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FEED INTAKE OF DAIRY COWS AS AN ECONOMIC SELECTION TRAIT

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SUMMARY

32 pairs of monozygons twins were fed ad lib. with a complete diet feed during the first 20 weeks post partum. The heritability (in broader sense) for milk yield, feed intake and energy deficit was 0.39, 0.17 and 0.19 resp. The genetic and phenotypic correlations between daily milk yield and feed intake were 0.14 und 0.26 resp. Therefore selection for feed intake should be based on progeny groups of A. J. bulls. To estimate the feed intake under field conditions the content of ketone-bodies in milk at the first and second test day p.p. can be combined with the milk yield and fat- and protein content. The correlation between estimated and actual energy deficit in 101 cows was r = 0.71. In field data with about 7500 cows there was a genetic variance of the acetone content in milk in cows with two and more lactations with $h^2 = 0.17 \pm 0.09$ and $h^2 = 0.09 \pm 0.06$ for the first and second test day p.p. resp., but not in heifers.

In most countries the metabolizable energy in roughage costs less than in concentrates, and therefore a high roughage intake reduces the feed costs. Where the amount of concentrates has been adjusted to the daily milk yields, high genetic correlations between milk yield and total feed intake have been observed, as summarized by Freeman (1967) and shown by Miller et al. (1972). Only few experiments have measured the voluntary feed intake at a constant concentrates: roughage-ratio (Grieve et al. 1976, Custodio et al. 1983). Here the correlations between daily milk yield and feed intake were much lower.

1. Twin experiments

In 1976 - 1982 32 pairs of monozygous twins were fed with a complete diet feed ad libitum with 6,6 MJ NEL/kg DM during the first 20 weeks post partum. The daily intake increased from 84 MJ NEL (= 12,7 kg DM) in the second week to 108 MJ NEL (= 16,4 kg DM) in the 12th week, the requirements for maintenance and milk production were highest in the fourth week with 117 MJ (Fig. 1). The difference between requirements and intake was called deficit and calculated on a weekly basis. After adjustments for years, lactation numbers and months of lactation the twin resemblance was used to estimate heritabilities and genetic correlations (in broader sense).

The heritability for milk yield during the first 20 weeks p. p. was $h^2 = 0,39$, for feed intake, however, only 0,17 and for deficit 0,19 (table 1). The phenotypic correlation between daily milk yield and feed intake was $r_P = 0,26$ only, the genetic correlation $r_A = 0,14$. As expected, the deficit depended as well on feed intake ($r_P = - 0,61$, $r_A = - 0,32$) as on milk yield ($r_P = 0,47$, $r_A = 0,79$). Selection for higher daily milk yield will therefore create a higher deficit which must be compensated by more energy from body reserves. In high yielding cows this mobilization might lead to fertility problems and ketosis.

Due to the low heritability selection for higher feed intake must be based on progeny groups under field conditions. Since a direct recording of feed intake would not be feasable in large numbers we were looking for indirect methods to estimate the energy deficit during the peak of lactation. The monthly change of chest girth was correlated with energy deficit as r = -0.27 (table 2), the correlations between urea content or oleic acid content in milk fat and deficit had about the same order.

2. <u>Feed intake and ketone-bodies in milk</u>
It is well known that overfeeding before calving and underfeeding after calving are the main reasons for ketosis in cows. Therefore we compared the ketone-bodies in milk with the energy deficit in 101 cows with daily records for feed intake. The ß-hydroxybutyrate content in milk was about the same in cows with a low and medium energy deficit but significantly higher in cows with a high deficit (figure 2). After reaching an energy equilibrium in week 12 p.p. these differences disappeared.

One single determination of the ß-Hb-content in milk during week 6 p.p. correlated with the accumulated energy deficit in week 1 to 8 p.p. as r = 0.51. If we combined two samples in the 3rd and 6th week and also the milk yields and fat contents at the same days the multiple correlation with the energy deficit was r = 0.71.

Though ß-Hb in milk seems to be an useful indicator for the energy deficit and/or feed intake at a given milk yield the ß-Hb-determination is to complicated for routine analysis. It is, however, possible to measure acetone in milk by the Fluid Injection Analysis routinely at low costs. Therefore we took about 35000 monthly samples from about 7500 cows together with the normal milk recording scheme and measured the acetone-content in milk.

The average acetone-content in heifer's milk at the first test day after calving was 0.11 mmol/dl, in cow's milk 0.23 mmol/dl. As expected there were positive correlations with milk yield and fat percentage and negative correlations with protein percentage (table 3). Here again we think that a regression equation with milk yield and fat-, protein- and acetone-content as independent variables will allow a sufficient accuracy in estimating feed intake.

In our field data we found 81 progeny groups with 6,0 daughters in first lactation and 13,1 daughters in second and later lactions. From these we estimated the heritability for aceton in milk as practically zero in heifers and as $h^2 = 0.17 \pm 0.09$ in cows at the first test day p.p. and $h^2 = 0.09 \pm 0.06$ in the second month after calving (table 4). In the third month there were apparently no genetic differences in acetone content anymore because nearly all cows reached the "normal" level of less than 0.10 mmol/dl.

Selection for low acetonecontent in milk after calving means directly a reduction in the frequency of ketosis in high yielding cows and indirectly an improvement of the feed intake in early lactation. Both will reduce the costs of milk production.

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Table 1 Heritabilities (diagonals), phenotypic correlations (above diagonals) and genetic correlations (below diagonals), week 1 - 20 p.p., 32 MZ pairs.

	DM-intake	FCM	Deficit	Weight
DM-intake	0.17	0.26	-0.61	0.47
FCM	0.14	0.39	0.47	0.06
Deficit	-0.32	0.79	0.19	-0.16
Weight	0.63	-0.05	-0.36	0.75

Table 2 Correlations between indicators and feed intake, milk yield and deficit (week 1 - 20 p.p., N = 64)

Indicator	DM-intake	FCM	Deficit
Monthly change of chest girth	0.10	-0.18^{x}	-0.27^{xx}
Urea in milk	0.26^{xx}	-0.16^{x}	-0.27^{xx}
Oleic acid in milk	-0.28^{xx}	0.10	0.31^{xxx}

Table 3 Correlations between acetone in milk and milk records (n = 8125)

	month p.p	test day records milk-kg	fat-%	protein-%
Heifers	1.	0.09[xx]	0.22[xxx]	-0.17[xxx]
	2.	0.10[xxx]	0.15[xxx]	-0.13[xxx]
	3.	0.12[xxx]	0.10[xxx]	-0.11[xxx]
Cows	1.	-0.02 n.s.	0.14[xxx]	-0.06[xx]
	2.	-0.04[x]	0.21[xxx]	0.02 n.s.
	3.	0.02 n.s.	0.11[xxx]	-0.04 n.s.

Table 4 Heritability of acetone-content in milk (81 sires with 1.297 daughters)

	month p.p.	$h^2 \pm sh^2$
Heifers	1.	0.01 ± 0.02
	2.	---
	3.	---
Cows	1.	0.17 ± 0.09
	2.	0.09 ± 0.06
	3.	---

Fig. 1 Energy requirements and intake in week 2 - 18 p.p. (32 MZ pairs)

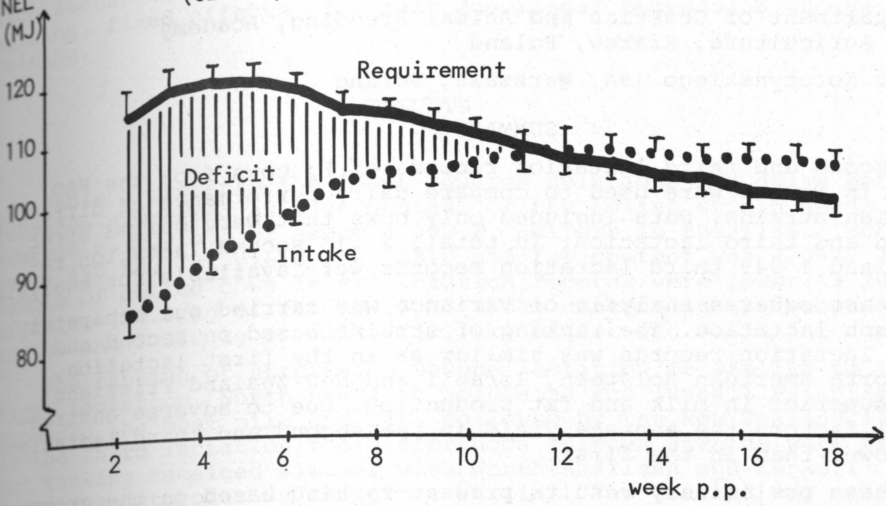

Fig. 2 ß-Hydroxybutyrate in milk (n = 94 cows)