Doctoral Thesis

Charakterisierung der effizienten Milchkuh

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Charakterisierung der effizienten Milchkuh

ABHANDLUNG

zur Erlangung des Titels

DOKTOR DER TECHNISCHEN WISSENSCHAFTEN

der

EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE

ZÜRICH

vorgelegt von

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SUMMARY

The aim of the first part of the present thesis was to develop a simple method for the estimation of live weight of dairy cows to be used in the field. The thesis provided basic information for the introduction of live weight data of dairy cows in breeding programs. The evaluation was made with data of Holstein cows in second or higher lactation collected at the research station Chamau between 1998 and 2000. The estimation based on a detailed model indicated significant parameters and their correlation to live weight of dairy cows. The detailed models were reduced to practicable models containing parameters highly reliable and easy to be measured. The final model for the estimation of live weight of dairy cows considered the covariables Body condition Score as well as heart girth, body length and body depth as fix effects. Considering these parameters in the model, the residual standard error obtained was 25 kg with a coefficient of determination of 76 %. Without any supplementary effort it should therefore be possible to estimate live weight at the same time as linear type scoring is made. Further investigations will be necessary to find out, whether the exactitude obtained is high enough for breeding programs.

In the second part of this thesis a comparison of two milk production systems, “Low-cost” and “High-output”- was made by using a herd model. The program was based on a model developed by Amer et al. (1994) and modified by Rätzer (1998). The herd model was established with a data base using the Microsoft® Access software. It included every possible parameter and was limited to milk production. The most important parameter was the production of a certain amount of milk for the market. The calving interval of cows could be chosen randomly within five different parameters (time between calving and first mating, interval between two inseminations, rate of gestation in function of lactation and number of insemination, maximum of insemination per lactation and gestation length). Taking into account different factors such as age structure of the herd, milk yield in relation to different ages and lactation length, the number of milking cows was determined by the milk quota. All calves and culled cows were sold. Heifers were bought pregnant. To derive the necessary basic biological and economic functions, data collected between 1995 and 2000 on the research station Chamau and information from scientific papers were used. Two basic variants, a low-cost and a high output variant were defined for the comparison. The milk quota was the same, namely 250'000 kg for both variants. The cows of the low-
cost variant were kept on pasture during summer time. The milk yield was 6'500 kg after the third lactation and the average live weight was 650 kg. Cows of the high-output variant were fed inside with a compound ration. Their production was 9'500 kg of milk after the third lactation with an average weight of 750 kg. All cows were inseminated by beef breed bulls. The yearly housing costs were 6.3 % of the money that was invested. The labour was estimated with CHF 25 per working hour.

Both basic variants showed losses of CHF 0.032 (low-cost) or CHF 0.020 (high-output) respectively per kg of milk produced. The income made by selling milk was equal (CHF 0.77/kg milk) for both variants. The profit for cows and calves sold was higher in the low-cost variant because of the higher number of animals. The profit made by selling culled cows was CHF 0.067 per kg milk in the low-cost variant and CHF 0.053 in the high-output variant. The income from calves was higher by CHF 0.022 per kg milk in the low-cost variant (CHF 0.088). The costs for infrastructure were lower by CHF 3'705 per cow in the low-cost variant. But, because of the larger number of cows involved in the low-cost variant, annual costs for housing (CHF 0.126) were higher in the low-cost variant than in the high-output variant (CHF 0.115). Feed costs per kg milk were lower in the low-cost variant (CHF 0.336) than in the high-output variant (CHF 40.1) because of cheaper roughage and less concentrates fed in the low-cost variant. The various expenses added up to CHF 0.165 in the low-cost variant compared to CHF 0.142 in the high-output variant. The various cost summed up to CHF 0.165 for the low-cost variant and up to CHF 0.142 for the high-output variant. Among the various costs, the costs for heifers were most important: CHF 0.117 per kg milk in the low-cost variant compared to CHF 0.100 in the high-output variant. Costs for veterinarian and insemination were insignificant. Cost for labour were higher in the low-cost variant (CHF 0.329) because of the higher number of animals (+14.0 animals) compared to the high-output variant (CHF 0.254).

The two basic variants were also evaluated using different scenarios for possible effects on breeding, production techniques, economical and agropolitical aspects.

1. Conception rate: A decline of the conception rate of 20 % reduced the net income per kg milk by CHF 0.019 (low-cost) and by CHF 0.017 (high-output) respectively. An improvement of 20 % for the conception rate increased the net income per kg milk by CHF 0.012 (low-cost) or by CHF 0.010 (high-output) respectively. 2. Milk yield: The improvement in milk production had a positive effect on net income per kg milk in both variants. 3. Persistence of milk yield: According to the model, the improvement of
persistence of milk yield reduced the use of concentrate. Positive effects on health and fertility due to fewer metabolic problems could not be considered.

4. **Dry matter capacity**: With increasing dry matter capacity it was possible to substitute expensive concentrate with cheaper roughage in the high-output variant. Consequently, feeding costs were lower and the profit was slightly higher.

5. **Survival rate**: An increase of 16% in the survival rate improved the net income per kg milk by about CHF 0.058 (low-cost) or by CHF 0.047 (high-output) respectively.

6. **Seasonal milk production**: The seasonal milk production was evaluated for the low-cost variant only. By implementing a seasonal milk production it was possible to reduce feed costs significantly. If conception rate was kept constant, the period of insemination had to be shortened in order to maintain seasonal calving. This procedure reduced the advantage of seasonal calving with regard to net income per kg milk because more heifers had to be bought.

7. **Costs for concentrates**: More concentrate was fed in the high-output variant than in the low-cost variant. If the price of concentrates dropped, the high-output variant made more profit than the low-cost variant.

8. **Housing costs**: The final benefit increased linear to lower housing costs in both basic variants.

9. **Milk quota**: An increase of milk quota improved the final benefit per kg milk.

10. **Costs for roughage**: A reduction of 20% of the price for roughage increased the net income per kg milk by CHF 0.050 (low-cost) or by CHF 0.060 (high-output) respectively.

11. **Labour costs**: Expenditure of human labour was estimated 29% higher in the low-cost variant than in the high-output variant. Because of the higher expenditure of labour per kg milk in the low cost variant, a reduction in labour costs was more profitable to the low-cost variant.

12. **Price of milk**: A decline of the price of milk of 20% reduced the net income per kg milk by CHF 0.154 in both variants.

13. **Direct payment**: If reduced income is absorbed by direct payment, one of the two basic variants can be favoured because of different farm structures. Direct payment coupled to land (low-cost +44%) or to the number of animals (low-cost +46%) will give preference to the low-cost variant.

The different scenarios indicated to which extend the net income per kg milk could be increased. The question remains how a major reduction in the price for milk can be recovered in future. The only realistic option seems to strongly increase the milk production per farm. If the milk production in Switzerland tends more and more towards one of the two variants (low-cost or high-output) according to the actual situation, it will have major impacts on the use of agricultural land in Switzerland.