females.
- -Genetic factors influencing the growth curve from birth to maturity.
- -Use of specific challenge tests or marker genes as indications of traits in the progeny.
- -Use of indirect measurements (e.g. physiological tests) at an early age to predict traits in the progeny.
- -Adaptation period at the start of test (treatments for infectious diseases, immunity problems).
- -Objective methods to improve estimates of body composition in live animals.
- -Relationships between live animal appraisal, carcass grading and carcass composition with the goal of efficiently producing red meat with acceptable meat quality.
- -Implementation of statistical methods such as animal model or reduced animal multi-trait BLUP models, selection index, restricted index keeping birth weight (or other traits) constant.

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