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ECOWEIGHT 2.0 – C programs for modelling the economic efficiency of production systems in beef and dairy cattle (short communication)

Abstract
Two C programs were written on the basis of a bio-economic model for a wide range of cattle production systems. The model simulates the life-cycle production of a beef or dairy cow herd and the growth performance of offspring in rearing and fattening. The Markov chain approach was used to simulate herd dynamics. The program calculates the structure of the integrated production system in its stationary state, the economic efficiency of the system expressed as a function of biological traits of animals and of management and economic parameters, the number of discounted expressions for direct and maternal traits transmitted by breeding animals and the economic weights for 16 economically important traits for beef and 21 traits for dairy cattle. The program is freely available on request.

Keywords: cattle, production systems, bio-economic model, economic weights, software

Zusammenfassung
Titel der Arbeit: **ECOWEIGHT 2.0 – C-Programme zur Modellierung der Wirtschaftlichkeit von Produktionssystemen für Fleisch- und Milchrinder** (Kurzmitteilung)
Für ein bioökonomisches Modell, das ein breites Spektrum von Produktionssystemen für Rinder abdeckt, wurden zwei Programme in C geschrieben. Das Modell simuliert die Lebensleistung von Kühen einer Fleisch- oder Milchrinderherde einschließlich der Wachstumsleistung der Nachkommen in der Aufzucht und Mast. Die Methodologie der Markow-Ketten wurde benutzt, um die Herdendynamik zu beschreiben. Das Programm berechnet die Struktur des integrierten Produktionssystems in seinem stationären Zustand und die Wirtschaftlichkeit des Systems, die als Funktion der biologischen Merkmale der Tiere sowie der Management- und wirtschaftlichen Parameter ausgedrückt wird; weiterhin berechnet es die Anzahl diskontierter Merkmalsausprägungen für direkte und maternale Merkmalskomponenten von Zuchttieren sowie die ökonomischen Gewichte für 16 Merkmale beim Fleischrind und für 21 Merkmale beim Milchrind. Das Programm ist auf Anfrage frei verfügbar.

Schlüsselwörter: Rind, Produktionssystem, bioökonomisches Modell, ökonomisches Gewicht, Software

Introduction
In the framework of sustainable agriculture, beef cattle farming has become an important factor in a great part of Europe. Maintenance of rural landscape has been one factor favouring the maintenance of a wide spectrum of beef breeds, while improving carcass and meat quality of slaughter animals produced in dairy farming systems has been a second important utilisation of beef bulls. The large variety of nature and marketing conditions for beef and dairy farming in Europe makes it almost impossible to define a general breeding goal even within a breed. In this situation a general bio-economic model describing the divergent production, feeding, management and breeding strategies is an important tool for defining alternative breeding objectives.

A relatively high number of models for the estimation of economic values for traits in beef and dairy cattle have been recently published. Most of them are more or less specific and were developed for a particular situation. They are constrained to pasture (URIOSTE et al., 1998; VEERKAMP et al., 2002) or in-door (ALBERA et al., 2002) systems. In some of them the economic weights are calculated separately according to the utilisation of beef and cross-bred progeny (PHOCAS et al., 1998) and then integrated to a general breeding goal.
The simulation of growth and carcass composition as well as of feed requirement in beef and dairy cattle has been worked out well (KOOTS and GIBSON, 1998; TESS and KOLSTAD, 2000; KOENEN et al., 2000). But these models hardly include the option to account the economic values of traits in beef bulls according to their utilisation in different breeding systems (pure-breeding, cross-breeding with beef or dairy cattle – WILTON and DANELL, 1981; AMER et al., 2001).
The aim of our work was therefore to develop a general computer program covering a wide range of breeding and production systems as well as a broad spectrum of management and economic conditions in which beef bulls can operate, including the dairy cattle system. This largely involved the use of published methodologies that were adapted and generalised to be in accordance with the general character of the model.

Short description of the modelled production systems

The four production systems included in the program are demonstrated in the Figure. Beef production systems 1 to 3 differ mainly in the replacement policy and the breeding strategy. System 1 is a pure-bred beef system producing females and males for own replacement and for other systems. System 2 is a cross-bred beef cow-calf pasture system producing their own replacement females but buying breeding bulls or their semen. In System 3, replacement females and males or sperm for artificial insemination (AI) are purchased and terminal crossing is applied. System 4 is a production system with dairy or dual purpose cattle that can be handled independently of the beef system (pure-breeding) or can partly apply crossing with beef bulls.
Several marketing strategies are allowed for surplus calves and/or heifers: (i) selling weaned calves outside the system, (ii) fattening weaned calves within the system, (iii) selling breeding heifers before mating and (iv) selling pregnant breeding heifers.
Fattening of animals is performed to a fixed slaughter weight. Deterministic models are used throughout. The management system of the beef cow-production system is modelled according to the typical situation in Central Europe. The reproduction cycle of cows is determined by the two feeding periods (summer and winter feeding) in temperate climate. Calving is restricted to the winter period before pasture. All calves are weaned at the same date, till the end of pasture period. The length of a reproduction cycle (interval between two subsequent calvings) is fixed to one year.
The production system with dairy or dual purpose cattle is modelled as a traditional dairy system with integrated intensive fattening of surplus bulls and heifers. Part of the cows can be crossed with beef bulls and the cross-bred male calves can be sold or fattened. Cross-bred female calves can be fattened or sold to cow-calf production systems making connection to beef production system 3. Mating of cows and heifers occurs through the whole year independently of the annual season, and only one

average feeding ration is expected for each animal category. The number of calvings per cow is restricted to 10. The length of the reproduction cycle is variable.
Six different cow categories are defined in each reproduction cycle (only 4 categories in the last cycle). They are: cows died, cows culled in three different time intervals, non-pregnant cows entering the next cycle and pregnant cows entering the next cycle. The herd dynamics is described in terms of these categories within the individual reproduction cycles and the probabilities of transmissions between them. Using a Markov chain approach, the stationary state of the cow herd is calculated (REINSCH and DEMPFLE, 1998).
Besides of the categories for cows, 24 categories for progeny are defined. In system 4, differentiation between pure-bred and cross-bred progeny results in a total of 48 categories. The relative frequencies of these categories are determined by the structure of the cow herd, the number of calves born in the herd each year and the marketing circumstances.
The profit, i.e. the difference between the present values of revenues and costs per cow and year at the stationary state of the cow herd structure, is the criterion of economic efficiency for all production systems. All revenues and costs occurring in the cow herd during a year and in the progeny born in the herd that same year are discounted to the date of calving.
The marginal economic value of a trait is defined as the partial derivative of the profit function with respect to the given trait. In the programs, the partial derivative is approximated by the difference quotient.
More detailed information on the modelled production systems are given in WOLFOVÁ et al. (2005, 2007).

Technical description and availability of the program

The program package was written in C under LINUX. In its recent version (2.0.19), it contains two programs: EWBC (for systems 1 to 3) and EWDC (for system 4). Compiled versions were tested under 32bit and 64bit LINUX and under Microsoft Windows®. The program package including executable files, the source code of the programs, sample parameter and input files and a detailed manual is freely available on request with the authors.
Both programs are structured in the same way. They are controlled by a parameter file each. There are altogether 29 data input files which are text files and all organized in the same way. A short comment on the content of each file is followed by the input parameters, always organized in three structural units (such a unit contains one or more lines). The first unit contains the value of the parameter, the second unit the description of the parameter and the third unit the units the parameter is given in.
Not all input files are needed in all runs; the input files needed for a concrete run are determined by the program and the parameter file. The data input files contain several hundred input values which can be modified. Further two files are used for reading text for the output of the results. One text file is used to transfer results of program EWBC to EWDC.
When writing the program we tried to place as much text as possible outside the program to text files. Therefore it is possible easily to localize the program; just translate all texts in the text files to your preferred language and the results file will be

in this language. The only information the program needs from the keyboard after starting its run is the name of the file the results are to be written to.
For each program, there are two result files. One file contains the most important results in an easy-to-read form and the second file contains the values of all variables used in the programs.
The main results of the program are the structure of the cow herd, total costs and revenues for all categories of animals, profit and profitability, economic values for a great number of traits and economic weights for individual selection groups (e.g. beef bulls) which are necessary for the construction of selection indices.

Concluding remarks

The program package ECOWEIGHT is suitable for bio-economic analyses of integrated cattle production systems. It can be used for analyses both on the population and on the farm level. The program package is under further development and the inclusion of further livestock species is intended during the next years.

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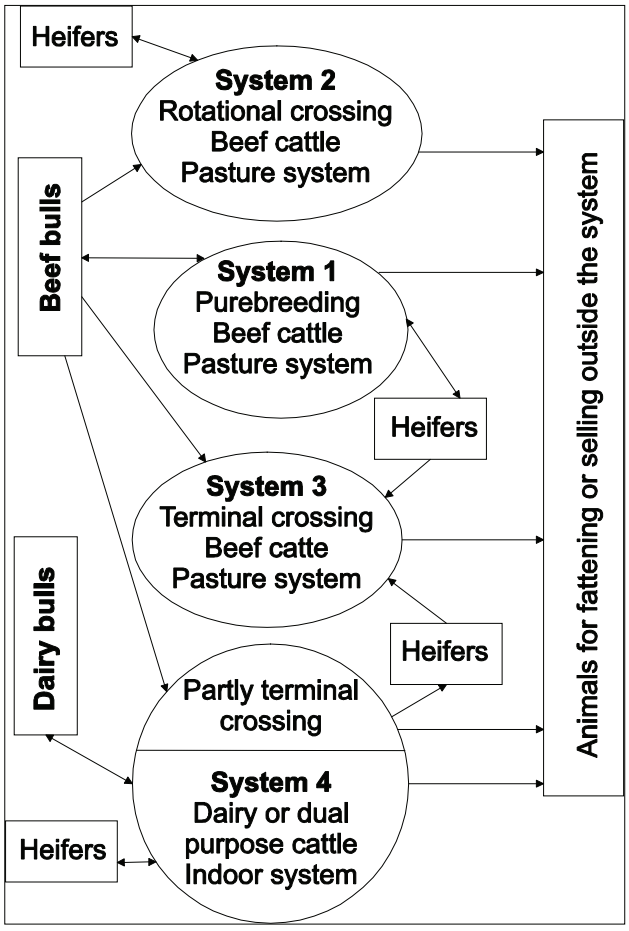

Fig. 1: Connections between four production systems in which beef bulls can exert genetic influence

References

ALBERA, A.; CARNIER, P.; GROEN, A.F.:
Economic values for beef traits in Piemontese cattle. In: Proceedings of the 7th WCGALP, Montpellier, (CD-ROM), Com. No. 02-22 (2002)

AMER, P.R.; SIMM, G.; KEANE, M.G.; DISKIN, M.G.; WICKHAM, B.W.:
Breeding objectives for beef cattle in Ireland. Livest. Prod. Sci. **67** (2001), 223-239

KOENEN, E.P.C.; BERENTSEN, P.B.M.; GROEN, A.F.:
Economic values of live weight and feed-intake capacity of dairy cattle under Dutch production circumstances. Livest. Prod. Sci. **66** (2000), 235-250

KOOTS, K.R.; GIBSON, J.P.:
Economic values for beef production traits from a herd level bioeconomic model. Can. J. Anim. Sci. **78** (1998), 29-45

PHOCAS, F.; BLOCH, C.; CHAPELLE, P.; BÉCHEREL, F.; RENAND, G.; MÉNISSIER, F.:
Developing a breeding objective for a French pure-bred beef cattle selection programme. Livest. Prod. Sci. **57** (1998), 49-65

REINSCH, N.; DEMPFLE, L.:
Investigations on functional traits in Simmental: 3. Economic weights at the stationary state of a Markov chain. Arch. Tierz. **41** (1998), 211-224

TESS, M.W.; KOLSTAD, B.W.:
Simulation of cow-calf production systems in a range environment: I. Model development. J. Anim. Sci. **78** (2000), 1159-1169

URIOSTE, J.I.; PONZONI, R.W.; AGUIRREZABALA, M.A.; ROVERE, G.; SAAVEDRA, D.:
Breeding objectives for pasture-fed Uruguayan beef cattle. J. Anim. Breed. Genet. **115** (1998), 357-373

VEERKAMP, R.F.; DILLON, P.; KELLY, E.; CROMIE, A.R.; GROEN, A.F.:
Dairy cattle breeding objectives combining yield, survival and calving interval for pasture-based systems in Ireland under different milk quota scenarios. Livest. Prod. Sci. **76** (2002), 137-151

WILTON, J.W.; DANELL, Ö.E.:
Relative rates of discounted expressions of traits in beef crossbreeding programs. Acta Agric. Scand. **31** (1981), 207-217

WOLFOVÁ, M.; WOLF, J.; KVAPILÍK, J.; KICA, J.:
Selection for profit in cattle. I. Economic weights for purebred dairy cattle in the Czech Republic. J. Dairy Sci. **90** (2007), 2442-2455

WOLFOVÁ, M.; WOLF, J.; PŘIBYL, J.; ZAHRÁDKOVÁ, R.; KICA, J.:
Breeding objectives for beef cattle used in different production systems: 1. Model development. Livest. Prod. Sci. **95** (2005), 201-215

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